BIOLOGICAL REALISM

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1. *Realism and Teleology: The Problem*

Cartesian epistemology treats the occurrence and intrinsic character of mental states as starting points for knowledge gathering - whatever we know of the external world we learn from our knowledge of our own internal states. How is it that mental states are able to inform us of what is outside of themselves? Descartes operated within an intentionalist tradition: he assumed that mental states conveyed to us an image of the external world, and his concern was with our reasons for thinking that the image was faithful to its model.

Berkeley agreed that internal mental states constitute the only starting points for epistemology. But he challenged Descartes' intentionalist assumption. He held that the only thing that one could get out of a mental state was the character of the state itself, not any image or message concerning the world outside the state. Hume put the point in this way:

> Our senses offer not their impressions as the images of something distinct, and external. They convey to us nothing but a single perception, and never give us the least intimation of any thing beyond. A single perception can never produce the idea of a double existence. (*Treatise:* I, IV, ii)

This insistence leads to the phenomenalist idea that sensory qualities - such as colors, shapes, etc. are characteristics primarily of perceptual states themselves, not external qualities imaged in perception. Berkeley based his idealism on this conception of the sensory qualities he thought it incoherent to apply the sensory qualities to matter, since what they properly characterize is perceptual states. If 'blue' adverts to a modification of consciousness, if it is a way in which we sense, what can it mean to say that the sky is blue? Given that our characterizations of things are ultimately grounded on the sensory qualities,

Berkeley concluded that we have no coherent way of characterizing matter.

Latter-day phenomenalists have found a way out of Berkeley's idealism. They agree that the sensory qualities are primarily applied to sensory states, but hold that they can be applied to external things indirectly. For example, to call a thing blue might be to say that it has the propensity to create blue sensations in us, under normal conditions. *Pacé* Berkeley, a phenomenalist can thus be a realist in one sense - he or she can hold that there are mind-independent things that cause us to have sensations. But the phenomenalist is hard-pressed to allow that we have any knowledge of external properties. According to the phenomenalist, the similarities that we detect in things are grounded in the fact that they cause us to be in similar states. What is it, for example, to say that two things are similar in color? Color characterizes our sensory states, and so it is to say that the sensory states that the two things induce in us are similar, not that the things bear any other similarity to one another independent of how we perceive them. Thus the properties that we attribute to external things seem to be based on similarities that we impose upon them, rather than on real similarities inherent in them. It seems natural, therefore, that a phenomenalist would be nominalistic about properties.

We can avoid this conclusion only if we can find reasons why it should be permissible to infer a real similarity from a similarity of sensory states that is, reasons why there should be a correspondence between similarity in sensory state and similarity in thing sensed. This is where teleology can enter the picture. If we were to hold that it is a function of perception to inform us of reality, we might then be entitled to hold that the "similarity space" of sensory states was so designed as to reflect real similarity. It would then be no accident that blue sensory states resemble each other more than they resemble red states, for this would follow from design considerations.

This sort of reasoning employs what G.A. Cohen has called a teleological "consequence law"[1]: that is, a law which says that if a certain characteristic is functional, then the thing will possess that characteristic. Consequence laws are derived, Cohen thinks, from the causal etiology of functions: things have functional attributes precisely because these attributes are functional. For example, the cause (or, more precisely, a cause) of my pencil being able to write is that writing is its function. Similarly with perception: if it is the case that the correspondence between the two similarity spaces is functional, and we may infer that it obtains.

It is not Cohen's intention, I assume, to allege that consequence laws are absolute generalities. Just because the functionality of a thing caused it to come to be, we do not have to conclude that its coming-to-be was inevitable. The precise form of an inference based on a consequence law, and the qualifications that must be attached to it, depend on how exactly we understand function, and on the grounds we have for attributing the functionality in the first place. If, for example, we think that we have grounds for thinking that perception is a divine endowment, created so that we may be informed of the way the world is, then given that God is omniscient and omnipotent, the consequence law would lead us to think that perception informs us of real properties. For why should God fail to achieve his purpose? But this reasoning makes it difficult to understand why we err. After all, we have assumed that accuracy is part of the function for which perception was created: why then has God not ensured that we make no errors?

Descartes faced this problem head on. He held that as far as belief is concerned, error is the outcome of our own exercise of free will. But he could not say the same thing about perception, since it occurs independently of the will. So he proposed in his *Sixth Meditation* that error occurs because there is an extended chain of causes intermediate between the external object of perception and its finally being registered in the mind.

