

Attention and Mental Primer

JACOB BECK AND KEITH A. SCHNEIDER

Abstract: Drawing on the empirical premise that attention makes objects look more intense (bigger, faster, higher in contrast), Ned Block has argued for mental paint, a phenomenal residue that cannot be reduced to what is perceived or represented. If sound, Block's argument would undermine direct realism and representationism, two widely held views about the nature of conscious perception. We argue that Block's argument fails because the empirical premise it is based upon is false. Attending to an object alters its salience, but not its perceived intensity. We also argue that salience should be equated with mental primer, a close cousin of mental paint that reintroduces difficulties for direct realism and representationism. The upshot is that direct realism and representationism are still in trouble, but not for the reason that Block thinks.

1. Introduction

Ned Block (2010) has argued that empirical studies of attention help to resolve philosophical debates about the nature of conscious perception. Drawing on experimental work from Marisa Carrasco's lab, Block first argues that attention alters the properties objects appear to have. 'Attended things look bigger, faster, more saturated and higher in contrast' (Block, 2010, p. 44).¹ Block then ingeniously leverages this empirical claim against two popular views of conscious perception—direct realism and representationism—and in support of *mental paint*, a type of phenomenal residue that cannot be reduced to what is perceived or represented.

In our assessment, Block's argument for mental paint fails because the empirical claim it is based upon is false. When properly evaluated, the balance of experimental evidence indicates that attention does *not* alter appearance in the way that Block claims. This does not mean, however, that the experimental evidence supports direct realism and representationism. On the contrary, we will argue that the evidence speaks in favour of a type of phenomenal residue that we call *mental primer*. Mental primer is like mental paint in that it is irreducible to what is perceived or represented, but it is unlike mental paint in that it does not even contingently represent anything in the world.

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Address for Correspondence: Jacob Beck, Department of Philosophy, York University, 4700 Keele Street, Toronto, Ontario, M3J 1P3, Canada.

Email: jbeck@yorku.ca

¹ Unless otherwise noted, all page references are to Block (2010).

Before we set out, a word about our approach is in order. Our critique of Block's argument will target the empirical claim that attention alters the properties objects appear to have. It is admittedly unusual for a critique of a philosophy paper to dispute an empirical claim, but we believe that the emphasis on this empirical claim is justified for the following reasons.

First, Block does not present his conclusions about direct realism, representationism and mental paint as conditional claims about what would follow if things were to turn out a certain way. Rather, he presents his conclusions as following from empirical facts: 'I will argue that *empirical facts* concerning attention point in a direction incompatible with direct realism, and then move to arguing that the same points conflict with forms of representationism' (p. 25, emphasis added). Moreover, a considerable chunk of his paper (pp. 33–41) is spent defending the claim that it really is an empirical fact that attention makes things look higher in contrast, bigger, faster, etc. So Block both defends and rests his argument on the empirical premise we will be challenging. (A caveat: at one point Block might be taken to suggest that appeals to empirical findings can be sidestepped in favour of introspection. We discuss this possibility in Section 7.)

Second, other philosophers (e.g. Stazicker, 2011; Brewer, 2013; Wu 2014; Hill 2016; Watzl, forthcoming) have, by and large, accepted Block's spin on the empirical literature even when they challenge his conclusions. As a result, discussions of the relation between attention and conscious perception have been distorted. Philosophers who want to defend direct realism and representationism go through contortions to show how those views can accommodate the 'fact' that attention makes things look bigger, faster, higher in contrast, etc. But if we're right that there is no such fact to accommodate, the contortions are unnecessary and debates about conscious perception can refocus on more central issues.

Finally, if we're right that the empirical facts are as we take them to be, direct realists and representationists are still in trouble, though for different reasons than Block supposes. The problem, we will argue, is that attention alters salience, and direct realists and representationists have no plausible account of salience. Our interpretation of the empirical facts about attention thus has a philosophical upshot beyond undermining Block's argument. It strips away the mental paint, but leaves behind a layer of mental primer.

2. Background

When you have a visual experience of a red tomato, there is something it's like for you to have that experience. Philosophers call this something-it's-like the *phenomenal character* of experience. Different experiences have different phenomenal characters. For human observers with normal vision, the phenomenal character of a visual experience of a red tomato differs from that of a green tomato. What it's like to undergo each experience differs.

What explains the difference in the phenomenal characters of different visual experiences? Block distinguishes three answers to this question:

*Direct Realism*²: Differences in phenomenal character consist of differences in the entities perceived or differences in one's relations to those entities. The phenomenal character of a visual experience of a red tomato differs from the phenomenal character of a visual experience of a green tomato because the former experience involves a red tomato and the latter experience involves a green tomato.

Representationism: Differences in phenomenal character are determined by differences in representational content—that is, differences in how experience represents the world to be. The phenomenal character of a visual experience of a red tomato differs from the phenomenal character of a visual experience of a green tomato because the former experience represents a red tomato and the latter experience represents a green tomato.

Mental Paint: Phenomenal character represents properties of stimuli, but only contingently. Thus, for humans on Earth, phenomenal red represents red (roughly: a certain surface reflectance property) and phenomenal green represents green (roughly: a different surface reflectance property). But things could have been otherwise. Phenomenal red could have represented green and phenomenal green could have represented red. Differences in phenomenal character are, therefore, determined by something mental that goes beyond what is perceived, relations to what is perceived, or what is represented. 'What the mental paint view denies is that the difference between conscious perception of red and of green is just the difference between red and green or representing red and representing green' (p. 30).

Block argues that certain empirical results from the study of attention undermine direct realism and representationism and point towards mental paint. Block is not the first to appeal to attention to challenge direct realism and representationism, but there are standard replies to these previous challenges to which Block's argument is supposed to be immune. Suppose you are looking at an ambiguous figure, such as a duck-rabbit. Shifts in your attention cause the phenomenal character of your experience to change. One moment you see a duck; the next, you see a rabbit. But what's in the world—the ambiguous figure—stays the same. Direct realists can accommodate this phenomenon by saying that you selectively attend to different aspects of the world—the property of being duck-shaped or the property of being rabbit-shaped—both of which are present in the figure. So the phenomenal character of your experience is still constituted by your relation to what's in the world, it's just that attention can alter which aspects of the world you're related to. Similarly, representationists can say that attention changes which aspects of the world you represent, but continue to maintain that phenomenal character is determined

² A reviewer suggests that 'direct realism' is an odd name for this view since representationists (and proponents of mental paint, for that matter) also maintain that the world is directly perceived. Fair enough, though here and elsewhere we follow Block's terminology for the sake of consistency.

