Perception, Attention and the Grand Illusion

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ABSTRACT: This paper looks at two puzzles raised by the phenomenon of inattentional blindness. First, how can we see at all if, in order to see, we must first perceptually attend to that which we see? Second, if attention is required for perception, why does it seem to us as if we are perceptually aware of the whole detailed visual field when it is quite clear that we do not attend to all that detail? We offer a general framework for thinking about perception and perceptual consciousness that addresses these questions and we propose, in addition, an informal account of the relation between attention and consciousness. On this view, perceptual awareness is a species of attention.

1. Introduction

If you focus your attention on a basketball game -- for example, on the number of times the white team possesses the ball -- you will be unlikely to notice the person in a gorilla-suit who walks across the court (Simons & Chabris, 1999). This is an example of what Mack and Rock (1998) call "inattentional blindness" (IB). This term calls to mind what they take to be the central theoretical upshot of IB: that we only perceive that to which we attend. This upshot gives rise to what we shall call the paradox of perceptual attention: to see detail in the environment, you must direct your attention to it. But how can you direct your attention to an unperceived feature of the scene? Surely in order to direct your attention, you must already perceive that to which you wish to direct your attention. This paradox would seem to threaten the very possibility of perceptual awareness.

This is not the only puzzle arising from the supposedly attention-dependent nature of perception. It does not *seem* to us as if we only see that to which we attend. It seems to us, rather, as if we are perceptually aware of the densely detailed, stable and persistent environment around us. But since we do not attend to all that detail, at least not all at once, then it would seem to follow that perceptual consciousness -- that feeling of awareness of all the detail -- is misguided. Indeed, reasoning along these lines has led numerous writers to argue that visual consciousness is a "grand illusion" (e.g. Blackmore, Brelstaff, Nelson & Troscianko, 1995; Dennett, 1991, 1992, 1998; O'Regan, 1992; Rensink, O'Regan & Clark, 1997).

Our aim in this paper is to speak to both of these puzzles. It should be clear that each is, in effect, a puzzle about the nature of perceptual consciousness. What is perceptual consciousness and what is its relation to attention? In what follows we offer a framework within which to answer these questions.

2. A Preliminary (and Obvious) Solution to the Paradox of Perceptual Attention

Let us begin by noting that the theoretical upshot -- that we only perceive that to which we attend -- appears to be in conflict with the common sense observation that we perceive a good deal more than we notice. Driving is an example of a visually-guided behavior which we seem to be able to perform, at least sometimes, in the nearly complete absence of attention. To give another informal and familiar example, many of us have had the experience of noticing, all at once, that a bell has been chiming, and indeed, that it is now chiming for, say, the third time. Surely the fact that we are able to say, now, that the bell has chimed three times indicates that we in some sense heard the bell before we first attended to it.

This conflict between the theoretical upshot and common sense is, however, more apparent than real. There can be no doubt that we are sensitive to a great deal of perceptual information -- that we are, for example, able to guide our behavior by the use of this information -- in the absence of attention. (Indeed, Bridgeman and his colleagues, as well as, others have shown that we can guide behavior with information that is *inconsistent* with what is in attention. See Bridgeman, Lewis, Heit & Nagle, 1979; Bridgeman, Kirch & Sperling, 1981; Bridgeman, Peery & Anand, 1997. See also Aglioti, DeSouza and Goodale, 1995; Daprati & Gentilucci 1997). So there is a sense in which one might say that we are perceptually sensitive to features of the environment of which we are unconscious. However, importantly, not all perceptual sensitivity is in this way unconscious. We mark this distinction by reserving the terms "perception," "seeing" and "visual experience" for conscious perception alone.

Notice that once this distinction is in place -- between that to which one is perceptually sensitive, and that which one perceives (of which one is perceptually conscious) -- the paradox of perceptual attention is near to being resolved. To experience detail, one must detect it. But to detect it, there is no requirement that one experience it. We now propose a more general framework within which to account for this distinction.

