ON WHAT WE SEE

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Abstract: This paper investigates the idea that perception can be, at once, a mode of direct awareness of the world *and* an encounter, in the first instance, with mere appearances. In developing this point, I introduce a sensorimotor account of perception according to which the senses are ways of exploring the environment mediated by different patterns of sensorimotor contingency (i.e. by the distinctive ways in which what the perceiver does affects how things appear).

The world we live in is the world of sense-data; but the world we talk about is the world of physical objects.

Wittgenstein (1980, p. 82)

A curious thing about the problem of vision is its simplicity. It can be put in four words: What do we see? What makes the problem so difficult is that it can be answered in at least two distinct, plausible, but apparently incompatible ways. A thoughtful person might say that seeing is an all-purpose way of finding out what's going on around one or about one's relation to one's immediate environment. We see things (e.g. a ball, a person, a bird, an armadillo), and we see all manner of states of affairs (e.g. that there are geese flying overhead, that a man is approaching, that so-and-so is breaking the law). But one might also observe that we can only see that which is visible, the visual appearances of things or states of affairs. You can see a man born in Jerusalem, but in seeing him (years later say), you don't see him born. His having been born in Jerusalem is not something that shows (Anscombe, 1965). More generally, what we see are always visual appearances, mere looks, just as what we hear are always sounds.

How can we reconcile these different answers to our simple question? This is a matter of some importance not only for philosophy, but also for perceptual psychology and the study of perceptual consciousness.

One solution would be to accept both answers. Vision is indeed an all-purpose way of finding out how things are in one's immediate environment.

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It is also a mode of awareness of visual qualities (looks). *To see is to learn how things are in one's immediate environment on the basis of the apprehension of how things visually appear to be*. Seeing is the two-step process of learning how things are from how they look.

Many philosophers and scientists have endorsed some version of this two-step approach and there is definitely some truth in it. But many of its proponents have gone on to conclude, I think erroneously, that from the fact that vision is a two-step process, it follows that it is necessarily 'indirect' or mediated, that it amounts to less than a mode of encounter with the world.

Among philosophers the most well-known version of an "indirect" view is the so-called sense-datum theory (which is closely allied to a certain brand of philosophical skepticism). According to its proponents (e.g. Moore, 1918–1919; Ayer, 1940; Jackson, 1977), we do not directly perceive things themselves; we perceive a special kind of mental object called a sense-datum. Perceptual judgments, on this view, "go beyond" what is strictly given in experience. For example, when you judge that you see a red tomato, what you really see are bulgy, round, red sense-data. This theory has been widely criticized (by, e.g. Merleau-Ponty, 1945/1962; Ryle, 1949; Austin, 1962; Hinton, 1973; Strawson, 1979; Snowdon, 1980; McDowell, 1982), and few philosophers subscribe to it today. Strawson (1979) noticed that one important problem with the sense-datum view is that it gets the phenomenology of perception wrong in a basic and important way. Strawson observed that you misdescribe your experience of, say, deer grazing in a meadow, if you attempt to describe it in a sense-datum language, e.g. in terms of patches of color and shape and so on. To describe the experience veridically, you must mention the deer and the meadow of which the experience purports to be the experience (see also Grice, 1962). Quite apart from whether experience accurately or veridically represents the world, it must be admitted that the question experience poses is that of whether things are as the experience presents them as being. It is the world, then, and not sense-data, that provides perception with its content.

Among psychologists, the two-step approach has tended to take the form of supposing that vision is a process whereby the brain (or the mind) produces a model or description of the environment on the basis of information made available in the retinal image (see, for example, Marr, 1982). This process of representation-building is widely supposed to be an inferential one (Gregory, 1980; Fodor & Pylyshyn, 1981). What Fodor and Pylyshyn have called the 'establishment view' supposes that we do not come into direct contact with the environment itself, but only with some aspect of the way that environment impinges on us. This view has recently been attacked by both scientists and philosophers (e.g. O'Regan, 1992; Churchland, Ramachandran & Sejnowski, 1994; Pessoa, Thompson & Noë, 1998a, 1998b; Noë, Pessoa & Thompson, 2000; Rensink, 2000;

O'Regan & Noë, 2001). These criticisms focus on the failure of this sort of model to capture the idea that vision is a way of learning about the environment that is suitable for the guidance of action and skillful behavior. Although I shall not enter further into this point now, it will become important as we go along.

My purpose in what follows is to present and defend a *direct* theory of vision while at the same time allowing for the fact that there is truth in the two-step view. This project is both psychological and metaphysical. I shall lay out a way of thinking about visual experience as a form of active exploration of the structure of appearances and I shall argue for the reality of appearances. In doing so I shall present and defend a new account of the nature of the sense modalities.

Occlusion-properties

Peacocke (1983) has attempted to do justice to the intuition that seeing is a two-step process—that it is, in the first instance, a mode of awareness of how things look—without succumbing to the mistakes of the sense-datum theory and without endorsing an indirect theory. It will prove instructive to consider his position.

According to Peacocke, when you have a visual experience—say the experience as of geese flying overhead—there is some way the visual experience presents the world to you as being. A complete description of the visual experience must mention this *representational content*. But in addition to its representational features, Peacocke argues, perceptual experience also possesses qualitative or sensational features which are not features of the way the experience represents things as being. Sensational properties of experience are features of what it is like to have an experience that are not features the experience represents the environment as exhibiting. (Sensational properties are often called 'qualia' in the philosophical literature.)

The argument for sensational properties goes like this. One can see, for example, that two trees are of the same size, even as one also sees that one tree (the nearer one) takes up more of the visual field than the other (the farther one). "Since", as Peacocke writes, "no veridical experience can represent one tree as larger than another and also as the same size as the other", it would seem, he concludes, that "size in the visual field" is a non-representational feature of the experience (Peacocke, 1983, p. 12). It is a sensational property.

Exactly similar points can be made, *mutatis mutandis*, about shape and, as Peacocke notes, color (see Peacocke, 1983, pp. 12–13).