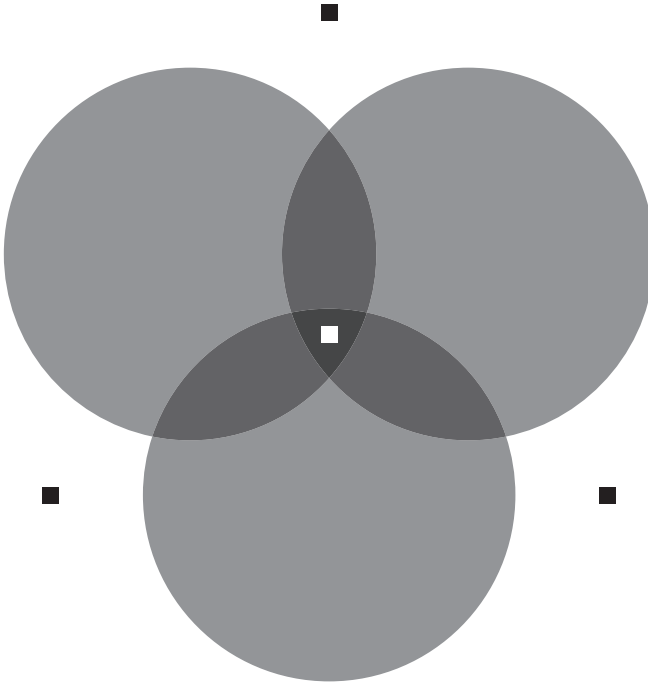


Figure 1 *The Tse Illusion* (Tse, 2005).

by representational content. Call this *the selective attention reply* to save direct realism and representationism.

Now consider the Tse illusion (Figure 1). When you fixate at the centre and attend to one of the three disks, the attended disk darkens in appearance. Attention thus changes the phenomenal character of your experience. Notice that direct realists and representationists cannot use the selective attention reply to explain this change. Since all three disks are equally dark, the change in phenomenal character cannot be a matter of selecting certain properties in the world and de-selecting others. There is, however, another reply available to direct realists and representationists: *the illusion reply*. Representationists can straightforwardly explain illusions by maintaining that perceptual experiences represent properties that are not there. In the case of the Tse illusion, attention alters the grouping properties that are attributed to the disks, which in turn leads the visual system to illusorily interpret the attended disk as darker. Direct realist accounts of illusions are more vexed. But as Block (pp. 48–9) notes, direct realists can attempt to dodge the challenge from illusions by limiting their claims about phenomenal character to *veridical* perceptual experiences.

What's unique about Block's argument is that it is supposed to close off both the selective attention reply and the illusion reply.

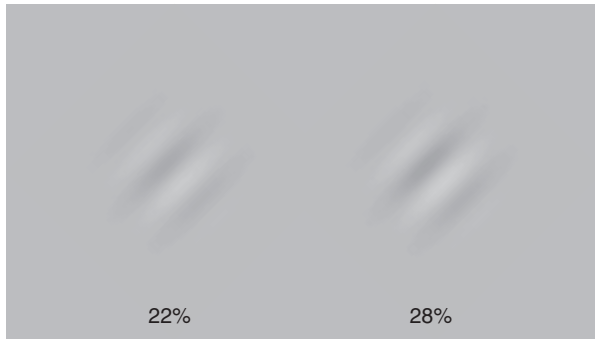


Figure 2 Gabor patches of 22% and 28% contrast, respectively.

3. Block's Argument

Block's argument draws on research by Marisa Carrasco and her colleagues. In the experiment Block focuses on, Carrasco, Ling and Read (2004) presented participants with a Gabor patch for 40 ms to either side of their fixation point (Figure 2). The participants' job was to report the orientation of whichever patch was higher in contrast.³ In some trials, a peripheral cue drew participants' attention to one side of the display just before the patches were presented. Because the cue was presented for only 67 ms and the Gabor patches were presented only 53 ms after the cue, subjects did not have time to shift their gaze towards the cued location, only their attention. Subjects thus 'covertly' attended to the cued location. Following the presentation of the patch, the subjects had 1 second to provide their reports (see Figure 3 for a summary). The main finding was that participants were more likely to report the orientation of an attended patch when its objective contrast was equal to, or even slightly lower than, that of the other patch. Following Carrasco, Block concludes that attending to a patch makes it appear to have a higher contrast. For instance, if you keep your eyes fixated on the dot in the centre of Figure 2 and attend to the Gabor patch on the left, it will, according to Block and Carrasco, appear to have the same contrast as the unattended Gabor patch on the right. An attended Gabor patch with 22% contrast appears to have the same contrast as a seen but unattended Gabor patch with 28% contrast. Using the same paradigm that Carrasco pioneered for contrast, similar results have been reported for spatial frequency and gap size (Gobell and Carrasco, 2005), motion coherence (Liu, Fuller *et al.*, 2006), colour saturation (Fuller and Carrasco, 2006), flicker rate (Montagna and Carrasco, 2006), and the speed (Turatto, Vescovi and Valsecchi, 2007) and size (Anton-Erxleben, Henrich

³ Carrasco *et al.* (2004) required subjects to report orientation rather than contrast in order to reduce potential response biases, but this complication appears to be unnecessary. Schneider and Komlos (2008) replicated Carrasco *et al.*'s results while having subjects judge contrast directly.

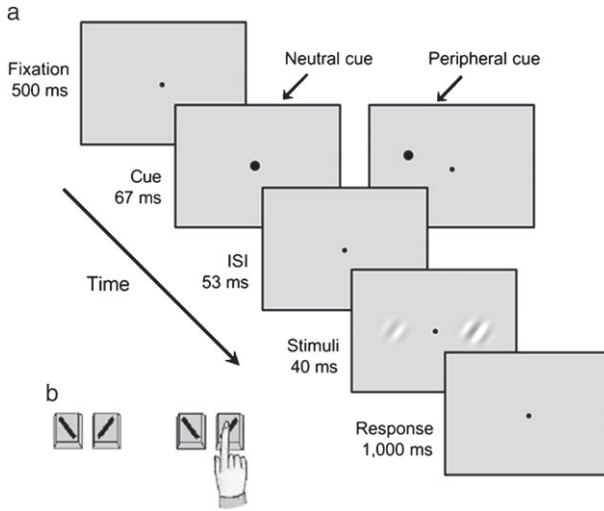


Figure 3 (a) Observers fixated on the centre dot. In some trials, a peripheral cue drew attention to the left or right of fixation. A Gabor patch was then presented to each side of fixation. (b) Observers had to judge the orientation of whichever patch was higher in contrast. (Carrasco, Ling, and Read, 2004, p. 309.) Reprinted with permission from Macmillan Publishers Ltd: *Nature Neuroscience* (copyright 2004).

and Treue, 2007) of moving patterns. Block summarizes: ‘The attended item looks bigger, faster, earlier, more saturated, stripier’ (p. 41). For reasons we will explain below, we are sceptical that these studies really support this claim, but before we examine the empirical evidence more closely we want to explain how Block uses the claim to argue for mental pain.

