CHAPTER 4

VISION

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1. INTRODUCTION

“Vision science—as Palmer puts it in his introduction to a recent, impressive work on the subject—is not just one branch of cognitive science, but the single most coherent, integrated and successful […]” (Palmer 1999, xvii-xviii). However chauvinist this judgment may seem, vision has undoubtedly been and still is a very important area in cognitive science, stimulating a particularly rich discussion between philosophers and scientists.

There are two opposing, radical attitudes with regard to the relation between philosophy and cognitive science. On the one hand are those (including most, but by no means all philosophers) who think that conclusions following from a priori arguments are more substantial than the empirical results provided by current sciences of mind. These people are inclined to regard such or such psychological theory as confirmation of their philosophical bents. On the other hand, there are scholars who accord priority at least to the most well-established experimental results. Building on empirical evidence, they try to outline a philosophical picture coherent with (current) scientific findings. Although I am in general more sympathetic with the latter strategy, I believe there are problems in the field which are still so hard to assess that we ought to assume a more pliant and cautious attitude, as will be shown in this chapter. Based upon the analysis of a case study—the controversy between direct and indirect realism—I will argue that some results from cognitive science can cast light on philosophical problems about visual perception. At the same time, however, it will become clear how the empirical research is also still constrained by philosophical hypotheses and prejudices.

2. THE PHILOSOPHICAL OPPOSITION BETWEEN DIRECT AND INDIRECT PERCEPTION

Philosophy has been much concerned with perception, especially in the seventeenth and eighteenth centuries, when the main subjects of philosophical reflection were the origins and foundations of knowledge. Many different questions have arisen in this domain, yet it is not an overstatement to claim that there is something to be regarded as the philosophical problem of perception, which could be expressed by the following question: can we directly perceive the external world?

Readers without a philosophical background may, quite legitimately, consider this question quite bizarre. What does “directly” mean? If it means that visual experience is automatic, immediate (that is, instantaneous) and fully unconscious of the underlying complex cerebral mechanisms, then the claim would seem to be trivially true. Yet, the idea that the external world could be given to us indirectly comes from what seems to be an equally trivial, prima facie harmless remark, namely, that we access the world through our sense receptors. Although we have good reasons to believe that receptors are reliable, they are nonetheless characterized by some resolution or grain features and certain specific ways of coding information. Our perception of the world is thus constrained by how the receptors work and bounded by their powers. For instance, we are blind and deaf to
some frequencies; things appear to us in such and such way, e.g., as having certain shapes and hues. It is only a small step from here to the somewhat skeptical conclusion that we do not know the world as it really is, but only as it appears to us. That is why the issue of perception has traditionally been an epistemological one in the classical sense, i.e., an issue concerning the reliability and justification of knowledge, closely related to the issue of skepticism. In one of his personifications, the skeptic dares put in question the existence of the world. Indeed, the dependence on sense receptors might be interpreted as entailing that we live in a world created by our senses, so that the world does not exist at all (“ontological phenomenalism”). However, notwithstanding our deference to the venerable question of skepticism, we do not take this skeptical hypothesis seriously, in the light of the naturalistic attitude underlying the essays included in this book. We may rather propose the more moderate philosophical position of indirect realism, according to which the contents of visual experience—what seems us to see in an act or event of vision—are, or derive from, the output of senses (in the broadest sense of the word, cf. note 1). That is, they are a kind of mental event. The mental nature of perceptual contents does not undermine the realism of this view, since the causal source of the contents is the external environment, which contains objects, properties and relations. These real items are reconstructed, usually in a reliable way, by mental—and ultimately, neural—operations.

By contrast, according to direct realism, the contents of visual perception are objects, properties and relations in the real world. Direct realists hold that indirect realism has a few, strongly implausible, epistemological and metaphysical consequences. The metaphysical upshot consists in the reification of mental entities, that is, a new form of Cartesian dualism; the epistemological consequence is the skepticism about the existence of the external world. More precisely, indirect realism cannot defeat the skeptical hypothesis: the non-existence of the world cannot be ruled out. In this respect, indirect realism would be on a par with ontological phenomenalism.

