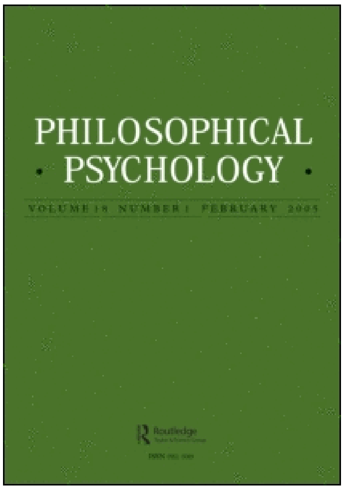

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Are sensory properties represented in perceptual experience?

Nicoletta Orlandi

Philosophers of perception widely agree that sensory properties, like color, are represented in perceptual experience. Arguments are usually needed to establish that something other than sensory properties, for example three-dimensional objects or kind properties, are part of perceptual content. Call the idea that sensory properties are represented in perceptual experience the Sensation View (SV). Given its widespread acceptance, we may expect to find strong reasons for holding SV. In this paper, I argue that we lack such reasons: SV is largely unjustified. We have surprisingly poor justification for thinking that sensory properties are represented in perception. By focusing on the case of vision, I show that an embedded understanding of visual perception, and empirical evidence in cognitive psychology, indicate that SV is far from warranted.

Keywords: Colors; Content; Perception

1. Introduction

Whatever else they may disagree about, philosophers of perception typically agree that sensory properties, like color, are represented in perceptual experience (Ayer, 1967; Clark, 2000; Fodor, 1983; Jackson, 1977; Price, 1950; Russell, 1912; Siegel, 2006). Arguments are usually needed to establish that something *other* than sensory properties, for example that objects or kind properties are part of perceptual content (Fodor, 1983; Siegel, 2006). Call the idea that sensory properties are represented in perceptual experience, the Sensation View (SV). In this paper, I argue that we lack strong reasons for holding SV. It is far from obvious that sensory properties are represented in perceptual experience. And while they *may* be represented, we have surprisingly poor reasons to suppose that they are. Further, I argue that we have no more reason to suppose that they are represented than we have to believe that other entities, such as objects, are represented.

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In section 2, I clarify the basic terminology, explaining what I mean by sensory properties, perceptual experience, and its content. In section 3, I spell out what SV amounts to, and suggest that it is widely held in philosophy of perception. In section 4, I survey a number of arguments that favor SV and show that such arguments are not sound. In section 5, I analyze our reasons for thinking that SV is unwarranted and section 6 concludes.

2. Preliminaries

Perceptual experiences are the kinds of mental states that paradigmatically occur when a subject perceives the environment. I understand perceiving the environment along the following lines: a subject S perceives X if S is in a state that carries information about X, the state is derived from an accredited receptor system (in the case of vision, the visual system),[1] and the state *represents* whatever it is that it carries information about. For a state to *represent* means two things: first, such state can occur even in the absence of that which it carries information about; and, second, such state is available for the performance of a number of other tasks (forming beliefs and judgments, guiding locomotion, learning, etc.).

The first condition on thinking of perceptual states as representational captures the idea that for a state to represent something, it has to be able to *misrepresent* it. If we take visual experiences to represent, then we should think that seeing X involves being in a state that carries information about X, and the state can occur even in the absence of X. Seeing a red apple, for example, involves being in a state that carries information about an apple being red. Such a state can misrepresent in the sense that it can occur even when the apple is not red, and even in the absence of the apple. A state of a system that is not able to misrepresent is also not a representational state.

The second condition on representation has it that a visual state represents only if the state is available for the performance of other tasks. Some of the tasks may be paradigmatically cognitive, like forming beliefs and learning; others may be non-cognitive like guiding locomotion. One can, for example, form the belief that a red apple is present based on one's visual representation of the red apple. And, similarly, one can move to grab a perceived red apple given one's visual representation of the apple.

I take misrepresentation and availability for other tasks as two minimal conditions on what makes a state a representational state, because I take them to reflect the kind of work that the notion of representation is called to perform. We tend to ascribe representational states to a system when the system's behavior cannot be easily (or at all) understood by making reference *solely* to environmental conditions. We say that a system represents something when the system's behavior seems to result, at least in part, from the manipulation of an internal model of the situation rather than from the situation itself. Two important features of the postulated model are, first, that in some cases, it can be inaccurate, and, secondly, that hypothesizing its existence explains what the system does because the model is available for the production of behavior. Accordingly, we should think of visual states as representational states that can misrepresent, giving rise to misperception, and that can serve, among other things, in the formation of belief and the guidance of action. A state that cannot misrepresent, or is not available for the performance of other tasks, or both, is not a representational state.[2]

That which the perceptual experience represents is its content: if S has a visual experience of an apple being red, then that the apple is red is the content of her experience. Accordingly, in this paper, I will talk interchangeably of what is represented in visual experience and of what is part of the content of such experience.

Why accept my characterization of perceptual experience? Because I think that this is roughly how perceptual experience is understood in most of contemporary cognitive science. The presumption that visual experiences are representational, for example, is hardly questioned.[3] Vision is usually taken to be a process that, from a set of proprietary stimuli, produces representations of the distal causes of the stimuli that are made available to other systems for a number of different tasks. How rich or detailed the representations are is a matter of controversy (Ballard, Hayhoe, Sullivan, & Triesch, 2003; Noë, 2004), but that such representations are produced is not. I tend to think that the plausibility of this assumption is a function of how explanatorily powerful it is (and has been) in giving models of vision, and in explaining the behavior of complex cognitive systems (like us). So long as thinking of vision as representational helps us explain, for instance, why one can be misled by one's visual experience, we have little reason to doubt the assumption.

