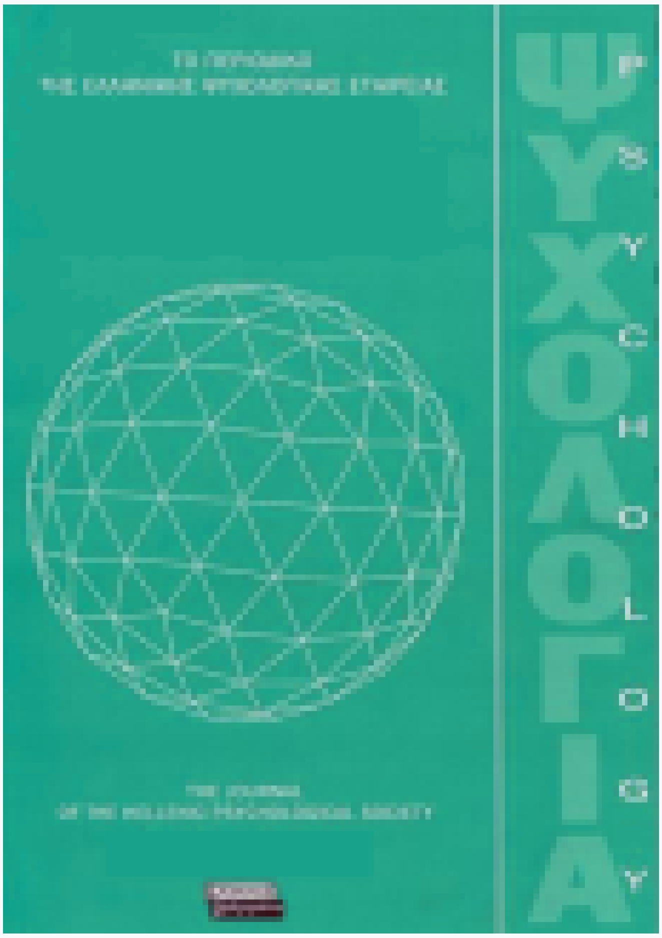
Psychology: the Journal of the Hellenic Psychological Society

Vol 4, No 2 (1997)



The ecological approach and the future of psychology

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doi: [10.12681/psy_hps.24219](https://doi.org/10.12681/psy_hps.24219)

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ABSTRACT The ecological approach to perception is very different from current models of information processing. This difference will become especially obvious as advances in neuroscience improve our access to the brain mechanisms on which perception depends. When we can see those mechanisms directly it will no longer be necessary to model them, but we will still need to understand the environmental information that they pick up and use. This paper focuses on two examples of ecological analysis: (1) The layout of objects and the environment as well as the position and movement of the perceiver are specified by *invariants of optic flow*. (2) The sizes of objects are often specified not with respect to perceived distance but by the relation between object size and *observer eye height*. The problem of mental imagery is also briefly discussed, as is the author's theory of the ecological, social, and cognitive development of the self.

Key-words: Ecological psychology, perception, self-perception

As the twentieth century draws to a close, the science of psychology faces an uncertain future. On one side is the familiar humanistic critique of science in general (and of the social sciences in particular), which seems to be finding new sources of strength in the current «post-modern» period. On the other side are certain remarkable developments in neuroscience, which may soon make some of our most familiar methods obsolete. The humanist critique comes from a well-established intellectual tradition that has long seen science as irrelevant to -indeed perhaps as destructive of- human values. What could it possibly contribute to an understanding of culture or of the self? The second threat is very different: it comes from the recent invention of new methods of displaying the activity of the brain. Psychology cannot ignore these developments in neuroscience, which will soon make many of our procedures as out of date as the introspections of Titchener and Wundt.

Although I take both these critiques seriously, I expect psychology to survive them. Indeed, it will do much more than survive. On one side, some forms of psychological research are and will continue to be indispensable prerequisites for the study of brain function. On the other side, those same forms of psychology have already made -and will continue to make- discoveries with significant implications for the human sciences. The forms I have in mind are those at the ecological level of analysis. The chief aim of my remarks today is to clarify that analysis and its implications.

