



The uncanny mirror: A re-framing of mirror self-experience [☆]

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ABSTRACT

Mirror self-experience is re-casted away from the cognitivist interpretation that has dominated discussions on the issue since the establishment of the mirror mark test. Ideas formulated by Merleau-Ponty on mirror self-experience point to the profoundly unsettling encounter with one's specular double. These ideas, together with developmental evidence are re-visited to provide a new, psychologically and phenomenologically more valid account of mirror self-experience: an experience associated with deep wariness.

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1. Introduction

The aim of this article is to re-cast mirror self-experience away from the cognitivist interpretation that has dominated discussions on the issue since the establishment 40 years ago of the classic, highly influential mirror mark test (Amsterdam, 1968, 1972; Gallup, 1970).

On a standard reading, passing the mirror mark test (self-directed behaviors toward a mark surreptitiously put on the face and discovered in the mirror) is an acid test of self-experience since it necessarily presupposes some form of conceptualized self-awareness (see Gallup, 1970, p. 87; Lewis, 1995). Not only do we want to question this claim by suggesting a leaner explanation, and by insisting on the need for a more careful distinction between different levels of self-awareness, we also want to dispute Gallup's claim that creatures that fail to pass the test are mindless. Finally, and this will constitute the main thrust of our article, we wish to argue that the mirror self-experience in the case of humans is considerably more multifaceted than suggested by Gallup. To provide support for this claim, we will consider the wariness typically associated with mirror self-experience. We will re-visit ideas formulated by Merleau-Ponty on mirror self-experience that points to the profoundly unsettling encounter with one's specular double.

2. Mirror magic and power

Mirrors are peculiar objects associated with peculiar, uncanny experiences. Myths and superstitions about mirrors abound. *Alice in Wonderland* aside, stories involving mirrors are typically unsettling. Mirrors are seen as providing more than mere reflections, casting souls and spirits, endowed with the potential power to trap them. For example, Narcissus lost himself in his own reflection and a spell of 7 years of unhappiness is casted onto those breaking a mirror. Mirrors surrounding a

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corpse are carefully draped, because it is said that anybody whose reflection is casted with a corpse will die soon after. After the burial of a familiar member, observant Jews sit Shiva (in mourning). During this time all mirrors are covered. In vampire stories, mirrors are powerful instruments for deciding who is alive and who is already dead. Meanwhile, in reality, mirrors do serve as instruments for deciding whether someone is alive or not, placing one close to the mouth to see if it collects the mist of a breath.

The unsettling experience of mirrors, particularly mirror self-experience appears to prevail across cultures, it is universal. Over 30 years ago, [Carpenter \(1976\)](#), a visual anthropologist, introduced mirrors to members of an isolated tribe (the Biama) living in the Papuan plateau where neither slate or metallic surfaces exist, and where rivers are murky, not providing clear reflections. Recording the initial reaction of adults confronted for the very first time with a large mirror reflection of themselves, Carpenter reports:

They were paralyzed: after their first startled response – covering their mouths and ducking their heads – they stood transfixed, staring at their images, only their stomach muscles betraying great tension. Like Narcissus, they were left numb, totally fascinated by their own reflections: indeed, the myth of Narcissus may refer to this phenomenon ([Carpenter, 1976](#), pp. 452–453).

The question is why is there such anxiety associated with mirror self-experience – an anxiety that might partially explain the abundance of malefic stories and folk beliefs surrounding mirrors? Why the “tribal terror of self-awareness” as Carpenter puts it in his account of first adult encounter with mirrors and other reflecting devices? Why anxiety and not elation or any kind of joyful interest in the discovery of an object with novel, unusual affordances?

3. False transparency and visual trickery of mirrors

To begin with, compared to other objects, mirrors are uncanny at a basic physical and experiential level. They are a source of visual enhancement as well as illusory perceptions, hence confusing. Physically, and at the direct level of perception and action, mirrors are a particular kind of surfaces in the environment, typically flat and polished, including the calm river in which Narcissus admired himself to death. When built for microscopes, telescopes, decoration, or dentist instruments, mirrors are categorized based on conventional and highly reliable measurements that allow the sorting of them as physical objects to serve particular purposes. Made of various materials (e.g., polished steel, melted sand, or plastic surface), they are measured in terms of thickness, surface, shape, and for their main affordance: light reflection.

Any surface in the environment reflects light, but a perfectly flat and polished mirror reflects close to 100% depending on how it is manufactured. In simple physical terms, mirrors are obstacles to light with the particular property of abruptly inverting its direction in space while maintaining its structure, hence the structure of the optic array that we perceive according to [Gibson \(1979\)](#).

Mirrors are visually tricky because they give perceivers an illusion of transparency, the exact opposite of what they are in their physical reality. Despite the illusion they give, they are *de facto* perfectly opaque with the caveat that their opacity is also refractory of light, in other words close to perfectly non-absorbing of light. That is the main distinctive feature of mirrors compared to all other objects in the layout.

Once the mirror is debunked by the perceiver who sees it for the reflection it affords and not the illusion of transparency it gives, the question is what is then perceived? At the most basic level, the perceiver perceives mirrors as tangible physical objects, not simply as cutouts or as framed windows of space that prolong the optical layout.

The use of rearview mirrors in backing up a car is a good paradigm when trying to figure out what happens when mirrors are looked at and not through, namely used to navigate portions of space that are not directly perceivable. The same could be said of the chimpanzee picking its teeth by holding a mirror in front of its mouth, or the prisoner tightening a piece of mirror at the tip of his toothbrush to monitor other inmates and the guards' traffic in the hallway.

All these instances entail some basic calibration of perceived space and of actions that are performed in that space. Implicitly, mirrors are perceived for what they are: opaque reflecting surfaces that provide the affordance of exploring new portions of the layout, allowing the visual monitoring of actions in regions of space that are not directly accessible to the eyes.

Mirrors are peculiar reflecting objects in the environment. Psychologically, however, they are objects of perpetual fascination mainly because of their ability to provide us with reflected images of ourselves, the mirror self-experience that is our main concern here.