Further, the presumption that visual experiences are used for tasks such as the guidance of action, the forming of beliefs, or the learning process, is uncontroversial. People may disagree about how directly visual experience guides action (Brooks, 1991; Fodor, 1983; Noë, 2004) but they do not disagree about whether it does. And even radical nativists (Fodor, 1998) agree that visual perception serves in the learning process. Whether experiences serve to *acquire* concepts or whether they merely *trigger* the concepts is quite irrelevant: what's important is that what concepts a subject has partly depends on the perceptual experiences she has had.

I do not presume, here, that perceptual experiences have to be conscious, whatever we may mean by that. All I assume is that when S has a perceptual experience of something, she is in a state that carries information about it, and such state can serve in the performance of other tasks. Accordingly, some perceptual experiences will be conscious in my account, but my characterization is liberal enough to include states that guide the subject's movements without being available to consciousness (Dretske, 2006).

By sensory properties, I mean properties such as color, size, sound, smell, hardness, and roughness. Since I will be talking primarily about visual experience, I will take color as a paradigmatic example. Hardly anyone doubts that color is represented in vision. That is, many suppose that SV is just obvious. In the next section, I expand on SV, and I show that it is widely held in the philosophy of perception.

3. The Sensation View

The Sensation View consists in the simple claim that sensory properties are represented in perceptual experience. As stated, the view seems uncontroversial. It is really hard to deny, or to even question that visual perception gives us information about color. And this incapacity to even question SV is what gives sensory properties a special status in perception. They are surely part of the content of perceptual experience: entities *other* than sensory properties may also be represented in experience, but it is more controversial that they are. Additional arguments are needed to suppose that perceptual experience carries information about things such as objects, events, and causal relations between them.

Given its widespread acceptance, we might expect to find strong reasons for holding SV. In what follows, I argue that we lack such reasons. SV is largely unjustified because the arguments that are mobilized in its favor are bad. Further, I contend that we have plenty of reasons to suppose that things *other* than sensory properties are represented in experience. As it turns out, perceptual experience *may* represent sensory properties, but such properties are not special in any way: we can't just assume that they are represented, and we have no more reason to suppose that they are represented than we have to suppose that other entities are represented. To provide a contrast class, I will consider the case of objects intended as connected and bounded regions of matter that maintain their connectedness and boundaries when in motion (Spelke, 1990). I think that it is uncontroversial that objects, rather than their sensory properties, are represented in perception. I leave it to the reader to run the same argument for other entities.

The Sensation View is a very popular view. It may not be explicitly endorsed as a "view," but everyone who is willing to grant that sensory properties are represented in perceptual experience tacitly upholds it. These include both those who believe that perception represents *only* properties like color, shape, and location (Clark, 2000; Marr, 1982; O'Shaughnessy, 2000; Tye, 1995) and those who believe that it has richer content (Peacocke, 1992; Prinz, 2006; Siegel, 2006; Siewert, 1998). The latter tend to agree that perception represents sensory properties, but they then argue that it represents more. They often do so by appealing to the influence of expertise or conceptual development on our visual experiences (Siegel, 2006; Siewert, 1998). I have no room to assess the arguments here; but even if the arguments were successful, they would presuppose acceptance of SV. Sensory properties are surely represented in perception: we need additional arguments to show that other entities are also represented. And notice that, according to the general gist of the arguments, we can visually represent things *other* than sensory properties only after the influence of experience and conceptual development. In and of itself, our perceptual apparatus gives us information only about sensory properties.

Now, although dominant, SV is more of a tacit assumption than something that is openly discussed and defended. It emerges in passages like the following:

> It is relatively uncontroversial that color and shape properties of some sort are represented in visual experience. Being orange and being spherical, for example,

> are properties that we can sensorily perceive a basketball to have.... The main question addressed in this paper is whether any properties are represented in visual experience, besides the ones standardly taken to be so represented. (Siegel, 2006, p. 482)

Siegel goes on to argue that there are good reasons to suppose that visual perception represents also kind properties, like the property of being a pine tree. Similarly, a number of researchers have argued that our visual experiences can represent, in addition to sensory properties, causation (Armstrong, 1997; Beebee, 2003; Siegel, 2008), objects belonging to the so-called basic categories (Fodor, 1983), and abstract entities like injustice (Prinz, 2006).

But while SV is prevalent, it is not always clear what arguments can be mobilized in its favor. Why think that sensory properties are represented in experience? Why be so confident that they are? Short of being an unjustified intuition, there have to be arguments for thinking that SV is true. In the next section, I discuss three main sources of confidence for this view, and show that they are all unsatisfactory.

4. Arguments in Favor of SV

Although very rarely defended, SV can count on at least three lines of reasoning that, if successful, establish its truth. One is the idea that, by simply introspecting the contents of our experience, we can be sure that sensory properties are represented by it. The second is the idea that visual perception, understood as a process, starts with the representation of sensory properties. Everything else is represented *by* first representing their sensory properties. The third is the idea that visual perception represents primarily simple properties and sensory properties are a paradigm of a simple property. In this long section, I argue that these three different lines of reasoning are unsuccessful.