3. Perceptual Sensitivity

Consider a simple phototactic device such as one of Braitenberg's vehicles (Braitenberg, 1984). The imagined vehicle is equipped with two light sensors positioned next to each other on the front of the wheeled vehicle. The left sensor is linked to the right rear wheel driving mechanism and the right sensor is linked to the left rear wheel driving mechanism. As a result of this wiring, the vehicle will orient itself toward light sources and move towards them. Such a simple mechanism can track and hunt light sources.

Suppose there is a light source on the left. If the vehicle were to turn in the direction of the light, then the light source would no longer be on the left. What stimulation the system receives depends on what it does and what the system does is affected by what stimulation it receives. This vehicle is built in such a way to *embody,* as it were, a set of rules of sensorimotor contingency.

Now consider a more complicated device such as a missile guidance system (MGS). The MGS pursues an airplane by making use, let's say, of visual information about the plane. The MGS is designed, let's say, to speed up in response to the diminishing of the image of the airplane in its camera and to maintain speed if the size of the image is growing. Similarly, the MGS is capable of modifying its behavior depending on whether the image of the plane shifts to the left or right, up or down. For example, the system might be designed to shift to the left when the image of the airplane shifts to the left in its viewfinder, thus bringing the image of the plane back into the center. The MGS, we may say, *has mastery of* the sensorimotor contingencies of airplane tracking, that is, it is built in such a way as to exploit, in its tracking activities, the interdependence between the

availability of sensory information and its motor behavior. The MGS is, in this sense, *attuned* to the structure of sensorimotor contingencies. The MGS is *perceptually coupled* with its environment.

We propose that perceptual systems in animals be thought of along the lines of the simple mechanical systems described here. A visual perceiver is familiar with (has mastery of) the ways in which visual information presents itself as a function of movement of the perceiver with respect to the environment. Movement towards an object causes an expansion of the retinal projection. A flick of the eyes to the left causes a displacement of projected items to the right. Owing to the curvature of the retina, the retinal projection of a straight line is deformed in a predictable manner as one directs one's eyes upward. There are a vast array of such sensorimotor contingencies; to be a perceiver is, *at least,* to be the master of these regularities. (See O'Regan and Noë, in press, for more detailed exposition.)

Perceptual sensitivity, on the view advocated here, consists in the ability to explore the environment in ways mediated by knowledge of the patterns of sensorimotor contingency that govern perceptual modes of exploration.

4. Perceptual Experience

We have described what we can think of as the *ground* of perceptual consciousness: the perceptual coupling of animal and environment that consists in the animal's access to environmental detail thanks to its mastery of the sensorimotor contingencies that govern the way it explores the environment. We have called this perceptual sensitivity. But for an animal to be *aware* of that to which it is perceptually sensitive is for it not merely to be appropriately coupled perceptually, but for it to integrate its coupling behavior with its broader capacities for thought and rationally guided action. The driver who fails to pay attention to what he or she is doing or to that to which he or she is responding is still able to exercise mastery of the sensorimotor contingencies needed to drive the car. When in addition the driver is able to make use of information not only about that to which he or she is perceptually sensitive, but also about the character of his or her perceptual tracking of the environment, we say the driver is *aware* of what he or she sees.

We thus propose a second level of perceptual capacity. First, there is perceptually guided activity or perceptual coupling. This is basic perceptual sensitivity. Second, there is the accessing of information about that to which we are perceptually coupled for the purposes of thought and action-guidance and also the accessing of information about the nature of one's tracking activity itself. This is perceptual awareness or perceptual consciousness.

5. Attention and IB

How does attention fit into our view? The precise role of attention in perceptually guided activity has been the subject of much study (see, for example, Pashler, 1998). What IB demonstrates is that you need attention for seeing. This is exactly what our view predicts. For what is seeing but access to and control over one's perceptual activity? But what is the confident exercise of access to and control over perceptual activity but the direction of attention to the activity? What we are calling perceptual awareness, then, just is a form of attention.

