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Reuven Dukas

■ Cognition

Mirror Self-Recognition

Mirror self-recognition (MSR) has been a controversial topic in the field of comparative psychology since it was first reported by Gordon Gallup in 1970. He provided behavioral evidence that chimpanzees were able to understand the nature of their mirror image, meaning

that they recognized themselves in the mirror. Consider the phenomenon. A mirror image is a two-dimensional representation of the world, just like a picture or a photograph. However, unlike a still image, it is dynamic and mimics the behavior of the viewer. A chimpanzee who demonstrates MSR must understand that the mirror image is an actual representation in both time and space, and also, that it is not simply another chimpanzee looking back at her. It is, in fact, herself. But what does this imply? Are the mental abilities that allow MSR associated with other, more sophisticated, cognitive skills? To answer that question, a more detailed consideration of MSR is necessary.

In Gallup's study, individual chimpanzees were each presented with a full-length mirror placed in front of their enclosure beyond their reach. Initially, the chimpanzees were agitated and responded as if their reflection was an unfamiliar individual. Within two or three days of exposure, they gradually stopped their social responses and began to use the mirror in novel ways. For example, they would make faces as they looked at the mirror, blow spit bubbles, or watch themselves chew food. Further, the chimpanzees also inspected areas of their bodies that they were normally unable to see, such as their teeth. Importantly, they used the mirror to guide their fingers during these investigations. Gallup termed these behaviors "self-directed," and interpreted them to mean that the chimpanzees recognized themselves in the mirror. To validate his interpretation, Gallup devised a test for mirror self-recognition. This test involved se-



To date, most individuals from all of the great apes have shown evidence of MSR through self-directed behaviors, the mark test, or both.

Courtesy of Jessie Cohen, National Zoo.

dating the chimpanzees and applying an odorless red dye on one eyebrow and the opposite ear. When the chimpanzee awoke, she would have no idea that the dye was present unless she looked in the mirror. If she specifically touched the dyed areas, using the mirror to guide

her fingers, this would be strong evidence for MSR. All of the mirror-experienced chimpanzees in Gallup's study passed this "mark test," thus supporting his interpretation of self-directed behaviors. Both measures are now used in studies of MSR.

Since Gallup's ground-breaking study, a number of scientists have investigated MSR in a variety of species, including dolphins, elephants, monkeys, and apes. Most of the research has centered on primates, which will be the focus of this essay. To date, individuals from all of the great apes (chimpanzees, bonobos, gorillas, orangutans, and humans) have shown evidence of MSR through self-directed behaviors, the mark test, or both. Among all of the other species of primates, only gibbons have demonstrated behaviors that are suggestive of MSR. While numerous studies have attempted to document MSR in other primate species, such as macaque monkeys, none have provided clear evidence of mirror-guided self-directed behaviors or passing the mark test. This difference across species is particularly interesting since individuals who have failed to show MSR clearly understand the reflective properties of a mirror and can use mirrors to obtain information about their environment. For example, macaque monkeys can use a mirror reflection to guide their hand in finding foods or objects that are otherwise hidden. Pygmy marmosets can learn to use a mirror to locate and monitor the position of rivals. When they threaten those rivals, they turn toward the rival's location directly, rather than threatening the mirror image. Yet, in these cases, the monkeys give no indication that they recognize themselves in the mirror.

In those species who demonstrate MSR, it does not appear immediately in young individuals, but must develop. In humans, the development of MSR parallels the development of other representational skills, such as symbolic play. In carefully controlled studies using a version of the mark test (one that does not require sedation), human infants do not show MSR until 15–18 months of age, and some as late as 24 months. The developmental course of MSR has not been well studied in other great apes, but there is some evidence that chimpanzees achieve this ability as early as 2½ years of age.

There are numerous examples of individual nonhuman great apes that clearly and convincingly demonstrate MSR. However, despite prolonged mirror exposure and ample opportunity to interact with their reflection, there are also individual great apes that have not demonstrated any mirror-mediated, self-directed behaviors or the ability to pass the mark test. This variation among individuals has been documented in all of the great apes. Some of these exceptions are most likely related to deprived rearing conditions characterized by lack of appropriate social contact and/or little or no mental stimulation. In other cases, well-socialized apes that have grown up in enriched environments also fail to demonstrate MSR. In these cases, the explanation for this apparent lack of ability remains unclear. The suggested possibilities range from simple lack of interest in the mirror to a cognitive deficit that interferes with comprehension of their reflection. Do these differences in performance mean that there are, for example, two separate kinds of chimpanzees—those who are capable of demonstrating MSR and those who aren't? The answer is no.