4. The mirror mark test and its standard cognitivist interpretation

Mirror self-recognition was introduced as a measure of self-awareness in non-human primates by [Gallup in 1970](#). In his well known experiment, chimpanzees who had been exposed to mirrors for 10 days – thereby making them familiar with the reflecting properties of the mirror – were sedated and while being unconscious they were marked with an odourless dye on the upper part of one eyebrow and the opposite ear. Back in the cage and fully recovered, they were observed for 30 min to account for any spontaneous touches of the marked area. Then the mirror was reintroduced and the chimpanzees were observed for mark-directed behaviour. Gallup reports that the number of incidences of mark-directed behaviour rose from

one during the post anaesthesia mirror-less period to four to ten in the period where the mirror was reintroduced (Gallup, 1970). According to Gallup's interpretation, passing the mirror mark test testifies to mirror self-recognition, thereby providing empirical and operational evidence for the presence of conceptual self-awareness (Gallup, 1977, p. 337). More specifically, on a prevalent cognitivist interpretation, a prerequisite for successfully passing the mirror self-recognition test and to correctly interpret the source of the reflection as oneself is that the creature in question is in possession of a "concept of self" (Gallup, 1970, p. 87). Other cognitivists have referred to "an internal model of self" (Keenan, 2003, p. 11), or an "*idea of me* or self-representation" (Lewis, 1992, p. 281). Since Gallup must be considered the main proponent of this general approach, let us take a closer look at his account.

On Gallup's view, mirror self-recognition testifies to the perfect match between the observer and the observed. As he put it "The unique feature of mirror-image stimulation is that the identity of the observer and his reflection in a mirror are necessarily one and the same." (Gallup, 1977, p. 334). Thus, it is important to emphasize that mirror exposure on Gallup's account do not give rise to self-awareness. Rather the capacity to correctly *infer* the identity between the observer and the reflection presupposes that the observing organism is already in possession of a sense of self-identity. As Gallup puts it, the mirror simply represents a means of explicating what the observing creature already knows. At the same time, however, he also argues that it provides the organism with a new form of knowledge, insofar as it enables the creature to see itself as others see it (Gallup, 1977, p. 335, 1985, p. 632).

The latter line of thought is reminiscent of ideas found in classical American sociology, and in his account Gallup explicitly refers to the work of Cooley and Mead. Cooley famously held the view that the human self is an interpersonal entity and as such dependent upon social interactions with others. Along similar lines, Mead argued that one can only become self-conscious (in the sense of becoming an object to oneself) in an indirect manner, namely by adopting the attitudes of others on oneself, and that this is something that can only happen within a social environment (Mead, 1962, p. 138).

As evidence in support of the Cooley–Mead hypothesis, Gallup refers to studies of isolation-reared chimpanzees, who failed to exhibit self-directed behavior in mirror situations even after extensive exposure. As a further test of the importance of social experience, two of the original chimpanzees were given 3 months of group experience, after which time self-recognition responses began to appear. Gallup postulates that it was the chimpanzees' opportunity to view themselves from the other's point of view, which made the difference (Gallup, 1977, p. 336).

Why does Gallup attribute such importance to the passing of the mirror self-recognition task? Not only because of its presumed relation to self-awareness, but also because it – on his view – constitutes a litmus test for the possession of consciousness. In the article "Self-awareness and the emergence of mind in primates" Gallup claims that consciousness is bidirectional. It allows one to attend outwardly to things in the world, but also to attend inwardly and to monitor one's own mental states (Gallup, 1982, p. 242). To that extent, consciousness covers and includes both awareness and self-awareness. In continuation of this line of thought, Gallup next claims that organisms that lack the ability to monitor their own mental states are mindless (Gallup, 1982, pp. 243, 245). This claim is further developed in the article "Do minds exist in species other than our own?" where Gallup claims that conscious experience necessarily presupposes self-awareness. Either one is aware of being aware, or one is unaware of being aware, and the latter amounts to being unconscious (Gallup, 1985, p. 638). Following this line of reasoning, Gallup can argue that although most organisms behave *as if* they are conscious and minded (Gallup, 1982, p. 242), prior to the emergence of self-awareness as evidenced from their ability to pass the mirror self-recognition task, they are mindless. They lack conscious experience, and only possess unconscious sensations, pains, etc. (Gallup, 1985, p. 638).

This conclusion has rather dramatic implications not only for our ascription of an experiential life to infants, but also to all those animals that remain incapable of recognizing their own mirror image. Some might object that the absence of evidence for self-awareness is not evidence of absence of self-awareness, but Gallup has been quick to ridicule this worry, by arguing that the same logic applies to Santa Claus and the Tooth Fairy (Gallup, 1985, p. 632).

Gallup's considerations are obviously related to the ongoing theory of mind debate. This is also brought out in passages where Gallup relates the possession of a mind (and the ability to monitor one's own mental states) to the ability to infer and impute mental states to others. Gallup claims that the tendency to impute mental states to others presupposes the capacity to monitor such states on the part of the individual making the imputation (self-experience is to that extent a precondition for other-experience) (Gallup, 1982, p. 243), and he consequently argues that we can use the presence of the former as evidence for the presence of latter (Gallup, 1985, p. 634).

5. Critical remarks

Gallup's account, although highly influential, has not been universally accepted. In fact, the very claim that mark-directed behavior is evidence for mirror-self-recognition has been called into question. The fact that some children after witnessing a mark on their mother's nose touch their own nose indicates that the passing of the mirror test might be a false positive (Mitchell, 1993, p. 304). The fact that children of some cultures are reported not to pass the mark test even up to the age of 6–7 years, suggests that the failing of the mark test might also be a false negative (Broesch, Callaghan, Henrich, Murphy, & Rochat, *in press*). Let us briefly outline some of the ambiguities, inconsistencies, and unwarranted assumptions that we find in Gallup's account (some of which have previously been exposed by Mitchell in a number of critical essays):