But the reasoning is unsound. The fact that no veridical experience can represent one tree as larger than another and also as the same size as the

other, does not entail that "size in the visual field" is a sensational property of experience. We can distinguish size and apparent size, or size and *how things look with respect to size from here* ("size in the visual field"). "Size in the visual field" is a distinct property from size. It corresponds to the size of the patch which one must fill in on the plane perpendicular to the line of sight in order perfectly to occlude an object from view. Let us call this property the occlusion size of an object (following Hyman, 1989).[1] Occlusion size is, it seems clear, a perfectly definite (relational) property of the scene, one that is related to, but distinct from size.[2]

One can distinguish shape and occlusion shape in the same way. A tilted round plate seen from an angle looks round, but it also looks elliptical from here. Is this to say of the plate that it looks both round and elliptical? No. Only in very unusual circumstances would one be tempted to think that the round plate, in this familiar scenario, is elliptical. What is true is that one sees that the plate is round and also one sees that the shape of the patch one would need to fill in on the plane perpendicular to the line of sight in order perfectly to occlude the plate would be elliptical. And so with color. When light falls on a wall in such a way that one can see that the wall is a uniform shade of white, say, even though one can see that one region of the wall is lighter than the other region, one is in a position to distinguish the color of the wall from its occlusion color. The occlusion color of a given region of a surface is the color of the patch one would need to fill in on a plane perpendicular to the line of sight in order perfectly to match the color at that region.[3]

We can speak, more generally, of occlusion properties (or O-properties).

O-properties are themselves *objects of sight*, that is, things that we see. They are visible. In normal life, however, we tend to pay them little attention. Only in special circumstances (e.g. in the task of artistic rendering) do they become important. With a little effort, we can become quite skilled at noticing them.

O-properties are relative; one must speak of the O-property of an object at a particular point in space. O-properties are also relational; they are determined by relations between objects in the scene and ambient light or illumination. But O-properties are perfectly "real" and "objective" in the sense that their nature is determined by relations between objects and the environment in which they are placed. Indeed, the relation of O- shape and O-size to shape and size can be given by precise mathematical laws (e.g. the laws of linear perspective). O-properties are features of the visible world, not features of our experiences or our sensations (as noted by Hyman, 1989).[4]

The existence of O-properties undercuts Peacocke's argument for sensational properties. That argument relies on a too narrow conception of the representational content of experience. Once one admits that, among the ways the experience can represent the environment as being, are the

ways things appear from a particular vantage point, one can see that the richness of perceptual experience perfectly reflects the richness of the world we experience. It turns out that there is no need to posit the existence of nonrepresentational properties such as "size in the visual field." Such aspects of the qualitative character of perceptual experience are in fact just aspects of the qualities of that which we perceive.[5]

But O-properties are not merely visible qualities, such as shape, size and color. They are looks of things, visual appearances.[6] It is this fact that enables us to appreciate what is true in the two-step approach to vision. Vision is a process of learning how things are from how they look. To see a round plate from an angle, for example, is to see something with an elliptical occlusion shape. We see its roundness in the fact that it looks elliptical from here. Likewise, it is not an accident that trees of the same size but at different distances differ in their occlusion size. To see is to be perceptually sensitive to how things look and so to become aware of how things are even apart from how they look. Whenever we see, we see how things visually appear to be (how they look).

This claim—that to see is to see looks (e.g. O-properties)—might seem to fly in the face of the fact that most perceivers would seem to have only passing knowledge of O-properties. For instance, most perceivers would not do very well at describing the occlusion shapes and sizes of things around them.[7] But as against this, consider that normal perceivers are in fact very quick to acknowledge, with almost no prompting, that there is a sense in which the round plate looks elliptical (even though it looks round), or that the nearer tree looks larger than the farther one (even though one can tell they are of the same size by looking), or that objects change colors as lighting changes (even though of course they do not *actually* change color). This shows, I think, that we are quite familiar with the facts of occlusion properties. We move in a sea of occlusion properties and we are aware of them (usually without thought or notice) whenever we are visually conscious. Indeed, to be visually conscious is to be aware of them.[8] This is perhaps what Wittgenstein had in mind in the quotation given at the outset. And it is a recognition of this fact that led Fry and Ruskin, on behalf of Impressionism, to claim that painting requires the *discovery* of visual appearances.[9]

The truth in the two-step view is that it correctly acknowledges that perceptual experience is in this way intrinsically perceiver-centered: visual experience is always experience of things being some way or other *from a point of view*. Perceptual content has an intrinsically perspectival aspect.

But notice two important facts about this reconstruction of the two-step analysis of vision. First, looks, on the view I am adumbrating, are not mental intermediaries or sense-data, but are themselves features of the environment, features of how the space one occupies is structured around one. To say, then, that to see is to learn how things are from how

they appear is to say that seeing is a way of learning how the world is from one's immediate apprehension of features of how the world in fact is. It is of course true that how things look (O-properties) are only perceivable by creatures with a very particular kind of physical make-up. But this fact does not derogate from their real existence, for conditions on the possibility of a creature's perceiving an entity of a specific kind are not necessarily conditions on the existence of that kind of entity.

Second, although I have said that when we see we learn how things are from how they look, this does not imply that we *infer* how things are from an independent assessment of their appearances (looks). Rather, how things look *informs* us of how they are. That is, as I shall try to make clearer in the following section, the active exploration of looks itself constitutes a mode of encounter with how things are. Visual experience is precisely such a mode of interaction with the environment.

Direct Vision

Readers may have noticed the similarity between the view I am presenting here and the theory of 'direct vision' of Gibson (Gibson, 1979). One of the aims of this paper is to advance our understanding of the foundations of Gibson's "ecological approach" to visual perception.

According to Gibson, the structure of light in the environment—what he called 'the ambient optic array'—uniquely specifies the layout of surfaces in the environment (1979, ch. 5). The perceiver need only visually explore this ambient structure to find out how things are. Perception, according to Gibson, involves the "direct pickup" of information about the environment in the ambient light (1979, ch. 14). This led Fodor and Pylyshyn (1981) to argue that Gibson fails to break with the inferentialist dogma of the so-called establishment.[10] For Gibson, no less than for traditional theorists, Fodor and Pylyshyn argue, we have a more immediate epistemic relationship to the light than we do to the environment it specifies (Fodor & Pylyshyn, 1981, pp. 165–168).[11] What is "picked up directly," according to Fodor and Pylyshyn, is not how things are in the environment, but how they are with the light. Whether you call it inference or not, perception is mediated by a complex cognitive process whereby we recover facts about the layout from the information available in the light itself.