The concept of an ecological level of analysis extends to many different fields. Grounded in

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James J. Gibson's (1979) explicitly ecological theory of perception (to which I will turn in a moment), it really includes every form of psychology that takes the physical or the social environment seriously. To adopt an ecological approach is to think of persons as deeply embedded in concrete situations: so deeply that neither individual nor environment can be understood without also understanding the other. Gibson argued that there can be no good theory of how people perceive without an equally good theory of the ocean of structured light that makes perception possible. Similarly, I believe, there can be no good theory of social behavior without an equally good theory of the public, reciprocal exchanges of information that characterize social life.

This definition of «ecological» may strike you as broad indeed, perhaps so broad as to be bland. Don't all cognitive psychologists begin with the environment? Don't they all present stimuli to their subjects? Indeed they do, but often the stimuli are only interchangeable means of testing hypotheses about mental processes. Many students of cognition care only about what goes on inside the head: about internal connections, mechanisms, and stages of processing. For them, cognitive psychology is about the machinery of the mind -which, they assume, more or less directly reflects the underlying machinery of the brain. Given that neither mind nor brain can be observed directly, the appropriate strategy has been to make *models* of them.

This argument has been persuasive for some thirty years, roughly since cognitive psychology began. By now the scope of model-making is impressive indeed. There are sophisticated information-processing models of face recognition, of object recognition, of word recognition, of speech recognition; of language understanding and language production; of attention, memory, reading, problem solving, deductive reasoning. Empirical studies of these models are usually based on the reaction times and errors of normal adult subjects as they carry out simplified laboratory tasks. Over the years this enterprise has generated many famous concepts: feature analysis, selective attention, pattern recognition, short -and long- term storage, mental rotation, schemas and scripts, semantic memory. All of them refer to processes that supposedly occur in the brains of subjects as they participate in cognitive experiments.

Despite the apparent success of cognitive modeling, it has always had its critics. My own reasons for being skeptical have not been those of the behaviorists, who object on principle to any account of mental processes; neither have they been those of the social critics of science itself. My critique has had a more ecological basis. To focus on internal processes in this way, relying on results obtained in relatively artificial tasks, is to overlook the complexity of real human action in the ordinary environment. But while I could easily elaborate this critique -and indeed have often done so- it may no longer be necessary. The entire scientific situation of psychology is about to change, in a way that has profound implications for cognitive modeling. That change will be brought about, I believe, by new methods now being developed in neuroscience. These methods, which can display the activity of the living brain with vivid clarity, will soon make traditional forms of cognitive modeling obsolete.

The most impressive of the new techniques are the several forms of computer-aided scanning, notably PET (Positron Emission Tomography) and MRI (Magnetic Resonance Imaging). In these procedures, computers are used to produce images of the brain in action - images that clearly reflect the differential activity of various networks and regions. Thus it is possible to see -quite literally to see- what the brain is doing as an individual carries out various mental tasks. These images show, not surprisingly, that many different areas of the brain are involved in almost everything we do. But in the ingenious hands of modern cognitive scientists (of whom Michael Posner is perhaps the most articulate) they are beginning to show much more than that. One of the most powerful procedures involves recording the brain's pattern of activity during two slightly different tasks, tasks that are identical except that one of them involves an extra mental step. With the aid of a computer, the typical neural patterns of the «baseline» task are then subtracted from those of the other. The result of this subtraction reveals the particular neural networks that are unique to the extra step.

Here is an example. In studying how people understand word meanings, an investigator might carry out PET scans as subjects engage in two related tasks which require them to read and to speak words aloud. In the baseline task, subjects simply read a presented noun, for example *knife*, and speak it aloud. In the extra-step task, they read the noun and then respond with an appropriate verb, for example *cut*. Subtracting the activation pattern typical of the first task from that obtained in the second task then enables the investigators to see the specific neural networks involved in interpreting and elaborating the meanings of words. Similar methods can be used to explore (literally, to *illuminate*) the neural basis of many other processes: selective attention, depth perception, pattern discrimination, and so on.

