Part I

Comparative and developmental approaches to self-awareness
1 Expanding dimensions of the self: Through the looking glass and beyond

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...any animal whatever, endowed with well-marked social instincts, the parental and filial affections being here included, would inevitably acquire a moral sense or conscience, as soon as its intellectual powers had become as well, or nearly as well developed, as in man.

– Darwin (1871, p. 472)

Introduction

Darwin’s conjecture that morality is an epiphenomenon of intelligence is consistent with increasing evidence that self-awareness depends upon cognitive and affective capacities present in only a few species. The connection between self-awareness and morality, of course, is that conscience is a manifestation of self-awareness. If we follow Darwin’s lead and compare the manifestations of self-awareness and their development in species closely related to humans, we may be able to begin to trace the evolution of self-awareness. In order to compare kinds and degrees of self-awareness, of course, we need a system for classifying the phenomenon and a method for diagnosing its manifestations. Ideally the classification system will allow us to identify a broad range of self-related phenomena so that we can compare many species and thereby reconstruct the evolutionary history of self-awareness and self-knowledge.

This volume grew out of a 1991 conference on self-awareness in monkeys, apes, and humans at Sonoma State University in Rohnert Park, California. A major goal of the conference was to bring together investigators who espoused opposing viewpoints on a variety of issues relating to self-awareness. Various chapters in this volume reflect quite different, and in some cases divergent, views regarding the following issues:

1. the capacity of various species for self-awareness, especially whether gorillas, macaques, dolphins, and pigeons display mirror self-recognition (MSR);
2. the nature of cognitive correlates of self-awareness, specifically, the developmental relationship between self-awareness and imitation, object permanence, theory of mind (ToM), and other abilities;
3. the influence of various rearing conditions on the capacity for MSR;
4. the validity of various methodologies for discovering self-awareness; and
5. the evolution and adaptive significance of MSR.

Another major goal of the conference was to bring developmental and comparative psychologists together with biological anthropologists to discuss the mutual implications of their theories and methodologies for studying the phenomenon of self-awareness across species. In accord with this goal, the conference highlighted the contributions of two pioneers in studies of self-awareness: Gordon G. Gallup, Jr., the comparative psychologist whose methodology has dominated comparative research on self-awareness for the past 20 years; and Michael Lewis, the developmental psychologist whose studies of the development of self-awareness in human infants and children have set the direction of developmental studies in this domain.

Mirror self-recognition as an index of self-awareness

In 1970 Gallup published his landmark paper on mirror self-recognition in chimpanzees, detailing a controlled methodology for verifying whether or not an animal recognizes itself in a mirror (see Gallup, SAAH3).1 In primates, studies of self-awareness as measured by mirror self-recognition have revealed that, in addition to humans, chimpanzees and orangutans – and possibly gorillas – display this ability, whereas monkeys and prosimians do not. A recent study (Hyatt & Hopkins, SAAH15) provides preliminary evidence that bonobos (pygmy chimpanzees) also are capable of MSR. The discovery of MSR in great apes has been a watershed in comparative psychology, especially coming toward the end of a period that denied the existence of mind in animals and humans. After two decades of research, however, the results of Gallup’s test are raising new questions.

Following 3 days of presentations, many participants in the conference on which this volume is based agreed that MSR is a far more complex phenomenon than was apparent. Important questions are raised by two sorts of ambiguities in the responses of various species to tests for MSR. On one hand, the mark test gives ambiguous positives: Evidence was presented that both human children and great apes experience considerable instability in the development of mirror self-recognition (see, e.g., Miles, SAAH16; Mitchell, 1993; also see Guillame, 1926/1971; Zazzo, 1982), sometimes reaching behind the mirror or calling their own image by the name of a sibling or friend after engaging in the self-directed behaviors, especially mark-directed behaviors, that have been considered definitive proof of MSR. Likewise, macaques, which do not spontaneously engage in other self-directed behaviors in response to mirrors, have apparently engaged in mark-directed behaviors (e.g., see Boccia, SAAH23; Thompson & Boatright-Horowitz, SAAH22).