4.1. Argument from Introspection

The Sensation View may be justified by the simple introspective observation that colors and sizes seem to be part of our visual world. When we pay attention to what we see in a given scene, we can just see that colors are present: it seems undeniable. This fact, however, can hardly justify SV. Before I explain why this is case, notice that this observation wouldn't be able to support the idea that sensory properties are "special," in that we can be more confident that they are represented *vis-à-vis* other entities. Our visual world doesn't seem to be composed of just colors, shapes and sizes, but also of meaningful objects located and moving in certain ways, and of events and scenes involving those objects. If we took introspective observation to be the sole method to establish what is represented in perception, we would be perfectly justified in thinking that perception gives us information about lots of entities *other* than sensory properties. As a matter of fact, some empirical evidence would support doing so. Subjects, asked to spontaneously report what they see, tend to more readily do so in terms of objects belonging to well-defined and meaningful categories (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976).

But leaving aside the issue of whether sensory properties are special, there are serious reservations concerning introspection and its ability to ascertain the content of experience (Siegel, 2007). One of the principal problems is that introspective observation alone is unable to distinguish the content of perceptual experience, and derivatively, what is represented by it, from the content of other kinds of mental states such as beliefs. Suppose, for example, that you are looking at an apple: the visual experience that you have when you see it has a given content. It could be that your visual experience represents only the color of the apple. From the experience of the color you then (unconsciously or subpersonally) infer the presence of the apple, forming the belief that there is an apple. That the apple is present is, in this case, the content of your belief, not the content of your visual experience. Your visual experience serves to ground the belief, but it carries information only about color.

Alternatively, your visual experience can represent the apple itself. From such a visual experience you could infer (unconsciously or subpersonally) the color of the apple. That there is something, say, red, in this case, is the content of your belief not of your visual experience. But notice that introspection is unable to tell us which of these two alternatives is correct. This is because introspection is unable to draw a distinction between what is represented by the visual experience, and what is represented by other mental states, such as beliefs. For this reason we cannot rely on introspection as the sole, or even the primary, method to ascertain the content of perceptual experience: it could be that we visually represent uncolored apples and then infer (unconsciously or subpersonally) their color. In this case, color would be represented by a belief state, not by a perceptual state, and we would lack reason to hold SV. So, the first argument for thinking that the Sensation View is true is unsuccessful, because introspection is not a good method to ascertain the contents of perceptual experience.

4.2. Argument from the Inferential Nature of Vision

The second argument for thinking that sensory properties are represented in visual experience is that the representation of such properties is what our visual system starts with in order to build more complex representations of objects. According to this line of reasoning, we perceptually represent objects and scenes in the world *by* first representing their sensory properties, thus we can be confident that visual perception carries information about sensory properties.

Supporting this argument is a widely accepted view of how visual perception works (Churchland, 1989; Fodor, 1988; Fodor & Pylyshyn, 1981; Gregory, 1970; Palmer, 1999; Rock, 1983). Cognitive psychologists tend to think of visual processes as computational, that is, as operations over representations where more complex representations are built out of less complex ones. The initial representations, derived from the stimulation of the retina by light, are representations of sensory properties like color, contrast and acuity. These initial representational states are typically called "sensory states," and the information they encode "sensory data." The visual system is then responsible for moving from the initial representations to the representation of distal objects. The process by which it does so is variously characterized as a form of unconscious inference, or interpretation, or construction. But however the process is called, the visual system performs it by relying on some principles or assumptions concerning the make-up of objects in the world (Marr, 1982; Rock, 1983; Spelke, 1990; Ullman, 1979). The system produces representations of objects by tacitly assuming, for example, that the causes of sensory data are rigid and three-dimensional: thus, it moves from the representation of color to the representation of a colored, rigid object by assuming that color patches typically inhere on a surface and that the surfaces typically bundle together to form objects.

In this picture, sensory properties are what is immediately given in visual perception. Everything else is built out of them by using some tacit knowledge of the physical world. Whether such knowledge is innate (Rationalism) or acquired (Empiricism) shouldn't concern us at this point. What's important is that, if we accept this view of visual processing, we are committed to the idea that sensory properties are what is immediately (i.e., non-inferentially) represented in visual perception, and nothing else is so represented. It's only after an unconscious inference, or an interpretation, or a construction, or a computation, which requires some knowledge of the world, that objects are given to us in experience. So, we have an argument for SV: sensory properties are part of the content of visual experience because the representation of sensory properties is what our visual system starts with in order to construct other representations of the world. While the representation of objects and scenes requires prior knowledge of the world (innate or acquired), the representation of sensory properties doesn't, and this explains why we need additional arguments to suppose that visual perception represents anything more than sensory properties: it's only when coupled with knowledge that the perceptual system can represent objects, and this can give rise to reservations as to whether the representation of objects is *purely* perceptual.[4] By contrast, the representation of color does not require any prior conception of the world, and it is, therefore, unequivocally perceptual.

