

Marine Mammals in Front of the Mirror—Body Experiences to Self-Recognition: A Cognitive Ethological Methodology Combined with Phenomenological Questioning

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Abstract

Various research programs study and analyze self-recognition and self-consciousness in animals and humans. This article briefly presents and discusses experiments investigating self-recognition in several marine mammal species and aims to introduce a new dual conceptual framework that could be a useful tool to understanding complex phenomena like self-recognition and self-consciousness.

Results of previous studies show that some marine mammal species can recognize their image in a mirror while others cannot. This discontinuity, also present in nonhuman primates, leads one to question the genesis and nature of the individual's relation to the self.

The relation of a subject to its environment is strongly associated with its perception of its own body. Sensorimotor interface of the subject enables it to get significant and relevant information from the environment; it then builds sense (meaning) through this particular relation. The complexity of underlying philosophical and ethical stakes related to this topic may demonstrate a need for multidisciplinary approaches. A recent attempt to point out the benefits of combining an ethological approach with phenomenological questioning has already been made (Delfour & Carlier, 2004). On one side, ethology takes an external perspective on the subject by studying and analyzing behaviors in the context of specific stimuli of the environment. On the other side, phenomenology allows a double "opening" (i.e., access) of subjectivity to the world and to others with an embodied, temporal, and imaginative consciousness (Merleau-Ponty, 1945).

This paper describes the theoretical and conceptual difficulties in studying self-recognition and self-consciousness in animals and reports on some major epistemological and methodological pitfalls to these studies.

Key Words: self-recognition, cognitive ethology, phenomenology, marine mammals

Introduction

In their study of animal cognition, Premack & Woodruff (1978) began their analysis of animal consciousness and cognition by observing and studying the animals' natural behaviors. They were the first to talk about "theory of mind." Others, like Dennett (1976, 1983), used another operational strategy called adopting an "intentional stance." The ascent through the levels of this stance leads an observer to describe lower to higher levels of intentionality, the highest of which only occurs if there is a mental representation of a mental representation (Dennett, 1987). In both approaches, it is presumed that the simplest form of consciousness is pure sensation (without any representation of an object or of the self). Self-consciousness appears in reflection, where consciousness intentionally refers to itself (in other words, when one is conscious of one's own conscious state). This ultimate level corresponds to Premack & Woodruff's (1978) "theory of mind" and to Dennett's "highest level." By showing in a subject its capacity to recognize itself based upon its own mirror reflection, we demonstrate the existence of the knowledge the subject has of its own physical appearance. This capacity has several implications regarding knowledge/cognition in which the recognition of the body is associated with a relation of identification/individualization to the alter ego (i.e., the other who is, at the same time, similar to and different from me), and it can be analyzed through various perspectives. For instance, Browne (2004) recently discussed such self-knowledge from a metacognitive perspective, revealing its complexity and its relationship to a self-conscious reflection.

In order to properly investigate the existence of any form of self-recognition in animals, a theoretical prerequisite is needed—the animal must be considered as a subject. Historically, occidental culture remains greatly influenced by René Descartes's dualism (see Mazliak, 2006), which distinguished the body (automat, without

any thoughts) from the soul (an emanation of God and the location of mental life). The body is *res extensa*: an extended thing with geometrical properties. While other animals had bodies, only humans also had a soul and occupied *ipso facto* the top of the evolution pyramid. Consequently, the question of consciousness in animal-machines did not make any sense. This mechanist conception of animality did not permit non-observable facts and contributed to the development of modern biology based upon observable facts and experiments.