Actual brain-scan methods are more complex than this illustration suggests, and include other controls that I have not described. My point is simply that they work. It is now possible -or will very soon be possible- to literally see the flow of information in the living brain as people perceive and attend and imagine and think. When that becomes possible, who will still be interested in hypothetical models? The imagined mechanisms that psychologists can devise will surely give way to the real mechanisms that neuroscientists can see.

Early in the next century, then, cognitive psychology is in for some serious intellectual housecleaning. Our familiar information processing models of the mind, built on and tested by laboratory reaction-time experiments, may soon go the way of the epicycles in Ptolemaic astronomy. Contemporary modelers of reading and remembering and thinking are already scrambling to keep up with the latest neural discoveries. Soon those who do not manage to retool will begin to suffer from what amounts to technological unemployment. When that happens, what forms of psychology will still be scientifically important? I believe it will be those psychologies that focus on the real rather than the hypothetical -in other words, those based on ecological forms of analysis.

It is time now to give some examples. As you know, the paradigmatic theory in ecological psychology is James Gibson's analysis of visual perception. Appropriately, Gibson's *Ecological Approach to Visual Perception* (1979) does not begin with the eye; it begins with a description of the environment. The ecologial approach to perception asks three fundamental questions:

(1) The objects of perception: what sorts of things do we actually perceive?

(2) The medium: what information specifies those things to perceivers?

(3) Finally, how do the perceivers pick up that information?

Brain science concerns only the third of these questions, but we shall soon see that the other two must be answered first.

To begin at the beginning, then, what kinds of things can be seen? Part of the answer seems obvious: we see what Gibson called the «layout of the environment». This includes the ground on which we stand, objects resting on that ground (or perhaps on other objects) at various places, the locations and shapes and sizes of those objects, and so on. But this analysis immediately implies something else: namely, that we also perceive ourselves. In seeing that this lectern is in front of me and that door is over there, for example, I also see that I myself am *here*, at a particular place with respect to the lectern and the door. Perception of the environment always involves co-perception of the self. This fact has two important implications. First, the old perceptual theories that begin with the retinal images of objects are inadequate: the self is rarely imaged on the retina, but its position can be seen nevertheless. Second, and perhaps surprisingly, the *self* plays an important role in the ecological approach to perception.

We will return to the self later; for the present, I must continue Gibson's list of perceivables. The objects that people see -especially the animate objects, such as other people- are often in perceptible motion. That is, we see not only *things* but also *events*. Objects move; they also undergo changes of shape, of expression, of orientation. What's more, the perceiver is often moving too. The typical laboratory situation, in which a seated observer looks briefly or fixedly at a stationary display, is an oddity in daily life. The visual system evolved to serve living animals as they move through a rich and often non-stationary environment.

Like other animals, people are not content with just observing the environment; they also act on it. To do so effectively, they must first be able to see what actions are possible. That is, they must see what the environment *affords* for them. Could I pick up that glass? Could I walk, here on this floor, as far as that door? Is the door wide enough for me to pass through when I get there? We are all, always, surrounded by a host of such possibilities; the important thing is to be aware of them. The visual system surely evolved so that animals could perceive affordances:

-this is something I can eat;

-that is a predator who may eat me;

-here is a path along which I can run away from him;

-over there is a cliff edge where I might fall.

To describe the functions of the visual system in this way is to make a new theoretical claim. The classical theories of perception assumed that vision begins with simple qualia like color and intensity and location. That was, I believe, a profound mistake. The modern practitioners of computer vision (especially those iinfluenced by David Marr) take the most fundamental perceptions to be of oriented bits of surface lying in various directions from the point of observation. This seems to me a major advance over the classical view, but it still does not go far enough. Ecological psychologists assume that the visual system evolved primarily to mediate the perception of affordances; this is still its basic function.

Let us turn now to the second question: what kinds of information make it possible to see all these things? What specifies layouts and events and affordances to perceivers? To address this issue effectively, we must begin with Gibson's most fundamental concept: *the ambient optic array*. At every point in the environment to which an eye might come, the incoming light -reflected to that point from nearby surfaces- is already densely structured. The optic array, by one definition, is the infinite set of all such points and their associated optical structures. Even more important, however, are the systematic changes that result when such a point (considered as a point of observation) moves from one location to another. The full structure of that movement-sampled array uniquely specifies both the layout of the environment and the observer's path of motion. It enables us to see things as they are. Note that there was an optic array long before there were animals or eyes to sample it. Evolution shaped our visual system to take advantage of the information that the array provides, just as it shaped our digestive system to take advantage of certain available nutrients. We live in the optic array: it surrounds us all, keeping us in touch with our world.