Understanding visual processes as inferential is made plausible by its conformity to current models of the mind that see mental processing as computational. But, however plausible, this way of understanding visual perception cannot be used to warrant SV. This is because there is a more plausible way of understanding vision. Current situated and embedded approaches to mental processes have questioned the model of vision as a process that builds a detailed representation of the environment from images of it (Brooks, 1991; Noë, 2004; Wilson, 2004). Elsewhere, I developed this line of research by suggesting that it is better to think of visual processing as non-inferential and, accordingly, as non-computational, at least in the traditional sense in which computations involve operations over symbolic states in virtue of some encoded rules.[5] We should rather think of the visual system as building a representation of the environment from retinal stimulations without going through intermediate representational stages.[6]

The first step in understanding how this is possible is to think of the visual system as relying on certain environmental regularities in order to interpret the retinal stimulus. The contrast here is between relying on the regularities versus representing them in the form of assumptions about the physical world.[7] We have seen that in computational/inferential models of vision, the visual system is said to rely on some prior knowledge of the world in order to build a representation of objects out of the representation of their sensory properties. For example, the system assumes that objects in the world are rigid. Alternatively, we can think of the system as relying on regularities occurring in the world without representing them, and thus without having any knowledge of them (tacit or otherwise). Objects in the world are typically rigid and the visual system can rely on this fact to produce a representation of objects directly from the retinal stimulation. Because the causes of retinal stimuli are typically rigid we end up seeing the world that way. Similarly, discontinuities in light intensity at the retina are generally caused by the presence of edges. The light that bounces off edges typically varies in intensity. Now, we can either think of the visual system as antecedently knowing this fact, or we can think of it as relying on this fact. The latter is the proposal I favor. The visual system doesn't first represent light discontinuities and then infer the presence of edges given its antecedent knowledge: it rather relies on the fact that discontinuities are caused by edges to represent their presence.

Systems that rely on environmental regularities without knowing anything about them are ubiquitous. Fire alarms seem to assume that smoke is typically caused by fire. This is why, when they detect smoke, they signal the presence of fire. But it is (to say the least) implausible to describe fire alarms as actually knowing anything about such regularity. Fire alarms have been built to signal the presence of fire by relying on the fact that smoke is typically caused by it: they don't have to represent such regularity in order to perform their function. Similarly, they detect the presence of smoke by relying on additional regularities. Optical fire alarms, for example, work roughly in the following way: they emit a beam of light and have a built-in photoelectric sensor in the proximity of the beam inside the so called "optical chamber." In the absence of smoke, the light in the beam travels in a straight line. When smoke enters the optical chamber and interferes with the path of light, some light is scattered by smoke particles, directing it at the sensor that in turn triggers the alarm. In this case, the alarm relies on the fact that smoke particles deflect the direction of light in order to perform its operations. The device doesn't need to possess this fairly sophisticated piece of physical knowledge. It simply relies on the physical facts to work as it does. Notice that in this and many other cases the regularity can enter into an explanation of the detector's behavior without being part of the detector's knowledge. The fact that smoke is typically caused by fire, and that smoke particles deflect light particles, explain why the device does what it does without being represented by the device.[8]

If we think of vision along the same lines, then we can stop thinking of the visual system as performing inferences or traditional computations: the system relies on certain environmental regularities, e.g., that light discontinuities are typically caused by edges. The regularities can enter into an explanation of why the system does what it does without being represented by the system. This means that the system automatically produces representations of edges and three-dimensional objects from a given set of stimuli without inferring such representations from others. And just like we don't need to think of the visual system as representing the regularities on which it relies, we don't need to think of the early stages of vision as representational. We don't need to think of the system as first representing light discontinuities and then inferring the presence of edges given its antecedent knowledge. Since sensory states don't have to serve in computations, we can also stop thinking of them as representations.

Why should we prefer this understanding of visual processing to the inferential one? For one thing, this approach rescues a point that is often made about representation (Millikan, 2004), which I discussed in the preliminaries. Representations are typically taken to be flexible states of an organism, paradigmatically beliefs, and they are often thought to be states that can serve for a variety of tasks. This means that representations are generally not dedicated in advance to any single purpose. But the sensory states that are thought to be the initial stages of visual processing are typically considered proprietary and dedicated states: their only function is to initiate visual computations. This raises doubts as to whether such states are representations at all. Proprietary and dedicated states of a system do not count as representations because they are not available for the performance of other tasks. In line with our initial conditions (see section 2), a state that is not available for the performance of other tasks (forming belief, guiding locomotion, etc.) is not a representation. Since early visual states are not so available, they are also not representational states. They are certainly states that, like those of a fire alarm, carry information, but they are not, ipso facto, representations.

Moreover, the embedded understanding of vision I am proposing has the advantage of ascribing less cognitive complexity to the visual system. This is precisely in virtue of the embeddedness of the system in our environment. In the account I am offering, the visual system works in close contact with the world in which it evolved and it relies on the world to function as it does. By relying on regularities rather than representing them, the system offloads some complexity to the environment (Haugeland, 1998; McClamrock, 1995).[9] This prevents us from entering the dispute concerning how the visual system acquired the knowledge it needs to possess to perform inferences. For a number of reasons, the dispute is often taken to resolve in favor of nativists: visual systems couldn't have acquired the knowledge of the physical world that they seem to possess, thus such knowledge must be innate. If this is true, then thinking of vision as inferential commits us to ascribing substantive innate architecture to the system: the system couldn't perform its function without it. We don't have to commit to this sort of nativism if we adopt the non-inferential account of vision I have outlined. We can explain how the system performs its function without having to admit that it possesses physical knowledge of the world.