The discovery of MSR in chimpanzees revealed the presence of a cognitive complexity that was previously assumed to be exclusive human territory. Courtesy of Jessie Cohen, National Zoo.

Organisms appear to show three classes of behavior as they gain experience with their own reflection. These classes are social, contingent, and self-directed. Social responses to the mirror vary, ranging from greeting or play behaviors to threats or a fear response. Contingent behaviors are those which appear to test the relationship between an individual's movements and those of the mirror image. An example would be waving the arm or hand while watching that action in the mirror. Self-directed behaviors are distinct since they involve the use of the mirror to guide a behavior that is focused on the body. An example would be an orangutan using the mirror to groom his face. In this situation, an important distinction is that the ape moves her hand away from the mirror, and toward her own body while observing her reflection. Her actions indicate a clear understanding of the nature of the mirror image. Generally, when first exposed to a mirror, individuals initially show social responses. These behaviors wane as contingent and self-directed behaviors emerge. This progression may occur gradually over hours or even days. In experimental situations, the mark test is used to validate interpretations about self-directed behaviors.

Even though all of these behaviors are involved in MSR, each is not necessarily supported by the same mental abilities. Social responses to the mirror indicate that an individual is "reading" the image, although there is no comprehension of what it actually represents. These social behaviors decrease, most likely because the "responses" produced by the mirror image are not reciprocal, as would be expected from an actual social partner. However, these actions do provide information that begins to establish a correspondence between the mirror image and the individual's own movements. Although contingency behaviors emerge as social behaviors decline, a specific relationship has not been demonstrated experimentally. However, the rise in contingency behaviors suggests that the individual has perceived some relationship or correspondence between her own body movements and position in space with that of the mirror image. We interpret contingency behaviors as explicit testing of this correspondence. Self-directed behaviors are probably the outcome of an individual's understanding of the mirror image based on information that is acquired during contingency testing. So, let us return to the initial question that was posed. Are the mental abilities that allow MSR associated with other, more sophisticated, cognitive skills?

Most researchers that have investigated MSR agree that a relationship exists between mirror self-recognition and the phenomenon termed *theory of mind* (TOM). Theory of mind refers to the ability of one individual to understand their own knowledge and perceptions, and attribute that ability to others as well. Individuals with TOM use this understanding to project thoughts and intentions to others. That is, based on their own thoughts and experiences, they have formed a theory of how minds work. Having TOM allows for a range of abilities that are otherwise impossible. Intentional deception is one clear example. Unlike deceptive behaviors that are primarily controlled genetically, commonly referred to as "instinctive," TOM-based deception relies on more complex mental abilities most commonly associated either with distraction from, or concealment of, information. A now classic example involves a group of captive chimpanzees living on a large island.

Watching from their indoor enclosure, the apes witnessed their caretaker carrying a box of fruits onto the island. Well out of sight, he buried the fruits, leaving just a bit exposed so that they could be found. As he returned with the empty box, the chimpanzees eagerly anticipated their release onto the island. Once outside, the apes dashed about searching for the fruit. However, none were able to find the correct spot, or so it appeared. Later in the day, as the group began their afternoon nap, one individual waited until all of the other individuals were resting, and unnoticed, headed off directly to where the fruits were buried. Apparently having noticed their location earlier, but concealing that information, he enjoyed all of them

Individual Variation and MSR: The Response of Two Orangutans upon Seeing Their Reflection

Robert W. Shumaker and Karyl B. Swartz

The study of MSR in nonhumans has a relatively short history, and the results have generated lively debates for scientists working in this field. These deliberations are normal and healthy, serving to refine ideas, interpretations, and methodologies. A fundamental aspect of this process is a shared understanding among colleagues of the basics that are associated with MSR. The specifics of a valid "mark test" makes a fine example. In this procedure, the subject must be completely unaware that a mark has been applied. Before the mirror is presented, the subject's behavior is carefully observed and recorded to ensure that no touches are directed at the mark, providing evidence that the subject is truly naive. Once the mirror is exposed, the subject passes the test when they specifically attend to the mark by actively using their reflection. Interpreting the results of a properly conducted mark test should be straight forward, but the responses of some individuals can make this difficult. A study of MSR conducted by Daniel Shillito with orangutans provides good case studies for discussion.

