

Reflections on self-recognition in primates

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Abstract. Evidence that apes touch head marks more in the presence of a mirror than in its absence have been taken to indicate that, unlike monkeys, they are capable of self-recognition and have a self-concept. Both of these conclusions are challenged. First, variance in mark-touching behaviour may be due, not to mirror-presence, but to the effects of anaesthetic recovery on species with a high baseline frequency of self-directed behaviour. Second, evidence of species differences in mirror-guided body inspection could not be explained in terms of the presence or absence of a self-concept. Since monkeys can avoid colliding with objects, they must possess the only kind of self-concept necessary for mirror-guided body inspection; i.e. the capacity to discriminate feedback from other sensory input. Rather than implying a self-concept, mirror-guided body inspection involves the use of novel, displaced visual feedback to guide action.

But man, proud man
Dressed in a little brief authority
Most ignorant of what he's most assured—
His glassy essence—like an angry ape,
Plays such fantastic tricks before high Heaven
As make the angels weep—who, with our spleens,
Would all laugh themselves mortal.

Shakespeare, *Measure for Measure*, II, ii.

Unlike Shakespeare's Isabella, many psychologists, biologists and anthropologists have become convinced by experiments with mirrors that humans are not alone among the great apes in having a 'glassy essence' or 'self'; both a subject and object of recognition, conceptualization and awareness, that can contemplate its own existence and mortality (Gallup 1977, 1979, 1983; Gallup & Suarez 1986; Morin & DeBlois 1989). The experiments apparently show that, while most animals respond to their mirror image as if it were a conspecific, chimpanzees, *Pan troglodytes*, and orang-utans, *Pongo pygmaeus*, use their reflections to inspect parts of their bodies, including marks on their heads, that are normally invisible. These experiments are widely cited, and their perceived implications are not only fascinating and profound, but comforting. Our forebears were distressed by any suggestion that humans are not unique among living creatures, but now, more than a hundred years after Darwin, we may find evidence of self-recognition in other animals, especially such close phylogenetic relatives,

rather reassuring (contra Gallup et al. 1977). It appears to confirm, in the face of deconstructivist, instrumentalist or other suggestions to the contrary (e.g. Dennett 1991) that unlike its mysterious predecessor, the soul, the self is a real thing, a tangible quantity, demonstrably present or absent in any given creature. Consequently, the argument put forward in this paper, that mirror experiments do not provide evidence of self-recognition, self-concept or self-awareness in apes, is unlikely to be well received. However, I advance it in the hope that it will provoke not only a more critical attitude towards mirror experiments, and more effective use of reflecting surfaces to find out about animal cognition, but also some re-examination of the relationship between 'rigor of method and relevance of result' (Dennett 1986, page 19) in comparative psychology. Even an informal survey of the literature on animal behaviour suggests that the relationship is inverse; that esoteric issues tend to be investigated with great experimental rigour, while studies addressing the relevant questions, those that have obvious implications for our understanding of our place in nature, are often methodologically weak. Sometimes the relevant questions demand field studies, or otherwise preclude the maintenance of tight experimental control, but this is not true of research on self-recognition in primates. Consequently, these investigations underline the contingent, rather than inevitable, nature of the rigour–relevance relationship.

It is not only the empirical methods, but also the reasoning, that is weak in primate mirror research. The reasoning that relates mirror behaviour to selfhood runs roughly as follows (e.g. Gallup 1977, 1983; Gallup et al. 1977). When a primate is confronted with a mirror it receives 'self-sensation' (Gallup 1977, page 331); it is, as a matter of fact, sensing itself. If the primate can use a mirror to inspect its own body, then this self-sensation must have given rise to 'self-perception' (Gallup 1977, page 331), or, more commonly, 'self-recognition' (e.g. Gallup 1977, page 329); the mirror image not only is, but has been perceived by the animal to be, a representation of itself. Self-recognition logically requires a pre-existing 'self-awareness' (Gallup 1977, page 330) or 'self-concept' (e.g. Gallup 1977, page 329), therefore use of a mirror for body inspection implies the possession of such a concept. The nature of a self-concept or a 'well-integrated self-concept' (Gallup 1977, page 334) is largely unspecified. However, as 'an awareness of one's own existence' (Gallup 1977, page 329) its possession is taken to imply, inter alia, the potential to view oneself as one is viewed by others, and 'to contemplate [one's] own death' (Gallup 1977, page 329).