We are already in a position to appreciate how this criticism of Gibson goes astray. Gibson layed great stress on the fact that light, as it concerns ecological optics, is not the light of the physicist (Gibson, 1979, pp. 47–64). Physical problems about light pertain to its nature as radiant engergy travelling in waves or packets and to the laws governing its behavior. Ecological optics, in contrast, is concerned with ambient light, that is,

with light as it fills space and interacts with the cluttered environment of the animal. Gibson criticizes traditional visual theory for failing to make this distinction. For Gibson, visual science ought to think of light—what he calls the ambient optic array—as providing information for the animal (not for the receptor).

I propose that we interpret the ambient optic array as the structured space of appearances (e.g. the space of O-properties). The sense of the Gibsonian claim that the ambient optic array specifies the environment (unlike the pattern of irradiation on the retina), is that how things looks specifies how they are. This has a superficially anti-Gibsonian flavor, for "looks" are usually thought of as a kind of internal sense-datum. But this is not how I am using the term. That how things look specifies how things are is a substantive empirical claim. Ecological optics, on this view, seeks to investigate precisely the mechanisms by means of which the structure of appearances is uniquely determined by environmental layout.

Consider a simple example. As you move around a rectangular table, you perceive its varying trapezoidal occlusion shape. The occlusion shape varies as one's spatial relation to the table varies. In this pattern of variation, however, there is invariance. Mathematically what is invariant is the relationship between the four angles and the four sides and their proportions (Gibson, 1979, p. 74). This invariance corresponds to the actual shape of the table. Active exploration of the occlusion structure presents one with the actual shape of the table. The invariant structure of reality unfolds in the active exploration of appearances.

Several important points can be made with reference to this simple example. First, as we have already observed, there is a lawful relationship between the character of O-properties and the 'actual' properties of which they are the appearances. The space of appearances is structured and lawful. In the case of O-shape and O-size, these relationships are fairly straightfowardly geometrical. In the case of O-color, the pattern of dependency is much more complicated.[12]

Second, and of great importance, the structure of appearance (or of the ambient optic array) specifies the environment only when thought of dynamically. That is, it is *change* or *flow* in the ambient optic array (variation in O-properties) that unfolds background invariance. For this reason, it is only the actively exploring or probing perceiver for whom the visual world is available.[13] At the end of the last section I stated that experience is the active process of engagement with how things look. We now see how such an active engagement can be *at once* an encounter with the looks of things *and* an encounter with things as they are apart from how they look. This is so both because how things look is a real feature of how they are and because variations in how things looks expresses invariant change (that is, how things are apart form how they look).

Finally, this enables us to see the error of Fodor and Pylyshyn's criticism. First, there is an important sense in which it is false that, in so far as we see, we have a more direct epistemic relation to light than we do to the world that is illuminated by light. If we think of light the way the physicist does (e.g. as packets of energy), then, in so far as we see, it is not obvious that we have *any* epistemic relation to light. We see light sources (e.g. the sun, light bulbs), and we see that which is illuminated by light. We do not see the light itself (see Gibson, 1979, pp. 54–55). But second, it is true that on Gibson's view, as I am reconstructing it, it is awareness of the ambient optic array that provides the basis for our awareness of the environment. That is, we learn how things are by discovering their visual appearances. But visual appearances, as I've argued, fall squarely on the world side of the mind/world divide. Moreover, as I've tried to show, we don't *infer* how things are from how they look. The active exploration of how things look (an aspect of reality) constitutes our very contact with how things are apart from how they look.

Sensorimotor Contingency and the Nature of Sensory Modalities

Given that it is frequently possible to perceive one and the same property or state of affairs by means of different senses, it would seem that we cannot distinguish sensory modalities by means of representational content. This led Grice (1962), among others, to propose that the difference between sensory modalities is a difference in the "introspectible character" of the corresponding experiences.

There can be no doubt that there are introspectibly accessible differences between the senses. After all, perceivers can usually tell whether they are seeing something, or feeling it (for example).[14] But we have considered reasons to reject the view that these introspectible differences consist in *non*representational features of experience (qualia). If one enriches the conception of the representational content of experience so as to admit that we experience not only things as they are in themselves, but also things as they appear, then we can account for (at least a good deal of) the introspectibly available, qualitative character of experience without appeal to such nonrepresentational features of experience as qualia or Peacockian sensational qualities. What differentiates the senses is that they are each modes of awareness, in the first instance, of different structured appearance-spaces. Sight and touch are each ways of encountering one and the same environment. But they differ in that in each case, the encounter with the environment is mediated by different patterns of appearance. Vision is a process of gleaning how things are, apart from how they appear, from the active exploration of structured looks-space (e.g.

the space of occlusion properties). Touch differs in being a mode of awareness of one and the same environment, but as mediated by how things feel. When we talk of the common content of visual, auditory and tactile experiences, we are describing what is experienced in a way that abstracts away from how things appear (how they look, feel, sound, etc).[15]

Sensory modalities may in this way be individuated by means of their corresponding appearance-structures (or objects). But we can also understand them, as it were, from the side of the animal. Thought of this way, what differentiates the sensory modalities are the different patterns of activity that constitutes their exercise.