Call the visual experience one has when attending to a Gabor patch with 22% contrast E_A , and the visual experience one has when seeing, but not attending to, that same Gabor patch E_U . E_A and E_U have different phenomenal characters, but the perceiver bears the same objective relation to the very same Gabor patch with the very same contrast (22%). Direct realism thus appears to be in trouble. Notice, moreover, that direct realists’ two standard replies to get around objections from attention will not work in this case. We cannot say that attention changes which aspects of the Gabor patch the perceiver is directly related to since the perceiver is related to a certain contrast in both cases, and the Gabor patch only has one contrast. Nor can we endorse the illusion reply since, Block argues, it would be arbitrary to choose either E_A or E_U as non-veridical. Attention constantly fluctuates across time and space, and there is no set amount of attention that makes perception veridical. Block concludes that the direct realist is left without the resources to explain the difference in phenomenal character between E_A and E_U .

One might suppose that the representationist is in a better position since she can assign different contents to E_A and E_U in order to explain their difference in

phenomenal character. But what contents should be attributed? Do we assign a 22% contrast to E_A , rendering it veridical, or a 22% contrast to E_U , rendering it veridical? Again, Block argues that either choice would be arbitrary. The only plausible reply for the representationist, Block argues, is to assign ‘indeterminate’ contents to E_A and E_U that would render them both veridical.⁴ For example, we could treat E_A as representing a 22–34% contrast and E_U as representing a 16–28% contrast. Since the actual contrast of the Gabor patch, 22%, falls within the range of contrasts attributed by each experience, each experience would then be accurate. At the same time, since E_A and E_U each attribute different contrast ranges, the representationist can allow that their phenomenal characters differ. Block objects, however, that this reply will not do. For while it provides the representationist with different contents for E_A and E_U , those indeterminate contents are not suited to explain the phenomenal characters of E_A and E_U . As Block puts it, ‘there is no single “look” that something has if it is 22% plus or minus 6% in contrast’ (p. 52).⁵

Block actually agrees that E_A and E_U have indeterminate contents. He just rejects the representationist claim that their contents determine their phenomenal characters. Instead, Block endorses mental paint. For Block, perceptual experiences have contents and phenomenal characters, but neither determines the other.

There is one more feature of Block’s view that deserves emphasis: his denial that attention changes how things objectively appear to be.

The change invoked by changing attention does not *look like a change in the world*—at least not to me. Take a look at Figure [2], fixating at the fixation point and moving your attention around. It does not look as if anything is *really* changing in contrast (p. 53).

Prima facie, this claim is in tension with Block’s interpretation of the Carrasco studies: ‘Attended things look bigger, faster, more saturated and higher in contrast’ (p. 44). In an attempt to alleviate this tension, Block suggests that the visual system keeps track of where attention is focused, and that we can think of this tracking as reflected in perceptual experience in the form of a little voice that says, ‘attended, so adjust downward’ or ‘unattended, so adjust upward’ (p. 54). Like a car mirror that warns

⁴ Block (2010) calls the contents ‘indeterminate’ to indicate that there is no one maximally determinate contrast that they represent, not that there is no fact of the matter about what they represent. Block (2010) also calls them ‘vague’ contents, but this is more misleading since the point is that experience represents contrasts as falling within a range, not that the borders of those ranges are fuzzy (though, like most borders, they surely are). The terms ‘intervallic content’ (Block, 2015) and ‘range content’ (Boone, draft) have also been used.

⁵ Although we will not press the point here, we feel that this is a weak link in Block’s argument. Consider a person who only discovers how bad her eyesight is when she gets an eye exam. The phenomenal character of her (uncorrected) vision was indeterminate all along, but she didn’t realize it until she donned her new glasses. It seems to us that a lesser degree of indeterminacy could be an unnoticed part of the phenomenal character of everyone’s vision. Stazicker (2011) and Boone (draft) develop similar objections to Block’s argument. Block replies in Block, 2015.

that objects are closer than they appear, perceptual experience carries a warning about its own distortions.

This suggestion is perplexing. If perceptual experience includes a little voice that recommends an adjustment, why don't subjects heed that recommendation in Carrasco's experiments? Why don't they adjust downwards for an attended Gabor patch and upwards for an unattended Gabor patch? If Carrasco's instructions consistently asked subjects to focus on their *conscious experience* of the Gabor patch rather than the properties of the Gabor patch itself, this result might make sense (though it would require considerable subtlety on the part of the subjects). But as Stazicker (2011, p. 130) observes, at least some of Carrasco's experiments ask subjects to report on the properties of the Gabor patch itself. It is thus puzzling why subjects in her experiments seem to consistently ignore the little voice, if it's really there.

Block's puzzling car-mirror theory of perceptual attention plays no direct role in his arguments against direct realism and representationism, and so it may seem that he could easily abandon it. But as Block knows, the visual system typically goes to great lengths to ensure that changes with the perceiver aren't conflated with changes in the world—for example, through mechanisms of size and brightness constancy that have obvious adaptive benefits. It would thus be surprising if attention altered perceived contrast, size, speed, etc. without some compensating mechanism, since that would mean that changes in the perceiver would be conflated with changes in the world, with potential adaptive costs. For instance, if attention changed perceived velocity without tracking and discounting that change, the organism could clearly be disadvantaged. So on its own, the thesis that attention alters perceived intensity is itself rather perplexing. Block's car-mirror theory, whereby attended objects look more intense but don't *really* look more intense, is intended to make it less so.

At this point, it's helpful to contrast Block's view with an alternative that we will later defend. According to this alternative, attending to a stimulus alters its *salience*, but does not change its *objective appearance*, or the properties that it appears to have. For example, this alternative view agrees that E_A and E_U differ in phenomenal character, but it denies that this difference is manifested in perceived contrast. Attending to the Gabor patch does not make it look as though it has a higher contrast; it just makes it more visually salient. This view is arguably simpler than Block's, insofar as it does not propose that attention alters perceived contrast only to correct for that alteration with a warning that the alteration isn't real. Rather, as attention shifts, the objective appearance of a stimulus stays the same. Only its salience changes.

What is salience? We address this question later (§8). But notice that Block agrees that shifts of attention alter salience. He just insists that they *also* alter the properties that stimuli appear to have. 'The attended item looks bigger, faster, earlier, more saturated, stripier. *No doubt increased salience is a result of these changes*, but it is not a substitute' (p. 41, emphasis added). So, the difference between our view and Block's concerns attention's alleged influence on objective appearance. In the following three sections, we explain why we reject Block and Carrasco's contention that the empirical evidence speaks in favour of such an influence.

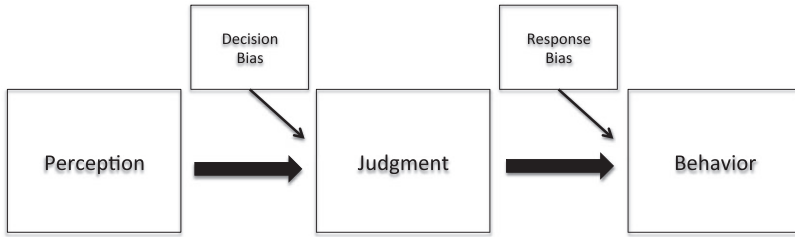


Figure 4 Behaviour in a perceptual task is mediated by judgment. Decision biases generate judgments that do not accurately reflect perceptions. Response biases generate behaviours that do not accurately reflect judgments.