> When I feel pain in my foot...this sensation is communicated by means of nerves dispersed through the foot, which, being extended like cords from there to the brain, when they are contracted in the foot, at the same time contract the inmost portions of the brain which is their extremity and place of origin, and then excite a certain movement which nature has established in order to cause the mind to be affected by a sensation of pain represented as existing in the foot. But because these nerves must pass through the tibia, the thigh, the loins, the back and the neck, in order to reach from the leg to the brain, it may happen that although their extremities which are in the foot are not affected, but only certain ones of their intervening parts..., this action will excite the same movement in the brain that might have been excited there by a hurt received in the foot, in consequence of which the mind will necessarily feel in the foot the same pain as if it had received a hurt. And the same holds good of all the other perceptions of our senses....From this it is quite clear that notwithstanding the supreme goodness of God, the nature of man, inasmuch as it

> is composed of mind and body, cannot be otherwise than sometimes a source of deception.[2]

Error takes place, then, because matter is imperfectly adapted to the purpose that God had for it and consequence laws must be qualified to allow for the possibility that a function cannot be realized because of the recalcitrance of the tools available for the task.

2. *Enter Biology*

In our more naturalistic era, the appeal to divine purposes has come to be regarded as unacceptable in treating of the philosophical problems of teleology. But some have felt that natural selection could be used to support a form of teleological consequence law similar to that of Descartes. If natural selection is to be used support the contention that perception acquaints us with real properties (not just real individuals), we should have to claim a) that being acquainted with real properties is evolutionarily advantageous, and b) that this evolutionary advantage gives us a reason to infer that we are in fact in touch with real properties. It is this form of biological realism that I want to examine in this article.

Robert Richards has recently shown that nineteenth century evolutionary treatments of perception took place against a background of phenomenalist ideas.[3] Evolutionary theorists such as Pierre-Jean Cabanis, Jean-Baptiste de Lamarck, Erasmus Darwin and Charles Darwin were influenced by the empiricist theory that thought consists in associations of ideas, and that behaviour flowed from these associations. They held that evolution worked towards providing animals with instincts, faculties, innate associations of ideas, and principles of behaviour that would enable them to survive and reproduce in a constantly changing environment.

It is clear that this notion of the evolution of the mind does support the veridicality of perception in a broad sense. Animals find themselves in very different circumstances at different times, and it is clear that in order to survive in these changing circumstances they have to act in ways that are appropriate to the circumstances. Thus they have to have means by which to ascertain the nature of their surroundings. Clearly, it would be an advantage if these means of detection were accurate, at least to the extent that they enabled behaviour to be environmentally appropriate. At the same time, it is quite unclear whether and to

what degree there needs to be a point-to-point correspondence between particular thoughts and the environmental circumstances they betoken. An animal does not, for example, need to have a scientifically accurate taxonomy of food sources in order to be able to recognise food. All it needs is to have is a quite subjective taxonomy of the real world - certain things promise pleasure, others do not. The animal will have a good chance of prospering if there is a correspondence between the pleasant and the nutritious. Evolution has not put the animal in touch with real properties here, as opposed to a more or less consistent but subjective way of viewing the world. Thus evolution could be taken as supporting a holistic and pragmatic theory of truth. If your beliefs and desires taken as a whole work well to ensure your survival and fecundity, then, taken as a whole, they are "true" but not as supporting a point-to-point correspondence theory of this form - the perception that x is blue is veridical only if the sensation of blue betokens a real property.

In order to support realism, then, the evolutionary theorist must rely on a somewhat more circumspect way of arguing than the one we have just outlined. He or she must not assume that evolution will produce systems that make contact with the external world either in an objective way, or point-to-point. But at the same time, there is no reason to rule out the possibility of objective correspondence. Point-to-point accuracy is one way of achieving holistic accuracy, after all, and in some cases it might be the easiest way. Thus there might very well be some systems that do make point-to-point contact with the world. The question is how we shall recognize these. In the next section I describe the sort of arguments that have been employed to suggest that color-vision puts us in touch with an external property. I am not after a necessary and sufficient characterization of perceptual systems that reveal real properties; my aim is simply to illustrate some sorts of argument that can be used to support the claim that a particular system is so, and to exhibit some relevant characteristics of such systems.

3. *The Case of Color Vision*

Color vision is interesting because the arguments which try to establish that colors are real appeal to particular, empirically established, features of the faculty itself, not to general evolutionary grounds.