Direct realists claim that these upshots are intrinsic to a familiar and unfortunately persistent epistemological account of perception, which dates back to Descartes and is still alive in the sense-data theory, the most recent version of classical British empiricism. This account is based on the idea that external things cause internal impressions. In the empiricist philosophical tradition sense receptors yield to sense impressions, and ideas come from impressions, by association or inference (depending on the version). As a consequence, the sensorial system yields an “idea veil”, the so-called veil of perception. What we can directly access in ordinary visual experience is not the world in itself, but a phenomenal world, whose features are defined by the nature of the receptors. For instance, in the sense-data theory, objects, properties and relations are construed with the primary contents of visual experience, such as color hues, blobs, spots, elementary shapes. We may disagree on what the perceptual primitives actually are, that is, on what the immediate constituents of visual experience are; but regardless of this, they are mental entities.

According to Putnam (1999), the failure of indirect realism also entails the bankruptcy of computational cognitive science, or, at least, of a certain philosophy of mind which seems to be implicit in classical cognitive science. Computationalism and indirect realism are indeed both committed to the thesis that what we can access
in visual perception is the output of sense receptors. On the other hand, computationalists may interpret this the other way round, claiming that, if computational cognitive science actually implies indirect realism, this would be a good reason for endorsing indirect realism. Either way the argument is brought to bear, it presupposes the existence of a link between the computational explanation of perception and indirect realism. Do we have good reason to believe this premise to be true? This is not an easy question to answer. I will argue that, although cognitive science cannot, in principle, provide a straightforward (or... direct!) answer to this question, it offers some useful cues to play down the question.

3. TWO PSYCHOLOGICAL ACCOUNTS OF VISION

From a quick overview of a few handbooks on the psychology of perception it is apparent that this is also an area of lively debate between those who support direct and indirect theories. Constructive theories are usually regarded as “indirect”, whereas “(the theory of) direct perception” is the term used by James J. Gibson to denote his ecological optics, which is explicitly presented as an alternative theory to constructive theories (cf. Gibson 1972).

These two approaches differ on several aspects. From the perspective relevant here, the crucial point is the following. According to constructivists, what is perceived is underdetermined by the information carried by photoreceptors, that is, the retinal information is compatible with more than one visual interpretation. The visual system must therefore integrate these data with further information in order to determine, in a “reconstructive” way, what there is in the world. This extra information is already available to the perceiver, either being innate, or (more traditionally) coming from learning. Sometimes this process of integration is regarded as a kind of unconscious inference. By contrast, according to Gibson and his followers, the visual system, far from reconstructing or inferring, merely extracts, picks out, the information present in the stimulation, “attuning itself” to the relevant information structures.

The underdetermination of the distal stimulus is an established fact in geometrical optics. For instance, one and the same retinal image can be projected from very different shapes. Therefore, to pursue his strategy, the ecologist must appeal to a different notion of stimulus. According to Gibson, information in the stimulus does not merely specify elementary features such as edges, contours or blobs. The information carried is about higher order invariants, that is, complex properties such as the texture gradient, optical flow, horizon ratio, which are identical to certain phenomenally perceived features. Or, at the very least, these higher order invariants co-vary with phenomenal items, according to simple laws. The stimulus can be so rich and structured because vision is not static. The agent’s eyes, as well as his head and body, move all the time. Movements generate differences, and differences carry information. The constructive conception of vision is too static, since visual processes are taken as the processing of static images on the retina. On the contrary, thanks to movement, the stimulus is not a two-dimensional image. It is rather a rich pattern of light, the so-called ambient optic array, which is rich enough to specify the pattern of surfaces in the visual field.