Beginning at a somewhat prosaic level, I first consider whether primate mirror experiments provide convincing evidence that chimpanzees and orang-utans can use mirrors for body inspection, as a source of information about their own bodies. I believe that they cannot, but, putting my reservations aside, I consider in the second part of the paper whether convincing evidence of mirror-guided body inspection would imply the possession of a self-concept. This will involve close examination of the first premise given above, that a mirror provides self-sensation, and some discussion of what exactly the possessor of a self-concept ostensibly has and knows. Finally, I suggest that while the use of reflections by animals cannot tell us whether the animals themselves are reflective, i.e. whether they have a self-concept, or are capable of self-recognition, it does allow us to investigate whether and how animals use novel, displaced, visual feedback to guide their actions.

MIRROR-GUIDED BODY INSPECTION

In the original study, published in *Science* (Gallup 1970; further details given in Gallup 1977), each of

four pre-adolescent chimpanzees was exposed to a full-length mirror, positioned 3.5 m and subsequently 0.6 m outside its cage, for 80 h over a 10-day period. On the 11th day, each animal was anaesthetized and marked on an eyebrow ridge and the top half of the opposite ear with a red, odourless, non-irritant dye, Rhodamine B. Four hours later, it was observed for 30 min in its cage in the absence of the mirror, and then for a further 30 min when the mirror had been replaced in its usual position. Three formally measured characteristics of the animals' behaviour in the course of the study were interpreted as evidence that they used the mirror to inspect their bodies. (1) Over the 10-day exposure period there was a decline in the frequency of 'social responses' and a corresponding increase in 'self-directed behavior'. (2) During the test on the 11th day, each chimpanzee touched the marked area of its head on average once before the mirror was introduced, and approximately seven times afterwards. (3) On the 11th day the chimpanzees spent, on average, four times as long (approximately 400 s) viewing themselves in the mirror as they had on the 10th day (approximately 100 s).

Increase in Self-directed Behaviour

Let us consider first what might have happened in the course of the 10-day exposure period. On initial exposure to the mirror, the chimpanzees reacted to the novel stimulus, their reflection, somewhat as if it were a conspecific, exhibiting social behaviour 'such as bobbing, vocalizing, threatening' (Gallup 1970). These activities displaced some components of the chimpanzees' normal behavioural repertoire, including various forms of grooming, i.e. 'self-directed' behaviour. However, as the animal habituated to the mirror stimulus, the frequency of social behaviour declined allowing the level of grooming behaviour to return to normal. Thus, all that the mirror did was to provoke social behaviour, and then gradually cease to do so. It did not exert a direct influence on 'self-directed' behaviour; the chimpanzees did not use it to guide body inspection.

Gallup (1970) did not collect the baseline data necessary to refute the foregoing interpretation. The frequency of the chimpanzees' 'self-directed' behaviour prior to mirror exposure, or during comparable periods in the absence of the mirror, was not measured. Nor could it be convincingly

argued that the form of the self-directed behaviour precludes this interpretation. Self-directed behaviour was never objectively defined, but was said to include: grooming visually inaccessible parts of the body, 'picking bits of food from between the teeth', 'manipulation of ano-genital areas', 'picking extraneous material from the nose', 'making faces', 'blowing bubbles', and 'manipulating food wads with the lips' (Gallup 1970, page 86). Chimpanzees happily engage in all of these behaviour patterns in the absence of mirrors, and it is difficult to know how a human observer could have been sure that, in the course of the experiment, they were provoked and/or guided by the reflection. Each chimpanzee was in a 'small' cage (size unspecified) precisely in order to compel confrontation with the mirror image, and therefore all behaviour occurred within its close proximity.

The subjectivity of judgements concerning the role of mirrors in self-directed behaviour is underlined by the results of an experiment with capuchin monkeys, *Cebus apella* (Anderson & Roeder 1989). On many occasions in the course of daily exposure to a mirror, one monkey, Chur, 'cocked his head to one side while looking in the mirror, and kept it in this position while slowly stroking his chest with one hand' (page 585). Some observers might interpret this as a classic gesture of self-contemplation or admiration. However, Anderson & Roeder (1989) reported that none of the monkeys in their study were 'observed to engage in self-directed behaviour suggestive of self-recognition' (page 585). Clearly, what is suggestive for one observer, may not be so for another.