The relevant evidence is this. The retina is equipped with receptors for colors, but these are sensitive only to the spectral

composition of light incident on the retina. The spectral composition of light is not (by itself) indicative of any property of external objects, since the composition of light reflected from objects will vary according to the light incident on them. One might expect, therefore, that the perception of color would be wholly non-informative about objective properties - indeed many philosophers have held just this but as it turns out it is not so. As has been recognized for a long time, color is not perceived as varying with illumination - perceived color is surface color not light color. (This phenomenon is known as "color-constancy".) Objects placed under trees, for example, will be photographed with a greenish tinge, but they will be seen normally. Again, wearing rose-colored glasses will not, proverb notwithstanding, lead you to perceive the world as rose-tinted.

The most dramatic experimental confirmation of color-constancy is due to Edwin Land and J.J. McCann.[4] They found that in certain special scenes consisting of a patchwork of rectangular color-patches (and called Mondrians for their resemblance to the works of that artist), human observers were able to detect that two surfaces were different in color, and what their true colors were, even when the illumination was so rigged that the surfaces were sending light of exactly the same spectral composition to the eye, so that they would have been indistinguishable to the color-receptors in the retina. J.J. Gibson has suggested that this constancy (or invariance, as he calls it) is sufficient by itself to indicate that color-vision informs us of real colors. He says:

> Certain properties of the energy flux at the skin of an active animal do not change, whereas others do. The former are invariant, the latter variant. It can be demonstrated that the invariants of stimulation correspond to invariant properties of the environment. Hence they are said to be 'information about' the environment. (My emphasis)[5]

Gibson seems to assert that sensory invariants must correspond to environmental variants. But this is surely false. There must, for example, be invariants that result from the physical nature of the perceptual system itself, and thus indicate nothing external. For example the ratio of distance to minimum resolved displacement will be constant, but the invariance of this quantity reflects nothing but the cellular structure of the retina. What Gibson must mean is that the invariants actually processed by a perceptual system correspond to external invariants -- he cannot mean that all possible invariants indicate external properties,

nor can he mean to say this about invariants that accidentally fall out of a system's construction.

But how can he know even this? His reasoning is not based on an exhaustive examination of all the invariants, only on a discussion of some that do in fact indicate external reality. I surmise that he must be making implicit use of a "consequence law" of the sort we discussed in section 1, above. His reasoning would then go somewhat as follows.

> 1. It takes elaborate mechanisms to find invariants in the ever-changing "energy flux at the skin of an active animal".
> 2. Such elaborate mechanisms can only evolve if they serve an evolutionary purpose.
> 3. The only plausible way in which such a mechanism could be advantageous in evolutionary terms is if it were correlated to some (useful) external information.

The argument presupposes a distinction between invariances that are the result of processing and those that are available merely by accident. Gibson's thesis ought to be modified in this way: if an invariance processing device is functional, then its function could only be that of indicating external properties. As we shall see, this thesis has to be qualified in important ways.

What exactly is an invariant? Gibson says that it is some feature of an incident pattern of stimulation that stays constant even when the pattern changes: in other words, it is a feature shared by different patterns of stimulation. Thus defined an invariant need not indicate anything external, nor is it necessary that those processed by functional devices should do so. There are cells in human visual pathways that will be activated by the movement of a spot or other pattern across the retina. These detect an invariant, since many different patterns of stimulation contain moving spots, and the cells in question are activated when any of these are present. Yet the activation of these cells does not betoken anything external, since they are sensitive as much to a movement of the head as to an external movement.

Given that there are some invariance detectors that work to find externally significant properties, and some that are concerned with internalities, we should expect that the system would somehow be able to distinguish the two types, since their behavioural significance is quite different. Gibson suggests (ibid, 166) that the externalities are those which cannot be changed at will, and this is the basis of the distinction. But this

cannot be the whole truth. We cannot change our feelings of pleasure or pain at will, yet we do not suppose that these indicate external invariances, nor do we tend to characterize the things that cause us pain as constituting a natural kind.

But we do perceive color as being external. Even our linguistic practices suggest that this is so. We define terms like 'blue' and 'round' as denoting external properties which are responsible for particular types of sensations – we do feel able in this sort of case to project classifications based on our sensory states outward onto the world, we do define the things that cause us to have blue sensations as constituting a natural kind. These facts suggest that there is a feeling that accompanies some perceptions, a feeling that they are perceptions of something external. Other perception-like states are not characterized by this awareness – for example, pain. Yet others, for example hearing and smell, are felt to be indicative of external circumstances but not of qualities of objects thus we hear sounds and smells as *emanating from* objects but not as *characterizing* them. We describe things in ways that imply only that they produce certain sounds or smells (hollow-sounding, sharp-smelling). With colors, however, to say that something *looks* blue is to disclaim its being blue.