The 19th century saw the emergence of a new philosophical current: “phenomenology.” Its representatives were Franz Brentano; Edmund Husserl, who emphasized the limits of cartesianism; and Martin Heidegger. According to these philosophers, the “phenomenology of life” can be described as “science of phenomena” since “phenomena” means “what appears – or – what is apparent” in Greek and “logy” is “knowledge, science.” In this philosophy, “appearance” is the key. Phenomenology studies the appearances of things, things as they appear in our experience, or the ways we experience things, thus the meanings things have in our experience. This discipline investigates conscious experience as experienced from the subjective or first person point of view. Following this emergence, a new “phenomenological psychology” appeared and was developed by Erwin Straus (1935), Jakob von Uexküll (1956), and Frederik Jacobus Buytendijk (1958). These researchers pursued a human-animal psychology by applying psychological concepts to animals. They chose the phenomenological approach to study the animal’s own perspective on its environment and rejected experimental situations and mechanist models. This approach remained marginal, however, and the dominant 19th and 20th century scientific communities shifted away from considering the psychology of animals. For example, in the 1920s, John Watson helped establish Behaviorist psychology by focusing on explaining behavior through associative and conditioning processes, and purposely forgot to open the “black box.” Even ethology, as first developed in the 1930s by Konrad Lorenz, demonstrated the existence of behavioral invariants (instincts) in animals that seemed to suggest a lack of complex mental representation (Lorenz, 1950). Early ethologists’ works mainly focused on determining and emphasizing the specific characteristics of various animal species by adopting an external point of view in regards to the animals.

Alternatives slowly emerged, however, including “cognitive ethology” in the 1970s (Griffin, 1976) that suggested other possible perspectives on animals and their relation to the environment. This approach mainly employed empirical

techniques and looked at underlying subjective aspects and associated conscious states. In addition, in the 1980s, Donald Griffin began to argue for the existence of conscious states in several organisms by rejecting Morgan’s Canon (the principle of parsimony), which had long been used as Behaviorism’s rationale. This movement was particularly strong in primatology. In the second half of the 20th century, some researchers studied the continuity of mental functions in animals and humans from a comparative psychological perspective (e.g., Vaclair, 1982; Seyfarth & Smuts, 1986).

Self-Recognition and Marine Mammals

Psychologists interested in development localize the beginning of the use and the understanding of symbolic function in young children between 1 to 2 y old. During this period, the child acquires the concept of object permanence. A Swiss psychologist, Jean Piaget, first introduced the concept in 1921. According to Piaget (1936), very young children did not understand that objects could still exist when not visible; they thought every object that had disappeared was out of existence. For them, their world is totally impermanent. Between 9 to 12 mo in age, the child learns to understand his or her own permanence as a person in time and space. This “existential Self” (Lewis, 1992) is built up and is able to act on the physical environment. Then, at about 2 y old, the child is able to understand that it is part of the environment as an “object” of this world. This is the stage of the “categorical Self.” The young human is able to place itself into categories. During this period, strangers frequently scare the child. Such behavior illustrates the relationship between the development of the symbolic function (concept of object, self-consciousness) and the capacity to identify an individual as a possible source of discomfort/hostility. That is, because of the emergence of the consciousness of an “alterity” (i.e., the recognition of the other in its difference), the child is able to make categories, to differentiate non-living vs living objects, and to recognize them. Zazzo (1969) and Fontaine (1992) demonstrated the child’s ability to recognize others in reality, or a mirror image of others, before being able to recognize his- or herself. Wallon (1945), a French philosopher, psychologist, and neuropsychiatrist, was the first to talk about “the mirror stage” in children. According to this author, at between 6 to 12 mo old, the emotional state appears to correspond to “affective symbiosis,” the interaction between the expression of the emotion and the ability to recognize oneself in a mirror. Lacan (1949) pursued this study and defined the “mirror state” as an emerging phase of self-consciousness,

including the role of the complete body image and the signification of the body in the identity constitution process. This newly acquired capacity to use the specular (mirror-based) image manifests itself when children who are placed in front of a mirror display self-directed behaviors and pass the mark test. In this test, a red mark is applied to the child's face without her or his knowledge, and then the child is placed in front of a mirror. Only 21-month-old children (and older) touch the mark on their faces, using the mirror to guide their movements. According to Lacan, the mirror stage helps the emergence of "the function of 'I'" and the "structuration of the body." As demonstrated by Tourette & Guidetti (2002), to know that who the child sees in the mirror is her- or himself, a child has to confront, but also to put in relation, different experiences—what it knows of its body (internally and externally) as well as what it sees in front of itself in the mirror.