If this is true then we shouldn't think of vision as first representing "appearances" and then representing objects. But then we still lack a good reason to hold SV. In the non-inferential picture I am proposing, the visual system, given the detection of light, automatically produces representations of specific rigid and three-dimensional objects without having to first represent their sensory appearances. If anything, we should be confident that visual experience represents objects. Sensory properties, e.g., the objects' colors, may also be represented, but there is no reason to just assume that they are. And there is no reason to be more confident about sensory properties being represented, than about the objects to which they inhere being represented. So, the argument from the inferential nature of vision cannot be used to establish SV.

4.2.1. Rejoinder: misperception

Perhaps support for inferential accounts of vision, and, indirectly, for the Sensation View, comes from the consideration that part of an adequate account of perception has to be an account of perceptual error, and this seems to militate in favor of inferential and computational accounts (Fodor & Pylyshyn, 1981). It is easy to see how error can take place if visual processing is inferential: misperception is connected with failed inferences. One's visual perception of a red apple, for example, is said to depend upon an inference from the appearance of the apple to the apple itself. But the inference can, in some cases, go wrong. Sometimes our visual system can infer the presence of a red apple from the appearance of a red apple (from a red patch) even when there is no red apple.

This argument is strikingly similar to an argument, sometimes called the "argument from illusion" (Ayer, 1967), offered in favor of sense data theory. Sense data, or sense impressions, or sensations, are typically regarded as the alleged mind-dependent objects that we are directly aware of in perception. Upon viewing a red apple in normal conditions, according to sense data theory, one is directly acquainted with a red and round patch, a sense datum, from which one infers the presence of the red apple. Since one could be wrong about the presence of the apple, one must infer such presence from the appearance of the apple. The appearance is what we are directly acquainted with: the object is only given indirectly (through a fallible inference).[10]

If the fact of misperception constitutes a good reason to prefer inferential accounts of vision, then perhaps we have another argument for SV. Explaining misperception requires thinking of vision as inferential. In particular, it requires thinking of vision as inferring the presence of objects from the representation of their sensory properties. But if vision is inferential in the way just described, then sensory properties are what is unequivocally represented in perception.

Now, I think that this rejoinder in favor of SV is not good: explaining misperception does not require thinking of vision as inferential. We can appreciate why this is the case by thinking of the alternative account of visual processing sketched above. The core idea is to take the visual system to rely on environmental regularities rather than representing them, and moving from retinal stimulations to representations of objects without going through intermediate representational stages. Objects in the world are the typical causes of retinal stimulations and they are typically rigid and three-dimensional. The visual system can rely on this fact to produce a representation of objects directly from the retinal stimulus. Similarly, edges are the typical causes of discontinuities in light intensity. The visual system relies on this fact to represent the presence of edges whenever a certain light pattern hits the retina. But notice that this is wholly compatible with the occurrence of duplicate retinal stimuli that are not produced by their typical causes. Laboratory conditions may replicate certain patterns of stimulation in the absence of rigid and three-dimensional objects, thus giving rise to perceptual illusions. And, in general, the visual system relies on regularities that have exceptions. Discontinuities in light intensity are mostly caused by edges but they can also be caused by cracks, shadows, hollow cavities and other conditions. Thus the visual system can go wrong by relying on facts that do not always obtain. If this is true, then we don't need inferences to explain misperceptions.

The example of the fire alarm from the previous section can help further clarify this point. The fire alarm relies on the environmental regularity that smoke is typically caused by fire. Thus, it signals the presence of fire when it detects smoke without knowing anything about the regularity. But of course things other than fire, such as car engines, can cause smoke. So, fire alarms can be tricked into signaling the presence of fire when running cars are present. Similarly, smoke particles are not the only particles that can interfere with the path of light in the alarm's optical chamber: vapor and gas can also do that. Thus, the fire alarm can detect the presence of smoke even when vapor and gas are present. And if one were to intentionally deviate the beam of light to hit the sensor, perhaps by using a mirror, the fire alarm could be tricked into detecting the presence of smoke in the absence of smoke or any other gas. So, we don't need to think of the fire alarm as performing inferences in order to explain how it "misperceives."

If this is true, then thinking of visual processing as non-inferential does not interfere with our ability to account for perceptual error. Misperception can occur even if representations of objects are produced as a direct response to retinal stimulation. So, this rejoinder in favor of inferential accounts of vision does not work.[11]

4.3. Argument from Simplicity

In section 4.2, I considered an argument that aims to establish the Sensory View by pressing on the idea that visual perception is inferential/computational and it starts with the representation of sensory properties. If this is the case, then SV seems to follow: colors are represented in visual perception because their representation is what the visual system uses to compute more complex representations of the world.

I argued that this line of reasoning fails to establish SV because there is a more plausible way of understanding visual processing, namely as embedded. The embedded visual system produces representations of objects from retinal stimuli without going through intermediate representational stages. I further showed that this way of understanding visual processing is fully capable of explaining how misperception is possible.