1. Gallup takes mirror-self-recognition to constitute hard proof for the presence of self-awareness. The arguments and evidence supposed to support this claim are quite fragile, however. First of all, Gallup fails to consider the possibility that there might be more than one type of self-awareness, and that although mirror-self-recognition might testify to the presence of one special form of self-awareness, the absence of mirror-self-recognition might be perfectly compatible with the presence of other (less sophisticated) forms of self-awareness. Indeed, as we see it, one decisive problem facing the standard interpretation of the mirror test is precisely that it underestimates how complex and varied self-experience is. Not only does it disregard the first-personal character of phenomenal consciousness (cf. Zahavi, 1999, 2005), it also overlooks the fact that infants have a sense of their own bodies as organized and environmentally embedded entities long before they are able to pass any mirror self-recognition tasks, and, hence, an early embodied sense of themselves in perception and action. Already from about 3 months of age, infants discriminate what pertains to the self and what pertains to someone else interacting with them. In the footsteps of Neisser and Gibson, one could call this early sense of self the infant's ecological self (Rochat, 2001, pp. 30–31, 41). In our view, we are here dealing with implicit and experiential preconditions for all other aspects of self that can be talked about and shared in words or in any other symbolic media. Secondly, Gallup's own definition of self-awareness turns out to be quite equivocal. Gallup's use of the term implicitly refers to a creature's introspective awareness of its own ongoing mental processes (i.e., the monitoring of its own mental states), but also to the creature's possession of a self-concept which in humans typically refers to the understanding of one's own permanence, character traits, preferences, desires, beliefs and motives. Now, Gallup's central claim is that mirror-self-recognition requires both the capacity for introspection and the possession of a self-concept. However, Gallup also claims that a creature that is incapable of recognizing its own mirror-image will possess neither. But it remains quite unclear (a) why knowledge of one's, say, character traits and permanence is presupposed in mirror-self-recognition – as if a person suffering from amnesia should be incapable of passing the mirror test; (b) why mirror-self-recognition should be linked to introspection – as Mitchell remarks, it is unclear what mental state a creature is supposed to attend to in recognizing itself in the mirror (Mitchell, 1997a, p. 23); and (c) why creatures who cannot pass the mirror-self-recognition task (including young infants and most animals) lack conscious experiences. On a certain construal of higher-order representation theory, Gallup's view might be comprehensible,¹ but he never provides the theoretical arguments to support this view, and as one of us have argued in a number of publications, there are various good reasons to reject the higher-order representation theory (Zahavi, 2004, 2005).
2. As we have seen Gallup in turn writes that mirror-self-recognition merely explicates a knowledge that was already there and that it provides a new form of knowledge. In our view, the former claim would miss out on the true import of mirror self-recognition. As we will argue below, far from amounting to a primitive and basic type of self-experience, far from simply confirming an already existing self-identity, the recognition of one's own specular image is in fact a rather sophisticated and distinct type of mediated self-recognition, one that takes place across distance and separation. This very idea might of course have been preempted by Gallup's references to Mead and Cooley, but these references are ultimately quite puzzling, since his own account flatly contradicts their views. As already mentioned, Mead argues that one – in order to conceive of oneself – has to see oneself as seen by others. Gallup endorses this view, but at the same time he claims that (conceptual) self-awareness is a precondition for both mirror self-recognition and for the ascription of mental states to others (a view he by the way does not argue for).² In addition, he repeatedly emphasizes the distinction between social responsiveness and self-directed behavior and claims that in recognizing one's mirror-image, one ceases to respond socially to it (Gallup, 1970, p. 86).³
3. In his account, Gallup highlights the importance of possessing a self-concept. At the same time, however, he does concede that mirror-self-recognition also presupposes the ability to project proprioceptive information and kinesthetic feedback onto the specular image (Gallup, 1970, p. 87, Anderson & Gallup, 1999, p. 189).⁴ Other leaner accounts are on the offering, however. In a number of papers, Mitchell have argued that mirror-self-recognition merely requires a kinesthetic sense of own body (subjective self-awareness), a capacity for kinesthetic-visual matching and an understanding of mirror-correspondence (Mitchell, 1997a, p. 31, 1997b, p. 41).

¹ As Carruthers has put it: "The main motivation behind higher-order theories of consciousness [...] derives from the belief that all (or at least most) mental-state types admit of both conscious and unconscious varieties [...]. And then if we ask what makes the difference between a conscious and an unconscious mental state, one natural answer is that the conscious states are states that we are *aware of*" (2008, Section 2). What this means, according to Carruthers, is that a creature only enjoy conscious states if it has the ability to reflect upon, think about and conceptualize its own mental states (Carruthers, 1996, pp. 155, 157). Given the conceptual requirement, Carruthers ultimately argues that only creatures that are in possession of a *theory of mind* are capable of enjoying conscious experiences or of having mental states with phenomenal feels (Carruthers, 1996, p. 158). Carruthers consequently holds the view that animals (and children under the age of three) are blind to the existence of their own mental states; there is in fact nothing it is like for them to feel pain or pleasure (Carruthers, 1998, p. 216, 2000, p. 203); an implication that, as he puts it, might have profound implications for our moral attitudes towards animals and animal suffering (Carruthers, 1996, p. 221).

² Consider by contrast, the view that social interaction might be the source of self-concept in humans. As Tomasello, for instance, has argued, a true self-concept develops in children from a general ability to categorize objects combined with the ability to adopt the perspective of others in joint attention toward objects, but also turned toward the child herself (Tomasello, 1999).

³ Gallup never explains the alleged connection between social interaction and mirror-self-recognition. His suggestion that it was the chimpanzees' opportunity to view themselves from the other's point of view that made them capable of mirror-self-recognition leaves it unexplained why autistic children who have deficiencies in their ability to recognize the perspective of the other on themselves, have no difficulties in passing the mirror test.

⁴ In addition, mirror-self-recognition obviously also requires the ability to recognize and distinguish faces (Keenan, 2003, p. 52), which is why people suffering from prosopagnosia are impaired when it comes to passing the mirror self-recognition task.

4. Mirror-self-recognition is for Gallup a one-dimensional affair. Creatures are either capable or incapable of accomplishing the task. No attempt is made to further differentiate the kind of mirror experience we find in creatures capable of passing the test, i.e., on Gallup's account there is no significant difference between the mirror self-experience possessed by human beings and chimpanzees. But, we should not overlook that mirror self-experience from a developmental perspective, rather than amounting to a climatic moment, is a continuous and multilevel experience (cf. O'Neill, 1988, p. 70; Rochat, 2003). In fact, it is particularly important to recognize that the infant's behavior and affective reaction to the mirror undergoes marked and dramatic changes from 3 to 24 months (see Amsterdam, 1968, 1972; Tomasello, 1999; Lewis & Brook-Gunn, 1979). As reported by Amsterdam in her 1968 and 1972 studies, four main developmental periods unfolding between 3 and 24 months: a *first period* of mainly sociable behaviors toward the specular image. Infants between 3 and 12 months tend to treat their own image as a playmate. A *second period* is accounted for by the end of the first year in which infants appear to show enhanced curiosity regarding the nature of the specular image, touching the mirror or looking behind it. By 13 months starts a *third period* where infants show marked increase in withdrawal behaviors, the infant crying, hiding from, or avoiding looking at the mirror. Finally, Amsterdam accounts for a *fourth period* starting at around 14 months but peaking by 20 months when the majority of tested children demonstrate embarrassment and coy glances toward the specular image, as well as clowning. These changes correspond to the complex interplay of cognitive and affective progress that take place during this early period of child development (Amsterdam & Levitt, 1980). To fully understand and assess the significance and import of mirror self-experience these changes have to be accounted for.