One particularly important form of information in the array is *optic flow*. In a normally cluttered environment, any movement of the point of observation produces a systematic flow pattern. The simplest case occurs when the observer moves toward an extended surface such as a wall. Every bit of optical texture in the array then flows outward from a central point, and that focus of expansion is exactly the point toward which the observer is moving. In this way, we can literally see where we are going. Another type of flow occurs when the observer moves parallel to a surface: all texture elements in the surface stream backwards with respect to the direction of movement. This streaming is a particularly effective source of information; under evolutionary conditions, it could result only from motion of the perceiver. For that reason, the visual system still relies on it as information for egomotion. (In our technological environment optic flow occasionally gives rise to illusions, as when we sit in a stationary train or car while a neighboring vehicle begins to move.)

In ordinary everyday movements, coordinated flow patterns are visible in all directions, everywhere in the visual field. They accurately specify the motion of the point of observation; we see just how we are moving, where we are going. To put it another way, we see *ourselves:* our own trajectories of motion. The self we see in this way is defined by its relation to the local environment, so I call it the «ecological self». Of course it is by no means purely visual: we have bodies as well as eyes. We constantly cause changes in our own environments, initiating actions that have perceptible consequences. Those particular parts of the world whose movements and changes we can consistently control are perceived as parts of *ourselves:* not just our bodies and limbs, but on occasion also our clothes or the car we are driving. Philosophers have often stressed the importance of embodied action in establishing a sense of self; that argument that is entirely compatible with the ecological approach.

It is important to see that the functions of optic flow could not have been discovered by the methods of neuroscience. The information I have been describing is in the light, not in the head. Once discovered, however, the fact that perceivers use this type of information establishes a new research agenda for brain science. Given the important role that optic flow plays in perception, there must be neural mechanisms sensitive to it. Indeed, many neural systems that respond to optic motion have already been identified; doubtless there are others still awaiting discovery. Thus neuroscience can provide part of the answer to Gibson's third question: how do perceivers pick up the information that the array provides? This example shows that the discoveries of ecological psychology can provide new and productive problems for brain research. Advances in neuroscience will not put us out of business. On the contrary, they will depend, in part, on ecological discoveries.

So far I have described only one simple type of optic flow. There are many others, and they provide different types of information to perceivers. While some specify movement of the self, others specify the motions of environmental objects. There is *looming,* for example: the rapid magnification of one sector of the array as it occludes more and more of the background. If that magnification is symmetrical, a looming display specifies that an object is on a collision course with the perceiver himself. Moreover, the *rate* of the magnification can specify how much time remains before the collision actually takes place. Many aspects of human movement control, such as those in fast-paced sports, depend on looming and related types of optic flow. In some cases the detailed structure of relevant flows is not yet fully understood, or is in dispute. There is still a lot to do in this domain; much of it will surely be done in the next few years.

The perceiver's sensitivity to optic flow begins very early, perhaps at birth. Very young infants will flinch away from a looming display, moving their heads back to avoid the impending collisiion. (They do not flinch in this way, however, if the flow is substantially assymetrical; that would indicate that the looming object will pass safely to one side.) Infants also pick up the streaming flow patterns that indicate motion of the self. That sensitivity can be demonstrated as soon as the baby sits up, but it is particularly dramatic in one-year-olds who have just learned to stand. The only necessary equipment is a small experimental chamber in which the walls can be moved independently of the floor. (The first such chamber was constructed by David Lee of the University of Edinburgh, whose work established many of the principles I am discussing today; cf. Lee, 1980; Lee & Lishman, 1975.) When the walls sway forward a little, a child standing in the room is likely to fall down. He does so because the optic flow information from the moving walls is of the sort that normally specifies backward motion of the self; in compensating for that illusory motion with a forward lurch, he effectively knocks himself down. Adults standing in the same moving room (which I have done), also experience many impressive illusions of motion.