Computational vision, which is still based on the paradigm of Marr’s theory
can be regarded as a form of constructivism, since it is committed to the thesis that the information carried by the stimulus must be conspicuously integrated in order to produce the ordinary visual experience. What characterizes the computational approach are precisely the specific suggestions about how this integration is performed: what is to be computed, and how it is computed. According to the computational approach, a good psychological theory of vision should describe, \textit{inter alia}, the algorithms which, step by step, reconstruct the properties of the distal stimulus. By contrast, the information extraction processes postulated by ecologists cannot be decomposed in psychologically more basic operations or (presumed) computations. Arguably, it is the task of the physiologist to discover how the nervous system is attuned to higher order invariants, as it is a task of biochemistry to cast further light onto the details of the neurophysiological story. But the ecological psychologist need not investigate over and above the specification of invariants: what they are and how they can be carried by the ambient optic array.

The differences between the ecological theory and the computational theory—or, more generally, between ecologists and constructivists—are gradually diminishing. There is indeed a mutual “outpouring” of ideas, although Gibson’s explicit rejection of the notion of computation makes it difficult to attain a real synthesis. Be that as it may, it is beyond the purpose of this paper to establish a systematic confrontation between these two approaches. My aim is rather to assess whether the above-mentioned features of the two approaches provide empirical evidence to either of the philosophical positions being discussed. Can we say that the computational theory of perception is a good instance of indirect realism? When psychologists say that perception is direct (indirect), do they mean the same thing that philosophers intend when referring to perception as “direct” (“indirect”)? Is there a third way over and above direct and indirect realism? These are the kind of questions we shall try to answer.

4. PSYCHOLOGICAL AND PHILOSOPHICAL ACCOUNTS: A COMPARISON

Firstly, it is important to point out that the issue discussed in philosophy is epistemological, whereas the psychological issue is explanatory. Philosophers argue about how perception should be regarded in order to fill a certain epistemological role: to warrant our knowledge of the external world. Psychologists deal with the problem of how visual perception works. They are not concerned with issues of justification since, in their view, nothing has to be justified. It is assumed that perception usually, though not always, works well. Sure, these two aspects are not fully independent of each other. For instance, an assessment of perception in inferential terms could be used to support the epistemological thesis according to which perception is the source of conceptual knowledge. However, one should be cautious in deriving epistemological conclusions from explanatory claims, since there seems to be no necessary link between a certain account of how perception works and such or such epistemological interpretation. In this sense, the concept of perception proposed from time to time by philosophers is to a large extent independent of the scientific accounts of its functioning. As we shall see, confusion between these two kinds of discourse is one of the reasons underlying Putnam’s hasty claim according to which the computational theory of perception is a
sophisticated version of the sense-data theory. As a consequence, Putnam charges (unduly) cognitive science with not being able to rule out skepticism.

Second, the terms “direct” and “indirect” are used in different senses in the two discourses. As we have seen, philosophers argue that perception is indirect insofar as the content of visual experience is a mental entity (from now on I will refer to this thesis as IPH, Indirect in the PHilosophical sense). The computational theory of perception can be said to be “indirect” on the following (PSychological) aspects:

IPS₁) To perceive properties and objects of the real world requires the integration (in a computational and/or inferential way) of information in the stimulus. In other words, world properties cannot directly be picked out in the stimulus.

IPS₂) To perceive requires mental or psychological operations. That is to say, the integration mentioned in IPS₁ can properly be described as a collection of psychological operations.

As far as I can tell, IPS₁ has in itself nothing to do with the philosophical concept of indirect perception. It is only when taken together with IPS₂ that IPS₁ seems to warrant (philosophical) indirect realism. The question is therefore whether IPS₂ is equivalent to IPH. Is it just a question of nuances or, instead, are the two claims substantially different?

