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Vision and abstraction: an empirical refutation of Nico Orlandi's non-cognitivism

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ABSTRACT

This article argues against the non-cognitivist theory of vision that has been formulated in the work of Nico Orlandi. It shows that, if we understand 'representation' in the way Orlandi recommends, then the visual system's response to abstract regularities must involve the formation of representations. Recent experiments show that those representations must be used by the visual system in the production of visual experiences. Their effects cannot be explained by taking them to be non-visual effects involving attention or memory. This contradicts Orlandi's version of the non-cognitivist hypothesis, but does so while vindicating her methodological position.

KEYWORDS

Compatibilism; determinism; experimental philosophy; fatalism; free will; moral responsibility

1. Introduction

Nico Orlandi (2014) has recently argued that "vision is not a cognitive process." By this she means that "visual perception does not employ representational resources to produce visual percepts" (2014, p. 94).

Orlandi is not the only theorist to have denied that vision is a process in which representations are employed. Such denials can also be found in Chemero (2000), Degenaar and Myin (2014), and O'Regan (1992). These denials are sometimes motivated by arguments of a more or less a priori sort, suggesting that vision could not possibly employ representations, since the claim that it *does* would depend on a notion of representation that turns out to be irresolvably problematic (Hutto & Myin, 2014). The motivation for Orlandi's representation-denial has a different character. Her denial is intended as an empirical claim supported by an inference to the best explanation. She tell us that her

main argument is *not* that inferential and cognitive accounts are implausible or incoherent. ... The claim is rather that cognitive and inferential accounts are empirical hypotheses and, as such, they can be replaced by more plausible empirical hypotheses. (Orlandi, 2014, p. 33)

Because it is an inference to the best explanation, Orlandi's argument depends on the premise that our theories of vision are not able to give *better* explanations when they are allowed to postulate the use of "representational resources to produce visual percepts." Much of her book can be understood as an attempt to substantiate this premise. Our intention in the present article is to refute it.

That might sound like an unconstructively negative agenda, but the pursuit of it will enable us to see some points that Orlandi herself ought to welcome, given her commitment to the construal of this issue as an empirical one. She writes that

part of what I would like to achieve in this book is some sense of how to test competing empirical hypotheses in vision. We need some shared sense of how to test ... that a state is representational. (Orlandi, 2014, p. 141)

The point that we shall be arguing for below is that, by understanding these matters in the way that Orlandi recommends, we can indeed “test competing empirical hypotheses in vision,” just as she hopes. But the result of such tests is to show that Orlandi’s own preferred hypothesis is mistaken.

2. Understanding Orlandi’s Hypothesis

Orlandi’s hypothesis is not intended to contradict the claim that information about the content of past experiences can exert an influence on what is presently being visually perceived. Her point is that the exerting of such an influence does not require the information in question to be *represented*.

This is plausible only because Orlandi means something quite specific by ‘representation’. In order to qualify as being a *representation* of some information, in Orlandi’s sense, it is not sufficient to be a causally explanatory state in which that information is stored. Such a notion of representation would be, she argues, “overly liberal” (Orlandi, 2014, p. 103). Her argument for this (with which we are not disagreeing) is that all sorts of processes use representations in this liberal sense. The use of such representations therefore cannot serve as a basis for the drawing of any philosophically interesting distinction between cognitive processes and non-cognitive ones. For those purposes, a more demanding notion of representation is needed, as outlined in the third chapter of Orlandi’s (2014) book.

In that chapter Orlandi gives her account of something that *is* sufficient for a causally-efficacious information-bearer to qualify as a psychologically-interesting representation. The account that she gives depends on the idea that representation is essentially involved in certain sorts of psychological *abstraction* (Orlandi, 2014, p. 131). We shall consider the details of this account below (section 4). The account is motivated by some very fundamental considerations concerning the question of what it is for a phenomenon to be psychological. “Psychology,” Orlandi tells us

is concerned with explaining behavior that does not reduce to the moving of limbs. Such behavior ... is often a response to what the individual takes to be constant despite the continuously changing proximal conditions.