To appreciate this point, note that in visual experience we represent objects as given all at once, arrayed in a manifold. We experience, in this sense, a visual field. As Martin (1992) has noticed, this is a feature of what it is like to learn about the environment by seeing which does not hold for touch. (A similar view is developed by von Senden, 1932/1960 and Jonas, 1966.) As Martin explains, in sight we experience "objects external to one as arranged in physical space" (p. 210). Tactile experience, on the other hand, "is experience of objects as they come into contact with one's body; one is aware of one's body and its limits and so aware of objects coming into contact with one's body as they discernibly affect those limits. Normal visual experience is essentially experience of objects as they fall within the visual field; tactual experience is essentially experience of objects as they press from the outside onto the limits of a felt sensory field" (p. 210). Martin notices that this "structural difference between the experiences" of sight and touch in part explains why the sense-datum theory has seemed so attractive in philosophical theories of sight, but not of touch. In the former case, sense-data are brought on to explain the possibility of hallucination. Sense-data are that of which we are aware when we are not really seeing what we think we see. But no such need arises in the case of touch. You are undergoing a tactile hallucination if your hand is restricted in movement in precisely the way it would be if it were pressed flat onto a wooden table, when in fact there is no wooden table there. There is no need to suppose that there is some kind of mental entity (a sense-datum) which is preventing one's hand from moving to explain the hallucination.

Martin introduces these points in the service of skepticism about the prospects of accounting for the different varieties of perception (corresponding to the different modalities) under the rubric of a single, all-purpose theory. But his points actually serve to direct attention to just the materials needed for such a general theory.

Consider that to feel a table—to learn about it by touch—is to encounter it in such a way that one's movements are, in appropriate ways, impeded by the table. In general, one might say, to feel a shape or texture

of a surface is, in this way, to allow one's movement to be molded by that which one touches. For something to feel this way or that (round, large, flat, rough) is for it to condition the possibilities of movement of the palpating hand or body-part in corresponding ways. The roundness, of course, exists apart from how it affects the probing hand. But for something to feel round (i.e. to appear round to the haptic sense) is precisely for it to affect the movement of the probing hand in a family of related ways. A sphere is such that if one moves one's hand in thus and such ways, one will have thus and such sensations. Tactile perception is a mode of awareness of the environment that is mediated by a particular network of *sensorimotor contingencies* (by a set of ways our movements affect our sensory states).

This notion of sensorimotor contingency is of suitable generality to play a basic role in an account of the nature of sensory modalities (see O'Regan & Noë, 2001; MacKay, 1967, 1973). The idea is that how things look, smell, sound, or feel (etc) depends, in complicated but systematic ways, on one's movement or action. The sensory modalities differ in the distinctive forms that this dependence takes. We have just considered features of the sensorimotor contingencies characteristic of touch. Sight has its own characteristic forms of sensorimotor contingency. Intuitively, how things look varies in systematic ways as one moves one's eyes, or head or body relative to the environment. A simple illustration of this is the fact that as you move, objects come into and out of view. What Gibson calls the occluding edge of one object "wipes out" surface, while at its trailing edge surface is uncovered (Bruce & Green, 1990). Importantly, this is reversible occlusion, and so is easily differentiated from the obliteration of things around one. This is an illustration of the manner in which perceptual exploration is structured by reliable patterns of sensorimotor contingency. A second example comes from patterns of "flow" in the optic field. Forward movement induces radial expansion in optic flow, while backward movement generates radial contraction. A distinct pattern of optic flow is generated by flight across the sky (as by a bird or a plane). The existence of such patterns in optic flow depends on the availability of distinctively visual patterns of sensorimotor contingency.

Note that there is an important relationship between invariant properties of the ambient optic array, discussed earlier, and regularities governing sensorimotor contingencies. So, for example, the invariance encountered as one walks around a rectangular table corresponds to a pattern of organization in the relevant sensorimotor contingencies.

On the view being developed here, then, the senses are modes of awareness of one and the same environment as mediated by different patterns of sensorimotor contingency. From the side of the object, what differentiates seeing and touching are their different objects (looks as opposed to feels, say). But from the side of the perceiver what differentiates seeing

from touching are the different patterns of activity in which seeing and touching respectively consist.

One interesting consequence of this approach is that it allows us better to account for the role of sensation and feeling in vision and perception generally. It is commonplace in the psychology of perception to speak of visual sensation. When you see, it is said, you have sensations. There are sensations of red, and sensations corresponding to odors and sounds. On this way of thinking, the occurrence of sensations is in part constitutive of perceiving. Related to this is the idea, rejected above, that perceptual experiences have sensational or qualitative properties that are independent of their representational content. But it now turns out that, on the view developed here, there are indeed qualitative differences in the character of perceptual experiences that are not differences in what those experiences represent. On the view developed here, to see is to explore the environment by means of the exercise of one's visual apparatus, e.g. one's eyes. The activity of seeing thus depends on one's awareness (at least sometimes) of one's eye movements, also on head and body movements, and so on characteristic patterns of bodily sensation.[16] Touch likewise depends, rather obviously, on awareness of the ways in which objects come into contact with one's body and affect one's body by giving rise to sensations. The occurrence of bodily sensations in this way contributes to what it is like to have an experience, and it does so in ways that are for the most part independent of the representational content of the experience. What determines the quality of experience, then, is two-fold. First, there is *what* you experience (the representational content). And second, there is, roughly, what happens to you while you experience. The qualia theory is right that there are nonrepresentational qualitative features of experience. But it is wrong to characterize such features as *intrinsic* properties of the experience. These nonrepresentational properties are in fact just features of what you happen to do when you are engaged in the activity of looking (say).

Note also that, on this view, to see one must not only explore the environment in a manner subject to laws of sensorimotor contingency, one must be the master of those laws. To be able to see is to understand (in a practical sense of understanding) how appearances covary with movements. When you put on inverting lenses (or look through a magnifying glass), the laws of sensorimotor contingency are changed. These changes may disrupt out ability to see if we are not the master of these new laws. (For a lengthier discussion of this point, see O'Regan and Noë, 2001) Merely to have visual impressions, or sensations of the sort that normally accompany seeing, or even to have the sorts of neural activity in the retina and brain characteristic of seeing, is not yet to see.

This point can be illustrated by consideration of the restoration of sight by the surgical removal of cataracts in the congenitally blind. It is

well-documented that the recovery of sight, thanks to this surgical procedure, is nearly as traumatic as its sudden loss. Case studies document the suffering and depression of those who undergo the surgery. Why should this be so? A clue can be found in the fact that surgery does not in fact restore sight. In none of the well-known cases, from the famous Cheseldon case down to the present day, does surgery result in vision (for a review, see von Senden, 1932/1960). Consider, for example, how Gregory and Wallace describe the first post-operative visual experience of their patient S. B.:

> 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.