The affective dimension of mirror self-experience tends to be overlooked by the dominant cognitivist and evolutionary perspective on self-recognition and its relation to theories of mind. This is an unwarranted reduction of the psychological complexity that is attached to mirror self-experience. From birth onwards, infants are exposed to people facing them and looking at them. As shown by the pioneer observations of Amsterdam (1972), and many other before her (i.e., Darwin, Guillaume, Zazzo, Preyer), this "en face" experience is first generalized to mirror self-experience (the child seeing another child in the mirror). It is only slowly that children comprehend that what they see as another non-self individual facing them is actually themselves projected on a flat surface. This is probably the primary source of the uncanny mirror self-experience and shows how much the typical embarrassment associated with such experience is not just a cognitive embarrassment or malaise, but is deeply rooted in the social life of children.

6. Revisiting Merleau-Ponty

To start unearthing the complex nature of mirror self-experience, let us briefly review the account offered by Merleau-Ponty more than 50 years ago in the long essay "The Child's Relations with Others." This text is based on a lecture course on child psychology given by Merleau-Ponty at the *Sorbonne*, but contrary to what the title might indicate, Merleau-Ponty was not primarily interested in various empirical findings pertaining to early forms of social interaction. Rather, he was raising and attempting to answer substantial philosophical questions concerning the relation between self and other. Indeed, his point of departure was precisely the alleged incapacity of classical psychology to provide a satisfactory solution to the problem of how we relate to others; an incapacity that according to Merleau-Ponty was due to the fact that classical psychology based its entire approach on certain unquestioned and unwarranted philosophical prejudices. First and foremost among these were the fundamental assumption that experiential life is directly accessible to one person only, namely the individual who owns it (Merleau-Ponty, 1964, p. 114), and that the only access one has to the psyche of another is indirect and mediated by his or her bodily appearance. I can see your facial expressions, gestures and actions, and on the basis of that I can guess what you think, feel or intend (Merleau-Ponty, 1964, p. 113, 114). Classical psychology had routinely explained the move from the visible exteriority to the invisible interiority by way of an argument from analogy, but Merleau-Ponty pointed to a number of difficulties inherent in this strategy. The objections he raised are very similar to the ones raised by Scheler years earlier in *Wesen und Formen der Sympathie*, but interesting as they are, we do not have time on this occasion to rehearse and assess these arguments (cf. Zahavi, 2001). Suffice it to say, that Merleau-Ponty concluded his criticism by rejecting the idea that my experiential life is a sequence of internal states that are inaccessible to anyone but me. Rather, on his view, our experiential life is above all a relation to the world, and it is in this comportment toward the world that I will also be able to discover the consciousness of the other. As he wrote, "The perspective on the other is opened to me from the moment I define him and myself as conducts at work in the world" (Merleau-Ponty, 1964, p. 117). Being a world-directed consciousness myself, I can encounter others who act, and their actions are meaningful to me, because they are also my possible actions. Merleau-Ponty consequently argued that we need to redefine our notion of psyche, as well as revise our understanding of the body.

It is in this context that Merleau-Ponty then starts to analyze mirror self-experience. Initially, he argues that the mirror (and other reflecting surfaces) furnishes the child with a visual presentation of its own body that is very different from what it can obtain by itself (Merleau-Ponty, 1964, p. 125). Hitherto the child has never seen its own face or the visual gestalt of its entire body. The mirror cannot only permit the child to perceive its own facial features, the mirror can also present it with a different apprehension of its own body's unity than what is available from interoceptive, proprioceptive and exteroceptive sources (Merleau-Ponty, 1964, pp. 119, 126). Merleau-Ponty initially describes this new unifying appearance of the body in terms of an objectification (Merleau-Ponty, 1964, p. 119). The idea basically being that the mirror affords us a quite different

possibility for taking our body as a clearly delineated object than interoception or proprioception. Merleau-Ponty next proceeds to investigate this objectification more carefully. For the child to recognize the specular image as its own is for it to become a spectator of itself. It is to adopt a perspective or viewpoint on itself that equals what others can adopt on the child. It is to recognize – and here it might be necessary to differentiate several developmental steps more carefully than Merleau-Ponty did – that one is visible to oneself and to others as well (Merleau-Ponty, 1964, p. 136). In short, the mirror permits the child to see itself as it is seen by others, and might also bring about the explicit realization that it is given to others with the same visual appearance that it is being confronted with in the mirror. As Merleau-Ponty writes,

At the same time that the image makes possible the knowledge of oneself, it makes possible a sort of alienation. I am no longer what I felt myself, immediately, to be; I am that image of myself that is offered by the mirror. To use Dr. Lacan's terms, I am "captured, caught up" by my spatial image. Thereupon I leave the reality of my lived *me* in order to refer myself constantly to the ideal, fictitious, or imaginary *me*, of which the specular image is the first outline. In this sense I am torn from myself, and the image in the mirror prepares me for another still more serious alienation, which will be the alienation by others. For others have only an exterior image of me, which is analogous to the one seen in the mirror. Consequently others will tear me away from my immediate inwardness much more surely than will the mirror (Merleau-Ponty, 1964, p. 136).

Let us try to untangle the guiding idea. Merleau-Ponty's central idea is that mirror self-recognition exemplifies a troubled form of self-knowledge. To recognize oneself in the mirror does not simply involve an identification of the felt *me* which is here, and the perceived *me* which is there, it also and more importantly involves the dawning realization that the felt *me* has an exterior dimension that can be witnessed by others (Merleau-Ponty, 1964, pp. 129, 140). In short, the decisive and unsettling impact of mirror self-recognition is not that I succeed in identifying the mirror image as myself. Rather, what is at stake here is the realization that I exist in an intersubjective space. I am exposed and visible to others. When seeing myself in the mirror, I am seeing myself as others see me. I am confronted with the appearance I present to others. In fact, not only am I seeing myself as others see me, I am also seeing myself as if I was an other, i.e., I am adopting an alienating perspective on myself. The enigmatic and uncanny character of the specular image is precisely due to this intermingling of self and other. It is me that I see in mirror, but the *me* I see has not quite the same familiarity and immediacy as the *me* I know from inner experience. The *me* I see in the mirror is distant and yet close, it is felt as another, and yet as myself. Even though the specular image might indeed look like any other person, it retains its unbreakable link to me. It shows up every time I look in the mirror, it is glued to me in the sense that it moves with me. I cannot freely establish a distance and perspective on it, as I can with other objects. Indeed, I cannot get rid of my exteriority, my exposed surface. One explanation for why the infant's initial delight when facing its mirror-image (a delight that is occasioned by its conviction that it is faced with a perfect play-mate) is replaced by wariness and embarrassment when it starts to recognize that it is faced with itself, might precisely be the emergence of this more complex and more ambivalent form of self-experience, with its odd mix of subjective and objective components.