Note that we do not identify attention and perceptual awareness. As Mack and Rock observe, they cannot be one and the same, since it is possible to direct one's attention to nonperceptual features (Mack & Rock, 1998, ch. 11). Indeed, it seems crucial that attention can be directed not only to future possibilities (anticipated events, for example), but also to past events in memory, to current feelings or sensations, and to parts of one's body that are out of view. Attention, in all these domains, consists in access to and control over information. We propose, then, that perceptual awareness is the application of this power of access and control to one's perceptual engagement with the world.

Note that our account provides the resources to give substance to the "obvious" resolution of the paradox of perceptual attention noted above in Section 2. Perceptual sensitivity -- perceptual engagement with the environment -- is the ground of perceptual awareness and attention and so is the ground of visual experience or seeing. You cannot see without perceptual coupling, but you can perceptually couple without seeing.

Mack and Rock's findings suggest, however, that much care would be needed to fill in the details of the account we are proposing. Of particular delicacy, for example, is their finding (reported on pages 18ff. and in chapters 5, 6 and 7) that there is less IB when the critical stimulus is the subject's own name, or a smiley face, and (more surprisingly) that there is no such decrease in IB for a close variant of one's own name-e.g. Jeck instead of Jack-or for a sad face. Mack and Rock rightly point out that such data on IB and salient stimuli would seem to favor the *late selection theory* of attention (Deutsch & Deutsch, 1963; van der Heijden, 1991) as opposed to an *early selection* account such as that of Broadbent (1958) and Treisman (1969). For our purposes, however, the central point to be underscored is that there is nothing in these findings that threatens our sensorimotor contingency account. You cannot see (that is, have conscious visual experience) without attention. This is consistent with the fact that some stimuli are better attractors of attention than other stimuli. Motion transients, for example, are powerful attractors of attention. Mack and Rock's findings on salience and IB suggest that *importance* and *affective charge* are also strong attactors of attention. Just as we can perceptually detect a change before we see it, so we can perceptually detect an instance of our own name -- because it is an instance of our own name -- before we consciously experience it.

6. The Grand Illusion

If, as the IB results seem to show, we only perceptually experience that to which we attend (or, as we can now say, that of which we are aware), then why does it seem to us as if we experience the whole scene before us? Do we have to conclude that the experience of a rich visual world in front of us is some kind of "grand illusion"? This is the second puzzle mentioned at the outset.

Consider the following example. You hold a bottle in your hands and your eyes are shut. You make finger-to-bottle contact at a number of isolated points. It seems to you, however, that you have tactile experience of the whole bottle. On the "detailed internal model approach" it would be supposed that the brain builds up a model of the bottle as a whole on the basis of information about the bottle contained in the points of contact. This is an example of amodal completion, of perceiving something you do not, strictly speaking, perceive. You seem perceptually to experience something about which you do not have complete information.

For another example, consider the perceptual experience of partially occluded objects. When you see a cat through a picket fence, you take yourself to perceive a cat, even though, if we imagine that the cat stands still, you only really see strips of the cat's surface through the slats of the fence. Crucially, there is a genuine sense in which you *experience* or *perceive* and do not merely surmise the strictly unseen portions of the cat. One's experienced relation to the unperceived portion of the cat is not at all like one's relation to the hallway outside one's door. The hallway is also felt to be present. But this feeling of presence is nonperceptual. The sensorimotor contingency theory offers an explanation for these phenomena. First, the perceiver of the cat "knows," in a practical sense, that a step to the right will produce new cat-surface. It is the knowledge that movement or alteration of the sensory organ gives rise, in systematic and predictable ways, to new sensory data that is that in which the sensory character of our contact with the cat consists. Second, it is precisely the absence of this sort of sensorimotor contingency in the case of the hallway outside one's door, or the room behind one's head, that makes these latter examples a 'thought presence' but not an 'experienced presence.' Consider another example. If you blink, this causes a dramatic effect on your retinal impression of things in front of you. Seeing, we argue, depends on one's implicit knowledge that such dramatic affects occur when you blink. On the other hand, blinking has no effect on your feeling of the presence of the room behind the head. This goes a long way to showing that the felt presence of the room behind the head is not a *perceptual* presence. (N.B. People are normally unaware of the perceptual consequences of blinking just as they lack conscious access to a great many sensorimotor contingencies, e.g. the effects on sensory stimuli of eye saccades. Knowledge of the multitude of sensorimotor contingencies constituting perceptual activity is implicit and largely unconscious.)