In the early 1970s, Gallup demonstrated the existence of a similar stage in chimpanzees (*Pan troglodytes*). He suggested we could talk about self-recognition in any subject that is able to treat and analyze its mirror image as the reflection of itself and not as a conspecific (Gallup, 1970). The actual consensus states that anthropoid apes, like chimpanzees, bonobos (*Pan paniscus*), orangutans (*Pongo pygmaeus*), and, more controversially, gorillas (*Gorilla gorilla*) are able to pass the mirror mark test (Suarez & Gallup, 1981; Hyatt & Hopkins, 1994; Patterson & Cohn, 1994) and that monkeys show less convincing results even if they can use the mirror for "oblique looks" and to direct their motor actions to retrieve hidden food items (Anderson, 1986; Anderson & Roeder, 1989; Marchal & Anderson, 1993; Paukner et al., 2004). Other mammalian species have shown no evidence of mirror self-recognition, except one female Asian elephant (*Elephas maximus*), which very recently passed the test (Plotnik et al., 2006). In the 1990s, other researchers reiterated these experiments with marine mammals.

Dolphins and their relatives were expected to recognize themselves in a mirror (Parker, 1991; Mitchell, 1993a, 1993b) because they possess a rich and complex social life (Pryor & Norris, 1991). The conceptual processes, vocal and motor imitation, referential understanding, and mental representation have been investigated extensively in dolphins (see Herman, 2002), and they seem close to nonhuman primates (great apes) in their cognitive abilities (Marino, 2002). Dolphins also have a highly developed neural system, although one organized differently from human brains. The highly convoluted brains of many dolphins are significantly larger than the human brain. The bottlenose dolphin brain, averaging 1.7 kg, is about 25% heavier than the human brain. The comparison

of the actual brain size with that expected for the species body size, known as "encephalization quotient" (EQ), shows that modern humans have the highest EQ: about 7 (i.e., our brains are about 7 times the size one would expect for an animal of our body size), but many dolphins possess EQs in the 4 to 5 range, which is significantly higher than all other animals (Marino et al., 2001). Moreover, dolphins are multimodal animals (Marino, 2004) as intermodal intra-corporeal communication (i.e., capacity for sensory integration) is the basis for an inter-corporeal communication (Gallagher, 2000), and they also possess metacognition (cognition about cognition), which could possibly be the basis for one form of psychological self-awareness (Browne, 2004).

Materials and Methods

To study self-recognition in marine mammals, researchers have several tools such as the mirror test (a subject placed in front of a mirror is observed), the mark test (a subject is marked when it is asleep and then placed in front of a mirror), video sequences of a subject (real time vs playback videos), and, finally, the use of signature whistles.

None of the following research was done with food rewards, so all results were dolphins' voluntary actions.

The Mirror and Mark Tests in Cetaceans and Pinnipeds

The experiments concerned bottlenose dolphins (*Tursiops truncatus*) (Marino et al., 1994; Marten & Psarakos, 1994; Reiss & Marino, 2001), killer whales (*Orcinus orca*), false killers (*Pseudorca crassidens*), and sea lions (*Zalophus californianus*) (Delfour & Marten, 2001). The animals had access to a mirror or a reflective surface (reflective glass walls; Reiss & Marino, 2001) in their pool. The durations of the various mirror exposures differed greatly. The mirror, or reflective surface, exposure ranged from 495 min (Reiss & Marino, 2001) to 260 h for two dolphins (Marten & Psarakos, 1994, 1995); the mean durations were respectively, 758 min for the killer whales, 54 min for the false killer whales, and 100 min for the sea lions (Delfour & Marten, 2001). Their behaviors were videotaped and were compared to behaviors developed in control situations such as absence of mirror (tested in all species), covered mirror, unmarked animal, behavior with a real stranger through an underwater barred gate (tested in bottlenose dolphins), and social interactions (tested in killer whales, false killer whales, and sea lions).

The Mirror Mark Test—Due to the impossibility of anaesthetizing these marine mammals (since their respiration, when unconscious, is not

automatic), researchers either sham-marked their subjects with nontoxic markers (e.g., water-filled marker or Vaseline) or marked the study subjects with nontoxic real markers (e.g., zinc oxide, gentian violet, ichthammol) (Marten & Psarakos, 1994), temporary black ink Entré marker (Entré, Westborough, MA) (Reiss & Marino, 2001), or antiseptic ointments (e.g., Mitosyl and Dermobion) (Delfour & Marten, 2001). The sham marking was done as a control in order to examine whether the animal's behavior was attributable to the tactile sensation of the marker rather than the mark itself.