In this way to infer that there is a face present is not to *see* a face in the normal sense. Sacks (1995) makes very similar observations 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. (Sacks, p. 114)

These patients have acquired some form of visual sensation, or impression, to be sure, but they have not yet acquired the ability to see.[17] This is exactly what we should expect on the sensorimotor contingency theory. For these newly acquired visual impressions have not yet been integrated into a stable sensorimotor repertoire. The patients have not yet mastered the patterns of sensorimotor contingency governing the occurrence of these sensations. And so the patient is unable to use these impressions to explore the environment in accordance with such patterns of dependency. In the absence of this integration, these visual impressions are like sentences in a foreign language. Although surgery restores the mechanisms enabling the sensation, it cannot restore the linkages between impressions and movement required for vision. What makes the acquisition of sight so very difficult, comparable to the loss of sight, is that it is no easy task in this way to establish this needed degree of sensorimotor integration.

On this account of the nature of sensory modalities, the senses are not merely channels by means of which information about the environment reaches the central nervous system, as argued recently by Keeley (Keeley,

forthcoming). This view is too liberal in what it counts as a sense. On Keeley's view, for example, the vomeronasal system (which controls human and animal responses to pheromones and explains such facts as that the menstrual cycles of women living in a college dormitory become synchronized, as found by McClintock, 1971) is a sensory modality. We can agree with Keeley that humans appear to be sensitive to vomeronasal variations. Such variations give rise to definite chemical and behavioral responses. Likewise, we may agree that vomeronasal sensitivity to pheromones constitutes an avenue whereby information about the environment reaches the central nervous system. But these facts are not sufficient to make it the case that we *perceive* vomeronasally. Consider, first, that there are no vomeronasal appearances, in the way that there are visual and tactile appearances. Vomeronasal information may make it more likely, for example, that an animal finds another physically attractive. But the animal does not find the other attractive *vomeronasally* (that is, in a vomeronasal respect). Vomeronasal states may influence our feelings, attitudes, actions, etc, but they do not inform perceivers as to how things stand in the environment. To concede all this, however, and this is a second point, is to concede that there are no vomeronasal experiences. There is no activitity of exploring how things are as mediated by one's encounter with how they vomeronasally appear. Third, and as a consequence of the first two considerations, even animals in whom the vomeronasal system is highly effective do not master the patterns of vomeronasal-motor contingencies that mediate their causal influence. That is, there is nothing analagous to knowing how to position one's nose to pick up a good scent, or the better to smell something, in the domain of vomeronasal information.[18]

The upshot of these points is that the vomeronasal system would seem to be a channel whereby information from the environment reaches the central nervous system which is not a sensory modality. Keeley's account of the senses would seem to go astray because it fails to make allowance for the fact that perception is a mode of activity on the part of the whole animal. It cannot be represented in terms of merely passive, and internal, processes of the kind involved in vomeronasal sensitivity.

Extended Perception

The sensorimotor contingency theory presented here provides some insight into familiar forms of "extended perception." A blind person can feel the texture of a surface at the head of the walking stick. There is likewise a sense in which we perceive the qualities of the paper on which we write with the tip of the pen, or the surface of the road with the wheels of the car. We can appreciate these phenomena better against the

background of our account of sensory modalities in terms of sensorimotor contingencies. What enables one to feel the surface of the road with the wheels of one's vehicle, or the surface of the ground with one's walking stick, is one's successful integration of the stick, and the car (etc), into one's broader pattern of sensorimotor integration.

A most remarkable instance of this sort of phenomenon is reported by Botvinik and Cohen (1998). Subjects were "seated with their left arm resting upon a small table. A standing screen was positioned beside the arm to hide it from the subject's view and a life-sized rubber model of a left hand and arm was placed on the table directly in front of the subject. The subject sat with eyes fixed on the artificial hand while we used two small paintbrushes to stroke the rubber hand and the subject's hidden hand, synchronising the timing of the brushing as closely as possible" (Botvinik and Cohen, 1998, p. 756). After a short interval subjects have the distinct and unmistakable feeling that they sense the stroking and tapping in the visible rubber hand and not in the hand which is in fact being touched. Further tests show that if you ask subjects with eyes closed now to point to the left hand with the hidden hand, their pointings, after experience of the illusion, are displaced toward the rubber hand. Botvinik and Cohen suggest that this experiment lends support to the idea that our sense of our body as our own depends on its differentiation from other objects thanks to "its participation in specific forms of intermodal correlation" (p. 756). The idea is that the body image is a model produced by the brain to organize information received from the different senses. But strikingly it only takes a few tricks to force the brain to alter the model (Ramachandran and Blakeslee, 1998). Whether this is right or not, what these strange experiments show is the importance for haptic perception, not just of touch, but of what we see and of what we understand to be going on. The establishment of a visual correlation (a sensorimotor link) is enough, it seems, to produce felt sensation. (The title of Botvinik and Cohen's article is "Rubber hands 'feel' touch that eyes see.")

What these phenomena suggest, and what the sensorimotor contingency theory predicts, is that seeing is a pattern of integrated sensorimotor activity. Seeing does not consist in what goes on inside the subject, whether this is thought of in neural or qualitative terms. There is doubtless all sorts of stuff going on (neural activity and feeling) and there can be no doubt that vision depends on neural activity. But what goes on in the brain (or inside the mind) is not sufficient for seeing. You only get seeing when you get the appropropriate level of skillful mastery of sensorimotor contingencies.