Mark-touching

Turning now to the results of the mark test, there is an obvious alternative to the standard interpretation of the chimpanzees' tendency to touch their marks more in the presence of the mirror than in its absence: in the mirror-present condition the animals had had longer to recover from anaesthesia and were therefore more active generally than in the subsequent, mirror-absent condition. If they were more active generally, they had a higher probability of touching the marked areas of their heads, not because they had detected the marks using the mirror, but simply by chance. The animals were anaesthetized with phencyclidine (Sernylan): a drug that is now seldom given to non-human primates because it results in an unusually long period of

post-anaesthetic catalepsy and dysnergia, or to humans because it causes 'prolonged postanesthetic confusion' (Chen et al. 1966). With a dose comparable to that used in the mirror study, monkeys, *Macaca mulatta*, reach a weak criterion of recovery (they are able to pull the anterior part of their body up, supporting its weight on their forelimbs) within 3-5 h of administration (Chen et al. 1966), and testing in Gallup's (1970) mirror-absent condition began approximately 4 h after the chimpanzees were injected.

If in the original study or in subsequent replications the chimpanzees had been tested a day or two after marking, or if the frequency of mark-touching had been measured in relation to that of other, similar behaviour, or if it had been compared with the frequency of mark-touching at the same time on previous days, then it might be possible to attribute the effect to use of the mirror to detect the marks. However, none of these measures have been reported, and it is therefore fully plausible that the occurrence of more mark-touches in the mirror-present condition is an artefact produced by the anaesthetic.

In the original experiment, two additional chimpanzees that had no prior exposure to mirrors were anaesthetized, marked and observed in the presence of the mirror on recovery. They did not make any mark-directed responses, but that does not mean that the other, pre-exposed animals must have been using the mirror to detect their marks. If the control animals reacted in the same way as other chimpanzees on first exposure to a mirror, they were almost certainly too busy responding socially to the mirror to engage in the normal grooming behaviour that had, by chance, given rise to mark-touching in the experimental subjects.

If the mark-touching effect really is an anaesthetic artefact, then one would expect it to have been replicated only in studies using an anaesthetic and involving animals with a substantial baseline frequency of grooming or self-directed behaviour, especially face touching. This prediction is confirmed by a review of subsequent experiments. Each of the formal studies reporting more mark-touching in the mirror-present condition has involved anaesthetic administration and subjects that engaged in a significant amount of self-directed behaviour prior to the mark test (Gallup et al. 1971; Suarez & Gallup 1981; Calhoun & Thompson 1988). The subjects in these experiments were socially reared chimpanzees and orang-utans.

Some studies used Ketamine rather than Sernylan as the anaesthetic agent (Suarez & Gallup 1981; Calhoun & Thompson 1988), but in these cases the exact time between anaesthetic and test was not specified, and, as in the Sernylan studies, no formal procedure was used to assess anaesthetic recovery. In five studies involving anaesthetic (Gallup 1970; Gallup et al. 1971; Suarez & Gallup 1981; Ledbetter & Basen 1982; Platt & Thompson 1985), no mark-directed responses occurred either in the mirror-absent or mirror-present conditions, but the animals in these experiments (gorillas, *Gorilla gorilla*, members of three species of monkey, *Macaca arctoides*, *M. mulatta*, *M. fuscata*, and an isolation-reared chimpanzee) were not observed exhibiting any self-directed behaviour in the days prior to the test. This suggests that they normally engage in little of the behaviour that might lead them inadvertently to touch marks on their heads, and is supported by data indicating that chimpanzees spontaneously touch their faces much more than do either monkeys (*Cebus griseus*, *Macaca silenus*, *M. pagensis*, *Cercopithecus neglectus*) or gorillas (Dimond & Harries 1984).

In four studies a mark test has been administered without anaesthetic, and three of these reported negative results (Anderson 1983; Robert 1986; Povinelli 1989). Anderson (1983) and Povinelli (1989) used animals (stump-tail monkeys, *Macaca arctoides*, and elephants, *Elaphus maximus*) with a low baseline frequency of the relevant kind of self-directed behaviour, but Robert (1986) studied a chimpanzee and an orang-utan. She exposed the two animals to a mirror over a 5-week period, and then marked their heads with the red, Rhodamine-B dye during their natural sleep. On waking and being exposed to the mirror, both animals behaved in the same ways as they had during previous bouts of mirror exposure. They did not touch the marks on their heads, but when, on a separate occasion, their toes were painted during sleep, they showed considerable interest in them upon waking.

