The Perceived Self in Infancy

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Discussions of the self have frequently generated distinctions between ways of viewing the self: for example, James's distinction between an existential self and a categorical self referred to by Butterworth; and more recently, Neisser's (1988) thoughtful article distinguishing five kinds of self-knowledge—the ecological, interpersonal, extended, private, and conceptual selves. We intend to make only one distinction in our comments—between a presumed conceptual self and a perceptually grounded self—a distinction recognized by Butterworth. Most people who write about the self have in mind a representational construct composed of images (e.g., body images, physiognomic features), attitudes, childhood memories, beliefs, and the like. Discussion of the self as perceived by way of direct detection of information is rare indeed. Neisser referred to a perceived self as an "ecological self" and Butterworth in his target article discusses information for a perceived self in visual proprioception located in optic flow patterns generated during locomotion and postural control.

J. J. Gibson (1979) said, "One perceives the environment and coperceives oneself" (p. 126). Optic flow patterns that define one's direction of movement and provide information for control of posture are indeed examples of information specifying the self as distinct from the world. But there are other sources of information that specify a self, enough to make the construction of a representation a luxury, if not superfluous. We describe these sources, showing their ubiquity and their adaptive value, leaving formulations of a conceptual self to others.

Flow patterns created by self-movement, as Butterworth indicates, do indeed provide information for oneself. But how is it that as we move through the layout, shifting position with respect to the room and the objects around us, objects do not appear to move with us, confusing any potential usefulness of optic flow for specifying ourselves as distinct from the world? Analysis of patterns of flow in the optic array caused by one's *own* movement shows them to be global, producing perspective transformations of all the surfaces in the array so that motion vectors vary with distance of the surface and its position relative to the observer. *Object* motion, on the other hand, produces local motion in the optic array, giving rise to shearing, occlusion and disocclusion, and patterns of accretion and deletion (wiping of texture) in relation to other objects of the layout. Adult observers have no problem distinguishing between these two sources of motion information, even when both occur at once. These two types of change are reliable information for a distinction between self and environment, and the information is detected and used for control of locomotion and other actions.

Now we have evidence that it is detected by infants as young as 4 months. Kellman, Gleitman, and Spelke (1987) put infants in a special apparatus, where object motion and self motion could be manipulated experimentally. Infants were seated in a chair mounted on a frame, connected with a rod, in front of the baby, that moved behind a screen. Either the frame supporting the baby's seat or the rod could be moved independently, in synchrony, or not at all. Habituation studies compared four conditions: (a) both rod and baby motionless; (b) rod moving, baby motionless; (c) baby moving, rod motionless; and (d) both rod and baby moving in synchrony. Results showed that infants distinguished visually between object movement (of the rod) and passive movement of themselves. Infants attend to visual events in the world very early and do not confuse information for such events with information specifying their own movement. When self-movement is active and spontaneous, it should be even more informative.

Babies, like adults, have sources of information about their own movement in addition to visual proprioception. They not only "see" themselves moving in the world, they "feel" themselves via somatosensory and vestibular systems. How do these sources of information mesh? Do they specify the same thing, an objective "self"? Older studies of toddlers observing themselves in a mirror suggested that at some point in development, children identified the mirror image of their actions with somesthetic-vestibular information for them (Loveland, 1986).

Recently, Bahrick and Watson (1985) showed that 4-month-olds perceive optical and somesthetic-vestibular information resulting from their own movements as identical, emanating from the same invariant source, their own bodies. Infants watched spontaneous kicking movements of their own legs on a video monitor, with direct view of the legs hidden by a screen. On another monitor placed alongside was an analogous display of another infant's legs (similarly dressed) or of their own leg movements videotaped at a different time. Preferential-looking measures provided strong evidence that infants distinguished between the contingent live display of their own leg motion and a noncontingent display of themselves or another infant. They perceived the invariant intermodal relationship between visual-proprioceptive and somatic-proprioceptive information. Identification of this invariant makes possible still another remarkable source of information for oneself as an actor upon the world.