Further support for the sensorimotor contingency view can be found by considering tactile vision substitution systems (TVSS), such as that devised by Bach-y-Rita (Bach-y-Rita, 1972; Bach-y-Rita, 1996; see also discussions in Heil, 1983, 1987; Dennett, 1991; Morgan, 1977). In TVSS, optical images picked up by a camera (worn, say, on the head) are

transduced in such a way as to activate an array of stimulators (vibrators or electrodes) in contact with the skin (on, e.g. the abdomen, back or thigh). Optical images in this way produce a localized pattern of tactile sensation. After an initial period of training, congenitally blind subjects cease to experience tactile sensations when they use the TVSS device, and come to report that they experience objects as arrayed out before them in three-dimensional space, just as captured by the camera. As Bach-y-Rita writes, "They learn to make perceptual judgments using visual means of analysis such as perspective, parallax, looming and zooming, and depth judgments" (1996). Such tactile-perception (following Heil, 1983, T-perception) enables subjects to make judgments of shape, size and number and also to perceive spatial relationships between things, of the sort normally made by vision. With sufficient practice, subjects are able to engage in tasks requiring skillful sensorimotor coordination, e.g. batting a ball or working on an assembly line. In addition, T-perception is liable to familiar forms of visual distortion and illusion, e.g. distant objects 'look' small, objects can occlude each other, etc. Tactile-vision may be a very poor substitute for seeing (resolution is low, function diminishes in cluttered environments), but it is indeed a substitute. The question I would like to pose is whether T-perception is indeed a form of prosthetic *vision*? Is TVSS a way of seeing? (On this, see discussions in Bach-y-Rita, 1996; Heil, 1993; O'Regan & Noë, 2001.)

To give the issue punch, let's engage in a little science fiction. Consider a variation on Grice's (1962) thought experiment. Suppose Martians finally come to visit Earth and they turn out to be friendly and to look like normal human beings. Let us suppose, in particular, that they appear to be normally sighted. They are capable, we discover when they learn English, of making what appear to be normal visual judgments such as, for example, "there are four colored balls rolling around on that green, felt covered table." They exhibit normal "looking-behavior," seeming to direct their attention to objects by eye, head and body movements, and they acquire "visual" information of the same sort that we do (e.g. information about shape, size, color, location, distance, etc). Likewise, let us imagine that Martian "visual" abilities are limited just as ours are by such factors as size, occlusion and darkness. But now let us imagine that on closer inspection it turns out that Martian vision is not normal vision at all, but T-perception. Martian eyes, it turns out, are prosthetic implants made to look like human eyes. They are actually cameras that drive an array of stimulators along the scalp (concealed by the hair). Martian TVSS is greatly improved over our current technology. It is high-resolution, allows for the perception of color, and allows for real-time action and coordination.

Can Martians see? T-perception is clearly not a form of touch, even though it depends causally on mechanisms underlying tactile perception.

For in T-perception objects are not experienced as coming into contact with one, but as arrayed in space before one. In general, the facts of T-perception, both human and Martian, are reasonably clear. (1) The organ of perception in both Martian and human T-perception is not the eyes. (In a sense, Martians don't have eyes!) (2) T-perception is not subserved by the the optic nerve, the visual cortex, or other "visual" parts of the brain (or by Martian analogues of these). It is subserved, rather, by activity in the somatosensory cortex (Bach-y-Rita, 1996). (3) It is plausible that the introspectible quality of T-perceptual experiences would be different from those of normal visual experiences, in so far as T-perception depends on tactile forms of contact. That is, T-perceptual "qualia" would probably be quite different from those of normal vision.

It is clear that (1)–(3) do not *entail* that Martians are blind. But if this is right, then it would appear that whether T-perceivers can see is not a question that can be decided by consideration of what is going on inside them, either at the level of qualia, or at the level of neural activity. This is exactly what one would expect on the sensorimotor contingency view. To ask whether or not T-perceivers see is to inquire into the character of the sensorimotor contingencies governing T-perception. Alternatively, it is to ask whether T-perception is a mode of encounter with the environment that is mediated by visual appearances such as O-properties. Posed this way, it is clear that whether T-perception is (or someday could be) a form of vision is not something that can be decided on the basis of reflection alone. It is an open empirical question to be decided on the basis of the study of T-perceptual activity.

But are (1)–(3) true? (1) can certainly be doubted. After all, one might argue that the concept *eye* is a functional one. Whatever functions as the organ of vision, one might say, is an eye, whatever its biological origin. Consider also that if Martian T-perception really were to enable high-resolution color perception capable of supporting normal coordination, then there is every reason to suppose that the tactile sensory array on which the TVSS system depends would be just as complex in its microscopic organization as the human retina.[19] Indeed, it would be the functional equivalent of a retina. Carrying this reasoning forward, it would appear that Martian TVSS does not give an example of vision without a visual cortex (thus undercutting (2)). Rather, it provides an example of a situation in which the parietal cortex (normally devoted to the support of somato-sensory activity) *becomes* the visual cortex.[20]

What of the seemingly intuitive point that T-perceptual qualia would differ from visual qualia? On the view developed above, if T-perception really is a way of seeing, there will be no differences at the level of Peacockian sensational properties. For the structure of visual appearance space and that of T-perception will be the same. Of course it is true that there will be some qualitative differences between T-perception and

vision in so far as the activity of T-perceiving and that of vision will differ in that they involve the exercise of distinct sensory apparatuses and so different patterns of sensation. In one sense, this is a trivial point. What could be more obvious than that there are differences of this sort between vision and T-perception? But the implications of the point are far reaching. The differences between the sensory modalities are not to be found by opening up the skull. The differences consist in the patterns of activity in which the exercise of the different modalities consists. This in turn suggests that efforts to discover the neural basis of perceptual consciousness (the search for the so-called neural correlates of consciousness) may founder on the fact that it is not neural activity, as such, that makes for visual consciousness. It is only neural activity as placed against the background of the integrated activity of the animal that can be thought to subserve vision (O'Regan & Noë, 2001; Noë, 2001; Noë & O'Regan, forthcoming). But the acknowledgement of this point requires that we adopt an animal-level and not a brain's-eye-view perspective on perceptual phenomena. And this is a quite substantial shift.