In the fourth study that did not involve anaesthetic, each chimpanzee was marked on its brow with white face cream 'in as surreptitious a manner as possible' (Lin et al. 1992, page 121). The results of this study are not directly comparable with those of other mark tests because the frequency of mark-touching behaviour was measured in the presence, but not in the absence, of a mirror. The authors claim to have found evidence of self-recognition in the form of a tendency, on the part

of 4- and 5-year-old chimpanzees, to touch their marks more often while looking in the direction of the mirror than while looking in a different direction. On average, each of the six animals in this age group touched its mark 3.3 times while looking towards the mirror, and 2.3 times while looking in another direction. These data do not provide convincing evidence that the chimpanzees were using the mirror to detect their marks, or to guide mark-touching behaviour, for two reasons. First, the difference between the frequencies of mark-touching is not statistically reliable. Second, and more important, there is no evidence that any effect of orientation to the mirror was specific to mark-touching behaviour. Interested by the mirror stimulus, the chimpanzees may have tended to keep an eye on it while performing all of their usual behaviour patterns. Furthermore, the observation that younger chimpanzees (2–2.5 years) tended to touch their marks more while looking away, rather than towards, the mirror, does not support the suggestion that the older animals were using the mirror to guide mark-touching behaviour. This is because other data, from the same study, showed that younger animals spent less time in total in the vicinity of the mirror than their elders. Thus, the younger animals were less likely than the older animals to touch their mark, or engage in any other behaviour, while incidentally also looking in the mirror.

In an earlier study (Suarez & Gallup 1981), when chimpanzees were marked under anaesthetic on their wrists as well as their heads, they were reported to have 'avidly groomed' (page 181) their wrists prior to the re-introduction of the mirror when 'attention rapidly shifted to the marked eyebrow ridge' (pp. 181–182). These descriptions conjure up a mental image of animals that are, contrary to my suggestion, alert and active throughout the test period following anaesthesia. However, this picture evaporates when one considers how little energy and coordination is necessary to touch a wrist, and looks at the figures to discover that, on average, the four chimpanzees touched their wrists just six times in the 30 min prior to mirror re-introduction. The descriptions further suggest that the decline in wrist-touching between mirror-present and mirror-absent conditions was due to the chimpanzees having been diverted by the sight of their head marks in the mirror. Given that a similar decline was observed in gorillas, which did not touch their brows after the mirror had been

re-introduced, it is more likely to have been due to simple habituation or waning interest in the wrist mark.

Viewing Time

In the original study (Gallup 1970), and in several subsequent experiments (e.g. Suarez & Gallup 1981), chimpanzees and orang-utans that have 'passed' the mark test have also been found to spend more time oriented towards the mirror on the test day than on previous days. This 'viewing time' effect has been interpreted as evidence that the animals have detected the marks on their heads using the mirror, but it is not persuasive either when considered in isolation or in conjunction with the results of the mark test. An increase in viewing time is essentially a dishabituation effect. It suggests that, following the marking procedure, the animal has detected some change in the mirror stimulus. The mirror image now contains a bright red, blood-like blob. However, an increase in viewing time does not imply that the change is perceived by the animal as having occurred in, or affected, its own body. If an increase in viewing time invariably correlated with 'passing' the mark test, then it might suggest that the change in the image is so perceived, and add weight to the claim that mark-touches occur more when the mirror is present because the mirror is being used to detect the marks. However, in an unusually thorough and careful study, Anderson (1983) found a viewing time effect in animals that failed the mark test. His stump-tail monkeys were marked after 4 days of mirror exposure in which there had been a steady decline in total responsiveness to the mirror. On the fifth, test day, the animals were reported to have shown no more mark-directed behaviour in the presence of the mirror than in its absence, but their overall responsiveness to the mirror was restored to the level observed on the first day of mirror exposure.

Effects of Mirror Removal and Relocation

Experiments examining the effect on rhesus monkeys', *Macaca mulatta*, behaviour of temporary mirror removal and relocation (Suarez & Gallup 1986; Gallup & Suarez 1991) have been interpreted as providing support for the conventional interpretation of the ape experiments reviewed above. Both studies involved a pair of

rhesus monkeys which had lived for years in the presence of a mirror, in a particular spot just outside their cage. They showed that the monkeys spent longer viewing the mirror, and made more social responses to the mirror, after it was moved to another location outside the cage (Suarez & Gallup 1986), and after it had been removed altogether for 5 days (Gallup & Suarez 1991), than they did before these interventions.

