

# Mirror test

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The **mirror test**, sometimes called the **mark test** or the **mirror self-recognition test** (MSR), is a behavioural technique developed in 1970 by psychologist Gordon Gallup Jr. as an attempt to determine whether a non-human animal possesses the ability of visual self-recognition.<sup>[1]</sup> The MSR test is the traditional method for attempting to measure self-awareness; however, there has been controversy whether the test is a true indicator.

In the classic MSR test, an animal is anaesthetised and then marked (e.g. painted, or a sticker attached) on an area of the body the animal cannot normally see. When the animal recovers from the anesthetic, it is given access to a mirror. If the animal then touches or investigates the mark, it is taken as an indication that the animal perceives the reflected image as itself, rather than of another animal.

Very few species have passed the MSR test. As of 2016, only great apes (including humans), a single Asiatic elephant, dolphins, orcas, and the Eurasian magpie have passed the MSR test. A wide range of species has been reported to fail the test, including several monkey species, giant pandas, sea lions, and dogs.<sup>[2][3]</sup>



Baboon looking in mirror

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# Method

In 1970, Gordon Gallup, Jr., experimentally investigated the possibility of self-recognition with two male and two female wild pre-adolescent chimpanzees (*Pan troglodytes*), none of which had presumably seen a mirror previously. Each chimpanzee was put into a room by itself for two days. Next, a full-length mirror was placed in the room for a total of 80 hours at periodically decreasing distances. A multitude of behaviours was recorded upon introducing the mirrors to the chimpanzees. Initially, the chimpanzees made threatening gestures at their own images, ostensibly seeing their own reflections as threatening. Eventually, the chimps used their own reflections for self-directed responding behaviours, such as grooming parts of their body previously not observed without a mirror, picking their noses, making faces, and blowing bubbles at their own reflections.

Gallup expanded the study by manipulating the chimpanzees' appearance and observing their reaction to their reflection in the mirror. Gallup anaesthetised the chimpanzees and then painted a red alcohol-soluble dye on the eyebrow ridge and on the top half of the opposite ear. When the dye dried, it had virtually no olfactory or tactile cues. Gallup then returned the chimpanzees to the cage (with the mirror removed) and allowed them to regain full consciousness. He then recorded the frequency with which the chimpanzees spontaneously touched the marked areas of skin. After 30 minutes, the mirror was re-introduced into the room and the frequency of touching the marked areas again determined. The frequency of touching increased to 4-10 with the mirror present, compared to only 1 when the mirror had been removed. The chimpanzees sometimes inspected their fingers visually or olfactorily after touching the marks. Other mark-directed behaviour includes turning and adjusting of the body to better view the mark in the mirror, or tactile examination of the mark with an appendage while viewing the mirror.<sup>[1]</sup>

An important aspect of the classical mark-test is that the mark/dye is non-tactile, preventing attention being drawn to the marking through additional perceptual cues (somesthesia). For this reason, animals in the majority of classical tests are anaesthetised. Some tests, use a tactile marker.<sup>[4]</sup>

Animals that are considered to be able to recognise themselves in a mirror typically progress through four stages of behaviour when facing a mirror:<sup>[5]</sup>

- (a) social responses
- (b) physical inspection (e.g. looking behind the mirror)
- (c) repetitive mirror-testing behaviour
- (d) realisation of seeing themselves

Gallup conducted a follow-up study in which two chimpanzees with no prior experience of a mirror were put under anesthesia, marked and observed. After recovery, they made no mark-directed behaviours either before or after being provided with a mirror.