According to computationalists, perception involves several processing stages, the outcome of which is the construction of certain visual representations. These are regarded as mental entities. In this sense, having a visual experience is tantamount to being in a relation with a mental representation. There is less than one step from this thesis to IPH, that is, to the claim that percepts are mental entities. On the other hand, indirect realism does not fit well with computational cognitive science, since this thesis regards the nature of conscious contents of experience. Cognitive science is not specifically concerned with conscious states. On the contrary, in most cases cognitive models concern subpersonal processes, which manipulate information whose structure does not emerge as an object of first-person awareness.¹² Computational vision largely regards those mechanisms and structures whereby we come to have a perceptual experience, whereas indirect realism concerns perceptual experience as such. In other words, indirect realism is concerned with the kind of states in which we experience, in the phenomenological sense, something. These are states in which something appears to us in a certain way. Take, for instance, the paradigm of indirect realism, the sense-data theory. Its starting point is that hallucinations and veridical perceptions cannot be phenomenally discriminated. Thus the conclusion of the argument concerns only the phenomenal structure of visual experience.

In the opposite field, the link between the ecological theory and direct realism is more apparent. We could even regard Gibson as having tried to outline the philosophical position usually labeled as “direct realism”, giving it a solid empirical basis. Indeed, since 1966 (and even before) he has presented his theory as an alternative to the philosophical doctrine of indirect realism, to which most psychological theories of perception are committed¹³. And he includes
computational vision among the psychological theories affected by the philosophical prejudice whereby to perceive involves the construction of mental entities. Therefore, when Putnam regards the computational theory as a new, (pseudo-?)scientific version of the sense-data theory, he makes Gibson’s very same point. Both claim that computationalism, insofar as it is committed to the notion of mental representation, re-introduces the veil of perception, entailing an unacceptable mind-body dualism (cf. Gibson 1972; Putnam 1999, 101-102, 169-170).

We would thus expect the rejection of mental representations in the ecological theory to be indisputable, i.e., that the Gibsonian notion of “direct”, far from being the mere denial of the opposite claim, makes it thoroughly perspicuous that the ecological theory is not committed to any kind of mentalism. However, brief reflection shows how there are a few objections to the Gibsonian use of “direct”. First of all, invariants are not environmental properties; they are properties of the (proximal) stimulus, at least in the sense that they cannot be defined independently of the perceiver. Indeed we perceive environmental properties by perceiving invariants. Then how can it be claimed that we perceive the external world directly? The ecologist’s answer is that there is a nomological relation between environmental properties and invariants: invariants are neither mental entities, nor the outcome of mental manipulations, in the sense that they are not signs or symbols of environmental properties (cf. Schwartz 1994, 144 ff.). Thus, it is easy to reply that the computational theory can also be described, after all, as a theory of direct perception: the kind of processing performed on the proximal stimulus—which nomologically co-varies with environmental properties—is not mental, meaning that it is not semantic or intentional, at least if we are confined to the domain of early vision (which corresponds, more or less, to the two lower processing stages according to Marr’s theory). Early vision representations are neither signs nor symbols. Gibson notoriously denies that perception involves computations, but this is not relevant here. The point is rather whether, in the light of Gibson’s criteria, visual representations are signs. Well, they are not. Representations causally co-vary with environmental properties. Being the result of certain computations does not make them more symbolic than invariants. Whether or not it is appropriate to say that representations are intentional is debatable; what is important is that, once (we) adopted the intentional talk, invariants turn out to be intentional as well. To sum up, anyone who wants to endorse the ecological theory as a form of direct realism, faces the following dilemma: either the ecological theory is also a theory of indirect perception, insofar as invariants are kinds of mental entities, or we lack a clear sense whereby ecological theory can be said to be “direct” (and computational vision can be said to be “indirect”).

There may be another, more positive way of characterizing Gibson’s version of direct realism, a way that makes the criticism of computational theory as a form of indirect realism more perspicuous. The idea is the following. Perceiving is something an animal does, that is, it is a kind of behavior. And behavior is a property of the whole agent. Therefore, explaining perception is to give an account of the relation between an agent and his environment, rather than to describe the working of a neural system at mental-functional level, as computationalists are inclined to think. Noé and Thompson found quite an effective way of expressing this point, which they take to be crucial in Gibson:
Perception [...] is not an occurrence that takes place in the brain of the perceiver, but rather is an act of the whole animal, the act of perceptually guided exploration of the environment. One misdescribes vision if one thinks of it as a subpersonal process whereby the brain builds up an internal model of the environment on the basis of impoverished sensory images. Such a conception of vision is pitched at the wrong level, namely, that of the internal enabling conditions for vision [...]. (2002, 3).