4. Bias

Other people's perceptions cannot be measured directly. They must be inferred, most typically from how subjects behave. Notice, however, that the link between perception and behaviour is mediated by perceptual judgment (Figure 4). This means that there are at least two ways in which one's behaviour can fail to reflect one's perceptions.

First, the link between judgment and behaviour can be corrupted by a *response bias*. Consider the Stroop task, in which subjects are asked to quickly report the colour of the ink in which a word is written. When the colour of the ink conflicts with the word (e.g. 'green' written in red ink), subjects often report the wrong colour. It is not that subjects misperceive the colour of the word, or form incorrect judgments about the word's colour. It's just that they have a hard time inhibiting the influence that their automatic interpretation of the word's meaning has on their behavioural response. Their behavioural response thus fails to reflect their judgment about the colour of the ink they perceive.

Second, the link between perception and judgment can be compromised by a *decision bias* that prevents subjects from taking their perceptions at face value. One type of decision bias occurs when subjects set their decision thresholds at an unusually low value, yielding disproportionately many false positives. Suppose you go for a swim in the ocean just after watching *Jaws*. You'll be more likely than in other contexts to judge seaweed brushing against your leg, or a shadow gliding along the ocean floor, to be a shark. Your perception doesn't change—the seaweed feels the same and the shadow looks the same as if you hadn't watched *Jaws*—but your threshold for judging that a stimulus is a shark is set to a hair trigger. You're biased towards deciding that anything that feels or looks remotely shark-like is a shark, rendering your judgments of your perceptions unreliable.⁶

⁶ We assume here that your perceptual experience of the seaweed brushing against your leg wouldn't itself be influenced by your background beliefs or fears. But our point doesn't require

Given the existence of response and decision biases, the question arises of how Carrasco *et al.* can be so sure that the reports of subjects in their experiment accurately reflect their perceptions. Recall that in the cued condition, when attention is drawn to one of the Gabor patches, subjects are more likely to report the orientation of the attended patch when its contrast is equal to, or even slightly lower than, the contrast of the unattended patch. Since subjects are instructed to report the orientation of whichever patch is higher in contrast, this amounts to obliquely reporting that the attended patch is higher in contrast. The question we are raising is how we know that these reports accurately reflect the subjects' perceptions and are not due to bias.

Carrasco *et al.* (2004) used two control conditions to try to address questions about bias. In the first condition, they extended the timing between the cue and target to 500 ms, which exceeds the range of attentional action, meaning that attention should no longer be directed to the cued location once the Gabor patch appeared. Doing so eliminated the effects of the cue, which is convincing evidence that the cues, and probably the attention they orient, are responsible for their observed effect. Notice, however, that this condition does not tell us whether attention directly affects perception itself, perceptual judgment, or only the response.

The second control they performed was to have subjects indicate which stimulus appeared to have the lower contrast, rather than the higher contrast. Their reasoning was that, if the cue invoked a response bias—causing the observers to be more likely to choose the cued stimulus, whatever the task requirements—then the effects of the cue ought to be reversed in this condition. They found that this manipulation reduced, but did not eliminate, the effect of the cue, suggesting that a response bias was present but could not explain the entire effect.⁷ However, this control experiment did not address the possibility that attention could have affected the decision threshold and not simply the response (Schneider and Komlos, 2008). Observers could decide which stimulus had a higher contrast, and, through an independent process, indicate which stimulus had the higher or lower contrast, as the experimental task demanded. There is no reason to expect that the attentional cue would interfere in any way with the abilities of an observer to invert his or her responses when asked to indicate which stimulus had the lower, rather than higher, contrast. In other words, the second control condition tells against a response bias, but it doesn't address the possibility of a decision bias. It doesn't show that subjects' perceptual judgments accurately reflect their perceptions.

this assumption. Our point is that judgments based on perceptions can be directly influenced by background attitudes, not that perceptions are never themselves influenced by background attitudes.

⁷ Block doubly misdescribes this control condition when he writes, 'the boost to the attended side persisted to the same degree even when the instruction was to report the orientation of the lower contrast patch rather than the higher contrast patch' (p. 37, emphasis in original). First, the boost was to a lesser degree, not the same degree. Second, there was no instruction in Carrasco *et al.*'s control condition to report orientation, but only to indicate which stimulus had the lower contrast. (Thanks to Britt Anderson for this second observation.)

Given the nature of the experiment, this is more than an idle worry. The subjects performed a forced-choice comparative judgment in a time-pressured situation, where the (very similar) stimuli were presented for less than $1/10^{\text{th}}$ of a second and judgments had to be rendered in less than 1 second. In these conditions, subjects are likely to lack much confidence about what they have seen, rendering their perceptual judgments highly susceptible to a decision bias. If we further suppose that attended stimuli are more salient—as Block agrees that they are—then we can see why subjects might judge the attended patch to be higher in contrast. Generally speaking, salience and intensity are strongly associated. The most salient stimulus in an array tends, all things equal, to be the most intense (the highest in contrast, the fastest, the biggest, etc.). Given their uncertainty about what they have seen, the salience of the attended patch may thus be sufficient to lower perceivers' decision thresholds for judging that the attended patch is higher in contrast, biasing them towards that judgment. It's as though perceivers unconsciously reason: 'Jeez, those stimuli went by so fast and really looked the same to me, but now I'm required to choose one of them as being higher in contrast. Goodness, how do I choose?! Well, the one on the left was more salient, and high contrast stimuli tend to be more salient than low contrast stimuli, so I guess the one on the left was higher in contrast.'

Notice that having subjects report the patch with lower, rather than higher, contrast does not control for this possibility. If attended stimuli are more salient, and subjects are disposed to judge that salient stimuli are higher in contrast when they are uncertain and have nothing else to go on, then subjects will judge that the attended patch is higher in contrast. Whether they then report the orientation of the attended or unattended patch will depend on whether they are instructed to report the orientation of the patch with higher or lower contrast.

So we have two explanations for Carrasco *et al.*'s results. According to the first, attention increases the perceived contrast of a stimulus. According to the second, attention increases the salience of a stimulus, which is then mistaken for a boost in contrast in the uncertainty-generating conditions of a fast-paced forced-choice comparative task. It is impossible to conclude from Carrasco *et al.*'s study which explanation is correct. Moreover, although we have been focusing on Carrasco *et al.*'s (2004) study of perceived contrast, the same problem arises for all of the studies that use this forced-choice comparative paradigm. These studies all report that attention increases perceived intensity—perceived size, speed, saturation, etc. But perceived intensity is always confounded with a decision bias.