This feeling of externality should itself be interpreted functionally, and color-constancy should be interpreted in the light of this feeling. The feeling of externality corroborates the view that color-vision is externally functional, and the constancy itself suggests that it is successful in performing its function. Color-vision can then be interpreted as functioning to put us in touch with external reality, but it takes particular facts about the faculty to argue in favour of this interpretation. We cannot support realism simply by citing evolution as generally leading to veridicality, but it is legitimate to attach functional significance to the feeling which accompanies color-vision, namely that colors are not only external but are properties of external things.

4. *Error and Computational Analysis*

Now it turns out that in fact the correspondence between perceived and real color is not as perfect as we have so far made it out to be. The visual system does in fact make errors with respect to its detection of external situations. How is a functional theory to interpret such errors? On the face of it, error suggests that a system is non-functional, and if this is so should we

not reject the system's claim to put us in touch with external reality? Because of the errors there will be no one property in the presence of which the system will respond in a particular way, and this will make it impossible to find a correspondence that tells us what property we are coming into contact with when we are in a particular state.

This consideration is important when evaluating Ruth Millikan's concept of normality of functioning.[6] Millikan claims of such "intentional icons" as beliefs and perceptions that they can do the work that they are supposed to do only if they are true. Thus when considering the mechanisms that lead to these beliefs and perceptions, we should consider those circumstances in which they perform their functions that is, those circumstances in which the mechanisms will lead to true beliefs or perceptions. Error is abnormal.

In essence, Millikan is offering us a rationale for a particular sort of move made by those who define color by reference to our perceptual states. Consider a definition of 'blue' as denoting the property of surfaces that causes us to be in a certain sort of perceptual state. Obviously this definition will not work, because we get to be in this state even in the presence of other colors. (For example, the shadows cast by red light look blue, as Land observes - this is a phenomenon he claims to explain.) So 'blue' is often defined as denoting the property of surfaces that causes us to be in a certain sort of perceptual state *in normal circumstances.* Millikan is to be understood as offering us a functional interpretation of the 'normal' in this schema.

The trouble with this suggestion is that it is not strictly true to say that it is the function of a perceptual process to yield true perceptions. In the first place, truth is (as Millikan certainly recognizes) only one of the variables that contribute evolutionary advantage. Speed and ergonomic efficiency also contribute, and it is entirely possible that a decrease in veracity could be compensated for, in evolutionary terms, by an increase in one or more of these other variables. Secondly, it may not at all be possible to arrive at à wholly veracious perceptual process - the desired result of the perceptual process might not be calculable with certainty given the available data. Thus the most accurate way of stating the function of a system of generating "intentional icons" is to say that it aims at veracity as one among several factors that lead to increased fitness.

There is a methodological difficulty, then, in concentrating on just those circumstances that lead a process to the truth. The difficulty is that it was not these circumstances that were historically responsible for the evolution of the perceptual pro-

cess in which we are interested. We have to look at a much wider range of circumstances: namely the circumstances in which the process gives the organism an advantage, even if this advantage is due to the other factors. Now, in this wider range of circumstances it will not be true to say that there is any one property that will be indicated by a particular perceptual state, for the circumstances will include cases of error.

There is, however, another way of achieving what Millikan has tried to do. We can try to identify which precise aspects of it contribute to truth gathering, which to speed, which to efficiency, and so on. Such an analysis will identify the quantity or quality that is being calculated - the mathematical aim of the process, so to speak and then identify the trade-offs and compromises that have been made in order to increase speed and efficiency. It will also identify the difficulties that exist in calculating the desired result, and display the more or less reliable methods that are used to calculate the result. It will view the physical process as an approximation to this ideal algorithm, and claim that it has been selected because it so approximates. And it will identify the mathematical aim of the process as the quantity or quality that it imperfectly reveals. It is only in the context of such a theory that we can offer a scientifically adequate identification of what external property a perceptual system reveals.