In this section, I discuss another argument that favors SV. The argument is not based on a particular model of visual processing. Proponents of the argument do not presume that visual processing *starts* with the representation of sensory properties; they rather hold that visual processing is likely to *end* with such representation. The basic idea behind the argument is that sensory properties are simple properties, partly because they seem to lack structure, and partly because they are straightforwardly correlated with physical quantities. There is a fairly plain correlation between colors and light intensity values at the retina, and we may suppose that relatively simple systems will be able to process such correlation. By contrast, we may think that it takes a fairly sophisticated system to represent complex entities like chairs, tables and trees, where the correlation with physical quantities is more complicated. Since the visual system is a fairly simple system, we may expect it to represent simple properties. Those who believe that vision is computational and modular, and those who believe that it is embedded, share the assumption that the visual system is a relatively simple system. Vision is a fast and automatic process that doesn't involve complicated operations. As a result, we may suppose that it has "shallow" outputs, in the sense of representing simple properties (Fodor, 1983).[12]

We then have a new argument for thinking that sensory properties are represented in experience. The argument holds that simple systems represent simple properties, where sensory properties are a paradigmatic example of a simple property. And since perceptual systems are simple systems, we can expect them to represent sensory properties. So, sensory properties are represented in experience. Given the simplicity of the visual system, we need additional arguments to suppose that visual experience represents anything more complicated than color. Notice that this argument can be used to establish not only SV, but also the stronger claim that sensory properties are the *only* properties represented in experience. Representing more complex entities requires more processing, and cannot be done by the visual system alone.

This way of arguing for SV is open to the obvious objection that simple systems don't need to represent simple properties, and that representing seemingly complex entities does not require complex systems. Thinking of vision as computational invites the thought that there is a correlation between the simplicity/complexity of the system and the simplicity/complexity of what is represented by it. The more complicated what is represented, the more computations are needed to represent it. But the correlation seems much less obvious if we adopt the embedded perspective.

The embedded visual system is a simple system that does not perform complicated computations: there is in fact a sense in which the system does not perform computations at all, because the system does not move from some symbolic (representational) states to others by following a set of rules. Rather the system offloads much of the complexity to the environment in which it is situated by relying on regularities, and by producing fairly complex representations directly from retinal stimuli. The complexity does not reside in the operations of the visual system, but in the environmental relationship between light intensity values and their causes that the system exploits. For example, there is a fairly complicated relationship between light intensity values at the retina and the presence of edges, but the visual system does not need to compute such a relationship. It rather exploits it to produce representations of edges given the intensity values. As a result, the system can represent seemingly complex entities without being itself complex. Because we think of the system as embedded in, and exploitative of, the environment in which it evolved we are not motivated to think that there is a correlation between its simplicity and what it is capable of representing. What it represents is rather a function of the environment in which it evolved and, likely, of the needs of the organism in which it is situated.

We can finesse this reply by looking at actual cases of fairly simple systems. In previous sections, I mentioned fire alarms as systems that represent seemingly complex entities despite being simple. But it would be nice to have examples of actual perceptual systems, in particular human perceptual systems. If the argument from simplicity is right, then our simple visual system should be able to represent primarily simple properties like color. Now, at least in the case of adult humans, it is hard to see why this is true. Adult visual experiences seem to be much richer than what the argument from simplicity predicts (Rosch et al., 1976).

Perhaps a more promising area of research for proponents of the argument from simplicity is given by the perceptual capacities of infants and children. The idea is that reasonably unsophisticated creatures with simple perceptual systems should be able to represent only simple properties. While adult visual systems may become complex with development, those of infants and children should produce representations with much simpler contents. In other words, if the argument from simplicity worked, we should expect children and infants to be able to visually represent primarily colors. Their simple and unadulterated perceptual system should be incapable of providing information about more complex entities. But the available evidence suggests that children and infants perceive the world in terms of rigid and persisting objects, rather than just in terms of their sensory properties. What kind of evidence is this? It is evidence concerning conceptual development and its different stages.

In the preliminaries, I pointed out that perception is one important way in which humans acquire concepts.[13] If simple perceptual systems can only represent sensory properties, we should expect infants and children to have concepts of sensory properties comparatively early in development. In other words, if the perceptual experience of infants and children carried information primarily about sensory properties, we should expect them to have the corresponding concepts early. More importantly, we should expect them to have sensory concepts before they have concepts of more complex entities like three-dimensional objects. The idea, common in empiricist circles, is that concepts of sensory properties, acquired from experience, are combined to produce concepts of more complex entities later in development. Children first learn what colors and sizes are from experience, and they then build the rest of their conceptual repertoire out of them. But the empirical evidence strongly suggests that conceptual development follows exactly the opposite timeline: concepts of objects are acquired earlier than concepts of sensory properties (Sabo, 2008).

For a long time, developmental psychologists such as Piaget (1954) thought that the world of infants and children was very different from the world of adults. While adults conceive of the world in terms of objects belonging to well defined categories infants and children lack the concept of an object. But a more recent and robust body of evidence strongly suggests that, contrary to what Piaget thought, children and infants possess the concept of an object surprisingly early, while they possess the concept of sensory properties like color, only relatively late.

Children first learn, at 12 months of age, names for objects; they learn color words only at 48 months of age, three years later (Bloom, 2000). Moreover, children exhibit what Bloom calls an "object-bias": they tend to assume that words name objects rather than their properties. For example, they may use the word 'hot' to refer to the whole kitchen stove. If we suppose that language acquisition and use roughly reflect what concepts children possess, we can take the evidence to suggest that children have a concept of object before they have a concept of color.

We obtain a similar result if we focus on research on very young infants (Baillargeon, 1993; Spelke, 1990). Infants at four months old expect objects to be solid, and to retain their spatio-temporal location when occluded. They are reliably surprised by the appearance of an object going through another object, or by the appearance of an object changing location without traveling some continuous path. By contrast, children expect objects to retain properties like color and size only later, past 13 months of age (Xu & Carey, 1996; Xu, Carey, & Quint, 2004).