Visual Experience

We have been examining a tension that exists between two ways of thinking about perceptual experience. On the one hand, there are those, like Grice (1962) and Strawson (1979), who are impressed by the transparency of experience. As Grice has written:

> . . . such experiences . . . as seeing and feeling seem to be, as it were, diaphanous: if we were asked to pay close attention, on a given occasion, to our seeing or feeling as distinct from what was being seen or felt, we should not know how to proceed; and the attempt to describe the differences between seeing and feeling seems to dissolve into a description of what we see and what we feel. (1962, p. l44)

An acknowledgment of this transparency is implicit in Strawson's criticism of the sense-datum theory: if we turn to experience and attempt to describe its quality, we end up describing the world we take ourselves to experience. We certainly do not take ourselves to describe sense-data. A similar problem arises in the history of psychology. Mach's (1959) drawing of his visual field fails adequately to represent what it is like to see his room (with left eye shut, reclining on a divan); in the end he produces a drawing of the seen room (as noticed by Wittgenstein, 1964/1975).[21]

On the other hand, there are those, like Peacocke, whose commitment to the view that perceptual experiences have sensational properties or qualia leads them to hold that experience is, if not quite opaque, then at least certainly non-transparent. For if one believes that there are aspects

of what it is like to have perceptual experience, that are not aspects of how the experience represents things as being, then one must hold that perceptual experience is not just a mode of encounter with how things are. It must also be thought to be a mode of encounter with the character of experience itself.

This conflict is sometimes thought of as a debate between those who think that the only content of perceptual experience is its representational (or "intentional") content, and those who think that this content falls short of exhausting or explaining what it is like to have a perceptual experience.

If the general view developed in this paper is correct, or even partially correct, then it may turn out that both the sensationalist and the representationalist are partly right and, in very important respects, partly wrong. The representationalist is right that one can characterize looks (color and apparent shape and size) in terms of what we see (representational content), but he is wrong, like the sensationalist, in relying on an impoverished conception of what we see. The sensationalist, on the other hand, is right that there are distinctively visual appearances (looks) that are not accessible to different senses, but he is wrong that these distinctively visual aspects are features of the experience that are independent of the way the experience represents the environment as being.

But it now seems that both the representationalist, and the sensationalist, make a deeper, more fundamental error. Each relies on a conception of visual experience according to which experiences are internal items of which we become conscious when we undergo them. Visual experiences are momentarily occurring, internal states of consciousness. Representationalism and sensationalism differ only in what they take to be the nature of the content of states such as these.

As against this conception, I have proposed that perceptual experiences are not internal, momentarily occurring states of this sort. I advocate that we think of experience rather as a form of active engagement with the environment. Perceptual experience is a form of interaction with the environment as governed by patterns of sensorimotor contingency. The qualitative character of experience, as we have seen, depends on two factors. First, it depends on the qualities that we experience (e.g. looks, sounds, etc). This is a representational feature. Second, it depends on the character of the activity in which the temporally extended activity may consist. So, for example, the fact that we do not make eye movements when we explore the environment haptically makes a difference to what it is like to touch. These differences in the sensorimotor contingencies governing the different sensory modalities are differences in the qualitative character of experience that do not correspond, directly at least, to differences in what is perceived.

Crucially, to endorse this active approach to perception is not to deny the importance of phenomenology or the possibility and significance of first-person reflection on experience. Indeed, it is to attempt to explain

how this kind of reflection can even be possible. It is difficult to see how it can be possible on either the representationalist or the sensationalist views. For the representationalist, after all, there is, in a sense, nothing to subject to phenomenological reflection. For to reflect on experience is, thanks to its transparency, just to reflect on how the experience represents the world as being. For the sensationalist, the qualitative character of experience is like Kant's object = X about which nothing can be known. The qualitative features of experience are intrinsically private, ineffable, indescribable somethings.

On the conception presented here, experience is the temporally extended process of probing the environment and encountering the world as mediated by different patterns of sensorimotor contingency. Seeing is different from touching or hearing, not because of a difference in what these senses enable us in the end to learn about the world (representational content), or in their "introspectible characters" (sensational content). It is different because the temporally extended activity of seeing is a different activity from that of hearing or touching. We do different things, make use of different body parts, rely on different features of our environmental situation, and, as I have argued, encounter different features of reality (different appearance-spaces). The subject matter of phenomenological reflection, then, is this temporally extended process of activity.[22] To engage in careful phenomenological reflection on visual experience is to reflect on our situated and embodied activity.[23]

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NOTES

[1] The term "occlusion size" is due to Hyman, 1989, chapter 3. Hyman anticipates my use of this notion in criticizing Peacocke. See especially Hyman, 1989, footnote 13, p. 59.

[2] Peacocke seems to consider this possibility and then to deny it (pp. 17–19). The possibility that light rays might bend locally, or that a perceiver might suffer from astigmatism, forces us to give up the idea that one might analyze the statement that the nearer tree takes up more of the visual field than the farther tree in terms of the filling in of patches along the line of sight. His idea, presumably, is that in certain possibly counterfactual situations (local bending of light, astigmatism), the nearer object would *not* require one to fill in a larger patch on the plane perpendicular to the line of sight. This is no doubt correct, but it does not weigh against the point made here. In the text I argue not for the possibility of representing the nearness or farness of an object in terms of occlusion, but rather, the identity of the *apparent nearness* or *apparent farness* of an object to the corresponding occlusion property. Peacocke, I think, does not address this point.

[3] The elaboration of a theory of color along these lines goes beyond what I can accomplish here. Broackes (1992) takes substantial steps in this direction.

[4] Peter Murray and Jerry Neu have pointed out a further respect in which occlusion-size is relational. The size of the patch on a plane perpendicular to the line of sight needed to

occlude an item from view depends not only on your spatial relation to the object, but on your distance from the selected plane. The *apparent size of the object from here* is identical to the size of the patch on a suitably chosen plane. What principles govern the selection of the plane? This is an important and interesting question, but one I cannot try to answer here.

[5] This is not to say that perceptual experience has no *non*representational features. I return to this point later in the discussion.

[6] O-properties are looks, but it may be that not all looks are O-properties. As noted by Hyman, (1989), not everything visible has a visible shape or size (e.g. the sky, snow). Also, one might wonder whether one can elucidate the Gibsonian notion of flow-properties of the optic field in terms of occlusion. My central claim here is that O-properties are an important subset of visual looks. I leave to another occasion a fuller discussion of the nature of looks that are not also O-properties.