Fuller and Carrasco (2006) tasked perceivers with comparing the hue of stimuli that varied from blue to purple and found that attended stimuli are not judged to be any bluer than unattended stimuli. The fact that an effect of attention is found for saturation but not hue is sometimes cited as evidence that the effect is genuinely perceptual and not a matter of bias. This fact does tell against a simple response bias. If perceivers favoured whatever stimulus they attended to, they would surely favour that stimulus whether they were judging its saturation or its hue. But Block goes further, arguing that this fact tells against a salience-based decision bias.

A cognitive decision bias should equally affect both saturation and hue. If the subjects are not aware of any difference in hue between the attended and unattended sides, it would seem that the 'salience' perspective would say they would choose the attended side. But they don't. (Block, 2015, p. 22).

In fact, the decision-bias explanation *predicts* that the attentional effect should vanish for hue. While saturation is associated with salience (all else being equal, the most saturated stimulus in an array is the most salient), hue is not. Given an array of stimuli that vary from purple to blue, we wouldn't expect one of them to pop out. Blue is not intrinsically any more or less salient than purple. Thus, the fact that attention does not influence reports of hue cannot be used to rule out a decision-bias explanation. If anything, it supports it.

5. The Equality Paradigm

According to the decision-bias hypothesis, Carrasco *et al.*'s results are an artifact of their fast-paced, two-alternative, forced-choice method. It's only because perceivers are forced to decide which of two identical-looking stimuli is higher in contrast that they fall back on salience to guide their decisions. There is, therefore, a straightforward way to test the decision-bias hypothesis: require a different decision. Instead of asking subjects which of two stimuli is the more intense, we can ask them whether two stimuli appear to have the same intensity or not. Thus, if two stimuli look equally intense, or subjects are uncertain about which is more intense, they aren't artificially forced to identify one of them as more intense anyway. They can report that the stimuli look equal in intensity.

If attention boosted the perceived intensity of a stimulus, it would cause subjects in the comparative task to report that one of two identical stimuli appears more intense than the other, and subjects in the equality task to report that two identical stimuli appear unequal in intensity. But when Schneider and Komlos (2008) used the same stimuli and procedures as Carrasco *et al.* (2004), but switched to the equality task, the effects of attention disappeared. When subjects observed two identical Gabor patches, they were most likely to report that the patches were equal in contrast, whether one of them was attended or not. Likewise, Schneider and Komlos found that attending to a lower contrast patch never increased the probability that subjects would report that the patch was equal in contrast to the unattended higher contrast patch. If Carrasco *et al.*'s results were due to a change in perception rather than a task-induced decision bias, simply changing the task to an equality judgment shouldn't have had this effect.

'But,' you may object, 'how do we know that observers in the equality task experience things in the same way as observers in the comparison task? Maybe observers in the equality task adopt a special strategy, such as dividing their attention more evenly across the two stimulus locations, which alters the appearance of the stimuli relative to the comparison task.'

Two considerations tell against this possibility. First, the exogenous attentional cues employed in both the comparative and equality paradigms draw attention automatically, and are thus impossible to ignore (Müller and Rabbitt, 1989; Remington, Johnston and Yantis, 1992). Given the demands of the experiment, there is no strategy that subjects could adopt that would stop them from attending to the cued location. Second, Schneider and Komlos (2008) performed a control experiment in which subjects did not know which of the two judgments they would be making, the comparative judgment or the equality judgment, until *after* the stimuli had disappeared from the screen. It was thus impossible for subjects to adopt a differential strategy based on the judgment they had to make. Yet when subjects performed the comparative task, they reliably reported that the attended stimulus was higher in contrast; and when they performed the equality task, the effects of attention disappeared. So there is good reason to think that attention is not affecting the objective appearance of the stimuli, but only the decision process.

While Schneider and Komlos (2008) only examined perceived contrast, the equality task has been documented to eliminate the effects of attention for other stimulus dimensions as well. Valsecchi, Vescovi and Turatto (2010) show that the apparent boost to perceived speed that accompanies attention to a stimulus in comparative tasks evaporates when subjects switch to an equality task. Block also brings up experiments probing temporal order judgments, which he claims show that attention can cause one stimulus to appear approximately 40 ms before another. Here, too, the reported results are restricted to comparative tasks. When subjects make simultaneity judgments, reporting not which stimulus appeared first, but whether they appeared at the same time or not, the effects of attention disappear (Schneider and Bavelier, 2003). It is thus becoming accepted that the simultaneity judgment is a more accurate representation of subjects' perceptions than the temporal order judgment (García-Pérez and Alcalá-Quintana, 2012). Using a line bisection task, it has also been recently shown that the comparative judgment cannot be trusted to give an accurate report of subjects' perceptions of line lengths (García-Pérez and Peli, 2014). Of course, it's an empirical question whether switching to the equality paradigm would erase the effects of attention on saturation, gap size, and the other properties whose intensity attention has been reported to increase using the comparative paradigm. But it would be a bold person who bet against it. For every stimulus dimension tested so far, researchers who switch to an equality task report—with only one exception (discussed below)—that the effects of attention disappear.

The effects of attention on behaviour are clearly task sensitive. When subjects perform a comparative judgment, the effects are present. When subjects perform an equality judgment, the effects are absent. We have been blaming the comparative task for encouraging a decision bias. But why not instead blame the equality task for an artifact, such as its own decision bias, that masks a real change in perceived intensity?

Given that the reported attentional effect disappears entirely in the equality paradigm, any artifact of the equality paradigm that masked a real increase in perceived intensity would need to be of a magnitude that just so happened to *exactly*

counteract that increase. Needless to say, such a coincidence is extremely unlikely; especially given that the reported effect is sizable (an attended 22% contrast stimulus is alleged to be perceptually equivalent to an unattended 28% contrast stimulus). It is, moreover, far from clear what sort of artifact one might appeal to. One couldn't appeal to a decision bias, since a decision bias in the comparative and equality tasks influences subjects' responses in different and orthogonal ways (Schneider and Komlos, 2008; García-Pérez and Peli, 2014). In the comparative task, subjects are deciding: 'Is stimulus A more intense or is stimulus B more intense?' A decision bias will thus push subjects towards one stimulus or the other, mimicking a real change in intensity. As a result, a decision bias in the comparative paradigm is degenerate with (i.e. cannot be distinguished from) a real change in intensity. But in the equality task, subjects are deciding: 'Are stimuli A and B equal in intensity or unequal in intensity?' A decision bias will thus push them towards more 'equal' or 'unequal' responses, but not towards judging one stimulus to be more intense than the other. The equality task thus cannot be blamed for hiding a real increase in perceived intensity.