My proposal is that this *taking* constitutes an early representational capacity. It is a capacity that involves abstraction. Achieving stability and constancy in perception are ways in which this abstraction takes place. (2014, p. 130)

If we adopt this proposal about the nature of representation then, in order to block Orlandi’s inference to the best explanation (by showing that representation-postulating explanations of vision are, in fact, the best ones), we will need to show that there are visual phenomena the explanation of which requires the visual system to be operating with states that store information in a form that abstracts away from “continuously changing proximal conditions,” so as to achieve “stability and constancy.” In order to show that the visual system does indeed operate with such states, we shall consider some recent experimental work that examines our visual response to the presence of abstract regularities. We describe that work in the section that follows (section 3) before explaining why the results of it are problematic for Orlandi’s position (sections 4–5).

3. The Visual Impact of Abstract Regularities

Research over the last 15 years has shown that the visual system can automatically and effortlessly extract information about regularities in its environment, even without there being any conscious awareness of those regularities (Fiser & Aslin, 2001; Turk-Browne, Jungé, & Scholl, 2005; Zhao, Al-Aidroos, & Turk-Browne, 2013). In a recent contribution to this research, Jiaying Zhao and colleagues have shown that a person’s visually based judgments can be biased by the presence of abstract regularities in the scenes recently observed by that person. To understand the significance of this, it will be necessary to consider some of the details of these experiments.

In all of the relevant studies, undergraduate participants were presented with a sequence of visual stimuli via a desktop computer. In the experiment that we shall be most concerned with here (Zhao, Cakal, & Yu, 2015, experiment 2), these stimuli were arrays of brightly colored disks. Between three and ten disks were presented in each array. They were distributed across the spaces of a four-by-four grid, the gridlines of which were not visible. Two examples can be seen in Figure 1.

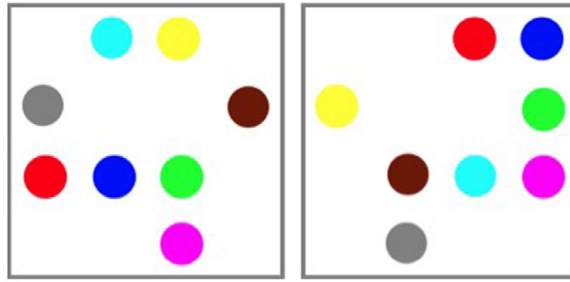


Figure 1. Arrays such as these were presented for 1000 ms and followed by a 1000 ms inter-stimulus interval. To view this figure in colour, please see the online version of this article.

Each participant was presented with 400 such arrays, each of which was presented for one second, followed by a one second interval during which no stimulus was presented. Each of the disks in these arrays was one of ten distinct colors. In 80% of the arrays each disk was a distinct color. In the remaining 20%, there were two disks of a matching color, presented in adjacent locations. Participants were given the task of pressing a button whenever these color duplications occurred. This task was used merely in order to ensure that the participants remained focused on the stimuli. The participants performed it well, suggesting that they did indeed remain focused.

Half of the 56 participants in this experiment were assigned to a “structured condition.” For these participants the distribution of the disks’ colors followed a strict pairing-rule. The rule dictated that red and blue disks only ever appeared together, with a red disk always being immediately to the left of a blue one; that the green and pink disks only ever appeared together, with a green disk always being immediately above a pink one; that yellow and brown disks only ever appeared together, with a yellow disk always being above and to the left of a brown one; and, finally, that cyan and grey disks only ever appeared together, with a cyan disk always being above and to the right of a grey one. So long as all of these constraints were met, each of the pairs could be shown in any part of the four-by-four grid. Two of the arrays satisfying these constraints are shown in Figure 1.

The remaining half of the participants were assigned to an unstructured condition in which there was no such rule determining the pairwise patterning of colors. For those participants the second member of each pair had no consistent coloring imposed upon it. Although the red disks that were shown to these participants only ever appeared as the leftmost member of some pair, those disks could appear to the left of any one of the remaining colors. The same held for each of the other color pairs.

Each pair of disks was presented in a location that was adjacent to some of the other disks in its array in both the structured and the unstructured conditions. This ensured that the paired disks were never spatially segmented from the other parts of the array in which they were presented. None of the participants were told about the existence of any rules determining the way in which the arrays were constructed.