In short, vision is a function of the whole organism; it is what allows it to navigate and act successfully in the environment.

As this quotation from Noë and Thompson shows, this is a different kind of explanation. While according to the ecological vision visual processes are processes of the whole agent, the computational approach has an analytical, decomposition-oriented character: computationalists search for what in the head, or in the brain, makes the visual experience of the whole subject possible. We could say, following McDowell (1994), that Gibson’s theory is a phenomenological theory of visual perception, in a dual sense. On the one hand, it is a personal level explanation; on the other, it is a theory which accounts for the sensorial (conscious) experience of an agent. However, things are actually more complicated than this. The notion of direct information extraction involves invariants, and at least some of these—e.g., the optical flow—are relevant to processing levels typical of what computationalists call “early vision”. These are parameters that have nothing to do with the conscious experience of an organism. Anyhow, even without wishing to subscribe to the phenomenological interpretation of the ecological theory, it is true that it is a personal level theory, inasmuch as it is essentially a macrostructural description of perception, that is, a theory of how a whole agent sees. This description postulates some psychologically primitive processes, such as the extraction of invariants, whose elucidation is a task for neurophysiology. By contrast, the computational theorist thinks these “black boxes” should be described using a psychological vocabulary, and, specifically, in terms of algorithms. The computational theory provides us with a microstructural explanation of perception, which is still psychological. It is exactly in this sense that the ecological theory repudiates mentalism: it does not regard the operations performed by the visual system as mental operations. However, this still does not prove that the kind of mentalism implicit in computationalism amounts to straightforwardly upholding indirect realism, characterized as the idea that there are mental entities “interposed” between the agents and the world. Just insofar as it is subpersonal and non-phenomenological, computational vision is not located at the same level of standard (philosophical) indirect realism.

5. A SOMEWHAT DEFLATIONARY APPROACH

Let us draw some tentative conclusions. First of all, our discussion of psychological theories suggests that direct realism and indirect realism can both be said to be (roughly) true, in two distinct domains of interpretation, that is, with respect to two different levels of description. More specifically, there is a sense of “indirect” such that it is not inappropriate to qualify visual perception as “indirect”, at least if one endorses (as I am inclined to) the thesis according to which the study
of the operations performed by the visual system is relevant to psychology. Indeed, since there is robust evidence for the thesis that vision involves a collection of computational/representational stages, visual perception turns out to be indirect at the subpersonal description level (see, supra, IPS₁ and IPS₂). At the personal level, where perception is described as a relation between the whole agent and the environment, it seems more appropriate to refer to perception as “direct”. The truth of direct realism comes from the powerful intuition that, in a perceptual act or event, the world is simply given to us, rather than represented (= re-presented): I, as the subject of visual experience, am not related to the process which makes the experience possible, I am related to the causal source of the experience. There is no more reason to doubt that what I am seeing is a real cat than there would be reason to doubt that I am holding a real cat. In this sense, perception should not be considered as an interface between us and the world. It is rather the part of our body—the functional subsystem—that allows us to orient ourselves successfully in the environment. This characterization, however, is clearly about the issue of what perception is for us, that is, what perception is when regarded as a phenomenological event. It has nothing to do with the microstructure of vision, i.e., the problem of how the visual subsystem works. The microstructure of visual perception clearly shows that perception is indirect at the subpersonal level. But this sense of “indirect”—let us call it the psychological sense—does not correspond to the standard philosophical sense, because the representations hypothesized by computationalists are not things one can see. They are not the content of visual experience; they are, rather, structures in virtue of which visual experience is possible. Therefore Putnam’s assault on computationalism appears misplaced, since he misses the distinction between the phenomenological (macrostructural) level and the microstructural level. “Indirect” in the psychological sense does not imply that percepts are mental entities; it only entails that percepts depend on mental operations, and this is precisely what is meant by the claim that percepts are “constructed”. Likewise, “direct” in the psychological sense does not entail that there are no mental operations at all. To assess perception as direct amounts (a) to denying the presence of cognitive operations, i.e. conceptual mediators, or thought processes; and (b) to minimizing or even completely ruling out the psychological significance of these operations. Indeed, since they are identified with processes of invariant extraction, these operations should be considered as psychologically primitive. We could thus say that empirical psychology—considered as a whole—plays down the relevance of the opposition between direct and indirect. These two qualifications account for two different points of view which can coexist peacefully.

