



ACTION IN PERCEPTION

ALVA NOË

Action in Perception

Representation and Mind

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Preface

This is a book about perception and consciousness. It is written for philosophers and for cognitive scientists, but also for artists, and anyone else who is interested in the way we manage to make—or fail to make—sensory contact with the world around us. In it I argue that perception and perceptual consciousness depend on capacities for action and capacities for thought; perception is, I argue, a kind of thoughtful activity.

Philosophy flourishes in the midst of scientific research, not only because philosophical problems are in good measure empirical, but because scientific problems are in good measure philosophical. This book is intended to contribute to the interdisciplinary *natural philosophy* of mind.

Action in Perception has been written against the background of ongoing collaborations (and friendships) with Evan Thompson, Kevin O'Regan, and Susan Hurley. I would not have written this book if not for these collaborations; I acknowledge my debt to them here.

I first got interested in perception as a B.Phil. student in Oxford in the late eighties. My interest was stimulated by the work of three philosophers whose work I read and with whom I had contact in Oxford: Peter Strawson, John Hyman, and Peter Hacker. The title of this book refers to Strawson's paper "Causation in Perception."

I began my own research on perception a few years later, as a graduate student at Harvard. Although this book bears only a distant relation to the dissertation I wrote there under Hilary Putnam, this preface is an appropriate place for me to express my gratitude to him: his insightful criticism, and his energetic example, continue to guide my own work.

I also owe a debt of gratitude to Daniel Dennett, who directs the Center for Cognitive Studies at Tufts, where I spent a postdoctoral year in 1995–1996. Some preoccupations of this book—for example, Gibson's

'ecological' approach to perception—were topics of our conversations. Dennett repeatedly challenged me to make explicit the significance of these matters for cognitive science. I try to meet his challenge in this book.

Many other people have helped me write this book, either directly, or indirectly.

For critical discussion (or correspondence) that has shaped my thinking, I would like to thank Adrian Cussins, Hubert Dreyfus, Sean Kelly, Philip Pettit, and the late Francisco Varela.

For helpful criticism of earlier versions of material in this book, or for critical exchange on related matters, I would like to thank Jonathan Cole, Edward Harcourt, Matthew Henken, Pierre Jacob, Tori McGeer, Dominic Murphy, Erik Myin, Judith Baldwin Noë, Luiz Pessoa, Jean Michel Roy, Kyle Sanford, Eric Schwitzgebel, John Searle, and Stephen White. Bence Nanay provided useful detailed criticism of the whole book, for which I am grateful. Thanks also to the members of my fall 2003 UC Berkeley seminar on consciousness and life.

I owe a special debt to several former teachers and colleagues: Stanley Cavell, David Chalmers, the late Burton Dreben, Warren Goldfarb, David Hoy, Hidé Ishiguro, Robert May, and Charles Parsons. As a philosopher and writer, I engage in imagined dialogue with them on a regular basis.

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I am grateful to the members of the Institut Jean Nicod in Paris for welcoming me among them and providing a stimulating environment in which to work on this book during the fall and winter of 2002–2003.

I cannot imagine having written this book without Miriam Dym.

I dedicate this book to my father, Hans Noë.

A.N.
Berkeley
May 2004

Acknowledgments

I thank the copyright holders of the following papers for permission to reproduce selections in this book:

Thought and experience. *American Philosophical Quarterly* 36, no. 3 (July 1999): 257–265.

Is perspectival self-consciousness nonconceptual? *The Philosophical Quarterly* 52, no. 207 (April 2002): 185–194.

On what we see. *Pacific Philosophical Quarterly* 83, no. 1 (2002): 57–80.

Is the visual world a grand illusion? *Journal of Consciousness Studies* 9, no. 5/6: 1–12.

Perception and causation: The puzzle unraveled. *Analysis* 63, no. 2 (April 2003): 93–100.

Experience without the head. Forthcoming in *Perceptual Experience*, ed. T. S. Gendler and J. Hawthorne. Oxford: Oxford University, 2005.

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Simons, D. J., and C. F. Chabris. 1999. Gorillas in our midst: Sustained inattention blindness for dynamic events. *Perception* 28: 1059–1074.

It is really vain to express the nature of something. We notice effects, and a complete account of these effects would perhaps comprise the nature of this thing. We attempt in vain to describe the character of a man; but a description of his actions and his deeds will create for us a picture of his character.