Studies that test the capacity to use visual information to re-orient confirm this result. When disoriented in a novel environment adults are able to use both spatio-temporal information and information about color to re-orient themselves. For instance, if you are disoriented in a room you will be able to use both geometric information (the length of the facing wall) and color information (the color of the facing wall) to re-orient yourself. But some evidence suggests that this is only a late development in humans (Hermer & Spelke, 1994, 1996). Children (18 to 24 months) do not re-orient by using color cues: in this respect children are strikingly similar to rats whose color vision is famously deficient.

This body of evidence indicates that infants and children have concepts of sensory properties like color only relatively late; by contrast they have concepts of objects surprisingly early. Since it is plausible to suppose that they acquired such concepts from experience, it is also plausible to suppose that their perceptual experiences represent objects to them. On the other hand, we may wonder whether their experiences represent sensory properties: one explanation for why they lack the corresponding concepts is that they don't have the relevant experiences. And while there may be alternative explanations for this fact, this is at least a plausible contender. Young children are, in fact, also unable to sort objects according to color: they initially sort objects according to other parameters (Vygotsky, 1962).

If this is true, then as a matter of fact, relatively simple perceptual systems are able to represent seemingly complex entities, like objects, and they may not represent fairly simple entities, like colors. So, the argument from simplicity does not succeed. As the evidence indicates, visual perception represents complex entities even if it is a relatively simple process. But then, again, we have no good reason to hold SV. Our embedded visual system produces representations of specific rigid and three-dimensional objects even if it is a simple system. So, we can be confident that visual experience represents objects. Sensory properties, e.g., the objects' colors, may also be represented, but there is no reason to just assume that they are. And there is no reason to be more confident about sensory properties being represented than about the objects to which they inhere being represented.

5. The Lack of Justification for SV

In section 4, I presented and rejected three main arguments that seem to militate in favor of the Sensation View. In this short section, I want to summarize the positive reasons that we now have for thinking that SV is largely unjustified.

The Sensation View consists in the simple claim that sensory properties are represented in perceptual experience. Given the widespread acceptance of SV, one would expect to see overwhelming reasons for supposing that SV is true. In section 4.1, I suggested that simple introspective observation cannot help establish SV because of its incapacity to distinguish the content of perception from the content of other mental states. The lack of justification for SV is further disclosed by thinking of vision as non-inferential and non-computational: if the representation of objects is obtained directly from retinal stimulation, then objects are what is surely represented in perceptual experience. The representation of objects does not require prior representation of their sensory properties, in particular of their color: such properties may also be represented, but we do not yet have reasons to suppose that they are.

Evidence in developmental psychology further supports this result. The evidence indicates, on the one hand, that simple perceptual systems, like embedded systems, can (and do) represent seemingly complex entities; and, on the other, it raises some questions concerning whether they represent simpler entities, such as colors. This is because infants and children have concepts of objects very early in development, before they have concepts of sensory properties. Since they plausibly acquired such concepts from experience, we can suppose that their perceptual experiences represent objects to them. By contrast, we can wonder whether their experiences represent color: one explanation for why they lack the corresponding concepts is that they lack the relevant experiences. So, we can again be confident that objects are what is represented in human perception. At the same time, we lack justification for SV. We still need reasons to suppose that visual experience represents colors.

The reader may be unsatisfied with my way of proceeding because I have only considered a small and partial number of arguments that allegedly support SV.

This is true: I have only looked at those arguments that I think play a role, more or less explicitly, in making SV seem obvious in contemporary philosophy of perception. There may be other arguments that establish SV, that I have not discussed. If there are any such arguments, they are surely welcome. One of the upshots of this paper is to motivate the reader to search for reasons for holding SV. If we can preserve our pre-theoretical intuition that visual perception represents colors, then we should do so: but we need this to be a well-argued claim rather than a *mere* intuition.

Notice also that the evidence I have adduced doesn't just serve to show that a specific argument against SV is unsuccessful. It also directly questions the truth of SV. A viable explanation for why young children lack color concepts is that they do not visually experience colors. And there is evidence concerning adult visual perception that raises similar doubts. Studies testing change blindness (Simons, Franconeri, & Reimer, 2000) show that people are very bad at detecting color changes, much worse than they are at detecting other kinds of changes. Observers asked to search for differences in a gradually transforming photograph of a natural scene are able to detect changes in color only 31% of the time, while they perform above average when the changes involve whole objects. This result raises questions as to whether the scenes' colors are represented at all to begin with. Given the overwhelming inability to notice a difference in color, even when searching for it, we may wonder whether observers ever represent the color of objects in the scene. If this is true, then we have little reason to believe, and some reason to doubt, that colors are represented in visual experience. Derivatively, the Sensation View is largely unjustified: sensory properties may be represented in perceptual experience, but we shouldn't just assume that they are, and we have little reason to believe that they are.

6. Conclusion

In this paper, I argued that SV is largely unwarranted. Sensory properties may be represented in perceptual experience, but like in the case of other entities, we need arguments to suppose that they are. I made this claim by showing that several argumentative strategies that favor SV do not work. I further defended an embedded understanding of visual processing, and claimed that there is little correlation between the simplicity of the embedded system, and what it is capable of representing. Empirical evidence in developmental and cognitive psychology confirms this result, and raises doubts concerning the truth of SV. If my argument is successful, then we shouldn't just assume that sensory properties are represented in perceptual experience, and we should be better inclined to agree that experience has a fairly rich content.