It is argued (Gallup & Suarez 1991) from these findings that rhesus monkeys have failed to provide evidence of mirror-guided body inspection in the mark test (Gallup 1970; Gallup et al. 1980) because they 'treat their reflection as a social stimulus', and not, for example, as I have suggested because they have a low baseline frequency of self-directed behaviour. If it had been shown that mirror relocation and removal selectively reinstated social behaviour, and that this occurs in all and only those primates that fail the mark test, then this argument might have some force. However, given the data in hand, it is not clear that relocation and removal has a specific effect on social behaviour, or that its effects vary systematically between primates that pass and fail the mark test. The frequency of non-social behaviour was not measured in the rhesus monkey experiments, but in a study of pygmy marmosets, *Cebuella pygmaea*, Eglash & Snowdon (1983) found that mirror relocation resulted in reinstatement of all 'orientational' responses to the reflection. There are no comparable published reports of the effects of mirror relocation and removal on chimpanzees and other primates that have been subjected to the mark test.

Lack of Convergent Evidence

I conclude on the basis of the foregoing review that the experiments initiated by Gallup (1970) do not show that any of the animals tested are capable of mirror-guided body inspection; i.e. of using a mirror as a source of information about their own bodies. Menzel et al. (1985) have claimed to provide independent evidence in support of the contrary conclusion, that these experiments indicate the capacity for mirror-guided body inspection in chimpanzees, but their data are not compelling. In their experiment, each of two chimpanzees was required to cover an ink spot with a hand in order to earn a food reward. On successive trials the spot was placed at various locations within a grid inscribed on one side of a door. The chimpanzee was on the other side of the door and could gain

access to the grid only by inserting its hand through a small hole in the door, at the centre of the grid. On the chimp's side of the door was a video monitor receiving simultaneous input from a camera positioned, on the other side of the door, in front of the grid. The video image, showing the grid, the ink spot and the chimp's hand, was on various trials either normal, reversed laterally (like a mirror), inverted, or reversed laterally and inverted. The data were reported primarily in the form of diagrams indicating the path traced by the subject's hand from the time that it was inserted through the hole in the door to the time when it either covered the ink spot or was withdrawn by the animal. These showed that the chimpanzees moved their hands fairly directly towards the spot only when the video image was normal, and when the image was distorted (reversed, inverted and reversed plus inverted conditions) but the true location of the spot was close to its virtual location, for example, when the spot appeared north of the hole in the video image and on the grid itself. When the true and virtual locations of the spot were disparate, the traces suggest that the chimpanzees initially moved their hands in the direction of its virtual location and then, after some flailing about in that region, either moved their hands in the opposite direction, initiated a random search, or withdrew their hands terminating the trial.

These results are consistent with the hypothesis that each chimpanzee used the video display as a source of information about the location of the ink spot, but not about the location of its hand relative to the spot. In the normal image condition they were rewarded, for example, for moving their hand downwards after insertion when the spot was south of the hole on the monitor. Thus, they learned that in the presence of various stimuli (spot and hole configurations on the monitor), various actions (defined and controlled kinesthetically) would be rewarded. When, in the distorted image conditions, these actions were not rewarded, instead of using the mirror to guide movements bringing the hand closer to the spot, they gave up, blindly engaged in random hand movements, or adopted the strategy of making an opposite response to that which had initiated the trial. How, if they did not use the video to detect their hand's location, did the chimpanzees know whether or not they had been successful? Success was signalled by receipt of a reward, by the feel of the ink on the grid, and/or by the disappearance of the spot on the monitor. We would say that

the spot had been covered by the hand, but perhaps the chimpanzees did not see it that way.

To find out whether the chimpanzees were really using the mirror to guide their hand movements it would have been necessary to include a control condition in which the subjects had access only to a (pre-recorded) video showing the spot's location, but not their hand. Using a similar method, Robinson et al. (1990) found evidence that, contrary to earlier claims (Lewis & Brooks-Gunn 1979; Bigelow 1981; Chapman 1987), human infants do not use their own reflection as a point of reference when they turn to view directly objects first detected in a mirror.

In conclusion, both when they are viewed in isolation and in conjunction with other primate mirror experiments, the mark test studies do not provide convincing evidence that any primate can use a mirror as a source of information about its own body.