—Goethe, *The Theory of Colours*

1 The Enactive Approach to Perception: An Introduction

The theory of the body is already a theory of perception.

—M. Merleau-Ponty

1.1 The Basic Idea

The main idea of this book is that perceiving is a way of acting. Perception is not something that happens to us, or in us. It is something we do. Think of a blind person tap-tapping his or her way around a cluttered space, perceiving that space by touch, not all at once, but through time, by skillful probing and movement. This is, or at least ought to be, our paradigm of what perceiving is. The world makes itself available to the perceiver through physical movement and interaction. In this book I argue that all perception is touch-like in this way: Perceptual experience acquires content thanks to our possession of bodily skills. *What we perceive* is determined by *what we do* (or what we know how to do); it is determined by what we are *ready* to do. In ways I try to make precise, we *enact* our perceptual experience; we act it out.

To be a perceiver is to understand, implicitly, the effects of movement on sensory stimulation. Examples are ready to hand. An object looms larger in the visual field as we approach it, and its profile deforms as we move about it. A sound grows louder as we move nearer to its source. Movements of the hand over the surface of an object give rise to shifting sensations. As perceivers we are masters of this sort of pattern of sensorimotor dependence. This mastery shows itself in the thoughtless automaticity with which we move our eyes, head and body in taking in what is around us. We spontaneously crane our necks, peer, squint, reach for our glasses, or draw near to

get a better look (or better to handle, sniff, lick or listen to what interests us). The central claim of what I call *the enactive approach* is that our ability to perceive not only depends on, but is constituted by, our possession of this sort of sensorimotor knowledge.¹

One implication of the enactive approach is that only a creature with certain kinds of bodily skills—for example, a basic familiarity with the sensory effects of eye or hand movements, and so forth—could be a perceiver.² This is because, in effect, perceiving is a kind of skillful bodily activity. It may also be that only a creature capable of at least some primitive forms of perception could be capable of self-movement. Specifically, self-movement depends on perceptual modes of self-awareness, for example, proprioception and also ‘perspectival self-consciousness’ (i.e., the ability to keep track of one’s relation to the world around one).³

A second implication of the enactive approach is that we ought to reject the idea—widespread in both philosophy and science—that perception is a process *in the brain* whereby the perceptual system constructs an *internal representation* of the world. No doubt perception depends on what takes place in the brain, and very likely there are internal representations in the brain (e.g., content-bearing internal states). What perception is, however, is not a process in the brain, but a kind of skillful activity on the part of the animal as a whole. The enactive view challenges neuroscience to devise new ways of understanding the neural basis of perception and consciousness.⁴ I return to this controversial topic in chapter 7.

This idea of perception as a species of skillful bodily activity is deeply counterintuitive. It goes against many of our preconceptions about the nature of perception. We tend, when thinking about perception, to make vision, not touch, our paradigm, and we tend to think of vision on a photographic model. You open your eyes and you are given, at once, a sharply focused impression of the present world in all its detail. On this view, the relation between moving and perceiving is only instrumental. It is like the relation between the lugging around of a camera and the resulting picture. The lugging is preliminary to and disconnected from the photograph itself. And so with perceiving. By moving yourself, you can come to occupy a vantage point from which, say, better to see your goal. And then, having seen your goal, you can better decide what to do. But the seeing, and the moving, have no more to do with each other than the photograph and the schlepping of the camera, or the boxer’s left hook, and the

training that preceded it. Which is to say, they have a lot to do with each other, but the relation is nonconstitutive: The effectiveness of the punch is strictly independent of how the boxer learned to do it, and the qualities of the picture are independent of how the camera ended up where it was.

Susan Hurley (1998) has aptly called this simple view of the relation between perception and action the input-output picture: Perception is input from world to mind, action is output from mind to world, thought is the mediating process. If the input-output picture is right, then it must be possible, at least in principle, to disassociate capacities for perception, action, and thought. The main claim of this book is that such a divorce is not possible. I doubt that it is even truly conceivable. All perception, I argue, is intrinsically active. Perceptual experience acquires content thanks to the perceiver's skillful activity. I also argue—but I don't turn to this until late in the book (chapter 6)—that all perception is intrinsically thoughtful. Blind creatures may be capable of thought, but thoughtless creatures could never be capable of sight, or of any genuine content-bearing perceptual experience.⁵ Perception and perceptual consciousness are types of thoughtful, knowledgeable activity.