Perhaps that's enough about optic flow. The main points I have tried to establish are the following:

1) A scientific understanding of perception must include an understanding of the information available to perceivers;

2) in the case of vision, that information consists of complex structures in the optic array;

3) many of those structures are produced by the activity of the perceiver himself;

4) for that reason, perception of the environment normally includes co-perception of the self-specifically, of the *ecological* self.

5) Ecological research is a necessary prerequisite to the study of the brain mechanisms involved in perception.

These principles do not apply only to optic flow; they recur in the analysis of many other perceptual achievements. As a second example, consider size perception. The perception of size is usually thought to involve the following problem: when objects cast images on the retina, the size of those images varies with distance of the objects. Nevertheless we experience «size constancy»: perceived size does not normally vary with distance. To explain this achievement, psychologists since Helmholtz have assumed that people make unconscious calculations in perceiving size -calculations that take into account not only the size of the image but also the apparent distance of the object. Although some version of that hypothesis still appears in every textbook of psychology, I think it is almost certainly wrong. The problem of size perception looks very different from an ecological perspective.

To begin at the beginning, what *is* size? What do we see when we perceive the size of an object? Do we really say to ourselves «that diameter of that drinking glass is about five centimeters» or «that doorway is nearly a meter across»? Surely not, or at least not often. The absolute measured size of an object rarely matters to us. What *does* matter are its affordances, which are partly determined by its size relative to that of our own body or body parts. What I really see and -need to see- is that this glass is small enough for me to grasp, or that doorway is wide enough for me to walk through. Size perception is *body-scaled:* we perceive objects with reference to ourselves. Many recent experiments have shown (what was perhaps obvious anyway) that such affordances are accurately perceived under normal conditions.

What kinds of information in the optic array could specify size in this body-scaled way? Must we make calculations based on retinal size and distance (as the classical theory suggests), and then compare the results of those calculations with some stored memory of our own body size? Fortunately not; there are other, more direct sources of information. One of these, available whenever you stand on level ground, is your own eye *height.* You can easily see where your level gaze intercepts any object -a tree, a house, a doorway- whatever its distance, all the way to the horizon. (For geometrical reasons, the horizon itself is always exactly at your eye height.) That point of interception specifies the size of the object with respect to *your* size very precisely -just the information you need in order to assess its affordances. Given where my gaze intercepts that doorway, for examle, it is clearly taller than me, of a height and width that would permit me to pass through it. No information about its distance is necessary at all.

Let me add one cautionary note. In trying to make the eye-height hypothesis plausible to you, I have misrepresented it a little. Perceiving size-based affordances doesn't actually involve an explicit comparison between object dimensions and eye height. That is, you don't begin by noting the point where your gaze intercepts the object and then proceed to make calculations and comparisons. Rather, the available pattern of contour and perspective in the optic array specifies both your own eye height and the affordances of the layout. Your visual system is already tuned to information of that kind, scaled to your own body and your own capabilities, just as my visual system is to mine.

This is a point worth emphasizing. If perceived object size is scaled to the standing eye-height and bodily capabilities of observers, it follows that objects do not have the same apparent size for everyone. A box on a shelf that affords reaching for me may be out of reach for you, if you are shorter. A ditch that affords leaping for you may be too wide for me, if you are in better physical condition: it is a narrow ditch for you, a wide ditch for me. Perceived sizes are scaled by the ecological self.

Many of us have had the experience of returning, as an adult, to a home where we once lived as a child. The experience is typically astonishing: everything is so much smaller than we rememberd it! That great huge fireplace is by no means huge now, the once long and frightening hallway is actually quite short, the tree in which we used to climb so high seems almost insignificant. How could we have been so profoundly mistaken? But of course we were not mistaken: our body-scaled perception of size was just as accurate then as it is now. Now that we are viewing it from an eye height of nearly two meters, the tree looks only half as large as it did when our eyes were only a meter off the ground.