On the other hand, the mark test gives ambiguous negatives: Evidence was presented suggesting that great apes and human children who show other signs of self-awareness sometimes fail to engage in mark-directed behaviors...
in response to mirrors, whether out of self-consciousness or embarrassment (e.g., Lewis, conference presentation; Patterson & Cohn, SAAH17; Swartz & Evans, SAAH11), or lack of self-recognition. This evidence is particularly significant given the repeated failure of gorillas to pass the mark test (Ledbetter & Basen, 1983; Suarez & Gallup, 1981). These puzzling negative results must be reconciled with videotape evidence for MSR in Koko, the language-trained gorilla, as well as reports of MSR in other gorillas (Law & Lock, SAAH20; Parker, SAAH19; Patterson & Cohn, SAAH17; Swartz & Evans, SAAH11).

The gorilla question

As has been indicated, conflicting reports regarding the gorilla’s capacity for MSR pose an intriguing problem. Observations of spontaneous mirror behaviors of the language-trained gorilla Koko that suggested MSR (Patterson, 1978, 1984) had been discounted by most but not all investigators because of their anecdotal nature (Povinelli, 1987). Nevertheless, because gorillas are close relatives of the other great apes, all of whom display MSR, and because gorillas are like the other great apes in their capacity to learn symbols (e.g., Patterson, 1980) and use tools (e.g., Maple & Hoff, 1982), investigators have been surprised at the negative results of MSR experiments. Gallup (SAAH3) and others (Povinelli, SAAH18) have attempted to explain the negative results by arguing that gorillas differ from other great apes in their mental abilities.

The conference provided a forum for the presentation and discussion of videotapes of the language-trained gorillas, Koko and Michael, responding to their mirror images in sham-marking tests as well as in spontaneous encounters (see Patterson & Cohn, SAAH17). These videotapes convinced most of the participants including Gallup himself that at least one gorilla, Koko, is capable of MSR (see Gallup, SAAH3; Povinelli, SAAH18).

Given the close phylogenetic relationship of the great apes, it seems clear that the capacity for MSR must have been present in the common ancestor of the clade, and hence that it must either be present in gorillas or have been lost subsequent to gorilla divergence (Parker, 1991; Povinelli, 1987, SAAH18). Povinelli concludes that gorillas have lost the capacity for MSR and that Koko’s performance reflects induction through special enriched rearing conditions. An alternative interpretation is that the environments of cross-fostered gorillas and naturally fostered gorillas are equally enriched as contrasted with the environments of solitary reared laboratory animals. Parker (SAAH19) expresses this perspective in her chapter, concluding that gorillas have probably retained the capacity for MSR.

Patterson & Cohn (SAAH17) note that the shy, almost secretive nature of gorillas may inhibit overt responses to the mark. Although their observations suggest some lines for future investigation, the question of why gorillas perform so poorly on MSR tests remains unresolved. Swartz & Evans (SAAH11)
report the case of one Florida zoo gorilla, King, who showed MSR, but also note the failure of the gorillas in their group in Gabon to display MSR, and the lower frequency of interest in mirrors displayed by gorillas as compared to chimpanzees.

The macaque question

The conference was also a forum for discussion of the surprising claim that some macaque monkeys pass the face mark test (see Boccia, SAAH23; Thompson & Boatright-Horowitz, SAAH22). Boccia suggests that the rarity of this phenomenon in macaques reflects the fact that individual variation is greatest at the margins or limits of a species’s abilities. Videotaped sequences of macaque responses to face marks raised several interesting questions about the adequacy of the mark test for assessing the kind of self-awareness seen in great apes. For Gallup (SAAH3), they raised questions about the adequacy of the methodologies used in these studies; for Boccia (SAAH23), about the adequacy of prior methodology for eliciting MSR is macaques. Like several other investigators, Boccia stresses the importance of long-term exposure of monkeys to mirrors, although the same is not true for apes (see Boysen, Bryan, & Shreyer, SAAH13; Parker, SAAH19).

Questions regarding the adequacy of the mark test for assessing ape like self-awareness arise in this context because macaques fail to display the suite of cognitive abilities that various investigators have associated with self-awareness: imitation, symbol use, role reversal, and deception. Participants agreed with Gallup that the mark test cannot be the sole criterion for self-awareness because of the possibility that the performance is a fluke, or that it is an artifact of training (see Gallup, SAAH3; Thompson & Contic, SAAH26).