In his essay, Merleau-Ponty remarks that the other's look starts to be felt as an annoyance when the child reaches the age of around 3, and that the reason for this is that the other's look displaces the child's attention from whatever tasks it is concerned and preoccupied with to a concern for the way in which it is presented to others (Merleau-Ponty, 1964, p. 152). To put it differently, the claim being made is that the other's look – and this was of course a theme that Sartre had already pursued intensively – motivates a shift in my self-relation. My awareness of the other's look can make me adopt a more distanced perspective on myself, can make me adopt the perspective of the other on myself.

But at this stage, there is something unsatisfactory about Merleau-Ponty's ontogenetic time table. On the one hand, mirror self-recognition is taken to be linked to an increased ability to recognize the perspectives of others on oneself and to assume a detached perspective on oneself. But the very same thing is said regarding my awareness of the gaze of the other, and whereas Merleau-Ponty dates the latter to around 36 months of age, he dates the former much earlier, namely at around 12–15 months (Merleau-Ponty, 1964, p. 130).

Merleau-Ponty's view provides a stimulating alternative to the dominant cognitivist view, but it also leaves various questions unanswered. Is social interaction and the awareness of the attention of others a precondition for the emergence of mirror self-recognition? This would be contrary to what Merleau-Ponty seems to be claiming. Or is it rather the case, that the ability to construe oneself as another, to adopt an alienating perspective on oneself, is a precondition for being able to encounter other subjects as others? Is it the other's foreign perspective that teaches me to adopt an alienating perspective on myself, or is it my constitutional otherness, my inherent capacity for self-objectification and othering, that in the first place makes it possible for me to encounter others?

Some recent empirical studies provide tentative answers to these questions, prior to and beyond the passing of the mirror mark test.

7. Mirror exposure and mirror self-experience in human development

Many longitudinal and cross-sectional observations of children's developing responses to viewing their own reflection in mirrors exist in the psychological literature of these past 150 years. There is a consensus on the general feature of this development, which has been described by Amsterdam (1968, 1972) in the first large cross-sectional study of 88 children aged between 3 and 24 months (two males and two females at each month of age). This study included the rouge mark test that

she invented in parallel to Gordon Gallup (1970, 1982) who used the paradigm for his comparative study of chimpanzees and monkeys.⁵

In her original study, Amsterdam (1968, 1972) coded children's reactions to the mirror in terms of whether they behaved as if they were facing a sociable playmate; observed their own movements, showed withdrawal, self-admiration or embarrassment, and finally whether they showed signs of self-recognition by touching the dot surreptitiously put on their face.

Aside from the landmark passing by a majority of children of the mirror mark test from around 20 months, a finding that is corroborated by many follow-up studies (e.g., Bard, Todd, Bernier, Love, & Leavens, 2006; Lewis & Brooks-Gunn, 1979), Amsterdam's original observations point to the fact that mirror self-experience develops to become incrementally troubling and unsettling for the healthy child. From being a curiosity and the innocent, yet illusory social joy of meeting a playmate, the encounter with the own specular image quickly becomes the source of an experiential wariness. Such wariness eventually passes, as mirror self-reflection becomes common and predictable, soon used for the control of self-presentation, while continuing to permeate adult folk stories and superstitions.⁶ The developmental process by which children decrease their wary reaction to their own specular image, not persistently reacting with fear and embarrassment, remains to be specified.

Coming back to the questions raised in our discussion of Merleau-Ponty, mirror self-recognition can hardly be a precondition for social cognition, since blind people who lack the former does not lack the latter (Bigelow, 1995). On the other hand, social cognition is arguably also not a precondition for mirror self-recognition since young autistic children, with deficiencies in social cognition can pass the mirror self-recognition test. They will remove the mark from their faces when they perceive it in the mirror. What is noteworthy however is that subjects with autism when facing a mirror do not show the signs of coyness and embarrassment so typical of non-autistic children (Hobson, 2002, p. 89). They do not seem much concerned with the way they appear to others; in fact, they seem to have difficulties conceiving of themselves as selves in the minds of others. The question to ask is what this tells us about ordinary mirror self-recognition as well as the range and form of self-awareness available to persons with autism (e.g., Williams & Happe, 2009), or any other individuals, human or non-human, passing the mirror mark test.

8. Non-human versus human mirror self-experience

What we have argued so far is that mirror self-experience attests to a considerably more complex and varied form of self-experience than the standard account allows for. But it could be objected that various non-human animals, including chimpanzees, can pass the mirror test and therefore possess mirror self-recognition, without any apparent affective wariness associated to it. We question however the straightforward equation of successful mirror mark test in children and non-human animals. It is not clear that mirror self-recognition in chimpanzees, among other species, corresponds to the cognitive and affective self-consciousness manifested in children passing the test. It is quite true that a chimpanzee can successfully use a mirror to guide its tooth picking activity, but the use of mirrors to act on regions of visual space that are not directly accessible, including regions of the body, can but does not necessarily entail self-recognition if the latter is understood as involving self-identification and self-objectification.

Observing a large cohort of individual chimpanzees and their reactions to mirrors, whether they were marked or unmarked, Povinelli (1995) concludes that long before chimpanzees are capable of presumably recognizing themselves in mirrors by either passing the mark test or using mirrors to engage in systematic self-exploration: "(...) they learn through proprioceptive and kinesthetic feedback that they can control the movement of the mirror image. Thus, the young animals appear to learn procedural rules for manipulating the behavior of the "other" animal they see in the mirror, and when confronted with the same situation except that the stimuli is a video of others, they are duped into executing the same procedural rules." (Povinelli, 1995, p. 171).

The learning aspect attached to the use of mirrors in either the context of self-exploration or the mark test, suggests that one of the main feature of mirror perception is the detection of what mirrors can afford for perception and action. That would

⁵ Note that numerous follow-up studies document children, beyond 24 months and in particular starting 3 years of age, identifying themselves in photographs as well as in video recordings (Lewis & Brooks-Gunn, 1979). From this age on, children explicitly manifest an enduring sense of self, projected in the past and differentiated from the here and now of mirror self-reflection (Povinelli, 2001).