Video Sequences

In order to help distinguish self-examination from social behavior in the context of dolphin-mirror interaction, Marten & Psarakos (1995) conducted additional tests using self-view television sequences in real time vs in playback mode. These researchers had previously determined that bottlenose dolphins respond to a televised image as if it were real (Marten & Psarakos, 1994). They successively ran four different tests: (1) in the first test, their hypothesis was if dolphins recognize themselves on television, their behavior should be different with a real-time self-view ("mirror mode") than it is when they are shown taped playback of

the same mirror mode material. They designed the test to elicit one response if the dolphin mistakes its television image for another dolphin, and a different response if the dolphin differentiates between real-time self-view and playback; (2) in the second test, they presented control data on dolphin interactions with real strangers for comparison with mirror mode behavior; (3) during the third test, they compared marked dolphin behavior in mirror mode with playback mode; and (4) in the fourth test, they examined whether dolphins turn when the real-time display on their television is suddenly switched from the usual frontal view to a side view.

Video Sequences and Signature Whistles—Following the proposal of the "signature whistle" hypothesis (i.e., stereotypic individually distinct call used to label or name itself or another (Tyack, 1986; Caldwell et al., 1990; Janik & Slater, 1998), we decided to study the dolphin's ability to associate a signature whistle with the appropriate visual representation of the dolphin to which it belongs. Thus, we designed an innovative experimental procedure that used an underwater touchscreen (Figure 1) concurrent with the emission in the pool of the signature whistle of the son of one of the three female dolphins in our experiment (Delfour, 2000; Delfour & Marten, 2005).

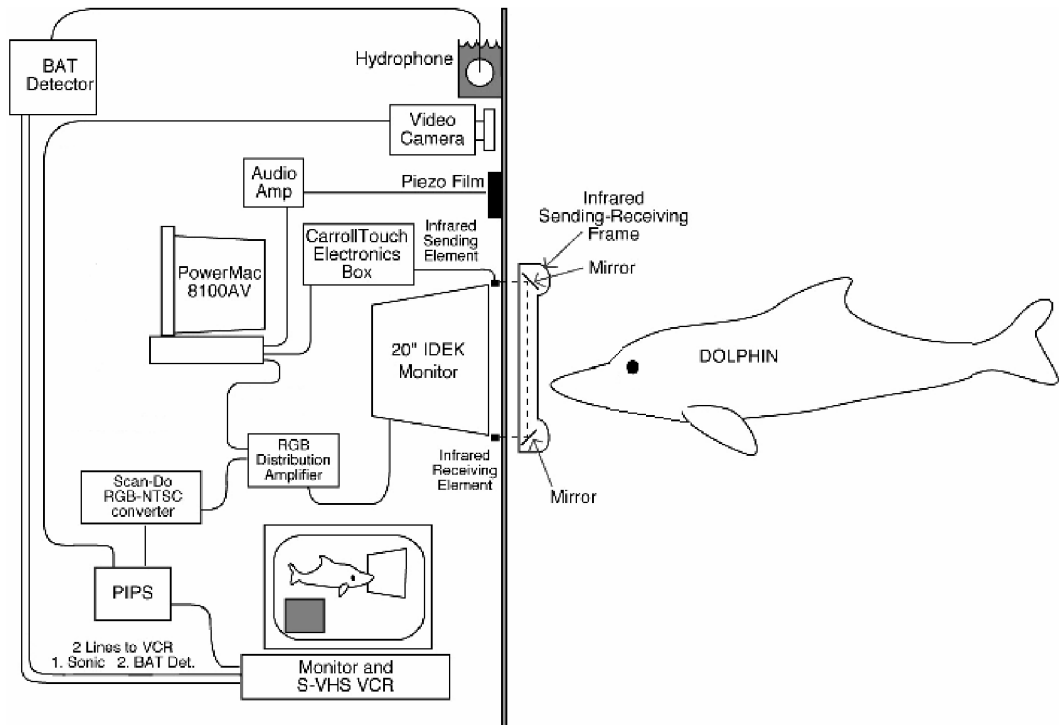


Figure 1. The underwater touchscreen diagram (inspired from J. Shure's drawing)

Table 1. Non-exhaustive ethogram with presence/absence of some of the self-directed and contingency checking behaviors when animals are in mirror situation (Delfour & Marten, 2001)