Relative size points in both directions. It is not just the sizes of trees and hallways that are specified in this way, but also your own: the size of the ecological self. Then you saw yourself as a child; now, you see yourself as an adult. No matter what your age, you need no mirror to see how tall you are. The information in the optic array specifies your own size quite precisely, albeit in terms of the sizes of other people and things.

In summary, this analysis of size perception leads to the same conclusions as did my earlier discussion of optic flow. To remind you, those conclusions are:

1) A scientific understanding of perception must include an understanding the information available to perceivers;

2) in the case of vision, that information consists of complex structures in the optic array;

3) many of those structures are produced by the activity of the perceiver; others, as here, depend on the *dimensions* of the perceiver.

4) For that reason, perception of the environment normally includes co-perception of the self-specifically, of the *ecological self*.

5) Here again, ecological research is a necessary prerequisite to the study of the relevant neural mechanisms. If the old theory of calculations based on retinal size and distance is really wrong, it is useless to search the brain for a center that makes those calculations! What would be worth looking for, in contrast, is a mechanism that analyzes the eye-height-based aspects of the structure of the visual field.

Perception makes effective action possible, but it also does something else. Having perceived the layout of an environment, we are likely to remember it. If this room were suddenly plunged into darkness, for example, I could still find my way to that door. I would have what is called an *spatial image* of the room: a partial mental representation of the previously perceived layout and its affordances. Images are not considered in Gibson's theory of perception, because they are based on information in the head rather than in the current optic array. Nevertheless, imagining has much in common with perceiving. Many images are derived more or less faithfully from perceptual experience; others may be constructed more freely. Each of us can easily retrieve and manipulate spatial images of many different places. Right now, for example, I can imagine many of the locations through which I passed on the way to this room. I can also imagine Crete as a whole (though I know it only from maps), as well as many other places I have known directly or indirectly. These images are related to one another, organized, connected. This room is in a certain building, the building is in Rethymnon, which in turn is in Crete in the Eastern Mediterranean. An interrelated set of such images is called a «cognitive map»; it typically has less detail but more layers and more structure than real maps do.

Just as perceiving the environment always involves co-perceiving an ecological self, so too imagining an environment always involves the position of an imagined self with a particular perspective. It is always a view from somewhere. (Sometimes the image even includes a view of yourself, seen as an observer might see you, but that is a special case that I will not pursue here.) Moreover, cognitive maps often include a sense -

typically not very specific- of the affordances of the situation being imagined. I may think of how I might get to the airport, for example, and what I would have to do there to board a plane. Of course these musings are often mistaken: it turns out that things aren't where I thought they were, or that they don't afford the actions I had expected. That's the trouble with relying on thought instead of perception! But we do it all the time, as we must if we are to live human lives. It is not enough to be a real ecological self in the real world; we also function as imagined selves in imagined worlds. Here neuroscience can expect to make a major contribution: there is much to learn about the neural mechanisms of imagery, and I look forward to learning it. But here too there are questions that cannot be answered just by studying the brain: on the one hand questions about the perceptual basis of imagery, on the other hand about how imagery is used in our dealings with the real environment.

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So far, I have only described half of cognition. I have spoken only of looking at inanimate things, of perceiving and imagining ourselves in terms of what those things afford us. But the world is *peopled:* the most important things to see and hear and feel -and to imagine- are our conspecifics. The most meaningful occasions of life involve interaction with others. Those interactions may be based on close physical contact, as when we embrace; on acoustical signals, as when we speak to one another; on visual information, as when we smile or exchange gestures; perhaps on other modalities too. Often, we use several modalities at once. Often, we engage in imagined interactions instead of -or in addition to- real ones. All too often, alas, we misperceive the affordances.

For most of us, social life is what makes life worth living. William James (1890) put it this way:

«No more friendish punishment could be devised, were such a thing physically possible, than that one should be turned loose in society and remain absolutely unnoticed by all the members thereof. If no one turned round when we entered, answered when we spoke, or minded what we did, but if every person we met 'cut us dead', and acted as if we were non-existing things, a kind of rage and impotent despair would ere long well up in us, from which the cruellest bodily tortures would be a relief; for these would make us feel that, however bad might be our plight, we had not sunk to such a depth as to be unworthy of attention at all» (p. 293).