Consider the following analogy. Take a file transfer process, implemented by a pair of FTP programs. One program is running on your client PC, the other on a remote server. Could we say that the two programs are in direct contact? Well, yes and no. In a sense, it is correct to say that the two programs communicate directly, because the requests specified by one of them are interpreted and executed by the other. However, there is a great deal of software (not to mention the several physical channels) interfacing the two programs. A request generated by the FTP-client is first transmitted to another local program, then to another, and so on, until it is received by a remote program and eventually by the FTP-server, the end point. There are many layers of processing, all required to allow communication. Put more simply, we could say that there are two kinds of communication: logical
communication, between the two FTP programs, and physical communication, between any pair of adjacent devices (either software or hardware) in the transmission chain. Likewise, a perceptual act could be considered as a logical communication between a subject and a piece of real world, but, in order to make perception possible, many processing stages are required and, in particular, some representational structures must be constructed.

From this analogy it is evident that the indirect view, re-interpreted as proposed, does not involve the philosophical bankruptcy (dualism, skepticism, impossibility to refer) of which Putnam complains. In fact my view is not committed to the thesis that representations are interfaces. Or, more specifically, they are not interfaces as in something which separates agents and reality. On the contrary, representations (and processing) are what make logical communication possible. I admit, however, that logical communication is somehow prior, in accord with the direct realist intuition. In this way both the “indirect intuition”, according to which perceptual content depends on mental operations, and the “direct” demand that we are simply in touch with the world are accommodated. With regard to the charge of reifying mental entities, the answer is that mental representations are physical entities individuated at the functional level; mental representations do not constitute an independent ontological realm, over and above the physical realm.

However, there is an important limit to the analogy. FTP programs are (the end-point) “boxes” in the transmission chain, whereas agents are not boxes, they are rather the wholes in which the boxes are instantiated. Moreover, the relation between a person and her computational (or, for that matter, physical) subsystems is not a standard parts/whole relation. Therefore the analogy accounts for the multilayered structure of perception, but not for the nature of the relation between an agent and the content of her experience, which remains to a certain extent a mystery. Indeed computationalists are faced with the problem of explaining exactly which kind of relation there is between us, the phenomenal subjects, and the representations built by perceptual subsystems. According to a standard account, the content of my visual experience supervenes on a computational-representational structure. This means that the instantiation of a representation (e.g., a Marr’s 2½-D sketch of a cat) necessarily yields the occurrence of an experience with a given content (e.g., my seeing a cat) but this statement leaves two questions open. First, there are good reasons to doubt that there is a systematic matching between common sense mental properties and computational properties, since the respective individuation criteria are very different. Second, why is a perceptual content experienced so-and-so, when a given computational-representational structure is instantiated? It is a well known fact that this is the problem of the alleged explanatory gap between physical-functional facts and phenomenal consciousness.