These videotapes also raised questions about the adequacy of the mark test to diagnose different, nonhominoidlike forms of self-awareness. Although the behavior of monkeys in front of mirrors generally indicates that they fail to recognize themselves (Anderson, SAAH21), several investigators have suggested that macaques (Boccia, SAAH23; Itakura, 1987; Platt & Thompson, 1985), baboons (Benhar et al., 1975), marmosets (Eglash & Snowdon, 1983), and perhaps some other monkeys may have some kind or degree of self-recognition. In particular, Mitchell (SAAH6) as well as Parker and Milbrath (SAAH7) argue that the purported absence of self-awareness in monkeys may be an artifact of the inadequacy of our current models and methodologies.

Several perspectives on self are proposed that may provide new insights into more primitive forms of self-awareness than those displayed by the great apes. Mitchell (SAAH6) distinguishes perceptual, imaginal, and evaluative aspects of self, and proposes that only the first two aspects may be present in monkeys, whereas all three are present in great apes (although the evaluative form occurs in the great apes only in the most rudimentary form). Parker and Milbrath (SAAH7) propose comparative use of a social/developmental
Expanding dimensions of the self

perspective focusing on the processes by which imitative and role-playing games develop self-awareness.

A comparative developmental perspective reveals that the mirror-related behaviors reported in macaques parallel several behaviors characteristic of human children that precede facial self-recognition (Boccia, SAAH23; Lewis & Brooks-Gunn, 1979; Platt & Thompson, 1985; Thompson & Boatright-Horowitz, SAAH22). These include social behaviors (facial and postural displays), body movements, body-directed movements (Boccia, SAAH23; Itakura, 1987), mirror-mediated reaching (Anderson, 1986), and mirror-mediated threat responses (Eglash & Snowdon, 1983) as well as other social responses to other monkeys (Boccia, SAAH23). This suggests that monkeys may display body self-awareness comparable to human children less than a year old.

In conclusion, the macaque studies point to two additional limitations of the mark test: First, data from the mark test do not in themselves indicate the capacities underlying MSR in human children and great apes. Second, because the test results are dichotomous (an animal either passes or fails), the mark test does not tap whatever capacities for self-awareness might exist in species that fail to display MSR. In response to their desires to overcome these limitations, contributors and other investigators have begun looking to alternative means of identifying self-awareness that will reduce ambiguity and give greater insight into the cognitive correlates of MSR, as well as of providing insights into simpler forms of self-awareness that may exist in monkeys and other mammals.

The dolphin question

Quite serendipitously, the conference also became a forum for discussion of self-awareness in dolphins. Given their popular reputation for intelligence, dolphins are natural candidates for studies of MSR. Although dolphins are mammals, their adaptation to aquatic habitats has involved significant divergence from primates and other nonaquatic mammals in many motoric and information processing capacities. These dolphin-specific patterns challenge researchers who wish to study MSR. Two chapters in this volume report efforts to tailor MSR studies to dolphins; both report that some dolphins display behaviors suggestive of MSR, including contingent head and mouth movements and mark-revealing movements (see Marino, Reiss, & Gallup SAAH25; Marten & Psarakos, SAAH24).

This result is not surprising given that like great apes, dolphins have large brains, a prolonged period of immaturity, the ability to learn symbol systems (Herman, 1980), engage in shifting coalitions, and display tool use and social imitation (Tayler & Saayman, 1973). Reports that dolphins have individual signature whistles (Caldwell & Caldwell, 1965) and that they may use the signature whistles of other animals referentially suggests that they may also
use their own signature whistles self-referentially. If so, they would constitute the only nonprimate to use symbols.\textsuperscript{2}

The pigeon question

The significance of MSR as an index of self-awareness in chimpanzees has been challenged in a paper by Epstein, Lanza, and Skinner (1981), which reports success in training pigeons to peck at a spot on their bodies that could only be seen with the aid of a mirror (see Gallup, \textit{SAAH3}; Thompson & Contie, \textit{SAAH26}). On the basis of their results, Epstein et al. suggest that MSR is solely an artifact of training. In their chapter, Thompson & Contie (\textit{SAAH26}) report on the results of their replication of this experiment, as well as on spin-off experiments designed to parse out various factors underlying the pigeons’ behavior. These investigators have failed to replicate the results reported by Epstein et al. They attribute their failure to elicit the MSR response in pigeons to that species’s dependence on narrowly construed matching rules and their inability to understand symmetry and identity relations understood by chimpanzees and children. Thompson & Contie argue that, although monkeys can be trained to use simple identity relations, they do not show the spontaneous propensity for identity relations that chimpanzees do. They end their discussion with a provocative comment on the significance of the difference between spontaneous, internal motivation and enforced, external motivation in regard to test performances in great apes versus monkeys and pigeons.