Though young infants have a limited repertoire of actions, numerous experiments have shown that they can use the movements available to them (leg kicks, arm waves, head turns, nonnutritive sucking, etc.) to produce a specific desired effect in the environment. For example, when spontaneous leg kicks were linked to the movement of a mobile strung overhead, infants discovered their own causal efficacy, first by kicking their legs to explore the experimental contingency, then by executing the movements with increased frequency and vigor to produce the desired effect (e.g., Rovee & Rovee, 1969; Thelen & Fisher, 1983). Yoked

control infants, whose leg kicks were not contingent on movements of the mobile, showed no increase in kick rate or amplitude. Careful analyses of facial expression during acquisition and extinction trials showed that infants appeared to enjoy their role as causal agent and became angry or fussy when the contingency was disrupted (e.g., Lewis, Sullivan, & Brooks-Gunn, 1985). Infants notice whether their actions have environmental consequences and use the resources available to them to maintain desired effects.

These findings appear to hold for social interactions as well. Infants are very adept at maintaining cooing and smiling "dialogues" with their caregivers, even when viewing mother's face on a video screen (Murray & Trevarthan, 1985). However, when the temporal structure of the interaction was disrupted by delaying the video image, infants noticed the change in efficacy of their actions and began to fuss, look away, and cease to participate in the dialogue. Infants' discovery of their own causal efficacy may be the basis for perceiving themselves as causal agents, as actors whose intentional, goal-directed, behavior may bring about (or fail to produce) a specific environmental change. As Preyer (1888) noted over a century ago, infants appear to derive gratification and a sense of self-control from observing the results of their own activity.

There is a concept, proposed by J. J. Gibson (1966, 1979), that unifies these ideas about perceptually based self-knowledge, the concept of affordances. Affordance refers to a reciprocal relationship between animal and environment. The environment (layout, events, objects) offers support for an animal's actions. Environmental supports that have utility for one animal may not for another; a chair affords sitting for an adult human, but not for an elephant, nor even for a 4-month-old infant. Our perceptions of the world must guide our actions, if they are to be adaptive. But perception of an affordance entails not only perceiving properties of environmental supports, it also entails perceiving the relation of these supports to oneself, the "animal–environment fit" (Warren, 1984). The offerings of the environment must be perceived on a scale relevant to oneself and one's capacities. The system we as perception psychologists must study, therefore, is one that encompasses the self as well as the world.

We are beginning to amass experimental evidence on development of perception of affordances that illuminates our understanding of this fit. Human infants surely have to learn about the affordances of the substances and objects around them. This process entails learning about their own capacities for action as well as the supports the environment offers for newly acquired actions such as crawling and, later, walking. Maturation of an action system appears to bring with it motivation for exploring both the required supports and infants' own abilities with respect to them (E. J. Gibson, 1988).

Studies of detection of affordances for locomotion, upright stance, and traversal of slopes suggest that children explore environmental supports for traversability and potential stability of posture not only in relation to the surface of support, but in relation to constraints imposed by their own anatomy and powers of perceptual-motor control. All the sources of information for a self identified so far now come into play. For stability, distinction of one's own motion from motion of objects and layout permits compensatory adjustment of posture and path (Lee & Aronson, 1974). Global flow patterns in the optic array warn the actor of an impending fall or collision. Schmuckler and E. J. Gibson (1989) showed that walking experience assists toddlers in differentiating flow patterns controlling posture from information for the persisting layout that controls "heading," arriving at a destination. E. J. Gibson et al. (1987) showed that toddlers, as distinguished from crawling infants, learn to use exploratory activities to test the consequences of actions informing them of the relative rigidity of a support surface, its "walkability." When control of walking upright is found to be difficult, toddlers traverse the surface by crawling. Adolph, Eppler, and E. J. Gibson (1990) studied infants' locomotion over upward and downward slopes. Multimodal information from vestibular, somesthetic, haptic, and visual sources again combine to guide the infant in learning what an upward or downward slope affords. Novice walkers explore and use information about their own capacities relative to a slope for guidance of ascent and descent. Crawlers are as yet unable to use such information for guidance even though they actively explore the support surface prior to traversal. They are still in the process of learning the relevant affordances.