While Block (p. 40) acknowledges that there is controversy about whether attention's alleged effect on objective appearance holds up in the equality paradigm, he asserts that the 'issue has now been resolved by Anton-Erxleben, Abrams and Carrasco (2010) which explores the methodological issues involved in same/different judgments, showing that when properly done, the perceptual effect can be demonstrated with both methodologies' (p. 40). This declaration is too hasty. While Anton-Erxleben *et al.* initially reported that attention could be shown to alter objective appearance using the equality judgment, Schneider (2011) observes that the maximum likelihood of an 'equal' response always occurred in their data when the stimuli were in fact identical, and shows that the reported attentional effect on objective appearance was due to misfitting their asymmetric data to a symmetric model (Figure 5a). Schneider (2011) points out that the psychometric functions that they report for each subject exhibit a skew, not present in the data of Schneider and Komlos, 2008, such that the equality judgments never reach a zero baseline for the lowest contrast test stimuli. Even though the point of maximal apparent equality still remains at the point of veridical equality, the skew in the low-contrast data pulls the fitted symmetric function in the low-contrast direction. Thus, if you attend to Figure 5a, which plots mean data from the equality task in Anton-Erxleben *et al.* (2010), and focus just on the data points while ignoring the curves, you'll notice that for each condition the data point with the greatest probability of an equality response occurs when the contrasts are in fact equal. So, regardless of whether the cue appeared at fixation (neutral cue condition), at the location of the standard stimulus (standard condition), or at the location of the test stimulus (test condition), subjects were most likely to say that the two stimuli had the same contrast when they did in fact have the same contrast. Still focusing on the data points and ignoring the curves, it is evident for all three conditions that the data points to the right (difference in log contrast > 0) asymptote to zero whereas the data points to the left (difference in log contrast < 0) asymptote to well above

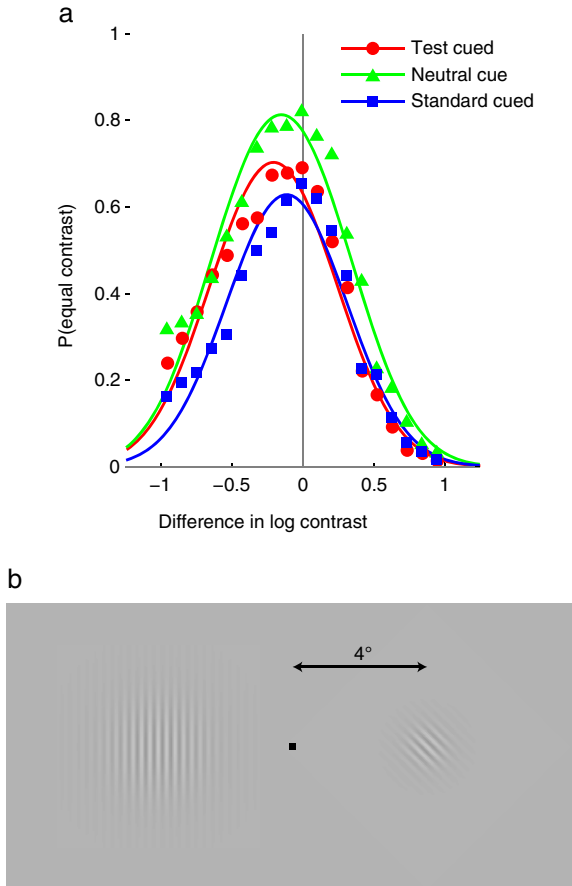


Figure 5 (a) Mean data from the equality task in Anton-Erxleben et al., 2010, as reanalyzed by Schneider (2011). The y-axis gives the probability of an ‘equal’ response; the x-axis gives the log contrast difference between the test stimulus (which varied from 10% to 67% contrast) and the standard stimulus (which was always 26%). Note the skew in the data and the mismatch between the maximum data points and the peaks of the curves. (b) A scale comparison of stimuli used by Schneider and Komlos (2008) and Anton-Erxleben et al. (2010). Because Anton-Erxleben et al.’s stimuli were so much smaller, they may have been harder to see at low contrasts, explaining the skew in their data at low contrasts.

zero. The data are thus asymmetric; there is a skew towards an ‘equal’ response at low contrasts but not high contrasts. Focusing now on the curves, which are generated from Anton-Erxleben et al.’s (2010) model, notice that their peaks fail to match the maximum data points, and are shifted to the left. This shift results because the curves are fit from a symmetric function whereas the data are asymmetric. By attempting to accommodate the significant tail in the data at low contrasts, the model winds up underestimating the maximum points in the data.

While it is not entirely clear what caused the skew in the data, Schneider notes that the stimuli Anton-Erxleben *et al.* used were much smaller and therefore harder to see (by a factor of 2) than Schneider and Komlos's stimuli, potentially causing subjects to guess at lower contrasts where the test stimuli would be particularly difficult to discern (Figure 5b). Schneider and Komlos (2008) used stimuli that were the same as those in Carrasco *et al.*, 2004, and it is not clear why Anton-Erxleben *et al.* (2010) chose to reduce the stimulus size for their attempted replication.

To quantify the skew in the data of Anton-Erxleben *et al.*, 2010, Schneider fitted a *scaled skew normal function*—a bell-shaped function with a skew parameter that causes it to tilt in one direction or another—to their individual subject data and found that, across all conditions, the skew was highly correlated to the attentional effect reported by Anton-Erxleben *et al.* for each subject (see Schneider, 2011, Figure 7). The more skewed the data were for a given subject, the higher the subject's attentional boost in apparent contrast was measured to be, suggesting that the reported effects of attention were simply a byproduct of the skew in the data.

To test his hypothesis that subjects' guessing at low contrasts could generate skewed psychometric functions and thus explain the attentional effects claimed by Anton-Erxleben *et al.*, Schneider tested a new model that included a parameter to account for low-contrast guessing. This model fitted the data better than Anton-Erxleben *et al.*'s model without any modulation by attention. Its peaks aligned with the peaks in the data, which were clearly at zero in all three cuing tasks, indicating no effect of attention on perceived contrast.

Anton-Erxleben, Abrams and Carrasco (2011) reply by analyzing the peak of Schneider's scaled skew normal function, which he used to quantify the magnitude of the skew present in their data. They report that the peaks of this descriptive function were modulated by attention. From this, they conclude again that attention does indeed alter appearance. However, as Schneider (2011) already demonstrated that the degree of skew was highly correlated with the size of the attentional effect, it is hardly surprising that an analysis of the skew function finds an effect of attention. By basing their analysis on the scaled skew normal function, Anton-Erxleben *et al.* take for granted that the attentional effect is caused by the low-contrast skew in their data, and thus fail to show that their reported effects of attention were anything other than artifacts of their small and hard-to-see stimuli.