SELF-CONCEPT

In claiming that mirror-guided body inspection, under the description 'self-recognition', implies the possession of a self-concept, Gallup (e.g. 1970, 1977) has suggested that this behaviour could be explained with reference to self-conceptualization. Variance between animals in terms of their capacity to use their reflection as a source of information about their own body is claimed to exist because some animals have a self-concept, or a 'sufficiently well-integrated self-concept', and others do not. It is worth evaluating this claim because, although the mark test studies do not provide it, I suspect that evidence of mirror-guided body inspection in primates will eventually be obtained. Before indicating the basis for this hunch, and suggesting that mirror-guided body inspection involves the use of novel, displaced visual feedback, I argue that reference to self-concepts could not possibly help us to explain the use of mirrors; it simply is not a relevant variable.

Body and Self

Self-conceptualization is not relevant because, to put it baldly, it is incredible that any primate (or indeed any vertebrate) lacks the only kind of self-concept necessary to use a mirror as a source of

information about its body; i.e. what might be described loosely as a 'body-concept'. All that the animal needs to know about itself is that its body is distinct from the rest of the world, including the bodies of other animals. Or, to put it more precisely, the animal needs to be able to distinguish, across a fairly broad range, sensory inputs resulting from the physical state and operations of its own body, from sensory inputs originating elsewhere. If it could not do this, then presumably it could not learn that when it is standing in front of a mirror, inputs from the mirror correlate with inputs from its body. However, it is equally true that if the animal could not distinguish extraneous visual input from visual and kinesthetic feedback from its own body, then it would constantly bump into things. Most vertebrates are capable of avoiding collision with objects and other animals, so it is clear that, whether they can use a mirror or not, they have this capacity.

This brief analysis of what an animal needs to know about itself in order to engage in mirror-guided body inspection indicates that any failure to do so is very unlikely to be attributable to a lack of the requisite self-knowledge. Furthermore, it shows that there is absolutely no reason to suppose that an animal that can use a mirror in this way will also be able either to contemplate its own mortality, or to appreciate that its reflection resembles the way in which it is viewed by conspecifics (contra e.g. Gallup 1977; Suarez & Gallup 1981; Povinelli et al. 1990; Gallup & Suarez 1991). These are no more than intuitions entrained by labelling the necessary self-knowledge a 'self-concept'. Following James (1910), humans with a 'self-concept' are commonly assumed, not only to know where their body ends and the rest of the world begins (the 'material' self), but also to have certain beliefs about their fate and moral standing (the 'spiritual' self), and about the way in which they are regarded by others (the 'social' self). While it may well be true that these three types of knowledge or belief co-exist in humans, there is no necessary, logical link between them. If an animal can use a mirror as a source of information about its body, this no more implies that it has wondered whether it will die, than that it has wondered about its role in the national economy. Both potential ponderings seem to presuppose that the thinker is a distinguishable physical entity, and neither would be in any sense necessitated by an apprehension that it is such an entity. Similarly, a chimpanzee that could use a

mirror as a source of information about its body might also appreciate that its reflection resembles what other chimpanzees see when they look at him. However, this is no more implied by mirror use than is knowledge of what a fly sees when it looks at him. We humans know that when an animal looks at its mirror image it is looking at a mortal beast, and at something very similar to what conspecifics see when they view that individual. However, to use a reflection of its own body the animal itself does not need to know these things any more than it needs to know that it is looking at an animal with 24 pairs of chromosomes and a high encephalization quotient.

An animal that could appreciate that its reflection resembles the way in which it is viewed by others would be capable of attributing mental states, of having beliefs about the beliefs of others, or a 'theory of mind' (Premack & Woodruff 1978). Several authors (e.g. Gallup 1977; Suarez & Gallup 1981; Povinelli et al. 1990; Gallup & Suarez 1991), assuming that mirror-guided body inspection requires a kind of self-knowledge that would encompass this ability, have suggested that the results of studies of mental state attribution in primates support the claim (e.g. Gallup 1970) that chimpanzees can, and monkeys cannot, use a mirror as a source of information about their own bodies. These studies purport to show that chimpanzees are better able than monkeys to deceive, and to engage in other behaviour which seems to involve mental state attribution (e.g. Whiten & Byrne 1988; Cheney & Seyfarth 1990; Povinelli et al. 1990). If there were a tight correspondence between mirror use and mental state attribution, if, across a broad range of species, it were found that animals that could do one could invariably do the other, then it might be argued that although there is no logical link between them, the capacity for mirror use implies the capacity for mental state attribution and vice versa. In fact, no such relationship has been shown to exist. Like the mirror experiments reviewed above, studies of mental state attribution in primates have uniformly failed to provide evidence of the target capability in any primate species (see Heyes 1993, *in press* for a review). Furthermore, since many autistic children, who cannot attribute mental states, begin to engage in mirror-guided body inspection at the same age as normal children, it is clear that these two capabilities are dissociable in human ontogeny (Ungerer 1989).