I cannot deal with these problems here. Rather, I wish to point out that, even if one supposes that perceptual events (= token-states, such as my seeing a cat at t₁) are identical to computational events—which I admit merely for the sake of argument—this does not mean either that the mental is “reified” or that we (as persons) are in touch with mental entities. Computational states are classes of neurophysiological events and, of course, we are not in touch with our brain events, at least not in a standard sense. The above-mentioned difficulties remain, but they do not specifically concern perception, and have nothing to do with dualism or skepticism.
6. CONCLUSIONS

Vision science offers several elements which allow us to solve, or at least to see in a different light, some traditional philosophical problems, such as the controversy between direct and indirect realism. However, although computational and ecological theories aim to be empirical accounts of visual perception, both embody some assumptions that we may well qualify as “philosophical”, about, e.g., how the proximal stimulus should be individuated, or what exactly should be included in vision. It is hard to see, at the moment, how empirical psychology might get entirely rid of these assumptions, which are still a priori to a certain extent. This explains why a few philosophical “cramps” are still to be found, and the psychological scientific study of vision cannot set aside some assumptions that are hardly justified on a purely empirical basis. Moreover, we are far from understanding the relation between the content of visual experiences and the representational structures postulated by computational psychology. Until we are able to cast light on this problem, accommodating or explaining away philosophical intuitions in a scientific framework, the theoretical status of (computational) cognitive science will remain shaky to a certain extent.

Our analysis of vision has highlighted the existence of a persistent interweaving between the empirical and the a priori—between science and philosophy. I think that this should not be considered as evidence that vision science has not been successful, or that it has not advanced so much since the beginnings of psychological research. On the contrary, the interaction between philosophy and science turns out to be cognitively fruitful; the point is rather that there are problems which are, in virtue of their nature, intrinsically hard to cope with in a purely empirical way.

NOTES

i See Smith (2002).

ii By “sense receptors” I mean not only the sensory organs, but also the overall set of neural subsystems dedicated to processing sensorial information, as far as it is possible to single out these (it is notoriously difficult to define accurate boundaries between sensation and perception). It is worth noting that there is a great temptation to say that our access to the world is “mediated by sense receptors”, an expression which seems to suggest explicitly that perception is indirect.

iii From now on I shall use “content” of a perception or visual experience, instead of “object”, in order to make it clear that I am talking about what we seem to see, without begging the question whether what we seem to see is what there actually is, e.g., the question of what is the nature of the “things” we see.

iv Arguments of this kind have recently been offered by McDowell (1994) and Putnam (1999).

v By, e.g., Russell (1912, chap. 1; 1918, chap. 8); Ayer (1940).

vi E.g., Bruce, Green and Georgeson (1996); Palmer (1999); Rock (1983).

vii The constructive conception, which dates back to Helmholtz, includes Richard Gregory (1970, 1980) and the late Irvin Rock (1983, 1997) among its most recent and influential scholars.

viii See Gibson (1979); Michaels and Carello (1981); Cutting (1986).
Since then, many studies have been conducted in the wake of the computational paradigm, and some of Marr’s hypotheses have been disconfirmed. Nevertheless, the general guide-lines of the paradigm are still those defined by Marr.

Neisser (1976) endorses the experimental approach of ecologism, yet holds the constructivist notion of anticipatory schema. Ballard (1991; 1996), who proposed computational models clearly inspired by Gibson’s insights, outlines a sensorimotor paradigm the central idea of which is that perception cannot be considered apart from action. Norman (2001) suggests (on the basis of neuropsychological evidence) that the two approaches account for two distinct perceptual functions, so that both are required to provide a full explanation.

Therefore, there is no scientific correlate with the notion of sense datum.

“I argue that the seeing of an environment by an observer […] is direct in that it is not mediated by visual sensations or sense data” (Gibson 1972, 77).

Arguably, the Gibsonian sense of “environment” is subject-related. One thing is the world, another thing is the environment. We might even say that there is no room in Gibson’s account for the notion of real world. But in this case his view could hardly be regarded as a form of standard philosophical (direct) realism.

See also O’Regan and Noë (2001).

As Dennett puts it: “The actual internal states that cause behavior will not be functionally individuated […] the way belief/desire psychology carves things up” (1981, 71). It seems that one can only subscribe to supervenience at the price of a strong, and perhaps too strong, idealization.

See, e.g., Chalmers (1996).