

# Is Mirror Test Still a Reliable Way to Investigate Self-awareness in Animals?

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## ABSTRACT

To find one simple, comprehensive definition of animal cognition has been a challenging question. The existence of self-awareness in animals can be one piece of evidence to prove the existence of animal cognition. In the paper, the author reviewed the criteria of the mirror test which has been widely used to examine self-awareness in animals and the animals that pass or do not pass the mirror test by reviewing and comparing papers using mirror test to study animal self-awareness. The author also discussed some weaknesses of the mirror test and possible ways one can innovate. As the mirror test can confuse when applied to animals that have complex social behavior, there is a need for innovations for the mirror test. The mirror test, a practice in psychology since the early 1970s, is used to determine whether an animal or young human child is naturally self-aware when looking at a reflection in a mirror. The idea of using mirrors to measure self-awareness was based on an experiment by Charles Darwin when he used them in zoos to observe the reactions of orangutans.

**Keywords:** *Animal behavior, Animal cognition, Self-awareness, Mirror test.*

## 1. INTRODUCTION

Due to the rapid development of technology, investigating and understanding the mechanism behind animal behavior has become easier for scientists than before. However, complex animal behaviors like cognition behavior and self-awareness are still difficult to study. The reason for this might be the limitations in the method. The mirror test has become the only method to investigate animal self-awareness for nearly 50 years since its invention in the 1990s. By reviewing and comparing papers using mirror test to study animal self-awareness, the author summarised how to mirror test works to help study animal self-awareness and some controversial discussion about the effectiveness of the mirror test. As the mirror test can cause confusion when applied to animals that have complex social behavior, there is a need for innovations for mirror test. The aim of the paper was to question the effectiveness of mirror test in the modern study of animal self-awareness.

## 2. THE BACKGROUND INFORMATION OF COGNITION

To find a simple, comprehensive definition of

cognition has been worrying scientists ever since the creation of the word cognition, especially when applying cognition to animal behaviors. Although the first comprehensive collection of papers discussing animal cognition was published in 1996 [1], many of the ideas about animal cognition in the papers has been challenged and debated until nowadays. Shettleworth, S.J. gave a well-accepted definition of animal cognition as “Cognition refers to the mechanisms by which animals acquire, process, store, and act on information from the environment [2]. These include perception, learning, memory, and decision-making”. Each scientist may have its own definition of animal cognition and add different units to make the general definition become more comprehensive. Not only the definition of animal cognition, but also the evidence to prove the existence of cognition in animals has become a challenging question for centuries. There are many different ways to solve the question. Self-awareness, among all the other ways, can be an interesting one to prove the existence of cognition.

Self-awareness can simply be considered as the ability to distinguish oneself from other individuals and the environment. As a human, we have cognition and can generate the concept of ego. In this way, if an animal can distinguish oneself from others, the existence of self-awareness then can be used as

evidence to further prove the existence of cognition.

### **3. THE MIRROR TEST ON CHIMPANZEES**

The mirror test is a widely accepted method to examine the existence of self-awareness in animals [3]. The main idea of the test is to investigate whether animals marked with red dye are able to recognise their own reflections in the mirror after prolonged exposure. In the original experiment carried out by Gallup, 2 male and 2 female wild preadolescent chimpanzees with little or no prior exposure to mirror were involved. The weight of chimpanzees was controlled in a range between 14.75 to 21.75kg and the chimpanzees were isolated in individual small cages for 2 days. After insolation, a full-length mirror with 3.5m distance in the front of the cage was placed and the behavior of chimpanzees was observed for 8h per day in a length of 2 days. After that, the full-length mirror is then move to a distance of 0.6m front and another 8-day observation is carried out. In total, an observation time of 80h was involved in experiment part 1. In the experiment, chimpanzees initially showed a high frequency of social behaviors, including bobbing, vocalizing, threatening, and so on, but then the frequency of social behavior declined rapidly over a couple of days. In the following days, chimpanzees show increasing frequency of contingency checking behavior such as looking at body part that is invisible without a mirror, making faces, blowing bubbles, and even manipulating food toward lip by watching the reflection. In part 2 of the experiment, a red alcohol-soluble dye was placed in the position of the chimpanzee's uppermost portion of eyebrow bridge and top half of the opposite ear without being realised. The dye would cause no olfactory or tactile cues and was harmless to animals. After 3h isolation with the mirror removed, chimpanzees were observed directly for 30min in front of the mirror and the number of times that they touch the proportion of dye was recorded. The high number of times of touching the proportion of dyes and the behavior of contingency checking could be used as evidence to prove that chimpanzees have self-awareness as they are able to link the mirror image with their own reflections. In order to make the result consistent, 2 male and 2 female adult stump-tailed macaques were also tested. However, macaques showed little declines in social behaviors in part 1 and no mark directed responses in part 2. So, macaques did not have self-awareness as they did not pass the test.