Behaviors	Dolphins	Killer whales	False killer whales	Sea lions
Repetitively moving head	✓	✓	✓0	0
Opening mouth	✓	✓	✓0	0
Opening mouth + repetitively moving head	✓	✓	✓	0
Vertical body position /mirror	✓	✓	✓	0
Controlled rhythmic bubbles emission	✓	✓	✓	0
Showing tongue + head movements	0	✓	0	0
Bringing objects	✓	✓	0	0

Results

The Mirror and Mark Tests in Cetaceans and Pinnipeds

Bottlenose dolphins show evidence of body examination using their mirror image (Marino et al., 1994; Marten & Psarakos, 1994; Reiss & Marino, 2001). Killer whales have self-directed and contingency checking behaviors in front of the mirror. False killer whales' behaviors are more difficult to interpret due to the ambiguous behaviours they displayed. In front of the mirror, they display behaviors similar to social behaviors, implementing long sequences of open mouth behavior (duration > 5 s). Finally, the sea lions do not display clear self-directed behaviors (Delfour & Marten, 2001). The main behaviors observed in front of a mirror are presented and compared in tabular form (Table 1).

The Mirror Mark Test—All conducted experiments showed that the bottlenose dolphins intensively examined their bodies, spending more time on the marked part of their bodies (Marino et al., 1994; Marten & Psarakos, 1994; Reiss & Marino, 2001). The killer whales showed mixed results. One of the marked females went directly to the front of the mirror, then went to the wall of her tank and rubbed her rostrum against it where the mark was present. Then this female came back to the mirror, returned to the wall to rub herself, and ultimately did several back-and-forth movements, each time she had less and less ointment on her rostrum (Delfour & Marten, 2001).

Video Sequences

When submitted to real-time videos of themselves, an adult dolphin displayed self-directed behaviors and three juvenile dolphins spent more time looking at their images in the real-time situation vs the playback mode. Marten & Psarakos (1995) marked the animals (on their side and mouth) in real-time situations primarily and observed the dolphins as they preferentially positioned themselves in

order to visually access their marked body parts using the mirror. Secondly, Marten & Psarakos (1995) alternated real-time frontal self-view and side self-view on the television and subsequently observed the animals turning their body to facilitate their self-examination. These researchers concluded that the dolphins perceived their television image as a representation of themselves and not as a conspecific. This was illustrated by the absence of social behaviors and the display of self-directed and contingency checking behaviors.

Video Sequences and Signature Whistles—The video presentation of the adult female's son on the touchscreen, and the production of his signature whistle in the tank, solicited an intense reaction in the mother. She positioned herself in front of the apparatus for a long period of time (about 225 min vs 155 min [mean] for the two other females), and she frequently rubbed the touchscreen (Delfour & Marten, 2005). More work is needed to better understand the acoustic and visual identifier cues among dolphins.

The experiments briefly presented here illustrate the current work on self-recognition in marine mammals and suggest some new tools (e.g., signature whistles, underwater touchscreen) that can improve our investigation.

Discussion

Through the use of the mirror test, the mark test, and the concurrent use of video sequences and signature whistles, empirical studies have shown that some marine mammal species (e.g., bottlenose dolphins, killer whales, and maybe false killer whales) are able to recognize visual representations of themselves in mirror images and on television as shown by their production of self-directed and contingency-checking behaviors. Consequently, we can presume that these species possess some kind of knowledge and understanding of their physical appearance, even if they cannot tactically explore their body (as, for example, in nonhuman

primates). This suggests the existence of self-recognition processes in these cetaceans. The reported experiments, however, do not by themselves permit us to conclude that self-consciousness exists in these animals. The results do not indicate whether dolphins or killer whales possess knowledge of the permanence of their bodies. The objectivization (see Merleau-Ponty, 1945) of the body is necessary for the subject to help it to recognize similarities between its own body parts and those of others, as well as to recognize a body part as being included in the entire/complete body. The recognition of its own body implies that the subject knows and recognizes its body as being its own—distinct yet similar to others’.