You may be wondering why I have changed topics so abruptly; why I have begun to quote William James instead of J. J. Gibson. In my view, however, the transition is entirely natural. Social perception is still perception, social imagination is still imagination. Most of the same principles apply, as do many of my predictions for the future of psychology.

Consider first how deeply we are embedded in the social environment. People do, usually, turn round when we enter and answer when we speak. We do the same for them. Mutuality of behavior is the rule, not only among humans but for many other species as well. Crickets call to crickets, frogs to frogs; dogs and apes and monkeys encounter each other in systematic, species-specific ways. Every such exchange brings something new into existence: namely, a series of reciprocated behaviors occuring at a particular time and place. Those social exchanges are *perceptible.* What is perceived is not merely the other's behavior, but its reciprocity with one's own. Both participants are engaged in a mutual enterprise, and they are well aware of it.

Considered as a participant in a shared communicative activity, each member of such a dyad is what I call an *interpersonal self.* Where the ecological self is active with respect to the local physical environment, the interpersonal self is an agent in an ongoing social exchange. That self, too, is perceived: we see ourselves as the target of the other person's attention, and as co-creator of the interaction itself. This is true whether we are returning an embrace or just maintaining eye contact, whether we are improvisinig in a jazz group or just taking turns in a conversation. You are aware of your own interpersonal activity, and of its intended result. You also perceive its actual result, the appropriate (or perhaps inappropriate) response of your partner. As in the non-social case, the fit between intention and outcome establishes a strong sense of personal effectiveness.

Interpersonal perception, like ecological perception, begins very early in life. Even newborn babies are interested in human faces: they look at them attentively and sometimes go so far as to imitate their expressions. By eight weeks or so babies have become exquisitely social, perhaps more so than they ever will be again. They return their mother's embraces, listen to her voice, look at her face, maintain eye contact. Such infants are still a long way from speech, but when speech is addressed to them they may goo-goo cheerfully in return. These «protoconversations» between babies and mothers are by no means neutral in tone. They are often punctuated with surges of joy, emotional outbursts that are systematically coordinated with the mother's own feeling. The frequency of such sustained and motivated behaviors testifies to the deep, innate human readiness for emotional relationships. Babies are interpersonal selves as well as ecological selves, from the beginning of life.

Recent infant studies -especially those of Colwyn Trevarthen and his collaborators in Edinburgh (Murray & Trevarthen, 1985)- have greatly increased our understandind of this earliest social experience, which Trevarthen (1979) calls «primary intersubjectivity». It will surely be the subject of intensive research in the coming years. Some of that research will have to be at the neurophysiological level. Patterns of action that appear so early and so clearly must be grounded in specific neural structures and processes- processes that ought to be accessible with the tools of modern neuroscience. But those necessary neurophysiological studies will have to be complemented by equally important ecologically oriented research, aimed at finding out what the babies and their mothers actually do, when they do it, what variables it depends on, and what difference it makes.

Although our interactions with other people begin at level of primary intersubjectivity, they do not end there. The infant soon begins to find out more about the people around him, and through them more about the world in which they live -the world in which he, too, must now begin to live. He learns that there is not just a physical environment but also a social and moral one; it consists of family and culture, of right and wrong. Eventually he -like all of us- acquires a sort of cognitive map of that complex domain, one by which he can orient himself and make meaningful choices. How does he learn all this? Where is the information?

He learns most of it from other people, of course; from his mother first of all (at least, this is the case in what Americans consider «traditional families»). That learning process cannot begin until the infant has trascended the stage of primary subjectivity. In that stage, as we have seen, his attention is directed entirely to the ongoing interpersonal exchange; there is no room for anything else. But beginning at nine months or so, something new becomes possible. Infant and mother begin to attend to other things - to objects, events, or ongoing activities- in such a way that each of them is aware of the others' interest. This stage, which Trevarthen calls «secondary intersubjectivity», is characterized by shared attention. The baby looks to see where its mother is pointing, or what she is looking at; by the same token, he may try to attract *her* attention to something *he* is interested in. Ecological and interpersonal perception have come together to create an entirely new possibility: the possibility of *teaching*.