Robots and the broader comparative question

Philosophers have been arguing the question of whether machines can be designed to have consciousness. Some, like Searle (1988) have argued that they cannot, while others, like Dennett (1991), have argued that they can. One of the participants in our conference, who did not contribute to this volume, is a systems engineer with experience designing robots for the U.S. Navy. Michael Fehling’s research suggests that certain constraints operate in all agents capable of acting purposefully, making decisions, and solving problems, whether these agents be animals or robots.

Among the constraints operating on such agents, also noted by Dennett (1991), is the necessity for distinguishing self-generated actions from other-generated actions. One of the intriguing convergences in the conference was that between Fehling’s and Watson’s models for the development of self-detection in human infants. Watson’s approach (\textit{SAAH8}) provides an interesting model for the design features underlying self-detection, which precedes self-recognition and other forms of self-awareness in human development.

Robot design speaks to one of the greatest challenges facing comparative evolutionary psychologists, that is, the need to develop comparative frameworks capable of identifying simpler forms of self in mammals and even in
Expanding dimensions of the self 9

nonmammalian vertebrates and more distantly related life forms. The chapters by Lewis and by Watson provide tantalizing clues to future directions. Whereas Watson distinguishes self-detection from self-recognition, Lewis distinguishes the machine self from the me-self – the idea of the self. Like Dennett (1991), he points to the biological necessity for distinguishing self from nonself at various levels of organization: the cellular level, the proprioceptive level, and so on. The machine self is ubiquitous among animals, while the idea of the self is apparently unique to great apes, humans, and dolphins.

Use of developmental models in comparative research in self-awareness

The conference was convened on the idea that models from developmental psychology constitute one of the most promising sources for comparative models of self-awareness (see, e.g., Anderson, 1984; Gallup, 1979). Various developmental models of self-awareness, for example those published by Lewis and Brooks-Gunn (1979), Baldwin (1894/1903), and Guillaume (1926/1971), have already stimulated both comparative studies and theoretical models of self-awareness. Lewis and Brooks-Gunn’s descriptions of contingent play with facial expressions associated with passage of the face mark test in human infants, for example, have stimulated an anecdotal report that zoo gorillas may recognize themselves in mirrors (Parker, SAAH19), and developmental studies of self-recognition in chimpanzees (Boysen, Bryan, & Shreyer, SAAH13; Custance & Bard, SAAH12; Lin, Bard, & Anderson, 1991). Parker (1991) has also used Lewis and Brooks-Gunn’s model and Piaget’s imitation series as a basis for the hypothesis that MSR in apes is based on the capacity for facial and gestural imitation. Boccia, in contrast, has used Bertenthal and Fischer’s (1978) model for the development of mirror self-recognition in human infants in her experimental paper on self-recognition in macaques (Boccia, SAAH23). More recently, Cameron and Gallup (1988) have studied the development of shadow self-recognition in human children, and Boysen, Bryan and Shreyer (SAAH13) have used their technique to study this phenomenon in chimpanzees. Mitchell (1993) has used Guillaume’s idea of kinesthetic–visual matching as a basis for one of his models of MSR. In contrast, Gallup (e.g., 1983) and other comparative psychologists have suggested that MSR in great apes is associated with a capacity for theory of mind.

While most of the studies of self-awareness in primates that draw on developmental models are nondevelopmental, we are pleased to include several studies of the development of self-awareness in great apes in this volume: The two studies of language-trained great apes draw on longitudinal data on single subjects (Miles, SAAH16; Patterson & Cohn, SAAH17) as does Gómez’s (SAAH5) discussion of mutual awareness in gorillas. In contrast, the developmental studies of laboratory animals depend upon cross-sectional data
on several animals of various ages (Boysen, Bryant, & Shreyer, SAAH13; Custance & Bard, SAAH12).

Developmental models are useful in comparative studies when they trace the origins of behaviors from their simplest nonverbal beginnings, and when they entail sequential transformations in which each succeeding ability depends upon the preceding ability (Mitchell, 1987; Parker, 1990). Such models are particularly useful from the comparative perspective when they address individual variation and when they propose causal models.