Having been presented with a full 400-item sequence of these disk arrays lasting for 15 minutes, the participants were then allowed to take a rest period for as long as they wished. The average length of this rest period was around two minutes. The participants were then asked to make one further visual judgment about the location of a single disk. This disk was flashed on the screen for 100 ms. It was followed by a three-second pause, after which the participants pointed out where the disk had appeared using a normal mouse-pointer on the screen.

The crucial finding from this experiment is that, for those participants who had been exposed to the paired colors of the structured condition (rather than to the random colors of the unstructured one), there was a tendency to locate this last solitary disk as having appeared at a location that was closer in space to the partner with which it had previously been paired.

The significance of this can be made clearer by considering the example of the red-blue pair. Those participants who had been assigned to the structured condition had only ever been shown a red disk

in the context of an array in which it had a blue disk to its right. They showed no awareness of this pattern, but, when they were briefly presented with a solitary red disk and were asked (after a three second pause) to locate the thing that they had just seen, they selected a location that was further to the right (towards the location where a blue disk would previously have been) than the location chosen by those participants for whom the red disks had been paired with disks of random color. The size of this difference in location was small, but some such difference was reliably observed for every color pair in the experiment. For instance, participants who had previously seen the green disk reliably appearing on top of the pink disk showed a tendency to locate a solitary green disk as being lower than those who had seen green disks in pairs where no coloring-rule was imposed; participants who had previously seen the yellow disk reliably appearing to above and to the right of the brown disk showed a tendency to locate a solitary yellow disk as further below and to the left than those who had seen yellow disks in pairs where no coloring-rule was imposed.

The observed influence of color-patterning on localization-responses indicates that, in the 15-minute exposure phase of these experiments, some information comes to be encoded concerning the regularity that governs the distribution of the colored disks. It is our contention that the best explanation of this phenomenon requires that one deny Orlandi's claim that the visual system uses no representations. In the section that follows we show that this encoding of information counts as the formation of a *representation*, according to the criteria of "representation" that Orlandi specifies. We then argue that the visual system must be using this representation in a way that makes a behaviorally-relevant contribution to the experience produced by the subsequently flashed disk (section 5). If the visual system uses such representations, then it *does* qualify as a cognitive process, contrary to what Orlandi has suggested.

4. Abstraction

It is crucial to our argument that the information that comes to be used by the visual system, following an encounter with the structured stimuli, includes *abstract* information. It is only because this information is abstract that the visual system's storage and use of it requires the formation of a *representation* in Orlandi's sense of 'representation.'

In explicating the relevant notion of abstractness, Orlandi suggests two criteria that together determine whether information is sufficiently abstract for its storage to be representation-requiring. The first criterion is that the information must pertain to something that is "absent" (Orlandi, 2014, pp. 122–128). The second is that the information must pertain to something that is "distal" (Orlandi, 2014, pp. 128–134).

Orlandi's criterion of absence is said to be met when the thing represented "is not impinging, or ... is only partially impinging on the sensory apparatus" (2014, p. 125). Information encoding the fact that the red disks in our experiment have always had a blue neighbor clearly satisfies this criterion. By the time that information affects behavior, several minutes have passed since any blue disk last impinged on the sensory apparatus of the experimental participants. Information pertaining to those disks therefore pertains to something that is absent, in the sense that Orlandi specifies.

Orlandi's criterion of distalness is somewhat more complex. At an early stage of Orlandi's discussion, we are told that

distal properties are properties of objects and events that remain constant despite variation in viewing conditions. A state that stands for them is a state that is removed from its proximal causes. (2014, p. 31)

There are two points in this quotation: one about constancy, and one about removal from proximal causes. Orlandi's point about removal from proximal causes can be addressed in the same way that we addressed the criterion of absence. Participants in our experiment's structured condition eventually represent a pattern instantiated by a sequence of stimuli that were observed prior to the taking of a two-minute break. Any state that encodes information about such a pattern must therefore be "removed from its proximal causes," since those causes are already a couple of minutes in the past. Their immediate influence on the nervous system would have long-since dissipated by the time the information pertaining to them makes its presence felt.