# History

The inspiration for the mirror test comes from an anecdote about Charles Darwin and a captive orangutan. While visiting the London Zoo in 1838, Darwin observed an orangutan, named Jenny, throwing a tantrum after being teased with an apple by her keeper. This started him thinking about the subjective experience of an orangutan.<sup>[6]</sup> He also watched Jenny gaze into a mirror and noted the possibility that she recognised herself in the reflection.<sup>[7]</sup>

# Animals that have demonstrated MSR

A large number of studies using a wide range of species have investigated the occurrence of spontaneous, mark-directed behaviour when given a mirror, as originally proposed by Gallup. Most marked animals given a mirror initially respond with social behaviour, such as aggressive displays, and continue to do so during repeated testing. Only a small number of species have touched or directed behaviour toward the mark, thereby passing the classic MSR test.

Findings in MSR studies are not always conclusive. Even in chimpanzees, the species most studied and with the most convincing findings, clear-cut evidence of self-recognition is not obtained in all individuals tested.<sup>[8]</sup> Prevalence is about 75% in young adults and considerably less in young and aging individuals.<sup>[9]</sup>

## Mammals

### Proboscidea

- Asian elephant (*Elephas maximus*): In a study performed in 2006 three female Asian elephants were exposed to a large mirror to investigate their responses. Visible marks and invisible sham-marks were applied to the elephants' heads to test whether they would pass the MSR test.<sup>[5]</sup> One of the elephants showed mark-directed behaviour, though the other two did not. An earlier study failed to find MSR in two Asian elephants;<sup>[10]</sup> It was claimed this was because the mirror was too small.<sup>[5]</sup> The study was conducted with the Wildlife Conservation Society (WCS) using elephants at the Bronx Zoo in New York. All three Asian elephants in the study were standing in front of a 2.5 m-by-2.5 m mirror – they inspected the rear and brought food close to the mirror for consumption. Evidence of elephant self-awareness was shown when one (and only one) elephant, Happy, repeatedly touched a painted X on her head with her trunk, a mark which could only be seen in the mirror. Happy ignored another mark made with colorless paint that was also on her forehead to ensure she was not merely reacting to a smell or feeling. Frans De Waal, who ran the study, stated, "These parallels between humans and elephants suggest a convergent cognitive evolution possibly related to complex society and cooperation."<sup>[5][11]</sup>



European magpies have demonstrated mirror self recognition

### Primates

- Chimpanzee (*Pan troglodytes*):<sup>[1][12][13]</sup> However, mirror tests with a juvenile (11 months old) male chimpanzee failed to reveal self-recognition.<sup>[14]</sup> Two young chimpanzees showed retention of MSR after one year without access to mirrors.<sup>[15]</sup>
- Bonobo (*Pan paniscus*)<sup>[16][17]</sup>
- Bornean orangutan (*Pongo pygmaeus*):<sup>[18]</sup> However, mirror tests with a juvenile (2-year-old), male orangutan failed to reveal self-recognition.<sup>[14]</sup>
- Human (*Homo sapiens*): Humans begin to show self-recognition in the mirror test when they are about 18 months old, or in what psychoanalysts call the "mirror stage".<sup>[19][20]</sup>

### Cetaceans

- Bottlenose dolphin (*Tursiops truncatus*): Researchers in a study on two male bottlenose dolphins observed their reactions to mirrors after having a mark placed on them. Reactions such as decreased delay in approaching the mirror, repetitious head circling and close viewing of the eye or genital region which had been marked, were reported as evidence of MSR in these species.<sup>[21][22]</sup>
- Killer Whales (*Orcinus orca*): Killer whales and false killer whales (*Pseudorca crassidens*) may be able to recognise themselves in mirrors.<sup>[23]</sup>

## Birds

- Eurasian magpie (*Pica pica*): The Eurasian magpie is the only non-mammal to have passed the mirror test. Researchers applied a small red, yellow or black sticker to the throat of five Eurasian magpies, where they could be seen by the bird only by using a mirror. The birds were then given a mirror. The feel of the sticker on their throats did not seem to alarm the magpies. However, when the birds with coloured stickers caught a glimpse of themselves in the mirror, they scratched at their throats—a clear indication

that they recognised the image in the mirror as their own. Those that received a black sticker, invisible against the black neck feathers, did not react.<sup>[8]</sup>

Until the study on magpies, self-recognition was thought to reside in the neocortex area of the brain. However, said brain region is absent in birds. Self-recognition in birds and mammals may be a case of convergent evolution, where similar evolutionary pressures result in similar behaviours or traits, although they arrive at them via different routes and the underlying mechanism may be different.<sup>[24]</sup>



Play media

Video of the responses of a European magpie in a MSR test. The magpie repeatedly attempts to remove the marks.