Novel Displaced Visual Feedback

How, if not with reference to a self-concept, could we explain species differences in the capacity to use a mirror as a source of information about the user's body? To answer this question it is necessary to re-examine the kind of stimulation provided by a mirror image. Gallup (e.g. 1977) described it as 'self-sensation', and concluded that its use requires a self-concept. This is an unsatisfactory description (and consequently an unsatisfactory conclusion) because mirrors are not distinctive in providing self-sensation. Animals are receiving self-sensation, sensory inputs generated by the state and operations of their own bodies, much of the time, for example, whenever they look at any part of their bodies, scratch themselves, or vocalize. What distinguishes mirror image stimulation from other, naturally occurring varieties of self-sensation is that it consists of novel, displaced visual feedback on the animal's physical state and behaviour. It is 'feedback' by virtue of its contingent relationship with the animal's state and behaviour, and it is 'displaced' in that the image is not spatially contiguous with the body it represents. Natural phenomena, such as shadows and still, clear pools of water have the potential to provide similar input, but mirror image stimulation may be said to be 'novel' in that, prior to mirror exposure, neither the animal itself nor its ancestors is likely to have had extensive experience of displaced visual feedback.

There are studies showing that both chimpanzees (Savage-Rumbaugh 1986) and rhesus monkeys (Rumbaugh et al. 1989) can use novel, displaced visual feedback to guide hand movements, and these are the basis for my hunch that evidence of mirror-guided body inspection will eventually be obtained. Throughout the monkey experiment, each animal had one hand on a joystick which was attached to the base of a video monitor. The movements of a cursor on the screen were contingent upon movements of the joystick, and the animal was rewarded initially for bringing the cursor into contact with stationary, and then moving, targets on the screen, and subsequently for pursuit tracking, i.e. maintaining contact between the cursor and a moving target. When they were required to track the cursor for 1 s the performance of both monkeys was errorless on approximately 90% of trials, and even when the tracking duration was as long as 10 s, they were correct on 65% of trials. This success in the tracking task required the animal to keep its

eyes on the screen and to use the cursor position as a source of novel, displaced, visual feedback on the position of its hand.

When mirror-guided body inspection is construed as the use of novel, displaced, visual feedback, these results suggest that evidence of mirror-guided body inspection will be found in both chimpanzees and monkeys. However, giving the mark-test experiments the benefit of all doubts, let us suppose that they showed that the chimpanzees did, and the monkeys did not, use the mirror as a source of information about their own bodies. How could this be explained? Clearly one possibility is that the monkeys were capable of using the mirror in this way, but that in the test context they had insufficient motive to do so. Thus, the monkeys may have detected the contingency between features of their own body and those of the mirror image, and consequently known that they had a mark on their head, but cared too little about this mark to bother to touch it. Note that in the pursuit tracking task (Savage-Rumbaugh 1986; Rumbaugh et al. 1989) the animals were compelled to use the displaced visual feedback in order to obtain the food reward.

Another, more testable, hypothesis is suggested by rodent data indicating that some behaviour patterns yield more intrinsic feedback than others, and that enhancement of this feedback can help to bring a behaviour under contingency control (Pearce et al. 1978; Morgan & Nicholas 1979; a similar hypothesis was advanced by Epstein et al. 1981). The monkeys may not have detected the relevant contingencies because they did not receive, or did not attend to, direct feedback from their bodies while viewing the mirror image. The mark-test experiments indicate that, after initial exposure, monkeys and chimpanzees do different things as they stand in front of the mirror. The social behaviour exhibited by monkeys may yield less intrinsic feedback than the auto-grooming behaviour exhibited by chimpanzees, and the monkeys may process the feedback that they do receive less thoroughly because they are more emotionally aroused.