My aim in this initial chapter is to set out the book's central themes.

1.2 A Puzzle about Perception: Experiential Blindness

For those who see, it is difficult to resist the idea that being blind is like being in the dark. When we think of blindness this way, we imagine it as a state of blackness, absence and deprivation. We suppose that there is a gigantic hole in the consciousness of a blind person, a permanent feeling of incompleteness. Where there could be light, there is no light.

This is a false picture of the nature of blindness. The longterm blind do not experience blindness as a disruption or an absence. This is not because, as legend has it, smell, touch and hearing get stronger to compensate for the failure to see (although this may be true to some degree; see Kaufman, Théoret, and Pascual-Leone 2002). It's because there is a way in which the blind do not experience their blindness at all. Consider, you are unable visually to discern what takes place in the room next door, but you do not experience this inability as a gaping hole in your visual awareness. Likewise, you don't encounter the absence of the sort of olfactory information that would be present to a bloodhound as something missing in

your sense of smell. Nor do you notice the absence of information about the part of the visual field that falls on the “blind spot” of your retina. In this same way the blind do not encounter their blindness as an absence.

It is easy to demonstrate that there are or could be forms of blindness that were not at all like being in the dark. Imagine that you are out in a fog so dense that no matter where you turn or how you strain you only experience a homogeneous whiteness. This is what psychologists call a *Ganzfeld* (Metzger 1930, described in Gibson 1979, 150–151). You can reproduce the experience of a *Ganzfeld* by placing half a Ping-Pong ball over each eye (Hochberg, Triebel, and Seaman 1951; Gibson and Wadell 1952; Block 2001). Gibson used this method to argue that stimulation of the retina by light is not sufficient for vision. For even though you enjoy a pattern of visual stimulation—in some sense, you see the *Ganzfeld*—you are in effect blind. You have visual impressions, but they are bleached of content.

The enactive view of perception predicts that there are, broadly speaking, two different kinds of blindness. First, there is blindness due to damage or disruption of the sensitive apparatus. This is the familiar sort of blindness. It would include blindness caused by cataracts, by retinal disease or injury, or by brain lesion in the visual cortex. Second, there is blindness due not to the absence of sensation or sensitivity, but rather to the person’s (or animal’s) inability to integrate sensory stimulation with patterns of movement and thought. Let’s call this second kind of blindness *experiential blindness* because it is blindness despite the presence of something like normal visual sensation.

Does experiential blindness actually occur? If it does, then we must reject the input-output picture. To see is not just to have visual sensations, it is to have visual sensations that are integrated, in the right sort of way, with bodily skills. Experiential blindness would provide evidence for the enactive approach to perception.

There’s good reason to believe that experiential blindness does occur. As an example, consider attempts to restore sight in congenitally blind individuals whose blindness is due to cataracts. Cataracts impair the eye’s sensitivity by obstructing light on its passage to the retina. From the standpoint of the input-output picture, it would be natural to suppose that removing the cataract would be like sweeping aside the blinds, letting in the light and thus enabling normal vision. This is not in fact what the medical literature on this teaches us.⁶ What we learn from the case studies

is that the surgery restores visual *sensation*, at least to a significant degree, but that it does not restore sight. In the period immediately after the operation, patients suffer blindness despite rich visual sensations. That is to say, they suffer experiential blindness.

Consider a few examples. Gregory and Wallace describe a cataract-surgery patient, S.B.:

S.B.'s first visual experience, when the bandages were removed, was of the surgeon's face. He described the experience as follows: He heard a voice coming from in front of him and to one side: he turned to the source of the sound and saw a "blur." He realized that this must be a face. Upon careful questioning, he seemed to think that he would not have known that this was a face if he had not previously heard the voice and known that voices came from faces. (1963, 366)

Sacks makes a similar observation of his patient Virgil:

He seemed to be staring blankly, bewildered, without focusing, at the surgeon, who stood before him, still holding the bandages. Only when the surgeon spoke—saying "Well?"—did a look of recognition cross Virgil's face.