In conclusion, there are 3 phases of self-recognition in the mirror test. The animal need to first show its social behavior when exposed to the mirror, followed by contingency checking behavior. The third phase is self-directed behavior, which generally can be displayed as positioning the body part marked with a dye that they can see with a mirror. If the animal exhibits self-directed

behavior, it can be assumed that it has the ability to recognize itself and hence has self-awareness.

To point out, not all the chimpanzees showed self-directed behavior and thus passed the mirror test. It can be conducted that personal differences like intelligence and past experiences may influence the initial response shown towards mirror exposure. Like native states, acquired skills or experiences also affects the ability of self-awareness in chimpanzees.

### **4. THE MIRROR TEST ON OTHER ANIMALS**

With the invention of the mirror test, scientists can test self-awareness in different animals under a standard criterion. As our humans have the ability of self-recognition, it is believed that our closest relative primates also have self-awareness. Evidence from experiments described that bonobos, the great ape species that closely related to chimpanzees, were able to pass the mirror test. Like chimpanzees, the majority of bonobos showed interest in mirror reflections and performed self-directed behaviors. However, the reality is not always simple and straightforward. It is unexpected that gorillas that show closeness to chimpanzees and humans in phylogenetic trees lacked the ability to pass the mirror test [4]. During the experiment, no contingency checking behavior was observed in gorillas. Although some argued that the pronounced gaze aversion displayed by gorillas may prevent them from exploring the mirror image. Gorillas did not pass the mirror test even after 4 years of mirror exposure using angled-mirror apparatus that solved the pronounced gaze aversion [5]. There is no compelling evidence for prosimians, monkeys, or lesser apes are capable to pass the mirror test [6]. In the mirror test, these animals generally stopped at the first level of the three phases of self-recognition and displayed only social behavior when exposed to the mirror. Another important point to point out is the ability of animals to display self-awarded behavior could change even they have passed the mirror test at first. For example, animals at different age stages will have different abilities to show self-awareness. Even for chimpanzees that have passed the mirror test, their ability to display self-recognition declines with age [7]. In this case, internal factors may have a huge impact on animals' ability to display self-awareness.

What happens if we consider the range to mammals? Besides humans and apes, dolphins and elephants are known for their brain capacity. It seems reasonable to question whether these two species can pass the mirror test or not. Not surprisingly, there are many reports that elephants are able to pass the mirror test [8]. Elephants have the advantage to touch most of the body with trunks which allows them to have the ability to work with mark tests regardless of their short arms and legs. A much larger mirror was used for elephants than for other

animals due to their large body size. Although papers claimed that elephants can pass the mirror test, not all individuals tested in the experiment succeeded. Dolphins also show their ability of self-recognition [9]. By using a one-way mirror in the experiment, observers can record dolphins' behaviors without being detected. It has been proved that dolphins significantly spent a longer time performing self-directed behavior by bumping the mirror with the marked body parts. In the paper, two young dolphins were also exposed to the mirror and their behaviors were analyzed over a 3-year period. The data showed dolphins display self-directed behavior at ages earlier than children and much earlier than chimpanzees.