These points may be illustrated by means of Land's computational theory of color-vision. The problem that this theory attempts to solve is this: what accounts for the constancy of color vision, given the variability of the retinal array? Land conjectures that color-vision occurs in two stages. Information about incident energy is separated out according to spectral composition: thus each point of the image is associated with a triplet of energy values ("luminances"), one for each of the three wave-length ranges to which the three types of cone-cells are sensitive. The first stage of color-vision smooths out local fluctuations in luminance, assimilating adjacent luminances to the same value if they do not differ by much[7] - this smoothing out results in quantity, called "lightness", which is more independent of illumination than is energy, because, as Marr puts it, "gradual changes in luminance are often due to changes in illumination rather than to changes in reflectance" (1974: page 1377, see note 7). The second stage is a process of calibration which associates colors with each triplet of lightnesses. This is done by means of ordinal comparisons of each triplet with others in the scene. As Land puts it:

> In normal images the sensation of white light will be generated by any area that is placed at the top of the lightness scale by all three [spectral ranges]. On the other hand, an area that stands at the top of only two of the three ... will be seen as some other color. Hence an area that is at the top of the lightness scale in the long- and middle-wave systems but is surpassed in lightness by some other area in the short-wave system will be seen not as white but as yellow. A similar inter-comparison of triplets of lightnesses ... provides the sensation of color, area by area, in spite of unpredictable variations in illumination. (1978: page 123, see note 4)

The ordinal, or comparative, positioning of the various triplets appears to be invariant over a wide range of illuminations, and thus accounts for color-constancy.

This theory enables us to identify and explain a number of misperceptions. The smoothing out of luminance values can lead to the perception of a surface as uniformly colored when in fact its color varies gradually. This is because the smoothing out process is successful because "gradual changes in luminance are *often* due to changes in illumination rather than to changes in reflectance". The system *assumes*, as it were, that all gradual changes are due to illumination and is successful because this is very often so. The correct causal-evolutionary story does not rely on a restriction of our attention to just the situations where the assumption works, as Millikan would have us believe, but to the frequency of such situations. It is the frequency of such situations judged by the costs of executing the algorithm, the price of error, and so on, that makes the procedure a good one, not the fact that in certain situations it works. Again the assumptions of the calibration process enable us to identify other errors. While standing in the snow, every color looks normal. But standing inside, in a tungsten-lit room, looking out at the snow, things look abnormally blue. Why? Because in the former case, the comparative lightnesses work out as normal, but in the latter things inside are more than usually red-lit, making the outside look deficient in reds. Conversely, and for the same sort of reason, if you stand in the snow, and look in on a fire-lit scene, everything inside will look reddish.

This algorithmic explanation of color-vision is confirmed if observed errors, and observed comparative speeds of various tasks, work out as it predicts. If an algorithmic explanation is confirmed, then we have reason to believe in the goals of processing it postulates. This tells us what, if anything, color-

vision reveals. If Land's theory is right, color is comparative lightness in continuously varying illumination.

What are the conclusions I have reached? First, I asked whether there was any reason for believing that perception reveals real properties of the world. I rejected the idea that the theory of evolution gives us some general reason for believing that all perceptual systems do this. Nevertheless, I claimed, there are some empirically established and some introspective facts about particular perceptual systems - I used the example of colorvision - which do suggest realism for these systems. Next, I asked how we could identify the properties that realistic systems reveal, given that such systems typically make errors in detection. I rejected the idea that we can rely on a concept of functional normality for this purpose, arguing that only a computational analysis of the goals of a process would suffice.

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NOTES

1. *Karl Marx's Theory of History: A Defence* (Oxford: Clarendon Press, 1978): chapter 9.
2. Elizabeth Haldane and G.R.T. Ross (tr) *The Philosophical Works of Descartes* vol 1 (Cambridge: Cambridge UP, 1911): 196-8
3. *Darwin and the Emergence of Evolutionary Theories of Mind and Behaviour* (Chicago: Chicago University Press, 1987): see especially chapter 1.
4. "Lightness and Retinex Theory", *The Journal of the Optical Society of America* LXI (1971): 1-11. See also Land, "The Retinex Theory of Color Vision", *Scientific American* CXXXVII,6 (December 1977): 108-28.
5. James J. Gibson, "New Reasons for Realism", *Synthese* 17 (1967): 162-72.
6. *Language, Thought, and Other Biological Categories: New Foundations for Realism* (Cambridge Mass: MIT, Bradford Books, 1984): chapter 1.
7. It is this first stage of the process that has received the most attention: see the two articles cited in note 4, and David Marr, "The Computation of Lightness by the Primate Retina", *Vision Research* 14 (1974): 1377-88.