## Animals that have failed to demonstrate MSR

A range of species have been exposed to mirrors. Although these might have failed the classic MSR test, they have sometimes shown mirror-related behaviour:

### Mammals

- Sea lions (*Zalophus californianus*)<sup>[23][25]</sup>
- Giant panda (*Ailuropoda melanoleuca*): In one study, 34 captive giant pandas of a wide range of ages were tested. None of the pandas responded to the mark and many reacted aggressively towards the mirror, causing the researchers to consider the pandas viewed their reflection as a conspecific.<sup>[26]</sup>

### Primates

- Gorilla: Findings for gorillas are mixed. At least four studies have reported that gorillas failed the MSR test.<sup>[18][27][28][29]</sup> It has been suggested that the gorilla may be the only great ape "which lacks the conceptual ability necessary for self-recognition".<sup>[28]</sup> Other studies have found more positive results, but have tested gorillas with extensive human contact, and required modification of the test by habituating the gorillas to the mirror and not using anaesthetic.<sup>[30][31]</sup> Koko reportedly passed the MSR test, although this was without anaesthetic.<sup>[32][33]</sup> In gorillas, protracted eye contact is an aggressive gesture and they may therefore fail the mirror test because they deliberately avoid making eye contact with their reflections. This could also explain why only gorillas with extensive human interaction and a certain degree of separation from other gorillas and usual gorilla behaviour are more predisposed to passing the test.<sup>[32][33]</sup>
- Gibbon (g. *Hylobates*, *Symphalangus* and *Nomascus*)<sup>[24][34]</sup>
- Stump-tailed macaque (*Macaca arctoides*)<sup>[1][26]</sup>
- Crab-eating macaque (*Macaca fascicularis*)<sup>[26]</sup>
- Rhesus monkey (*Macaca mulatta*):<sup>[1][26]</sup> It has been reported that rhesus monkeys exhibit other behaviours in response to a mirror which indicate self-recognition.<sup>[35]</sup>
- Black-and-white colobus monkey (*Colobus guereza*)<sup>[36]</sup>
- Capuchin monkey (*Cebus paella*)<sup>[26][37]</sup>
- Hamadryas baboon (*Papio hamadryas*)<sup>[26]</sup>

### Birds

- African grey parrot<sup>[25]</sup>
- New Caledonian crow<sup>[38]</sup>
- Jackdaw<sup>[39]</sup>

### Octopuses

- Octopuses oriented towards their image in a mirror, but there is no difference in their behaviour in this condition, compared with a view of other octopuses.<sup>[40]</sup>

## Animals that may exhibit MSR

### Fish

Two captive giant manta rays showed frequent, unusual and repetitive movements in front of a mirror suggested contingency checking. They also showed unusual self-directed behaviours when exposed to the mirror.<sup>[41]</sup>

### Criticisms of the test

The MSR test has been criticised for several reasons, in particular, because it may result in findings that are false negatives.<sup>[24]</sup>

The MSR test may be of limited value when applied to species that primarily use senses other than vision.<sup>[42]</sup> For example, dogs mainly use olfaction and audition; vision is used only third. It is suggested this is why dogs fail the MSR test. With this in mind, the biologist Marc Bekoff developed a scent-based paradigm using dog urine to test self-recognition in canines.<sup>[19][42]</sup> He tested his own dog, but his results were inconclusive.<sup>[43]</sup> A 2016 study<sup>[44]</sup> suggested a new ethological approach, the “Sniff test of self-recognition (STSR)” which may shed light on different ways of checking for self-recognition.