From these considerations we see now that the sensorimotor theory provides us with the resources to explain (or rather to explain away) the so-called grand illusion hypothesis.

Consider the bottle example again. Although it is true that you perceptually experience the whole bottle, notice that it is not true that it seems to you as if you perceptually encounter each and every part of the bottle's surface. What is true is that you take yourself to have access to the whole bottle because the whole of it is there in your hands.

Exactly similar points hold in the case of vision. Look around the room. Reflect on what it is like to see. Does it seem to you as if you see *all* the environmental detail in uniformly sharp focus, all at once, now? Clearly not. To make out detail, we need to fixate, and when we fixate, that which is now presented to us only peripherally is now outside the range of clear focus. These points are familiar to psychologists, but they are also, or so we argue, familiar (at least implicitly) to normal perceivers. To be a normal perceiver is to be a master of the ways in which we manipulate ourselves to get better looks, better sniffs, and so on, of the clutter around us. This mastery shows itself in the thoughtless automaticity with which we direct our gazes, squint for better focus, pat our pockets in quest of glasses, and so on.

What *is* true is that we take ourselves *to have access* to environmental detail, for we take ourselves to be, in the manner described above, coupled or attuned perceptually with (or to) the environment. The "feeling of the presence" of all the environmental detail consists, as we have seen, in our practical knowledge that we have access to it. Crucially, it not only seems to us as if we have access. We *do* have access to the detail. True, we do not have access to all that detail in what is "coming in now". But crucially, while it does seem to us as if the detail is all there now, in the world, it is *not* the case that it seems to us as if all that detail is represented all at once in consciousness.

It is of course true that people are surprised by the results of experiments on inattentional and change blindness. In addition, students are apt to find astonishing familiar psychology demonstrations of their inability to tell the color of an object held in peripheral vision. It is sometimes suggested that this astonishment is evidence that we do tend to think of our experience along the lines of the "details in the head" conception. But there are other ways of explaining the astonishment. On our view, vision is a complicated skill-based activity. We tend to be unaware, when we are engaged in our perceptual lives, of the complicated things we do when we see. Just as dancers, musicians, or athletes are inattentive to the subtle modulations they undertake in the conduct of their activity, so perceivers fail for the most part to attend to the ways in which seeing depends on eye movements (as well as on head and body movements). The surprise we feel in demonstrations such as these is comparable to the surprise we feel when we discover how difficult it is to perform a manual task such as typing or driving with a splint on one's little finger. We are insensitive to the complexity of the things we do when we do things.

We conclude, then, that there *is* no grand illusion. It is wrong to say that perceptual experience is misleading or illusory (at least in the respects relevant to the present discussion). (For related discussion of this issue, see Noë, Pessoa & Thompson, 2000; Noë in press.)

7. Conclusion

In this paper we have proposed an account of the nature of perception and perceptual consciousness that both predicts and explains the phenomenon of IB. In addition, our model provides satisfying answers to the two puzzles stated at the outset. *How can we see, if in order to see we must attend to that which is not yet seen?* Our answer is that we are perceptually sensitive to a great deal more than we are aware of. *Why do we have the feeling of the immediate presence of environmental detail despite the fact that we do not, at any given moment in time, attend to any but a small fraction of that detail and also that we lack a richly detailed internal model?* We offer an account of the feeling of presence by analyzing it in terms of confident skill-based access to detail. Further, we challenge the often repeated claim that the fact that we have this feeling of contact even though there are no detailed internal models in the head demonstrates that perceptual consciousness is a grand illusion. It does not seem to us as if we have all the detail in the head. It seems to us as if the detail is there, in the world, where in fact it is (Pessoa, Thompson & Noë, 1998; Noë et al., 2000). Finally, we propose to treat perceptual awareness as, in essence, the application of attention to one's own perceptual engagement with the environment.

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