Virgil told me later that in this first moment he had no idea what he was seeing. There was light, there was movement, there was color, all mixed up, all meaningless, a blur. Then out of the blur came a voice that said, "Well?" Then, and only then, he said, did he finally realize that this chaos of light and shadow was a face—and, indeed, the face of his surgeon. (1995, 114)

Finally, Valvo's patient made the following entry in his diary:

after the operation, I saw the light of the doctor's probe, appearing like an atomic explosion on a background of black. Then I saw something which I understood afterwards was the doctor's hand and, clearly, his fingers; they seemed small and red (and to me it resembled the hand of the devil). . . . What I took to be black holes I recognized after about a month as windows in houses facing the hospital. (Valvo 1971, 9)

These patients suffer from experiential blindness, or so I propose. Their visual sensitivity is restored, to be sure. Each of them undergoes dramatic and robust visual impressions or sensations in the immediate aftermath of the surgery. But none of them, in having these sensations, has acquired the ability to see, at least not in anything like the normal sense. The visual impressions they now receive remain confusing and uninformative to them, like utterances in a foreign language. They have sensations, but the sensations don't add up to experiences with representational content.

The existence of experiential blindness is of great importance. It demonstrates that merely to be given visual impressions is not yet to be made to

see. To see one must have visual impressions that one *understands*. This is brought out forcibly in connection with Gregory and Wallace's S.B. They write, concerning S.B.'s state about a month after his operation:

At first impression he seemed like a normally sighted person, though differences soon became obvious. When he sat down he would not look round or scan the room with his eyes; indeed he would generally pay no attention to visual objects unless his attention were called to them, when he would peer at whatever it was with extreme concentration. (Gregory and Wallace 1963, 364)

S.B. has visual impressions, but he lacks, at least in part, a practical understanding of their significance for movement and thought. The point is not only that S.B. lacks the ability to use his impressions to guide movement, although this is true. In normal perceivers, sensation is smoothly integrated with capacities for thought, and for movement; so, for example, we naturally turn our eyes to objects of interest, we modulate our sensations with movement in a way that is responsive to thought and situation. A sharp sound makes us turn in the direction from which the sound emanates. A ball rushes toward us and we reflexively duck. A person speaks to us, we turn to him or her. In this sort of way, and in countless ways like this, sensory impressions are immediately coupled with spontaneous movement. This coupling is missing for S.B. and the other patients. S.B.'s deficit, however, is more far-reaching even than this; S.B.'s inability to use what he sees to guide movements is caused by what is in effect an inability to see (experiential blindness). S.B. lacks understanding of the sensorimotor significance of his impressions; he lacks knowledge of the way the stimulation varies as he moves or would move. As a result, or so I propose, his impressions are without content and he is, to a substantial degree, blind.

Defenders of the input-output picture may be skeptical. Perhaps, they might argue, one can grant that the newly post-operative patients are blind, but without conceding that they are *experientially* blind. After all, there would seem to be evidence that their difficulty stems not so much from abnormal sensorimotor integration, as from abnormal *sensations*. Look at how they describe their experience. Sacks' Virgil reports encountering movement, color, "all meaningless, a blur," and Valvo's patient describes impressions of atomic explosions on a background of dark. These aren't normal visual sensations. They are clearly abnormal. This line of objection may be strengthened by considering that inactivity of retina and

visual cortex could lead to some degree of stunting of the development of neural connections needed for mature adult vision. Until these possibilities are eliminated, the skeptic can insist that we are not entitled to treat the condition of these patients as *experiential* blindness (i.e., as blindness due to lack of sensorimotor knowledge rather than to lack of perceptual sensitivity). To establish genuine experiential blindness, we need to control for changes in the quality of visual impressions themselves. Until we can do this, we have no argument for the enactive approach and no argument against the input-output picture.

This objection has some force. In section 1.3 I turn to an example of putative experiential blindness that is not vulnerable to this criticism. Taken together the two examples make a strong case for experiential blindness, and so for the enactive approach.

1.3 Being Blinded by What You See

Glasses, or spectacles, belong to the humdrum everyday technology of perception. One of the most common kinds of glasses, or corrective lenses, are for myopia (or nearsightedness). In myopia, light from distant objects, which enters the eye in parallel rays, is brought to a focus before the retina, rather than on it. Light from nearer objects does not consist in parallel rays and is brought to a focus on the retina. What glasses for myopia do is bend light from distant objects so that it enters the eye at the same angle as light from nearer objects, thus allowing it to be brought to a focus on the retina.

What happens if glasses consist of prisms that distort or bias the light entering the eyes in strange or unnatural ways? Suppose you construct lenses so that light from objects on the left enters the eye just as light coming from an object on the right would enter the eye if you were not wearing the lenses. A left-side object would thus stimulate right-side retina, and also right-side brain (that is to say, the parts of the retina and brain normally stimulated by objects on the right). It is reasonable to suppose that in a case such as this you would have an experience as of an object on the right side.