This leaves us needing to address Orlandi's other criterion of distalness: that distal properties "remain constant despite variation in viewing conditions," and hence require the achievement of "stability and constancy" if they are to be encoded (2014, pp. 31, 130). Orlandi explains this criterion in a later part of her discussion:

When we see a line drawn on paper we also see something *distal*, because we see something constant and stable that preserves its appearance through changes in retinal projection. (2014, p. 134)

When we see the color of a disk that is shown for a full second, in normal viewing conditions, we see something that is distal in the sense that this quotation indicates: we see a disk that is "constant and stable" and that "preserves its appearance through changes in retinal projection," such as might come about because of head or eye movement when our participants are looking to see whether the array contains any duplicated colors. A state encoding information about the disks in our experiment does therefore represent something distal in Orlandi's sense.

The defender of Orlandi's position might nonetheless try to claim that the information that comes to be stored is only information about those disks' *proximal* properties and not about their distal ones. The proximal properties of a stimulus are said to be

properties of the stimulus that tend to change continuously as viewing conditions change. Light intensity is a paradigmatic example of a proximal property. It is a property that tends to figure in the laws of the physical sciences, and it is a property that is in continuous flux when it hits the sensory organs. (Orlandi, 2014, p. 129)

It is here that our argument depends crucially on the fact that the responses of the participants in our experiment are modulated by information pertaining to a pattern in the *relative positions* of the disks' colors, so that the red disks in our experiment are always seen to the left of blue ones, wherever in the grid they are presented. The disks are seen to have this relative position in various parts of the screen, in conditions which, over the course of 15 minutes, would produce various retinal projections. The property of having been accompanied by a blue neighbor cannot, like light intensity, be "in continuous flux when it hits the sensory organs." There are no "laws of the physical sciences" that apply to items on account of their having been consistently accompanied by a blue neighbor. The property that comes to be encoded cannot be a proximal property in Orlandi's sense. The state that encodes information about such a property does therefore qualify as a representation by Orlandi's criteria of distalness.

5. Are the Effects of Regularity Visual?

When taken by themselves, the results that we have been considering above are open to more than one interpretation. The interpretation that we favor takes them to be the consequence of the participants' having an experience of absence (not in Orlandi's sense of 'absence', but in the more familiar sense, in which we would say that a person who was hearing the silence in a room was experiencing the absence of sound from it).

At any time there are, of course, a great many things that are absent from one's perceived environment. Most of these absences are perceptually unregistered. But it is a familiar fact that not all of them are. When some ongoing but ignored background hum is suddenly stopped, one can sometimes have an experience in which the *absence* of that hum becomes perceptually salient. In such a case—and also in certain visual cases that have been more systematically studied in laboratory conditions (Mitroff & Scholl, 2003)—the absence of a thing can be a part of the content represented in an experience (Farennikova, 2013; Sorensen, 2009). We conjecture that such an experience of absence may be involved in creating the effect that the above experiment demonstrates.

Our conjecture, more specifically, is that after having seen a series of stimuli in which red disks always occur to the left of blue ones, those participants who are then presented with a solitary red disk can sometimes experience that disk as appearing *without a blue disk beside it*. They can experience the red disk and also experience the absence of its now usual mate. The result of this is that when these participants are asked, after a three second pause, to click on the location of the thing that they

have just very briefly experienced, their responses take account of the experienced-as-absent mate as well as the experienced-as-present disk. The experience of these participants contrasts with the experience of those participants who were presented with unstructured stimuli. Those participants do not perceptually register the absence of anything in particular, and so respond on the basis of having experienced the present disk alone.

The outcome of this experiment does not require this particular interpretation. It could equally well be accounted for if we were to suppose that the experience of structured stimuli induces some sort of visual illusion in which subsequent disks appear to be displaced from their actual locations. Other explanations are also possible. There are (as in any psychological task) several different factors that together determine a person's performance in the task of visually guiding a mouse-pointer to the place where a disk has been flashed three seconds earlier. Any of these factors might be implicated in the effect that we have observed.

Some of the factors that are implicated involve attention and memory. These might be thought to create a problem for our argument. Orlandi is committed only to denying that visual perception *uses* representations. She does not deny that visual perception *produces* representations as its outputs, nor that such representations can then play a role in influencing attention and memory. If one could plausibly maintain that the processes of attention and memory that are at work in this context are not themselves visual processes, one might then maintain that the results described above are consistent with Orlandi's hypothesis.