Limits of the Cartesian Dualism and Benefits to the Use of the Concept of an “Embodied Subjectivity”

In the human world, when a subject stops thinking, his or her body and the entire environment still exist, but he or she is no longer conscious of it, and in the same way, a subject doesn’t need to prove the existence of his or her body to legitimate the fact that he or she thinks. This was the basis of Descartes’s dualist conception that separated the thinking mechanism from its somatic anchorage and precluded scientists from considering animals as real subjects. Even more contemporary models of animal cognition remain incomplete due to the fact that they are based on identifiable human capacities that we then look for in animals. In the “theory of mind” model (Premack & Woodruff, 1978), for example, researchers aim to find out if a subject has a representation of another’s mental state. This includes human representations such as postulating what the other knows or does not know, imagining what the other may want by using one’s own experiences of desire, and the ability to deliberately lie. It remains difficult to empirically apprehend the different states of consciousness, and human-oriented perspectives unfortunately tend to involve “fragmented” notions of the Self by separating the body, the mind, and the actions/experiences, failing to establish a benefic comparative approach by mainly looking for identifiable human capacities in animal candidates.

By focusing instead on the relationship established by the subject to its body, we circumvent this rupture and, thus, have an appropriate base for investigating animals whose motor capacities are different from ours. In addition, by refuting the Cartesian dualism, we can examine the emergence of self-consciousness in an embodied, incarnated subjectivity. From a phenomenological point of view, the adjective *incarnated* specifies a cognition based upon the corporeal/body experience (via the sensorimotor interface) and upon an individual variability (biological, psychological,

and cultural) (see Varela et al., 1993). “Embodied experiences” refer both to the ways a subject perceives or becomes conscious of its body and to the ways the body experiences the world (Gallagher, 2000).

At the origin of the notion of “embodied cognition,” Merleau-Ponty (1945), in his *Phenomenology of Perception*, developed the concept of the “body-subject” (an alternative to the Cartesian “cogito”) and emphasized the fact that consciousness, the world, and the (human) body are mutually “embedded.” According to Merleau-Ponty, the significance of the body (or “body-subject”) is too often underestimated. The body should not be considered as a simple object that a transcendent mind orders to perform varying functions. He claimed that we are our bodies, and that our lived experience of our bodies denies the detachment of subject from object, mind from body, etc. The body shows its capacity to occupy the position of both perceiving object and subject of perception in a constant oscillation. This author distinguishes the “objective body” from the “phenomenal body.” The first one can take the object mode (i.e., being object of the world) while the second one appears to itself by having the world appear and cannot close up on itself/on a pure interiority (i.e., the phenomenal body needs to open itself to the world and to experience it in order to emerge). The objective body, however, is not only “to be for the other”: it co-exists with the phenomenal body “for me.” The body is comprehended according to two different modes: (1) the object-body and (2) the subject-body. The body’s experiences actually determine the way each individual will build up the world, and they *ipso facto* constitute different perspectives of this world. In this way, they are related to von Uexküll’s (1956) concept of *Umwelt*. This author emphasized the major role of the circular relation between a subject and its subjective world. The sensorial organs and the sensitive receptors allow the subject to perceive the world (*merkwelt*) while the subject acts on the world by its impulsions and reactions (*wirkwelt*). The sensorimotor actions of a bird vs those of a cat are different by nature and lead to the emergence of a various and species-specific *Umwelt*. In addition, we also need to take into account intraspecies experiences. It is as a result of these that the individual’s perspectives on its world must also be seen as social (i.e., its conspecifics share those experiences), as individual (this subject is the only one to experience them at the present time), and as historical (as a product of experiences spread over a lifetime).

By using the theoretical framework of phenomenology, new questions can be formulated to understand the knowledge a subject possesses of

itself, and to apprehend the processes that enable the emergence of individualization and self-recognition. Thus, understanding the cognitive processes implicated in the emergence of self-consciousness requires one to study the body's recognition processes that constitute the individual/world interface.