A comprehensive developmental study of self-awareness in human infants that addresses many of the issues conference attendees raised in regard to comparative studies was published in 1979 by one of the main speakers at the conference, Michael Lewis (and his associate, Jeanne Brooks-Gunn). This large-scale, controlled study assessed manifestations of self-recognition in four modalities:

1. recognition of mirror representations of self;
2. recognition of videotape representations of self and others;
3. recognition of pictorial representations of self and others from photographs;
4. verbal labeling of pictures of self and others.

In the mirror and videotape modalities, they used the following behavioral measures: attention, facial expression, vocalization, and imitation. In the mirror modality they also distinguished mirror- and self-directed (including mark-directed) behaviors, studying reactions to the self and the mother in counterbalanced face-marked and -unmarked conditions. In the videotape modality they also distinguished contingent play. Two controlled studies were done in each modality.

In the mirror study they found that smiling and cooing remained constant across age groups, body-directed behaviors decreased across the 15–18- to the 21–24-month groups, while silly faces and mark-directed behaviors increased from zero to moderate frequencies across the 9–12- to the 15–18-month group, and continued to increase across the 15–18- to the 21–24-month group. The face-marked condition infants displayed increased interest in the mirror image and increased silly and coy behavior as well as face touching; no face touching was seen in infants younger than 15–18 months, however. Some infants in the older age groups failed to touch the face-mark, but commented on it.

In the videotape study infants responded with contingent play (making faces, sticking out their tongues, and playing peekaboo) to live (on-line) images of themselves, while they responded with imitation to delayed images of themselves and to other infants. The incidence of contingent play peaked between 15 and 24 months. The incidence of contingent play in both the mirror and video studies led the investigators to conclude that “contingent play is not a precursor but rather an indicator of self-knowledge” (Lewis & Brooks-Gunn, 1979; p. 109). The incidence of imitation in these studies led
Expanding dimensions of the self

them to a similar conclusion about imitation. On the other hand, contingency play and imitation preceded recognition of specific perceptual features.

In the pictorial study, the investigators measured the infants’ visual fixation, positive affect and spontaneous vocalizations in response to pictures of themselves and others of the same and older ages of both genders, including strangers and familiars. In the verbal labeling study, in which they were asked to label pictures of themselves and others, infants used their own names at 15–18 months, but did not use personal pronouns to refer to themselves or others until 21 or 22 months of age.

Over all, Lewis and Brooks-Gunn found a consistent age trend toward self-recognition by all of their measures. They also found a consistent trend toward concurrent recognition of age and gender categories in others. Although they were unable to definitively identify the “causes” of MSR, analysis of cognitive correlates of self-recognition suggested that contingency play was the most significant correlate of self-recognition, and that sixth-stage object permanence, though necessary, was not sufficient. They also concluded that although contingency mediated the emergence of self-awareness, the ability to recognize the self independent of contingency was the next major milestone in the development of self-awareness. Contingency self-recognition was the origin of the existential self, whereas feature self-recognition was the origin of the objective self.

In the 1979 study and in his subsequent work, Lewis (SAAH2) has emphasized the developmental relationship between social emotions and self-awareness: In subsequent work, he notes that the self-conscious emotion of embarrassment arises by 2 years of age, coincident with MSR, while the self-evaluative emotions of shame, guilt, pride, and hubris arise at about 3 years of age, coincident with the internalization of standards of conduct (Lewis et al., 1989). Later cognitive achievements in middle childhood and adolescence lead to the development of consensual, and later principled, morality (e.g., Kohlberg, 1984; Piaget, 1965) (see Table 1.1) Developmental studies confirm Darwin’s intuition that morality is a product of cognitive processes operating in a social context.

Imitation and the social matrix of self- and other-awareness

Lewis’s work highlights the importance of the social context in the development of self- and other-awareness. Although our conference lacked sociologists and social psychologists, six of the presentations focused on social aspects of self-awareness: Hart and Fegley (SAAH9) present evidence that MSR in human infants is preceded developmentally by social imitation specifically (as opposed to object imitation); Gopnik and Meltzoff (SAAH10) present developmental data from imitation and theory-of-mind research to show that self-awareness and self-concepts develop hand in hand with other-awareness and concepts of others (also see Lewis & Brooks-Gunn, 1979). Parker and Milbrath (SAAH7) elaborate a Meadian model to argue that self-awareness