[7] Gombrich (1960/1961) gives an interesting example. Stand before the fogged up mirror in your bathroom after showering. Outline your head in the mirror with your finger. You will be astonished at how small the visual image of your head is. But this is the occlusion size of your head as seen in a mirror. Do we really want to say that whenever you see yourself in a mirror, you also see that your head has this occlusion size? No. You don't see that your head has this occulsion size, but you do perceive the occlusion size. After all, it is right there, before your eyes! Stephen White, in conversation, has rejected this claim that we unconsciously perceive occlusion properties. To support this rejection he directs attention to the following example. When you sit in a car and look out the front, you see the front window pane and you look through it to the road without. What is the occlusion shape of the front window pane? I was unable, on the basis of memory, to provide the correct answer. But does this show that we do not see the occlusion shape of the window pane? Not at all. It shows only that we do not normally identify occlusion shapes, that we lack concepts of various occlusion shapes, and that we rarely attend to occlusion shape. It is interesting, though, that as soon as White told me the answer I saw that he was right. In some sense, I had known it all along!

[8] This is true even when our experience is diffuse and obscure as when we see a red Ganzfeld.

[9] This is discussed in Gombrich (1960/1961).

[10] They write: "Where Gibson speaks of directly perceiving features of the layout in consequence of picking up features of the light, the Establishment theory speaks of perceiving features of the layout in consequence of transducing features of the light. Thus far, the differences are merely terminological. The important fact is the agreement that the subject's epistemic relation to the structure of the light is different from his epistemic relation to the layout of the environment, and that the former relation is causally dependent on the latter" (Fodor & Pylyshyn, 1981 p. 165).

[11] Fodor & Pylyshyn argue that for Gibson the fact that the light contains information about the layout is the result of the fact that there is a causally mediated correlation between the layout and the light. But then "contains information" is a symmetric relation. The layout can with just as much right be said to contain information about the light.

[12] As suggested in a previous note, to defend these remarks about color goes well beyond what I can hope to accomplish here. The view of color I am working with here is essentially that of Broackes (1992), according to whom colors are ways of affecting light. To use an example of Broackes's, consider a brand new red car in the bright sunlight. One sees that it is red. But one also sees that its surface reflects the sunlight, as well as the scene around it. At any given point on its surface, it may be that it does not really look red at all. And yet one sees that it is red. Its redness stands to the way it happens to look here and there, or in

this light rather than that, as its shape stands to its occlusion shape. To see that something is red is to see that there is something constant, something invariant among all the variability in the way it looks.

[13] It may be that all that is required is that the animal be in motion relative to the environment, not that it be actively moving itself within the environment. Crucially, animals do actively move themselves, and the pattern of change in appearances as one moves with respect to the environment is different from the pattern evoked when things move with respect to one. Whether or not we must be *self*-actuating, self-actuation brings forth structure that is not brought forth when one is stationary.

[14] But not always. Consider this example brought to my attention by Stephen White. The next time you are in a plane, moving down the runway for take-off, fix your gaze straight ahead towards the nose. You will notice that as the plane lifts off, the front of the plane will appear to lift and rise upward. Now in fact, since you do not move in relation to the plane itself, the nose does not actually visibly rise up relative to you. The puzzle is that it looks as if it does. This would appear to be a visual illusion induced by verstibular stimuli. What is striking (as noticed by John Heil, who expressed this thought to me in an unpublished comment on an earlier version of this paper), is that this would appear to be a visual illusion as of the lifting nose accompanied by a *correct* judgment that the nose of the plane is lifting. (Indeed, one might suggest that this is a real-world example of what Lewis (1980) called "veridical hallucination", i.e. veridical visual experience that fails to count as genuinely perceptual because of the deviant manner in which it is produced.) The problem with this suggestion is that it begs the issue whether the relevant perceptual experience *is* a visual one. I am prepared to bite the bullet and assert that it is *not* the case that it really looks as if the nose is lifting. The lifting of the nose is just not visible from where you sit. Careful attention to the visual qualities of the experience demonstrates that this is so. Of course one might wish to say this example shows that what are strictly non-visual features of the context can really make a difference to how things look. But this seems far-fetched.

[15] If this line is right, then we can endorse the Aristotelian view that each of the senses has its *proper objects*. The proper object of each sense is the type of appearance (looks, sounds, etc) that is made available to that sense. In addition, because the laws governing the relation between the environment and the several appearance-spaces are different, there will be features of the environment (e.g. color) which are not available to all the senses. This is compatible with its being the case that the senses enable one, by means of one's encounter with appearances, to come into contact with how things are apart from how they appear.

[16] The importance of one's awareness of one's eye movements for accounts of vision has been emphasized by Husserl and other Phenomenologists.

[17] For an additional example, consider the patient of Valvo (1971) who 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 . . ." (9).

[18] Keeley proposes that the vomeronasal system is a sensory modality that lacks qualia and he offers this as a counterexample to the view that the senses can be individuated by their different qualia. I agree, but for different reasons, that the senses cannot be individuated in terms of qualia.

[19] This point was suggested to me by Evan Thompson.

[20] Terms such as "visual cortex" and "somatosensory cortex" are functional, not anatomical. In normal humans the visual cortex corresponds to the occipital lobe, and the somatosensory cortex corresponds to the posterior parietal lobe.

[21] Wittgenstein concluded that it is not possible to make a representation of the visual field. A similar thought has more recently been developed by Dennett 1991. For more on Mach's drawing, see Thompson, Noë & Pessoa, 1999; Noë, 2000; Noë & Thompson, forthcoming.

[22] On this approach to phenomenology, it is interesting to note, there is no longer any theoretically important asymmetry between first and third person approaches to phenomenology. I do not have any priveleged access to the character of my experience, and the phenomenological character of your experience is as open to me as is that of my own. The question whether there are first-person methodologies for the study of experience has become an important theme in recent consciousness studies. See, for example, the papers collected in Varela & Shear, 1999.

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