Self-Recognition Versus Self-Consciousness and Their Biological Correlates

One of the main difficulties in understanding this phenomenon is due to the plethora of terms used. The ability to recognize representations of oneself and to be aware of one's own mental states have, in different writings, been called self-awareness, self-representation, self-recognition, self-consciousness, etc. (Crook, 1983). The difficulty in defining the terms and the concepts has already been mentioned by Gallagher (2000), who quoted the so-restrictive Dennett's definition (1976) of self-consciousness, which prevents "small children" from being self-conscious. He also reported on Bermúdez's statements (1996), who conceived the existence of a primary self-consciousness that includes three major elements: (1) a body schematic control of movement (i.e., a sensory feedback mechanism, a sense of agency for one's actions, a sense of causing movement), (2) a pragmatic differentiation between self and nonself (a sense that arises in movement and action), and (3) the recognition that the other person is of the same sort as oneself. Gallagher (2000) considered that "the body-schematic senses of agency and ownership, along with the self/non-self differentiation, are sufficient to constitute a primary, embodied form of self-consciousness in the neonate, and likely late-term fetus." These types of studies on childhood development (also see neonate imitation, Meltzoff & Moore, 1977) represent a very good source of inspiration for studies on animal subjects.

"Self-recognition" seems to be the most appropriate and accurate for describing "the acquisition of knowledge on its own physical appearance shown by the capacity to differentiate its own external visual representation from the others" (Anderson, 1984, p. 36)—that is, via the visual representation of the specular image.

While many people readily infer consciousness given such self-recognition processes, in order to extend our reasoning, we need to clarify these subtle distinctions. Indeed, consciousness is etymologically "with knowledge" and, as such, it can be defined by a relation to, a movement to, a surpassing to, and allowing access to a double presence—that of the world (the other) and the self. In humans, self-consciousness is, thus, a metacognitive process. It is necessary to know that we are

conscious. The subject is not only an integrating part of the world, but it becomes able to position itself in front of the world (a world to know and to understand)—it distances itself from the world. Consciousness can be considered to be an integrating operation of the self and the world, and of the self by the world (Depraz, 2002).

Given that consciousness is incarnated (embodied), it is very tempting to look for its biological roots. Recent research investigating the neural substrate of self-recognition in humans has implicated the right prefrontal cortex (Keenan et al., 2001). If this is the case, then nonhuman primates that fail the mirror test would be expected to have a less-developed right prefrontal cortex. This appears to be the case in at least gorillas (*Gorilla gorilla*). Only a few individuals have shown mirror self-recognition (Suarez & Gallup, 1981; Patterson & Cohn, 1994; Shillito et al., 1999). Alternatively, one might predict that such animals (i.e., some monkeys) would be structurally or anatomically less lateralized than nonhuman primate species that pass the test (Gallup et al., 2002). Researchers like Morin (2002, 2003), however, criticize these neurological findings, claiming that the terms that were used were ambiguous and arguing for a more complex, neural-sociocognitive process in humans. Investigating lateralization in nonhumans might guide us in the understanding of the underlying mechanisms; we should keep in mind, however, that the process of self-consciousness must be more than a simple correlation between experiences and a neural substrate.

Moreover, in those subjects that displayed contingency checking behaviors, even without fully passing a "mark test," we could argue that they have the necessary prerequisites to construct an "action identity." This knowledge (qualified as "procedural" in humans) contributes to the identity of the person and is illustrated by the capacity of a subject to recognize its action "style" and to be able to better predict its future actions when knowing its past actions (Knoblich & Flach, 2003). In the perception-action dynamic loop, the body (and its actions) plays a major role in self-(re)cognition. The correlative status of neural studies, like the approach of a cognitive study alone, fails to explain the emergence of self-recognition and self-consciousness.

The Hypothesis of a "Situated" Self

We could envisage circumstances where self-recognition would be limited to the recognition of body movements (cf. the action identity developed by Knoblich & Flach, 2003) or of body parts. This would imply that when one asks, "Does an animal recognize itself?" the answer would not only be "yes" or "no," but it would allow us to define a

progressive emergence of this cognitive capacity in the animal kingdom. Following this last point, Delfour & Carlier (2004) proposed an analysis grid to describe the use of the specular image and the construction of the body image in various animal species (Table 2). To develop this grid, we used Rochat's (2003) work on the different levels of self-awareness and Gallagher's (2000) conceptual point of view (i.e., contrary to body schema, the subject builds its body image, and this body image embraces the subject's perceptual experience, conceptual comprehension, and emotional attitude towards its body). According to this researcher, it is necessary to clearly distinguish body schema/image to set a non-ambiguous basis of reasoning about the role played by the body in action and cognition (e.g., reciprocal interactions).