Another concern with the MSR test is that some species quickly respond aggressively to their mirror reflection as if it were a threatening conspecific thereby preventing the animal to calmly consider what the reflection actually represents. It has been suggested this is the reason why gorillas and monkeys fail the MSR test.<sup>[45][46]</sup>

In a MSR test, animals may not recognise the mark as abnormal, or, may not be sufficiently motivated to react to it. However, this does not mean they are unable to recognise themselves. For example, in a MSR test conducted on three elephants, only one elephant passed the test but the two elephants that failed still demonstrated behaviours that can be interpreted as self-recognition. The researchers commented that the elephants might not have touched the mark because it was not important enough to them.<sup>[47]</sup> Similarly, lesser apes infrequently engage in self-grooming, which may explain their failure to touch a mark on their head in the mirror test.<sup>[24]</sup>

### Other animals' reaction to mirrors

Primates, other than the great apes, have so far universally failed the mirror test. However, mirror tests with three species of gibbon (*Hylobates syndactylus*, *H.gabriellae*, *H. leucogenys*) have shown convincing evidence of self-recognition despite the fact that the animals failed the standard version of the mirror test.<sup>[48]</sup>

Rhesus macaques have failed the MSR test, but use mirrors to study otherwise-hidden parts of their bodies, such as their genitals and the implants in their heads. It has been suggested this demonstrates at least a partial self-awareness, although this is disputed.<sup>[49]</sup>

Pigs can use visual information seen in a mirror to find food, and show evidence of self-recognition when presented with their reflection. In an experiment, 7 of the 8 pigs tested were able to find a bowl of food hidden behind a wall and revealed using a mirror. The eighth pig looked behind the mirror for the food.<sup>[50]</sup> BBC Earth also showed the foodbowl test, and the "matching shapes to holes" test, in the Extraordinary Animals series.<sup>[51]</sup>

Pigeons are capable of passing a highly modified mirror test, but only after extensive training.<sup>[52][53]</sup> In the experiment, a pigeon was trained to look in a mirror to find a response key behind it, which the pigeon then turned to peck to obtain food. Thus, the pigeon learned to use a mirror to find critical elements of its

environment. Next, the pigeon was trained to peck at dots placed on its feathers; food was, again, the consequence of touching the dot. The latter training was accomplished in the absence of the mirror. The final test was placing a small bib on the pigeon—enough to cover a dot placed on its lower belly. A control period without the mirror present yielded no pecking at the dot. When the mirror was revealed, the pigeon became active, looked in the mirror and then tried to peck on the dot under the bib. However, untrained pigeons have never passed the mirror test.<sup>[54]</sup>

Manta rays repeatedly swim in front of the mirror, turning over to show their undersides and moving their fins. When in front of the mirror, they blow bubbles, an unusual behaviour. They do not try to socially interact with the mirror image, suggesting that they recognise that the mirror image is not another ray. However, a classic mirror test using marks on the rays' bodies has yet to be done.<sup>[55]</sup>

## Robots

In 2012, early steps were taken to make a robot pass the mirror test.<sup>[56]</sup>

## Rouge test

The *rouge test* is a version of the mirror test used with children.<sup>[57]</sup> Using rouge makeup, an experimenter surreptitiously places a dot on the face of the child. The child is then placed in front of a mirror and their reactions are monitored; depending on the child's development, distinct categories of responses are demonstrated. This test is widely cited as the primary measure for mirror self-recognition in human children.<sup>[58][59][60]</sup>

### Developmental reactions

From the age of 6 to 12 months, the child typically sees a "sociable playmate" in the mirror's reflection. Self-admiring and embarrassment usually begin at 12 months, and at 14 to 20 months most children demonstrate avoidance behaviours.<sup>[57]</sup> Finally, at 18 months half of children recognise the reflection in the mirror as their own<sup>[58]</sup> and by 20 to 24 months self-recognition climbs to 65%. Children do so by evincing mark-directed behaviour; they touch their own nose or try to wipe the mark off.<sup>[57]</sup>