In fact, as experiments by Stratton (1897), Kohler ([1951] 1964), and later Taylor (1962) demonstrate, this is not what happens, or at least not what happens right away. The initial effect of inverting glasses of this sort is not

an inversion of the content of experience (an inversion of what is seen) but rather a partial disruption of seeing itself. Inverting lenses give rise to experiential blindness. Consider what one subject, K, wrote of his initial experiences in Kohler's experiment with displacing spherical prism spectacles:

During visual fixations, every movement of my head gives rise to the most unexpected and peculiar transformations of objects in the visual field. The most familiar forms seem to dissolve and reintegrate in ways never before seen. At times, parts of figures run together, the spaces between disappearing from view: at other times, they run apart, as if intent on deceiving the observer. Countless times I was fooled by these extreme distortions and taken by surprise when a wall, for instance, suddenly appeared to slant down to the road, when a truck I was following with my eyes started to bend, when the road began to arch like a wave, when houses and trees seemed to topple down, and so forth. I felt as if I were living in a topsy-turvy world of houses crashing down on you, of heaving roads, and of jellylike people. (Kohler [1951] 1964)

K is not completely blind, to be sure; he recognizes the trucks, the trees, and so forth. But nor is he completely able to see. His visual world is distorted, made unpredictable and topsy-turvy. To this extent, K suffers blindness. Crucially, the kind of blindness K suffers is not caused by any defect in sensation. K receives normal stimulation. The light reaching his eyes is sharply focused and fully information-bearing. He receives exactly the stimulation he would receive were he looking at an object in a different spatial location without the inverting lenses. The inability to see normally stems not from the character of the stimulation, but rather from the perceiver's understanding (or rather failure of understanding) of the stimulation.

This is exactly what the enactive approach would lead us to expect, as O'Regan and I have argued (O'Regan and Noë 2001a,b; Noë 2002a; see also Hurley and Noë 2003a). The basis of perception, on our enactive, sensorimotor approach, is implicit practical knowledge of the ways movement gives rise to changes in stimulation. When you put on the distorting lenses, the patterns of dependence between movement and stimulation are altered. This alteration has the effect of abrogating sensorimotor knowledge or skill, even though there is no change in the intrinsic character of stimulation. As a consequence, movements of the eye and head give rise to surprising and unanticipated changes in sensory stimulation. The result is not *seeing differently*, but failing to see.

Strictly speaking, the goggles do not produce *total* experiential blindness. This is because the only sensorimotor dependencies that are affected are those pertaining to aspects of spatial content. For example, left-right reversing prisms do not affect one's sense of up and down (although they do affect one's sense, say, of the speed with which the visual world "swings by" as one moves one's eyes). Moreover, left-right reversing goggles do not affect one's sense of light and dark, color, and so on. When you put on left-right reversing goggles, you enjoy *some* perceptual experience. For example, you can tell whether the lights are on. This is not surprising, given that the goggles don't change *all* the patterns of sensorimotor dependence, only those that are related to spatial orientation.

The enactive view would also lead us to expect that vision will be restored once one comes to grips with the new patterns of sensorimotor dependence. The experimental literature supports this. Kohler's reports suggest that adaptation occurs in stages. The first stage of adaptation is the experience of inverted content. Now objects on the left do indeed look just as if they are on the right. Your visual experience has acquired nonveridical content. But this state of partial adaptation is highly unstable. Your left hand may look as if it is on the right, but it continues to *feel* as if it is on the left (Hurley and Noë 2003a). And when you snap your fingers, the sound of your "hand on the right" seems to come from the left. At the next stage of adaptation, visual experience "captures" auditory and proprioceptive experience, resolving conflicts between these sensory modalities in favor of vision. The object on the left not only looks as if it is on the right, but it now sounds and feels as if it is too. If subjects are allowed (indeed required) to actively engage with and explore their environment, a third stage of adaptation comes about in which experience comes to "right itself" and veridicality is restored. Now objects on the left look as though they are on the left, even though they continue, as before, to activate retinal and brain areas associated with right-placed stimuli. This is the final stage of adaptation. (For discussion, see Hurley and Noë 2003a.)