The difficulty facing this defense of Orlandi's hypothesis is not in maintaining that attention and memory play a role in bringing about the effects that we have described. It is in maintaining that whatever contribution is made by attention and memory to those effects, such a contribution does not itself qualify as a case in which visual perception uses representations in producing a percept. To see that this latter claim cannot plausibly be maintained—and so to see that the effect observed by Zhao and colleagues does provide a counterexample to Orlandi's hypothesis, even if it is understood to be attention or memory involving—it will be useful to consider the cases of memory and attention separately. We first consider the case of attention.

5.1. Attention

The current orthodoxy among philosophers and psychologists is that visual attention is the result of an “integrated competition” taking place between the several different representations that are generated in the course of normal visual processing (see Ruff, 2011; Wu, 2014, section 2.4). Rather than being implemented by an attention-specific set of neural processes, this competition takes place during visual processing itself, “in the several extrastriate regions coding different properties of the visual input” (Duncan, 1998, p. 1308). It even takes place during some of visual processing's earliest stages (O'Connor, Fukui, Pinsk, & Kastner, 2002). Since the competition-based theory of attention implies that visual attention is guided by the outcome of a competition that takes place during visual processing itself, it entails that it would be a mistake to suppose that the representations used in guiding visual attention are not, *ipso facto*, used in the production of visual percepts.

There might nonetheless be some cases in which the representations that guide our attention can be thought of as being representations that perception is not itself using. These would be cases in which attention is serving merely to orient the perceiver's processing resources, and not to influence the way in which those resources operate. Attention does sometimes behave in this way, but there is a considerable body of research that enables us to rule out the idea that it is attention of this sort that explains such results as we have been considering. The crucial point here is just that the timescale at which the orienting of attention operates is known to be very much shorter than the timescales that are involved in the experiment that we have been considering. The subjects in that experiment are shown a sequence of stimuli that lasts for 15 minutes. They have a rest period of a couple of minutes' duration, after which they are shown a stimulus and, three seconds later, asked to indicate its location. All of

these intervals are orders of magnitude greater than the tens or hundreds of milliseconds over which the effects of attention-based orientation have been found to operate (see, for example, Carrasco, Ling, & Read, 2004; Cavanagh, 1992; Luck & Ford, 1998). If there is attention at work over these intervals, it is not the sort of merely orienting attention that is disjoint from the visual processes themselves. The defender of Orlandi's hypothesis therefore cannot claim that the effect we have observed is merely attentional and not visual.

Nor can it be claimed that that effect is an effect of entirely dorsal stream processing, influencing the visual-guidance of action without making any difference to the formation of a visual *percept*. Moving a mouse-pointer to the location of a disk that has been seen three seconds previously is not the sort of action that can be guided by a perception-independent dorsal process (Milner & Goodale, 2006, section 6.5). It is the sort of action that needs to be based on a visual perception.

5.2. Memory

The long time scales of Zhao and colleagues' experiment might seem to open the door to a memory-based explanation of the effects that they observe, and this, again, might be taken to remove the problem for Orlandi by allowing those effects to be regarded as non-visual.

It is certainly true that memory must play a role in the production of the effects that we have been discussing. Information about the pattern in Zhao and colleagues' stimuli must be retained in some sort of memory during the rest period between the presentation of stimuli and the eventual performance of the localization task. That information must then exert its influence at the time when the participants' localization judgments are made. If the information influences those judgments because it has made a difference to the visual experience of the participants, then it *is* being used in the formation of a visual percept. The case then continues to be a counterexample to Orlandi's hypothesis. But if the information exerts its influence on the localization judgment in some other way—perhaps by biasing the response-selection process, or perhaps by interfering with the storage of information during the three seconds pause between observing the solitary disk and indicating its location—then Orlandi's hypothesis can be maintained, since that hypothesis denies only that vision itself makes use of represented information when producing visual percepts.