This achievement, unique or nearly unique to the human species, opens the door to language - and through language to conceptualization and culture. Language becomes comprehensible because now the child has a way of knowing what his mother is talking about. Consider first the case of concrete nouns. If Andreas and his mother are both attending to the dog, and mother says dog, Andreas knows what she means because he knows what she is attending to. That knowledge is essential. Michael Tomasello (1988; Tomasello & Farrar, 1986) has shown that children learn new concrete nouns almost exclusively during bouts of shared attention. A similar principle applies to the learning of verbs, though in that case the object of shared attention is more subtle. When Andreas drops a toy and mother says «Did you DROP that?, both of them are thinking of the same event (the dropping of the cup, a moment ago), and both of them know it. Again it is because Andreas knows what his mother has in mind -what they both have in mind- that he can understand what she means by «drop». Shared attention is the key.

It is about this time that children acquire the beginnings of a self-concept. It probably happens in the following way. Young Andreas is already accustomed to following the direction of his mother's attention, and he knows that she uses particular words to refer to particular objects. But on this occasion, being a mother, she is attending to *him*. As she does so, she may call him by name: «Andreas!» He realizes, then, that there is something in the world with that name. And what is that something? Judging by the direction of his mother's gaze and her attention, it must be the very same ecological self that he has already been perceiving for many months. She is thinking of *him*. He is evidently something to think about; soon, he begins to think about himself.

But WHAT does he think about himself? Many things, of course; at present we know far too little about these early conceptualizations. But a substantial proportion of young Andreas' thoughts, not only those about himself but those concerned with the activities and the people around him, have a distinctly moral tone. He thinks to himself: this is right, that is wrong; this is good, that is bad; *I* am good, *I* am bad. And also: this is how *we* are, that is how *they* are; this is what I *am* like, that is what I *should be* like. Andreas has discovered that in addition to the concrete physical environment with its easily perceptible affordances, there is also a richly imaginable moral environment that has crucial affordances of its own. In a word, he has discovered culture.

The interrelations between culture and the self have only recently become the subject of serious empirical research in the United States. Although American psychologists have studied the development of the self-concept for years, most of them did so without giving culture much thought. They simply assumed that there was one normal way to grow up and one normal sort of person to become: an autonomous, independent, consumption-oriented American with high self-esteem and just the right set of family values. Happily, this oversimplified (but all too American!) mode of theory is beginning to change. The work of Hazel Markus and her collaborators (e.g., Markus & Kitayama, 1991) is a case in point. They have been exploring the self-concepts of individuals in many cultures, and have found that neither autonomy nor independence nor even self-esteem are universally valued aspects of the self. Just one illustration will have to do. Many studies have now shown that the great majority of Americans, both children and adults, believe that they are well above average in intelligence as well as in other desirable qualities. They cannot all be right, of course, but nevertheless they go on believing it. Markus's results show, however, that this over-estimation of the self is far from universal; in Japan, for example, the opposite is true. Self-concepts are not universal; they depend intimately on their cultural settings.

What does all this have to do with the future of psychology? It means that there is -and there will continue to be- lots of work for everyone to do. These processes of acculturation and learning cannot be studied by neuroscience, because they are not in the head. Culture, like the optic array, is in the world. Social psychology -including the all-important social psychology of learning- will flourish in the twenty-first century right along with the ecological study of perception, and for the same reason. Individuals are embedded in environments, both cultural and physical; there is no way to understand one without also understanding the other.

That brings me to my final point. If scientific psychology has long seemed irrelevant to any serious thinking about the human condition, that may be because it has for so long been focused only on the mind (considered as a proxy for the brain) or on the brain itself. Models of mental processes cannot do much to help us understand what people's lives mean to them, what they think of themselves, and what difference that may make. Even when we are able to describe the inner processes of the brain more accurately and completely, as we surely will in the decades to come, that description will contribute very little to our understanding of human life as it is experienced. But a more ecological and social psychology -one that has room for the self, for action, for development, and for culture- may make a far more substantial contribution. That is what I hope, and indeed what I confidently expect.

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