From the standpoint of the enactive view, this is an extraordinarily important phenomenon, a powerful illustration of the fact that perceptual experience acquires content as a result of sensorimotor knowledge. I return to some of these issues in chapter 3. For now the point is this: Once full adaptation has been achieved, the result of *removing* the lenses is comparable to the initial effects of putting them on. Taking the glasses off induces

exactly the same kind of experiential blindness, and for exactly the same reasons that putting them on did at first: The glasses (or their absence) cause a sudden abrogation of the patterns of dependence of sensation and movement. Kohler's subject describes the effects of taking the lenses off as follows:

As I begin to move and walk about, the room begins to move too. What I am experiencing are the apparent movements of the objects around me. As I approach one of them, it seems to move to the right. I reach out for it and touch—air: my arm has completely missed it, passed to the left of it. . . . Even more peculiar are the relative changes inside the room. When I move my head (vertically or horizontally), not a single point remains stationary in relation to another point. If a certain point moves along with me in the visual field, then some other point will infallibly move in the opposite direction, as if indicating to me in no uncertain terms that it is not the least bit bound by what the other points appear to be doing at the time.

The world I am in seems to have become a total chaos of continuously changing distances, directions, movements, and Gestalten. Nothing remains stable and the experience is so confusing that I am unable to detect what laws the transformations abide by . . . everything remains without rhyme or reason. There is no such thing as *a* size or *a* movement; as soon as I move my body or my head, any object is apt to become smaller or larger, stationary or mobile. (Kohler [1951] 1964, 65)

The effect of removing the lenses, then, is to produce nonveridical, distorted, chaotic visual impressions, even though the patterns of visual sensation now produced are exactly as they were before the lenses were first put on. Objects on the left stimulate the parts of the eye and brain that have always supported the sensory experience of leftness. The inability normally to perceive is the result not of changes in the intrinsic character or location of the sensory stimulation, but rather of the induced breakdown in our mastery or control over the ways sensory stimulation changes as a function of movement.

To summarize, experiential blindness exists and is important for two reasons. First, it lends support for the enactive view. Genuine perceptual experience depends not only on the character and quality of stimulation, but on our exercise of sensorimotor knowledge. The disruption of this knowledge does not leave us with experiences we are unable to put to use. It leaves us without experience. For mere sensory stimulation to constitute perceptual experience—that is, for it to have genuine world-presenting content—the perceiver must possess and make use of *sensorimotor knowledge*.

Second, it provides a counter example to the more traditional input-output picture. Kant ([1781–1787] 1929) famously said that intuitions without concepts are blind. The present point is that intuitions—patterns of stimulation—without knowledge of the sensorimotor significance of those intuitions, are blind. Crucially, the knowledge in question is practical knowledge; it is know-how.⁷ To perceive you must be in possession of *sensorimotor bodily skill*.

1.4 The Joys of Seeing

A natural line of objection to the enactive approach goes like this: True, our perceptual capacities are bound up with bodily skill and action. We use our eyes to guide our movements and to enable action. But that is not always the case. Sometimes we see not in order to act, but just in order to know, or to enjoy our experiences of seeing. When you lie back and watch the passing clouds, or when you visit an art gallery, or watch TV, you are not using visual skills for purposes of action. Pylyshyn (2001) has made this point; he adds that “much of what we see guides our action only indirectly by changing what we believe and perhaps what we want” (999).

This criticism of the enactive view would seem to gain support from the study of neurological disorders of vision. Patients with *optic ataxia* (resulting from lesions in posterior parietal cortex) are unable to make use of what they see to guide movements. As Milner and Goodale write, “Yet despite the failure of these patients to orient their hands, to scale their grip appropriately, or to reach towards the right location, they have comparatively little difficulty in giving perceptual reports of the orientation and location of the very objects they fail to grasp” ([1998] 2002, 520). Milner and Goodale argue that there are two largely autonomous visual systems. Damage to the dorsal stream (from striate to posterior parietal cortex) impairs visuomotor skill without harming vision or visual awareness as such. Damage to the ventral stream (from striate to inferotemporal cortex), in contrast, can produce striking visual agnosias, impairing object recognition and judgments of size, orientation and location, while leaving visuomotor skill largely intact. Their subject D.F., for example, showed excellent visually guided control of grasp, reaching, and hand posture in general. According to Milner and Goodale, “Yet when she was asked to use her finger and thumb to make a perceptual judgment of the object’s width on a

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