⁶ It is interesting to mention that Russian documentary film maker Viktor Kossakovsky filmed his own 2 year-old son Kosakovsky (2005) raised in a house with no mirrors when he encounters for the first time his own specular image. In a non-edited, almost continuous 45 min shot, Svyto recapitulated the four periods described by Amsterdam in her study, in the same exact order and with dramatic transitions plagued with joy, anger, and deception. After a period of puzzlement and hesitation, Svyto first tries to engage his own image in playful exchanges, getting very excited in fencing and banging the mirror, exploring then the perfect contingency of his own movements and the movements of the specular image experienced as another. He eventually shows great distress and despair in not being able to create a dialogic exchange with the image. Svyto at times, looks under the free standing mirror in search of the elusive and ambiguous image of the self as another. In a poignant scene, toward the end of the movie, image of which was actually chosen for the advertising poster of the movie, shows Svyto crying, trying in vain to hug and embrace his own image, cheek on cheek with arms spread out on the mirror surface. In a last sequence, after approximately 40 min, the movie shows Svyto coming to term with his own reflection, and the fact that it is just himself in the mirror, and not an elusive playmate. Svyto ends up relishing his own specular image, admiring and combing his hair with obvious delight. Svyto recognize that the image in the mirror refers to his own embodied self, situated in front of its surface. It reflects back at him how he looks like from the outside. The drama that makes Kossakovsky's movie particularly memorable, is the child's portrayed struggle in coming to term with the fact that the mirror is not a transparent window or open door revealing a new playmate. This slow realization is clearly for Svyto a source of intense wariness toward his own specular image as an alienated object, including long bouts of agitation, rage, and the expression of poignant despair, that is eventually transformed into an intense display of narcissism and self-consciousness.

include the detection of the mirror affordance for actions toward something discovered on the face (e.g., a mark that is visible only, scentless and otherwise unfelt).

In the original Gallup (1970) study that compared different species of macaque monkeys and chimpanzees tested in the mirror mark test, all animals were exposed to mirrors for 10 days before being anesthetized to have, unbeknownst to them, an odorless bright red mark placed on their upper eyebrow ridge and ear. At the beginning of the 10 day exposure to mirrors, Gallup reports that the animals responded to their own specular image by expressing species-specific social behaviors including threat, invitation to play, and sexual displays. Similar responses are observed in dogs or cats (Zazzo, 1982). However, within 2–3 days, unlike the macaques, Gallup reports that chimpanzees (our closest primate relatives), begin to show behaviors that are self-directed.

Based on the fact that chimpanzees are also those who 7 days later pass the mark test by touching it directly rather than in the mirror, sometime even looking at their finger immediately after touching the mark, Gallup concludes that the self-directed behaviors he observes prior to the test are indicative that chimpanzees discover that the image in the mirror is their own embodied self, and nobody else.

In his observations, Gallup includes contingent body and play face movements that are uniquely performed by chimpanzees in the category of self-directed behaviors. However, follow-up studies show that these behaviors are not good predictors of whether individual chimps will pass the mark test, presumably the “acid test” of self-recognition (Lin, Bard, & Anderson, 1992). Nor are they good predictors of whether the animal will use mirrors to explore not directly visible bodily regions, which according to Povinelli would be a better index of self-recognition than the mark test (Povinelli, Rulf, Landau, & Bierschwale, 1993).

With the emergence of self-directed behaviors, chimpanzees certainly learned in 2–3 days to take a different perceptual stance toward the mirror: they learned to look “at” the mirror rather than “through” it, as if it were transparent and revealing an elusive other. It does not entail, however, that they also suddenly managed to conceptualize something about themselves that they *re-cognized* (i.e., cognized again) by looking *at* the mirror. In other words, the interpretation that self-directed behaviors in front of the mirror is the expression of an identity relation between the specular image and a representation of the embodied self is questionable. Yet it remains a basic assumption of Gallup. Another possibility, however, is that the chimps act like this because for 10 days they have learned new affordances of the mirror and of themselves behaving in front of the mirror, becoming agents of new visual effects while acting in it, enticed to reproduce rich multimodal events by looking at their image. This learning would entail a self-experience as agent of these multimodal events. However, it does not have to involve any kind of conceptual self-awareness.

As documented in Povinelli et al. (1993) and Povinelli (1995), many mirror self-exploratory behaviors of chimpanzees involve bringing body parts in contact with the mirror surface, hence bringing regions of the body in “specular” contact with each other. It is reasonable to think that in these kinds of activities, the individual is creating a map of spatial, one-to-one correspondences between felt regions of the body coming into contact with the same region of the specular image that is moving in perfect contingency on the mirror surface.

The reason why the chimpanzee would reach toward the mark and not toward the specular image is that in its mapping of the embodied self and the specular image, the animal learns incidentally also the reflective affordance of the mirror. They learn that it is a solid reflective surface and not a forward extension of space. They learn that there is nothing to reach and grab for other than its surface. They learn that things are reachable the other way, toward the embodied self and not forward in the newly mapped 2-dimensional space that is the mirror. It takes Chimpanzees 2–3 days to show signs that they are learning these affordances, once they learned to look at, rather than to look through the mirror. When 7 (??) days later, according to Gallup (1970) original observations, they pass the mirror test, they certainly learned further the perfect mapping between the 3-D embodied self and its 2-D specular projection, but not necessarily the concept of their identity: that the image is the embodied self. The learning is primarily perceptual and direct, not inferential and conceptual.

Such perceptual mapping would *de facto* create a sensori-motor equivalence between the embodied self and its perfectly contingent and spatially congruent specular reflection. But this “doubling” of the self would be perceptual and not necessarily entail the conceptualization of an “identity” relation between the mirror image and the self, in other words a conceptualization that it is me in the mirror. The fact that other species including magpies (Prior, Schwarz, & Güntürkün, 2008) have in the meantime been shown to pass the mirror mark test also puts pressure on the strong conceptual requirement.

One way to test this leaner interpretation would be to manipulate the first 10 day mirror exposure of the chimpanzees with one group allowed to come close and touch its surface (as in Gallup and many other comparative studies), while another would be allowed only to experience it at a distance or at an angle. The leaner perceptual mapping interpretation proposed above predicts that significantly more chimpanzees of the first group (able to physically touch the mirror surface) would pass the mark test. If the rich identity interpretation of Gallup is correct, the manipulation would not make any difference. The jury is out.

9. Suggestions for new research

The fact that so many unsettling myths surrounds mirrors as special objects in the environment is indicative of the complexity of human mirror experience, particularly mirror self-experience. There is more than a simple affirmation of a pre-existing identity attached to it, there is also what Merleau-Ponty describes as the unsettling experience of a profound alienation of the embodied self or what might be the sudden awareness of one’s public appearance and self-presentation to others.