The relation between the equality and comparative paradigms has been further probed by Kerzel *et al.* (2010), who replicated both the comparative contrast task of Carrasco *et al.* (2004) and the equality contrast task of Schneider and Komlos (2008). Although they found that the cuing effect was most pronounced in the comparative task, they also found a small cuing effect in some versions of the equality task. But upon closer examination, Kerzel *et al.* found that the cuing effect in both paradigms was driven by observer inexperience, difficult-to-discriminate stimuli, poor discrimination abilities, and response speed. The less certain subjects were about which Gabor patch had the higher contrast—because they were unpractised at discriminating the patches, were presented with patches that were hard to discriminate, were poor discriminators, or privileged speed over accuracy—the more

likely they were to say that the cued Gabor patch had the higher contrast. Since this is exactly what one would predict if the attentional effects were being driven by a decision bias, Kerzel *et al.* conclude that the effects are due to factors that influence perceptual judgment rather than perception itself.

So although Block writes that it ‘has now been resolved’ that the attentional effect persists in the equality paradigm (p. 40), the totality of the experimental evidence is far more equivocal than he suggests, and in our estimation points, on balance, towards the opposite conclusion. Changing from a comparative task to a same–different task tends to eliminate judgments that the attended stimulus is more intense, suggesting that attention biases decisions but does not alter perceived intensity.⁸

6. Additional Evidence

In addition to the comparative studies performed by Carrasco and her colleagues, Block briefly discusses three further lines of evidence that he takes to support the view that attention increases perceived intensity. But as we will now show, they are all equally compatible with the hypothesis that attention only increases salience.

Gain Modulation. Block points out that attention and stimulus contrast are both linked to gain modulation in visual cortex neurons. For example, attending to a stimulus and increasing the contrast of a stimulus can both lead to *response gain*, a boost in neural firing rates (McAdams and Maunsell, 1999). Similarly, attending to a stimulus can cause *contrast gain*, which lowers the range of contrasts to which neurons are sensitive, leading attention to mimic the effects of an increase in contrast (Reynolds, Pasternak and Desimone, 2000). Block summarizes, ‘In general, increasing attention

⁸ Although our focus in this section has been on the equality task, it is worth noting that experiments by Prinzmetal *et al.* (1997) and Anderson (2016) using a matching task (matching a stimulus to some set of standard stimuli) tell a similar story. Anderson’s studies are particularly noteworthy because they were designed to parallel Carrasco *et al.*’s (2004) in many respects. When his participants were instructed to report the orientation of the stimulus with higher contrast (by rotating the appropriate response bar until it matched the orientation of the higher contrast stimulus), his findings mirrored theirs. But Anderson also found that the attentional effect in this task held up when the contrast of the cued stimulus was zero. Of course, a stimulus with zero contrast is invisible—it’s a phantom. Participants were thus reporting the orientation of empty space, which can only be explained by some type of bias. Moreover, when Anderson asked subjects to directly report the contrast of a stimulus by matching it to the appropriate level on a graded contrast meter, there was no effect of attention on reported contrast. Thus, switching from a comparative forced-choice task to a matching task eliminated the effect, further suggesting that the effect is an artifact of the comparative forced-choice task. Although Anderson’s findings are naturally interpreted in terms of bias, Anderson instead interprets them as showing that appearances themselves are task-sensitive. When the task changes, so do how things look. But we find this interpretation hard to square with Schneider and Komlos’s control experiment in which subjects didn’t receive instructions about which task to perform until *after* the stimuli disappeared from the screen, and so we take Anderson’s findings to provide further evidence of bias.

has a similar effect in the visual cortex as increasing contrast itself (p. 38). Block infers that attention and contrast both increase perceived contrast.

One problem with Block's appeal to gain modulation as evidence that attention boosts perceived contrast is that it could equally be interpreted as evidence that attention boosts salience. Block is betting that gain modulation in visual cortex neurons is a neural correlate of perceived contrast. Increased contrast leads both to an increase in perceived contrast and to neural gain, so Block infers that increases in perceived contrast are realized in the brain as neural gain. Since attention also causes neural gain, Block concludes that attention boosts perceived contrast. But an alternative possibility is that gain modulation is a neural correlate of salience rather than perceived contrast. While it's true that increasing contrast increases perceived contrast, it's also true that increasing contrast increases salience.

Alternatively, the neurons that exhibit gain modulation might not be a neural correlate of either perceived contrast or salience. Both salience and perceived contrast are most likely to be properties of neural populations. There is, in all probability, no single neuron that determines how salient a stimulus is, or how much contrast you perceive it to have. Yet gain modulation is a property of individual neurons. It is, moreover, a property that only *some* contrast-sensitive neurons display in response to attention. Of the contrast-sensitive neurons in V4 that Reynolds *et al.* (2000) recorded in their oft-cited demonstration of contrast gain, fewer than half were modulated by attention. Pooresmaeili *et al.* (2010) also showed that at least within V1, contrast and attention are distinct and distinguishable codes, meaning that one needs to know the activity patterns of two separate populations of neurons to infer (a) the perceived contrast of a stimulus and (b) whether the stimulus is attended. These facts suggest that the neurons that exhibit gain modulation may be a shared part of two separate, if overlapping, neural populations: one that codes for contrast and another that codes for attention. It would thus be rash to conclude that attention increases perceived contrast simply because attention and increased contrast both cause *some* neurons to exhibit gain modulation.⁹

Adaptation. Block (pp. 38–39) observes that attention has some of the same psychological effects as an increase in stimulus intensity. In particular, increasing attention to a stimulus first enhances, and then later impairs, adaptation to that stimulus in much the way that increasing the contrast of the stimulus does (Ling and Carrasco, 2006). But just because conscious attention can cause some of the same effects as increased contrast doesn't mean that it has to do so by increasing perceived contrast.

⁹ There is a further problem with the appeal to gain modulation. Whereas its responses are multiplicative (the higher the contrast, the greater the effect), the responses of attention are additive at both the population level, where the activity of groups of neurons is measured (Buracas and Boynton, 2007; Theile *et al.*, 2009; Pooresmaeili *et al.*, 2010) and at the psychophysical level, where behaviour is measured (Schneider, 2006; Cutrone *et al.*, 2014), suggesting that gain modulation is not the neural correlate of whatever it is that attention boosts. Note, moreover, that an additive effect fits naturally with our contention that the attentional effects result from a decision bias that is acting independently of the actual contrast.

Attention increases the neural firing rate of some (but not all) neurons in early visual cortical areas, and the adaptational effects of attention may simply be a byproduct of this increased neural activity. Alternatively, increased contrast and increased attention may each increase salience, which in turn causes adaptation. More would need to be known to decide among these competing explanations of adaptation.