To have a "self" means to possess a visualisable and distanced construction of the body (cf. Strauss, 1935) and, from a phenomenological point of view, to be able to recognize oneself means to consider one's body as an object. Since the "self" represents a temporarily and spatially stable entity, we suggested not only that this permanence is a necessary prerequisite essential to the recognition of a "self" but that the emergence of a "situated self" depends upon local situations and some particular psychological states (Delfour & Carlier, 2004).

This grid starts from a subject's state of fusion with its environment (this state precedes Piaget's state of the permanence of the object). Several phases of differentiation and decentration follow (i.e., the ability to move away from one system of classification to another one as appropriate [Piaget, 1936] and see also the stages of "existential" and "categorical" Self developed by Lewis [1992]), to end in a distanced state characterized by the emergence of a stabilized self in time and space as

well as in a social perspective—the subject is able to identify/recognize itself, the others, and itself from the others. It is at this level that the subject then passes the mirror/mark test. This last phase corresponds to a complete incarnation (embodiment) whereas the previous states illustrate an incomplete incarnation/embodiment. In the light of this analysis, a reconsideration of the nonhuman primate literature, and the reported experiments done on cetaceans, reveals that some of these animals are at the first phase of differentiation (i.e., they possess a distanced body image of themselves; stable in time and space). That is, they perceive their bodies differently from a conspecific's and from the environment. In as much as they also are able to use the mirror to explore their bodies and to display self-directed and contingency checking behaviors, this means that they are able to understand the completeness of their bodies. The exigent mirror test actually presupposes a process of recentration on the body from a reflection—to recognize its specular image, the subject must go through a previous stage of differentiation/decentration to then be able to recentrate on its body and its mirror image. We suggest that an emerging process gradually moves the animal from a state of fusion (absence of any body image) toward a state of distanciation where the animal envisages itself in scenario with various ecological, individual, and social contexts. The subject's encounter with the environment is situated and deeply fixed in its body. It would be interesting to test this emerging process to explain interindividual differences within a same species and/or between species.

Conclusion

Studying self-recognition and consciousness in animals requires a multidisciplinary approach to

Table 2. The construction of the body image; the emergence of sensorial abilities, immediate souvenirs, and anticipations characterized its genesis.

Construction of the body image and emergence of self-consciousness						
Process / environment	Fusion (base)	Differentiation	Decentration	Decentration / recentration-comparison	Distanciation; situated self	Distanciation; stabilised self in social space and time
Mirror test	Nonpertinent	Failure	Failure	Failure	?	Success
Use of specular image	None	Reflection = conspecific	Interest without specific reaction	Interaction with the reflection; intermodal link	Comparison of specular /body image	Comparison reflection/corporal image; stable reactions



better comprehend this complex subject, to better consider the underlying philosophical and ethical stakes, and, ultimately, to better formulate the questions we want to ask.

Delfour & Carlier (2004) pointed out the benefits of combining an ethological approach with a phenomenological inquiry. On one side, ethology puts an external perspective on the subject by studying and analyzing its behaviors in relation to specific stimuli from the environment; on the other side, phenomenology allows a double opening of subjectivity to the world and to others with an embodied, temporal, and imaginative consciousness (Depraz, 2002). To conclude, I would like to emphasize the difficulty in studying self-recognition and self-consciousness in animals, and I will report here some major epistemological and methodological pitfalls (see also Delfour & Carlier, 2004). On the epistemological point of view, it is very difficult to legitimate the fragmentation of the various psychological, cognitive, and developmental processes that are applied to humans (i.e., cognition, self-recognition, self-consciousness, body image, etc.) to nonhuman mammals. All terms come from a human linguistic and symbolic system of reference. It might not be truly pertinent to try to find them *sensu stricto* in animals. Moreover, we consequently forget to identify other possible processes (i.e., phylogeny). On the methodological side, all the tools to explore self-recognition in both primates and marine mammals come from human psychological experiments, and the mirror and mark tests both require a high level of self-consciousness. Animals that fail these tests might, nonetheless, under different conditions, demonstrate the emergence of a “situated consciousness” that depends upon the local situations and their scaffoldings.

Trying to unambiguously explain the underlying concepts in self-consciousness vs the above-discussed self-recognition, we might consider self-consciousness as a dynamic and integrative process involving the unification of various representations of the world that are issued from an active and complex neuronal network in relation to various sensorimotor actions (Delfour & Carlier, 2004).

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