In recent research (Broesch et al., *in press*), for example, we compared responses to the classic mirror mark test in over two hundreds 2–3 year-old children growing up in highly contrasted cultural and socio-economical contexts (middle-class USA, rural Kenya, Fiji, Grenada, rural Peru, and Canada). We found marked differences among these children. In rural and more traditional contexts, children showed significantly less touching or removing of the mark, typically facing their own specular image frozen, subdued, and avoidant. For example, we tested over 100 children from a rural village in Kenya, with an age span between 18 months and 7 years. Of these children, only 2 (less than 2%) did pass the mirror mark test by touching or removing the mark they discovered on their face. All the Kenyan children stood transfixed, staring frozen and inhibited at their image. This is in sharp contrast with what is reported and corroborated with Western children (Canadian and American) who by 20 months pass in majority the mirror mark test. It thus appears that the meaning of discovering oneself in the mirror with a mark on the face depends on the cultural circumstances of the child. Whether for example they dare modify and correct their self-presentation by removing a mark on their face that was surreptitiously put there by an adult. The passing of the mirror mark test appears, at least in the human child, to depend on normative pressure from the cultural environment (i.e., more or less emphasis on submission and obedience to adult's authority, see also Keller, Kartner, Borke, Yovsi, and Kleis (2005)).

The primary force of social conformity behind the passing of the mirror mark test is further evidenced by recent data we collected at our Laboratory in the USA (Rochat & Broesch, *submitted for publication*). We compared the behavior of 2–4 year-olds in the classic mirror mark test when they were either the only one with a mark on their face or in a situation where the experimenter and all the adults surrounding the child during test also wore the same mark (yellow "Post-It" sticker) on their forehead. We found that significantly more children passed the mirror mark test by touching and removing the mark when they were the only one with a mark during test. When everybody around them were also marked, children showed significantly more hesitation in touching and removing the mark on their forehead, often putting it back on their forehead in an apparent attempt at conforming with the social norm established in the testing room. These observations clearly indicate that there is more than cognition involved in the child's mirror self-experience, but also a sensitivity and awareness of evaluative others as well as a conformity to perceived social norms, what is allowed or promoted by the culture, and what is not. They demonstrate the role of socio-affective factors in the development of mirror self-experience. Even when the child begins to manifest explicit recognition of self in mirrors, it is rarely for itself, in a solipsistic way, but in relation to others, working on self-presentation, arranging and correcting its public appearance (see Rochat & Broesch, *submitted for publication*). This is a central trademark of mirror self-experience and its social use, at least in humans.

From a comparative perspective, the question is whether such factors might play a role in non-human species reported to pass the mirror mark test (e.g., chimpanzees, elephants, or dolphins). Would an elephant or a chimpanzee be less inclined to touch the mark on its forehead, thus passing the mirror mark test, if it saw all other members of the group wearing the same mark? Would these animals show the same signs of normative conformity, and inhibition as children do? These are questions that need to be answered before human and non-human mirror self-experience can be equated.

More comparative research should investigate the possibility of similar laboring on self-presentation explicit in children from the time they pass the mirror mark test, in species that pass or do not pass the test. Likewise, there should be more comparisons between healthy and autistic children in their use and reactions to mirrors, whether these children show more or less inclination toward working on their self-presentation (hair inspection, removal of spots and marks, deliberate attempts at correcting its physical appearance). Such research are necessary to assess the specificity of human mirror self-experience in social and affective terms, above and beyond the assessment of purely cognitive and conceptual capacities thought to be revealed by the mirror mark test.

10. Summary and conclusions

Mirror experience in general, and mirror self-experience in particular, are unsettling at both a perceptual (optic) and affective level. This might account for the recurrent malefic themes of fear and anxiety surrounding mirror myths and superstitions. As pointed by Merleau-Ponty decades ago, mirror self-experience is a profoundly alienating self-experience. The embodied self is experienced through and within the confine of the own physical body, yet "objectified" in its projection outside of the body, onto the mirror surface. An "uncanny" sort of out of the body experience. This forms a deep experiential "me but not me" paradox (Rochat, 1995).

From a comparative perspective, the fact that an increasing number of mammalian and even avian species are reported passing the test, puts pressure on what it might exactly mean, in particular whether it implies actual "re-cognition" in the sense of an internal model of self that is identified in the specular image. More parsimonious accounts remain feasible, including the learning of mirror affordances by touching its flat, non-transparent surface. Such exploration would allow for the direct mapping of felt bodily regions onto the mirror reflection. Mirrors would then be objects that augment visual access to otherwise invisible bodily regions.

At the level of emotion and affectivity, mirror self-experience appears to be universally unsettling, beyond optical trickery and the self-alienation described by Merleau-Ponty. The objectification of the self as seen by others is another source of fear and anxiety at least in humans. This is for example what vernacular English captures in the term "self-consciousness", or the awareness of others' potential judgments on the self, the universal source of social awkwardness, including shame and embarrassment, but also pride and hubris. It remains to be tested whether like us, other animals demonstrate self-alienation,

self-consciousness, and in general are equally motivated to seek attention and social recognition from others, by the fear of being judged, evaluated, ultimately ostracized or falsely admired by others (Rochat, 2009).

More research is needed using tests and experimental paradigms to explore mirror experience, like the mirror mark test, but tapping more into how mirrors are used by individuals to gauge and control their public appearance, assess how they are viewed by others, a proclivity that we suspect is uniquely exacerbated in humans, developing in all healthy children across cultures from around their second birthday.

There comes a point in human ontogeny when mirror self-experience and third person perspective on the self become inseparable. This makes such experience incommensurably more rich and intricate than the solipsistic recognition and conceptualization of the embodied self in the mirror that would be indexed by the passing of the mirror mark test.