It appears that self-recognition in mirrors is independent of familiarity with reflecting surfaces.<sup>[59]</sup> In some cases the rouge test has been shown to have differing results, depending on sociocultural orientation. For example, a Cameroonian Nso sample of infants 18 to 20 months of age had an extremely low amount of self-recognition outcomes at 3.2%. The study also found two strong predictors of self-recognition: object stimulation (maternal effort of attracting the attention of the infant to an object either person touched) and mutual eye contact.<sup>[61]</sup> A strong correlation between self-concept and object permanence have also been demonstrated using the rouge test.<sup>[62]</sup>

### Implications

The rouge test is a measure of self-concept; the child who touches the rouge on his own nose upon looking into a mirror demonstrates the basic ability to understand self-awareness.<sup>[63][64][65]</sup> Animals,<sup>[42]</sup> young children,<sup>[20]</sup> and people who have their sight restored after being blind from birth,<sup>[19]</sup> sometimes react to their reflection in the mirror as though it were another individual.



A human child exploring his reflection

Theorists have remarked on the significance of this period in a child's life. For example, psychoanalyst Jacques Lacan used a similar test in marking the mirror stage when growing up.<sup>[66]</sup> Current views of the self in psychology position the self as playing an integral part in human motivation, cognition, affect, and social identity.<sup>[60]</sup>

## Methodological flaws

There is some debate as to the interpretation of the results of the mirror test,<sup>[42]</sup> and researchers in one study have identified some potential problems with the test as a means of gauging self-awareness in young children.<sup>[67]</sup>

Proposing that a self-recognising child may not demonstrate mark-directed behaviour because they are not motivated to clean up their faces, thus providing incorrect results, the study compared results of the standard rouge test methodology against a modified version of the test.<sup>[67]</sup>

In the classic test, the experimenter first played with the children, making sure that they looked in the mirror at least three times. Then, the rouge test was performed using a dot of rouge below the child's right eye. For their modified testing, the experimenter introduced a doll with a rouge spot under its eye and asked the child to help clean the doll. The experimenter would ask up to three times before cleaning the doll themselves. The doll was then put away, and the mirror test performed using a rouge dot on the child's face. These modifications were shown to increase the number of self-recognisers.<sup>[67]</sup>

The results uncovered by this study at least suggest some issues with the classic mirror test; primarily, that it assumes that children will recognise the dot of rouge as abnormal and attempt to examine or remove it. The classic test may have produced false negatives, because the child's recognition of the dot did not lead to them cleaning it. In their modified test, in which the doll was cleaned first, they found a stronger relationship between cleaning the doll's face and the child cleaning its own face. The demonstration with the doll, postulated to demonstrate to the children what to do, may lead to more reliable confirmation of self-recognition.<sup>[67]</sup>



On a more general level, it remains debatable whether recognition of one's mirror image implies self-awareness. Likewise, the converse may also be false—one may hold self-awareness, but not present a positive result in a mirror test.

## See also


- Animal consciousness
- Cognitive tests
- Narcissus (mythology)
- Self-agency

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## External links

- List of animals who passed the mirror test and promising candidates on [animalcognition.org](http://animalcognition.org)
- The World First Self-Aware Robot and the Success of Mirror Image Cognition (Lecture at the Karlsruhe University and the Munich University, Germany), 8 November 2006.
- Elephants pass mirror test of self-awareness (The Guardian)
- Elephants' jumbo mirror ability (BBC News)
- Elephant study published in Proceedings of National Academy of Sciences, USA
- Elephants see themselves in the mirror (Newscientist.com with video)
- Can a robot pass the mirror test? – Raúl Arrabales Moreno, 2010-01-08

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