We do not hesitate to acknowledge that there are non-visual mechanisms that make some contribution to the effect we have observed. We do deny (and all that our argument needs us to deny) is that the mechanisms operating here are *exclusively* non-visual ones. This can be ruled out by an inference to the best explanation of our results when these are considered alongside the results of others.

One line of evidence suggesting that the influences of implicitly stored information must include visual influences comes from an experiment that was conducted by Peter Kok and his collaborators (Kok et al., 2013). The 24 participants in this experiment had to judge the predominant direction of movement in a visual array containing a number of randomly moving dots. The participants were presented with several such arrays grouped into 12 blocks of forty. Each array was preceded three-quarters of a second before it began by an auditory cue. The participants were not told (and in all but two cases they did not guess) that the pitch of this auditory cue carried information about the direction in which the dots would be moving. The participants nonetheless seemed to have formed an implicit representation of this fact, since they judged the dots to have been moving in a more rightward direction in those trials where this was what the auditory cue indicated (Kok et al., 2013, p. 16279). This experiment was intended to examine whether the expectations that are created by such a cue are "able to change the contents of the *sensory* representation" (Kok et al., 2013, p. 16275). The results suggest that they are.

Like the effect that was observed in the experiment we have been discussing above, the effect that was observed by Kok et al. creates a *prima facie* problem for Orlandi's non-cognitivist hypothesis. The challenge arises, in both cases, because the performance of a visual task is influenced by information that has come to be represented following exposure to a structured set of stimuli. The defender of Orlandi's hypothesis might protest that because the information in the Kok et al. experiment concerns a simple auditory tone, such information is not distal. The state encoding such information would

then not qualify as a representation in Orlandi's sense. This would prevent us from arguing against Orlandi's hypothesis on the basis of the Kok et al. experiment taken by itself. But our argument is instead based on what the Kok et al. experiment tells us about the likely explanation of the effect that we considered in the first part of this paper. The point that we want to take from Kok is just that the effect of implicitly abstracted information can include a *visual* effect.

Kok et al. provide evidence that implicitly abstracted information can have a visual effect. Their fMRI data show that stochastic information contained in the auditory cue impacts information processing that takes place in the early parts of the visual cortex. Their analysis of the patterns of activation that were observed in V1, V2, V3, V3A, and MT+ show that these early visual areas together carry information about the direction of motion that is indicated by their auditory cue. Kok et al. showed this by using a forward-modeling technique to analyze the patterns of activation across several voxels of the MRI image in a way that enabled them to reconstruct the direction in which their participants judged the dots to be moving. Their modeling technique was best able to reconstruct the judged direction when its reconstruction was based on data from all of these visual areas taken together, but when each area's data were considered alone, the reconstructions based on data from the *earlier* visual regions (V1, V2, and V3) were *more* accurate than those based on data from later regions (V4, V3A, and MT+) (see Kok et al., 2013, Figure 5A). Kok et al. take this to indicate that the "integration of prior information and sensory input is reflected already at the earliest stages of sensory processing" (2013, p. 16276).

If information that has been abstracted from *audition* can contribute to the processing taking place in visual cortex, as Kok et al. show, then it seems very likely that information that has been abstracted from *vision* can make a similar contribution. The evidence that we have reviewed above indicates that such information can influence the performance of visual tasks. It therefore seems likely that it does so while influencing the representation of information in the visual cortex. We suggest that the best explanation for this is that such information contributes to the visual processing by which our visual experience is generated. If that is correct, then Orlandi is wrong to claim that vision uses no representations.

6. Conclusion

Inference to the best explanation has respectable epistemic credentials only if the theories that it favors give us the best explanation for all of the relevant explananda. For a theory of vision, the range of relevant explananda is enormous. There is no chance that its growth will stop anytime soon.

Philosophical theories that are supported by inference to the best explanation can therefore have only a provisional status. That is true of Orlandi's theory, but it is no less true of its cognitivist rival which we have been defending here. The results that we have been considering are new ones and were not available to Orlandi at the time her book was written. We have suggested that these data swing the balance of probabilities in favor of the idea that visual processes form and use representations in the course of generating our experiences. This contradicts Orlandi's own preferred theory of vision, but it does so only provisionally, and only after having adopted her conception of the way debates about this issue should be framed and addressed.

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