References

- Amsterdam, B. K. (1968). Mirror behavior in children under two years of age doctoral dissertation, Univ. North Carolina. Order No. 6901569; University Microfilms, Ann Arbor, MI, 48106.
- Amsterdam, B. (1972). Mirror self-image reactions before age two. *Developmental Psychobiology*, 5, 297–305.
- Amsterdam, B. K., & Levitt, M. (1980). Consciousness of self and painful self-consciousness. *Psychoanalytic Study of the Child*, 35, 67–83.
- Anderson, J. R., & Gallup, G. G. (1999). Self-recognition in nonhuman primates: Past and future challenges. In M. Haug & R. E. Whalen (Eds.), *Animal models of human emotion and cognition* (pp. 175–194). Washington, DC: American Psychological Association.
- Bard, K. A., Todd, B. K., Bernier, C., Love, J., & Leavens, D. A. (2006). Self-awareness in human and chimpanzee infants: What is measured and what is meant by the mark and mirror test? *Infancy*, 9(2), 191–219.
- Bigelow, A. (1995). The effect of blindness on the early development of the self. In P. Rochat (Ed.), *The self in infancy*. Amsterdam: Elsevier.
- Broesch, T., Callaghan, T., Henrich, J., Murphy, C., & Rochat, P. (in press). Cultural variations in children's mirror self-recognition. *Journal of Cross Cultural Psychology*.
- Carpenter, E. (1976). The tribal terror of self-awareness. In P. Hockings (Ed.), *Principles of visual anthropology*. Berlin: Walter de Gruyter GmbH & Co.
- Carruthers, P. (1996). *Language, thoughts and consciousness. An essay in philosophical psychology*. Cambridge: Cambridge University Press.
- Carruthers, P. (1998). Natural theories of consciousness. *European Journal of Philosophy*, 6(2), 203–222.
- Carruthers, P. (2000). *Phenomenal consciousness. A naturalistic theory*. Cambridge: Cambridge University Press.
- Gallup, G. G. (1970). Chimpanzees: Self-recognition. *Science*, 167, 86–87.
- Gallup, G. G. (1977). Self-recognition in primates: A comparative approach to the bidirectional properties of consciousness. *American Psychologist*, 32, 329–338.
- Gallup, G. G. (1982). Self-awareness and the emergence of mind in primates. *American Journal of Primatology*, 2(3), 237–248.
- Gallup, G. G. (1985). Do minds exist in species other than our own? *Neuroscience and Biobehavioral Reviews*, 9(4), 631–641.
- Gibson, J. J. (1979). *Ecological approach to visual perception*. N.Y.: Houghton Mifflin.
- Hobson, R. P. (2002). *The cradle of thought*. London: Macmillan.
- Keenan, J. P. (2003). *The face in the mirror: The search for the origins of consciousness*. N.Y.: Harper Collins Publishers.
- Keller, H., Kartner, J., Borke, J., Yovsi, R., & Kleis, A. (2005). Parenting styles and the development of the categorical self: A longitudinal study on mirror self-recognition in Cameroonian Nso and German families. *International Journal of Behavioral Development*, 29(6), 496–504.
- Kosakovsky, V. (2005). Svyto. Documentary film.
- Lewis, M. (1992). *Shame: the exposed self*. New York: Free Press.
- Lewis, M. (1995). Aspects of the self: From systems to ideas. In P. Rochat (Ed.), *The self in infancy: Theory and research* (pp. 95–116). Amsterdam: North-Holland, Elsevier Publishers.
- Lewis, M., & Brooks-Gunn, J. (1979). *Social cognition and the acquisition of self*. New York: Plenum Press.
- Lin, A. C., Bard, K. A., & Anderson, J. R. (1992). Development of self-recognition in chimpanzees (Pan troglodytes). *Journal of Comparative Psychology*, 106, 120–127.
- Mead, G. H. (1934/1962). *Mind, self and society*. Chicago: University of Chicago Press.
- Merleau-Ponty, M. (1964). The child's relations with others. In M. Merleau-Ponty (Ed.), *The primacy of perception* (pp. 96–155). Evanston, Ill: Northwestern University Press [trans. W. Cobb].
- Mitchell, R. W. (1993). Mental models of mirror-self-recognition: Two theories. *New Ideas in Psychology*, 11(3), 295–325.
- Mitchell, R. W. (1997a). Kinesthetic-visual matching and the self-concept as explanations of mirror-self-recognition. *Journal for the Theory of Social Behavior*, 27(1), 17–39.
- Mitchell, R. W. (1997b). A comparison of the self-awareness and kinesthetic-visual matching theories of self-recognition: Autistic children and others. *Annals of the New York Academy of Sciences*, 818, 39–62.
- O'Neill, J. (1988). *The communicative body: Studies in communicative philosophy, politics and sociology*. Evanston: Northwestern University Press.
- Povinelli, D. J. (1995). The unduplicated self. In P. Rochat (Ed.), *The self in infancy: Theory and research* (pp. 161–192). Amsterdam, North Holland: Elsevier Science.
- Povinelli, D. J. (2001). The self: Elevated in consciousness and extended in time. In C. Moore & K. Lemmon (Eds.), *The self in time: Developmental perspectives* (pp. 75–95). Mahaw, N.J.: Lawrence Erlbaum Associates.
- Povinelli, D. J., Rulf, A. R., Landau, K., & Bierschwale, D. T. (1993). Self-recognition in chimpanzees (pan troglodytes): Distribution, ontogeny, and patterns of emergence. *Journal of Comparative Psychology*, 107, 347–372.
- Prior, H., Schwarz, A., & Güntürkün, O. (2008). Mirror-induced behavior in the magpie (*Pica pica*): Evidence of self-recognition. *PLoS Biology*, 6(8), e202. doi:10.1371/journal.pbio.0060202.
- Rochat, P. (1995). Early objectification of the self. In P. Rochat (Ed.), *The self in infancy. Advances in psychology book series* (pp. 53–71). North Holland, Amsterdam: Elsevier Science Publishers.
- Rochat, P. (2001). *The infant's world*. Cambridge, MA: Harvard University Press.
- Rochat, P. (2003). Five levels of self-awareness as they unfold early in life. *Consciousness and Cognition*, 12, 717–731.
- Rochat, P. (2009). *Others in mind*. New York, NY: Cambridge University Press.
- Rochat, Broesch (submitted for publication). Social awareness and early self-recognition.
- Tomasello, M. (1999). *Cultural origins of human cognition*. Cambridge: Harvard University Press.
- Williams, D., & Happe, F. (2009). Pre-conceptual aspects of self-awareness in autism spectrum disorder: The case of action monitoring. *Journal of Autism and Developmental Disorders*, 39, 251–259.
- Zahavi, D. (1999). *Self-awareness and alterity. A phenomenological investigation*. Evanston: Northwestern University Press.
- Zahavi, D. (2001). Beyond empathy. Phenomenological approaches to intersubjectivity. *Journal of Consciousness Studies*, 8(5–7), 151–167.
- Zahavi, D. (2004). Back to Brentano? *Journal of Consciousness Studies*, 11(10–11), 66–87.
- Zahavi, D. (2005). *Subjectivity and selfhood: Investigating the first-person perspective*. Cambridge, MA: The MIT Press.
- Zazzo, R. (1982). The person: Objective approaches. In W. W. Hartup (Ed.), *Review of child development research* (Vol. 6, pp. 247–290). Chicago: Chicago University Press.