Shillito and his colleagues worked with a group of captive-born orangutans who had never been formally tested on their responses to mirrors. After careful planning and preparation, including all of the proper control procedures, mark tests were begun. Two individuals provided notable results.

Junior, an adult male orangutan, proved to be an exceptionally interesting subject. He showed no awareness of the mark until the mirror was presented. Once his reflection was visible, he quickly noticed the mark and touched it with his finger as he looked directly into the mirror. After touching the mark, he smelled and inspected his finger, although the dried paint had left no residue. Without a doubt, he clearly passed the test by using his reflection to guide his fingers toward the odorless paint that was streaked across his brow. In every way, he provided a convincing response. Even without the presence of a mark, Junior demonstrated a particularly strong interest in his reflection. He sat in front of the mirror for long periods, inspecting areas of his body that were otherwise invisible to him. He would open his mouth into a wide yawn and examine each of his teeth. In addition, he observed his genitals, carefully touched the area around his eyes, and even gently exposed the inside of his eyelids as he gazed intently into the mirror. On at least one occasion that might be considered self adornment, he draped a burlap bag over himself like a shawl and looked at his reflection. One interpretation is that he was admiring his appearance.

Bonnie, an adult female orangutan, behaved quite differently when exposed to a mirror. Although attentive and interested, she showed no clear indication that she recognized her reflection. When given the mark test, she provided a unique response. As with Junior, she was completely unaware that a mark had been painted on her forehead. Upon presentation of the mirror, she looked directly at her reflection. She made no attempt to touch the mark, but then quickly walked away from the mirror. She moved directly across her enclosure to a water spigot, turned it on, and vigorously rubbed her forehead under the stream. The mark was completely washed away. Officially, Bonnie failed the mark test. Would you agree with this interpretation?

himself and then returned to the group. In this case, the deceiver clearly had information that he withheld from the group. By not acting on what he knew, until he was satisfied that the other group members were sufficiently occupied away from the fruit, he eliminated any potential competition. His ability to understand that he knew something that the rest of the group did not, and to deceive them by concealing that information, is best explained by theory of mind.

Although there is clear overlap in the mental abilities that support MSR and TOM, this does not mean that the two are equivalent. An individual who shows MSR has the mental capacity to make use of the information provided by his reflection to reveal knowledge of himself as a separate entity. The mirror is the methodological bridge between this self concept and behavior. The mirror provides an opportunity for the individual to demonstrate knowledge that is otherwise private. However, this level of understanding does not sufficiently explain the range of behaviors that is associated with TOM. In our view, showing self-directed behaviors or successfully passing the mark test is not sufficient evidence to support the notion that TOM is present. Even though the cognitive skills that are necessary for MSR are also essential for TOM, at least three additional capacities are required as well. Specifically, they are the ability to consider one's own thoughts, the ability to understand that those thoughts are distinct from those of other individuals, and the ability to use that knowledge to predict or manipulate another individual's behavior.

The cognitive ability that allows MSR is directly related to the other, more sophisticated, mental skills necessary for TOM. It is the first in a suite of interdependent cognitive capacities that lead to the expression of TOM.

The discovery of MSR in chimpanzees revealed the presence of a cognitive complexity that was previously assumed to be exclusive human territory. That phenomenon has now been extended to all of the other great apes as well. Current research into TOM is proceeding in a similar manner, providing evidence that the mental skills that are present in the nonhuman great apes exceed previously accepted limits. As our understanding of the minds of the great apes continues to progress, the boundaries that separate humans from the other great apes continue to be blurred. As Charles Darwin suggested, the mental differences between humans and the other great apes are in degree, not in kind.

See also Cognition—Animal Consciousness

Cognition—Mirror Self-Recognition and Kinesthetic—
Visual Matching

Further Resources

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