It may be surprising that similar reports were also found on birds, the species that many of us may not be expected to have self-awareness. This institution may be right at first as birds have relatively small brain capacity and evidence showed that species like common hill myna and the African grey parrot did not pass the mirror test or showed any ability of self-recognition [10]. However, things became confused when the number of tested bird species increased. Although finches and parakeets do not pass the mirror test, they spend appreciably more time in front of their own reflection in a mirror than in front of another bird, food, or a blank piece of cardboard over days [11]. This preference can be considered an initial step of self-awareness as they show increased interest with reflections than others and start to distinguish the differences between them. There is also evidence showed that birds can display self-directed behavior with external experiences. One experiment carried on pigeons showed that pigeons can pass the mirror test after training [12]. The first evidence of mirror self-recognition of birds was carried out with Magpie [13].

As self-awareness is expected to be found in animals with high intelligence, mirror test has only been carried out on animals that either show close relativity to humans in the phylogenetic tree or have large brain capacity. In other words, only limited species like mammals and birds have been tested. In conclusion, it is hard to define a clear line in animal kingdoms that half of the animals have self-awareness and the other half do not due to limited data size.

## **5. CONTROVERSIAL DISCUSSIONS ABOUT THE MIRROR TEST**

As the mirror test was invented nearly 50 years ago and has only been a focus on mammals and birds, it seems reasonable to ask whether or not it still works in current situations with other animals. There was a discussion about the paper that reported the existence of self-recognition in horses [14]. On one side, the experiment proved horses' ability to display self-directed behaviors thus showing that horses are capable to have self-awareness. On the other side, many criticisms about the paper pointed out that the experimental setup and the data

analysis raised problems as the horses were just looking at the mirror rather than exploring the images [15]. There was another paper that showed the cleaner wrasse *Labroides dimidiatus* fish are capable of self-recognition [16]. This surprising founding immediately raised many discussions. Many argued that the abnormal up and down swing pattern of cleaner wrasse should not be considered as contingency checking behavior and hitting the mirror with body part with the mark should not be considered as self-directed behavior as they may all be social behaviors. The author of the paper also doubted the accuracy of their results. If a fish, the species that was considered as lacking the ability of cognition, can pass the mirror test, can we believe the accuracy of the mirror test results on other animals? Instead of questioning the accuracy of the mirror test, others claim that the criteria of the three phases behavior in the mirror test can cause confusion when being carried out on animals that show huge variation in behavior. In their view, the procedure of the mirror test is accurate. The question is how to adapt mirror test in different animals with different behaviors. In other words, there is a need for innovation for the mirror test.

Horowitz, A found that dogs spend a longer time investigating their own odor even compared with a new modified stimulus, indicating that novelty alone does not explain the behavior as expected [17]. So, there is a potential to create an "olfactory mirror test" that could be used as an innovative mirror test. However, there is no convincing evidence in neither dogs, elephants, dolphins, magpies, horses, manta rays, squid, or ants using the "olfactory mirror test" [18]. Also, the "olfactory mirror test" has limited applications as it can only be used with animals that for animals that use olfactory cues.

As the invention of the new mirror test is time consuming, what happens if we change our understanding about animal self-awareness itself? In the inventor of the mirror test Gordon Gallup's view, the existence of self-awareness in animals only has 2 options – yes or no. if an animal passes the mirror test, then it has self-awareness. If the animal does not pass the mirror test, then it lacks the ability to self-awareness. Under his influence, many scientists use this yes-or-no criterion in their experiments. But is this idea really match reality? Frans de Waal [19] proposed his idea about self-awareness in animals from a gratitude perspective. Different animals have different levels of self-awareness. Being able to pass the mirror test may indicate the high level of self-awareness in that animal. In a similar way, the animals that fail to pass the mirror test may have a lower level of self-awareness rather than having no self-awareness. So, the mirror test can only be used to roughly distinguish the extremes values of animal self-recognition in this case. The frequency of self-directed behavior in mirror test can be considered as different levels of self-awareness. New criteria or methods that can quantify levels of self-awareness are needed.

## 6. CONCLUSION

In conclusion, self-awareness can be considered as evidence of animal cognition and the mirror test is one way to investigate self-recognition in animals. Some animals pass the mirror test and others do not. There is no clear classification of animals that have or lack the ability to recognize themselves. Since the mirror test has been used for 50 years, there is a need for both innovation in test methods and the concept of different levels of animal self-awareness. In this paper, the mirror test research with limited animal species was included, mainly focusing on mammals and birds, but the effectiveness of the mirror test in other animals has remained unknown.

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