Thus, it becomes clear that information for perceiving oneself is available even in infancy and that infants learn progressively with the advent of new action systems what the world affords for them as observers and actors in their own right. But to understand this, we must first understand that the person, infant or adult, is not just a "self," but an animal that lives in a reciprocal relationship with its environment.

Note

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Perception, Conception, and Infant Self-Awareness

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The idea that humans begin life somehow undifferentiated from their environment has had a compelling fascination for psychological theorists. In the ideas of theorists as diverse as Helmholtz, Freud, and Piaget, some version of this idea can be found. Initially, the infant is said to lack some demarcation between itself and the world, failing to understand the difference between its own actions and events in the world, its own boundaries and those of objects, or its own needs and desires and those of others.

Butterworth does a great service by reexamining the issue of self–other differentiation from an ecological perspective. This reexamination is typical of recent work in early cognitive development in taking as its departure point a relatively new appraisal of infant perception. From this perspective, which owes much to an ecological approach, perceptual systems are seen as having evolved to pick up information about the environment and the self within that environment. The infant's perceptual abilities may not be as precise or as versatile as the adult's, but their function is the same. An earlier view, shared by most if not all theorists who viewed infants as "undifferentiated" from the environment, held that the senses initially deliver to the infant only meaningless sensations. From this starting point, it would be hard to ascribe an initial self–world discrimination to infants, especially one rooted in perception. The widespread belief in initial nondifferentiation has been more or less a default hypothesis. It surely has not been carefully connected to empirical observations.

The possibility entertained by Butterworth, that self-perception is grounded in early perceptual activity, is not only compatible with, but might be expected from an ecological approach. Complex perceptual systems are the property only of mobile organisms. Tasks such as perceptual control of posture and locomotion, as well as detection of relations between the self and other entities, are fundamental. Moreover, analyses of the optic array suggest that information is available to specify with high accuracy many aspects of self-motion and position, object motion, and spatial relations. One might imagine evolved perceptual systems that do not initially make use of such information, but it is much easier to imagine the opposite. The empirical evidence reviewed by Butterworth suggests that the self and the world are distinguished by infants early on.

Perception Versus Conception

Given the likelihood of an intrinsic foundation for differentiating the self and the world, what sense can we make of young infants' failures on more advanced tasks, such as the rouge-removal task? It is here that I am not as comfortable with the analysis presented. Butterworth is careful to note uncertainties of interpretation, but he favors the view that initially, the young child has only *perceptual* representations of self, and that qualitatively different *conceptual* representations emerge with further development.

This distinction is best approached cautiously. It has taken a long time for psychologists to move from sensationist characterizations of infancy to perceptual ones. Sensationists attributed to the infant not knowledge, but something preliminary to knowledge—that is, sensations. There is now ample evidence that an infant's perceptual systems place her in meaningful contact with the world from very early on. But is there something preliminary about this knowledge? Can it be characterized as *merely perceptual* and thus not quite *real* knowledge, much as an earlier approach found the contents of the infant's mind to be *merely* sensory? In attributing perceptual knowledge that is not conceptual, I wonder if we are not on the verge of replaying the sensation versus knowledge script, which, however interesting, is becoming a bit dated.

Is there reason to believe in a perceptual–conceptual shift? One concern is that some arguments appear to furnish reasons by shifting the term "perceptual" to mean "sensory." This happens to some extent in the target article. For example, in discussing Mounoud and Vinter's (1981) proposed revisions of Piaget's theory of sensorimotor development, Butterworth refers to the initial stage: "The most basic, and the one that characterizes the initial state of coordination we have been discussing, they call the 'sensory' code. This is not the same as Gibsonian terminology but one can see a close affinity." The affinity here appears to be more with Piaget's sensorimotor stage (and traditional sensationism) than with ecological views of early perception. Development begins with the same old meaningless sensations or images. From such a beginning, later qualitative change would, of course, be necessary. As an argument for qualitative change, however, this view begs the question.