If experiments confirmed this hypothesis, it would still be necessary to explain why chimpanzees and monkeys behave differently in front of mirrors. Gallup (e.g. 1970; Gallup & Suarez 1991) claimed that it is because the monkeys think that the image is another animal while the chimpanzees realize that it is themselves, but this is not a satisfactory explanation, for two reasons. First, it fails

to explain how a chimpanzee arrives at the belief that the image is itself, and why a monkey does not. Even if we assume (without justification) that chimpanzees have, and monkeys do not have, the requisite variety of self-concept, the question remains as to how a chimpanzee might reach the conclusion that the mirror stimulus represents the content or object of that concept. It seems inevitable that this conclusion would be reached, if at all, as a result of learning that, unlike for example those of conspecifics, changes in the mirror stimulus are contingent upon changes in the animal's own body. Thus, identification of the mirror-image as 'self' rather than 'other' might be a consequence, but not a cause, of the kind of behaviour exhibited in relation to the mirror.

Second, Gallup's explanation is unsatisfactory because an animal that grooms in front of a mirror, even one that uses the mirror to guide grooming, may perceive the image as 'mirror beast', a cold, flat, odourless creature; or as 'cool copycat', a cold, flat, odourless creature that is a near-perfect mimic. Under the influence of such a perception, an animal might touch its brow thinking 'He's got a mark on his head; I wonder whether I have too'. The purpose of this rather fanciful illustration is to show that, far from being a natural consequence of identification of the image as self, mirror-guided body inspection does not even imply that self-identification has resulted from interactions with the mirror. To test the 'mirror beast' and 'copycat' hypotheses it would be necessary, for example, to find out whether primates touch their brows on being confronted with a familiar, brow-marked conspecific; and to examine the effects on mark-test performance of exposure to mirror-image-like stimuli the movements of which are related in various ways to those of the subject. Experiments of the latter kind, in which infants are shown pre-recorded videos of themselves, have already been conducted by human developmentalists (e.g. Bigelow 1981).

Returning to the question of why monkeys and chimpanzees may differ in their capacity to use mirrors as sources of information about their bodies, it should finally be noted that the difference may be 'central'. That is, even when monkeys receive and attend to direct and mirror feedback, they may be unable to detect the relationship between them. Given that monkeys are successful in Rumbaugh's pursuit tracking task (Rumbaugh et al. 1989), this is unlikely to be a simple con-

sequence of either the novelty or displacement of mirror feedback. However, it is conceivable that either the left-right reversal of mirror stimulation (Tobach 1987), or its isomorphism with direct visual feedback, might cause special problems for monkeys.

CONCLUSION

I have argued that mirror experiments have not provided evidence in any primate of mirror-guided body inspection, or self-recognition, and that even if they did, any species differences in this capacity could not be explained in terms of the possession of a self-concept. If these arguments are valid, then why has it been thought otherwise for more than 20 years? I think that three prejudices, or currents of thought, have conspired to make the self-concept interpretation seductive.

First, the methods and reasoning involved in primate mirror experiments may not have been subjected to close scrutiny because their results, which apparently show that a self-concept is possessed by two great apes, are consistent with anagenetic (Rensch 1959) and scala naturae assumptions about the evolution of intelligence (Hodos & Campbell 1969; Campbell & Hodos 1991). If similar experiments had been claimed to indicate that clams and toads, or even cats and monkeys, were unique among non-human animals in possessing a self-concept, then they may have been viewed more critically.

Second, 'self' is rather a slippery word with at least two, confusable meanings. Sometimes we use it to divide nature into two, unequal parts; that which belongs to, or is physically part of some object, and that which is not. For example, an oven is 'self-cleaning' if it stays clean without the intervention of things (e.g. cloths, chisels) that are not part of the oven. Thus, with respect to cleaning, the oven constitutes a 'self', and everything else is 'other'. At other times, we use 'self' to refer to the hypothetical essence of a human being, their identity, or ego, what makes them a person and distinguishes them from all other people. It is possible that these two meanings of 'self' have become confused in the interpretation of primate mirror experiments. To engage in mirror-guided body inspection (and to avoid bumping into things) an animal must recognize that it is a 'self' in the former sense; i.e. it must be able to distinguish its own body from the rest of the world. However,

owing to the ambiguity of the word 'self', this may have beguiled us into thinking that the animal must also have, and recognize that it has, an 'essence'.

Finally, the claim that experiments with mirrors reveal evidence of a self-concept may be compelling because for centuries mirror metaphors have been used to encapsulate the properties of the 'mind', 'self' or 'soul' (Rorty 1979). Although his writing was seldom derivative, Shakespeare was no more than conventional in portraying the human essence as 'glassy', and the subterranean influence of this metaphor may have made it seem natural to regard the use of certain reflections as evidence of reflection.

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