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Notes

[1] There is considerable debate concerning what to include as part of the visual system. I am sympathetic to the view that the visual system includes a moving head and body (Noë, 2004; Wilson, 2004). But, for present purposes, we can assume the less controversial picture of the system as including only the eye with its retina and optic nerve, and the visual cortex. I don't think that the main argument in this paper turns on this relatively narrow conception of what the visual system includes.

[2] I think that these two conditions on representation are in line with how the notion is used in cognitive science. To just give a couple of examples, William James remarks that we impute mentality to beings only when what they do is explained by their "idea" of what the conditions are, rather than by the conditions themselves (James, 1892/1950, chapter 1). A similar approach is found in the more contemporary work of Rodney Brooks. Brooks remarks that there is no need to talk of representation when "to a large extent the state of the world determines the action of the creature" (1991, p. 150).

[3] J.J. Gibson (1979) is sometimes interpreted as denying that perception is representational, but contemporary Gibsonians, like Alva Noë (2004) do not follow Gibson on this point.

[4] I take this to be part of the debate concerning the distinction between observation and theory in philosophy of science. Those who argue against the distinction (Churchland, 1989) maintain that any representation obtained from sensory states is informed by one's conceptual repertoire, and is, therefore, theory-laden. Defenders of the distinction, on the other hand, argue that perceptual processing is insulated from the influence of one's conception of the world, and the representations that it produces are thus genuinely perceptual, or theory-neutral (Fodor, 1984, 1988).

[5] See my *Seeing in practice: Putting vision in its place* (unpublished manuscript), available upon request.

[6] I am open to the idea of there being a sense of "computation" under which the embedded perceptual systems I describe count as performing computations. See Wilson (2004) and Haugeland (1998) for arguments in favor of extending the notion of computation beyond what traditional digital computers do. At the very least, embedded perceptual systems are computational in the sense that they can be *described* as performing computations, even if they do not literally do so.

[7] I am indebted for this idea to, among others, Zenon Pylyshyn (1999) and Robert Wilson (2004). Pylyshyn talks about the visual system embodying the assumptions rather than representing them; Wilson talks about exploiting the assumptions or using exploitative representations of them. I prefer the jargon of relying on regularities in order to make clear that the assumptions are not encoded anywhere in the visual system. See also Sabo (2006) for a similar model of our mechanism of concept acquisition.

[8] This reflects a distinction between explanatory reasons and justificatory reasons that is spelled out by Fred Dretske (2006). Explanatory reasons are facts that explain, or help explain, why something happens: they are the reasons *why* something happens. Justificatory reasons, on the other hand, are given by the way in which facts are represented to be: they are reasons *for* something to happen. Justificatory reasons are also explanatory, but they explain by making reference to the way things are represented to be. In the fire alarm case, the fact that smoke particles deflect the direction of light is one of the explanatory, not justificatory, reasons for what the alarm does, because the fire alarm does not represent that fact.

[9] I leave it open whether the visual system is not only embedded in the environment, but it also forms a coupled system with the environment, and can be said to extend beyond the skin's boundaries (Clark, 1997; Wilson, 2004). There is considerable debate concerning the plausibility of the extend view (Adams & Aizawa, 2008; Rupert, 2004) and I do not have space to approach the debate here.

[10] Questions arise concerning the similarities between sense data and the sensory states posited by contemporary vision scientists. The latter are typically taken to be representational states, and thus states that can misrepresent. Perception can go wrong both in representing an apple when there is no apple and in representing something red when there is nothing red. By contrast, the perception of sense data was typically assumed to be not only direct but also infallible. One couldn't be wrong about the sensory appearance of an object: one could only be wrong about the presence of the object. In other words, one could be wrong about the presence of an apple, but one could not be wrong about the presence of something red (the sense datum). This and the introspective accessibility of sense data are two important differences between traditional sense data theory and contemporary inferential accounts of visual processing.

[11] Defenders of inferential/computational accounts sometimes appeal to perceptual shifts rather than misperception in order to defend their view (Churchland, 1989; Rock, 1983). Inferential accounts are said to be better able to explain how we can have different experiences of the same figure, like when we shift from seeing a duck to seeing a rabbit in the famous duck-rabbit figure. In such cases, the visual system seems to interpret the same visual stimulation in different ways suggesting the presence of an inference. Elsewhere, I provide an embedded account of perceptual shifts, and explain how the embedded visual system can produce different experiences without performing inferences. See my *Embedded seeing-as: Multi-stable perception without interpretation* (unpublished manuscript) and *Searching for the duck: A situated account of aspect shifts* (unpublished manuscript), available upon request.

[12] This is part of the reason why David Marr (1982) thought that vision proper ended with the representation of shapes rather than with the representation of meaningful objects. Obtaining a representation of objects, according to Marr, requires matching the visual percept with stored, and more complex, representations.

[13] There are certainly other ways of acquiring concepts. One can acquire the concept of a unicorn, for example, without ever perceptually encountering one. But it is undeniable that perceptual experience is one important way in which we get our concepts, and this is all that I am assuming in this paper.

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