EEG Studies. Block cites a study by Störmer, McDonald and Hillyard (2009) that uses a modified version of Carrasco's comparative paradigm with auditory rather than visual cues, along with an EEG (an electroencephalogram, a device that measures neurally generated electrical currents at the scalp) to gain a window into subjects' neural activity as they completed the task. Störmer *et al.* found a similar behavioural effect as Carrasco *et al.* (2004)—attention increased judgments of contrast—and also found that those judgments correlated with increased neural activity in the visual cortex. Block concludes that the effect of attention is perceptual, and we agree. But whereas Block takes the perceptual effect to be indicative of an increase in perceived contrast, we interpret it as an increase in visual salience—an interpretation that Störmer *et al.* (p. 22460) acknowledge as a live possibility.¹⁰

This concludes our review of the empirical evidence. At the very least, we hope to have persuaded the reader that the controversy over attention's alleged influence on perceived intensity is, *pace* Block, far from 'resolved' (p. 40) or 'settled beyond any reasonable doubt' (p. 37). While our position is that the best interpretation of all of the evidence points away from an effect of attention on perceived intensity and towards a salience-based decision bias (attending to a stimulus boosts its salience, which is then mistaken for a boost in stimulus intensity in conditions of uncertainty), we can imagine a cautious reader who feels that she isn't in a position to judge, on the basis of our presentation alone, which side has it right. After all, much of the evidence we have reviewed is highly technical, and we have of necessity abstracted away from some details for the sake of accessibility. We invite such a reader to follow along for the remainder of the article in a conditional spirit: if the advocates of a decision bias are correct, what is the philosophical upshot?

7. Introspection

We have been arguing that empirical studies do not support the conclusion that attention alters perceived intensity. One might wonder, however, whether empirical studies are really needed. Can introspection not settle the issue? At one point, Block says something that may seem to suggest as much. While discussing whether

¹⁰ Referring to Carrasco *et al.*'s (2004) control experiment, Störmer *et al.* (p. 22460) proceed to criticize the salience hypothesis: 'it seems hard to reconcile this salience hypothesis with previous findings that stimuli at the cued location are judged to have higher contrast even when the subject's task is to report which stimulus is lower in contrast.' But as we showed in §4, this control experiment only tells against salience facilitating a response bias. It does not speak to our proposal that salience facilitates a decision bias.

the extremely brief (40–100 ms) presentation times for the stimuli in Carrasco's experiments are too short to alter their conscious appearance, he writes:

The issue of the size of a conscious effect for these very brief stimuli can, however, be sidestepped because the attentional effect is visible in the sample stimuli printed on the page. You can see it yourself using Figure [2]! (Block, p. 41)

One reading of this passage is that Block thinks that if you simply look at Figure 2 and shift your attention around, you can tell through introspection that the perceived contrast of the Gabor patches changes. Carrasco's experiments aren't needed; the influence of attention on perceived contrast is manifest through introspection.

If this is indeed Block's view, it is curious for two reasons. First, Block spends a lot of time describing and explaining Carrasco's studies. Why go through all the trouble if his considered opinion is that introspection alone establishes attention's influence on perceived contrast? Second, as Block knows, the question whether attention alters how things consciously look to be has long been debated, with respected psychologists such as James (1890) and Fechner (1882) reaching opposing conclusions on the basis of introspection.¹¹ No doubt, part of the difficulty is that introspection is not immune to theoretical influence. Most contemporary commentators have thus sensibly concluded that introspection is not equipped to settle the issue.¹²

Our suspicion is that Block does not intend, in the above passage, to imply that introspection can settle whether attention alters how things look to be. Rather, he is explaining why anyone who accepts Carrasco's findings should take them to concern conscious perception rather than unconscious perception. In other words, we interpret Block as holding that introspection reveals that there is *some* difference in the phenomenal characters of E_A and E_U , but not what the nature of that difference is. Carrasco's findings are needed to show that the difference corresponds to a difference in perceived contrast. Consequently, Block cannot escape our negative assessment of the empirical evidence by retreating to introspection.

8. Salience

We agree with Block that attention alters the phenomenal character of perceptual experience. There is a phenomenal difference between E_A and E_U . But, whereas

¹¹ For what it's worth, one of us (KS) introspectively finds that there is no difference in perceived contrast between E_A and E_U , and the other (JB) introspectively finds that he cannot tell whether E_A and E_U differ in perceived contrast. Both of us agree, however, that there is *some* phenomenal difference between E_A and E_U .

¹² For example, Watzl (forthcoming, p. 2) endorses the inability of introspection to settle the matter (and endorses the Block-Carrasco interpretation of the empirical evidence) when he writes, 'While the effects of attention on appearances are small (and so Fechner and James couldn't resolve the issue on the basis of introspection alone), they are statistically significant and reproducible.'

Block holds that the phenomenal difference between E_A and E_U is at least partly a difference in perceived contrast, we maintain that it is only a difference in salience.

The notion of salience obviously plays a central role in our explanation of attention's influence on experience and behaviour, and so the time has come to say something about how we understand it. We note, however, that the question of how best to understand salience should interest Block, too, given his claim (quoted above) that attention increases salience in addition to increasing perceived intensity.

We begin with a distinction between *relational salience* and *dispositional salience*. Relational salience is always relative to a perceiver and a time. For example, if you're presently attending to a 22% Gabor patch, then it is relationally salient to you right now. A stimulus is dispositionally salient, by contrast, when it is disposed to be relationally salient to normal perceivers in normal conditions. Thus, pop-out stimuli, such as a lone vertically oriented bar among a group of horizontally oriented bars, would count as dispositionally salient even when no one is around to perceive them. Relational salience is clearly the basic notion, and by 'salience' we will henceforth always mean relational salience unless otherwise noted.

Crosscutting the relational–dispositional distinction is a distinction between *phenomenal* and *functional* salience. Wayne Wu (2011) introduces the term 'phenomenal salience' to capture the meaning that we have been implicitly presupposing throughout this paper. According to Wu, 'phenomenal salience' refers 'to the way an object or property figures to a subject when she consciously attends to it in perception, a way that constitutes what it is like to attend to that object or property' (Wu, 2011, pp. 93–4). Phenomenal salience is thus the phenomenal character of perceptually attending. So, the phenomenal difference between E_A and E_U is a difference in phenomenal salience. As Wu notes, phenomenal salience seems to be what is at issue when James (1890, p. 284) writes, 'Accentuation and Emphasis are present in every perception,' or when psychologists deploy the metaphor of attention as a spotlight or zoom lens, or when Campbell (2002, pp. 7–8) writes of attention's power to 'experientially highlight' one object among many. Given our interpretation of the empirical evidence, we maintain that phenomenal salience cannot be explained in terms of increased contrast or any other aspect of objective appearance. We return to this issue in Section 9.

When a stimulus is functionally salient, it is treated as important by the perceiver's perceptual and/or cognitive systems. It is prioritized for processing, and is more likely to be selected for action and cognition. When psychologists use the term 'salience' they often seem to have functional salience in mind. Attention increases the salience of a stimulus in the sense of increasing the probability that the stimulus will be selected for action and cognition.

There are certainly close links between phenomenal salience and functional salience. Changes in phenomenal salience are generally accompanied by changes in functional salience. But if attention can be deployed in the absence of conscious awareness—as blindsight (Kentridge, Heywood and Weiskrantz, 2004) and masking experiments (Jiang *et al.*, 2006) both suggest—there is reason to think that stimuli can be functionally salient without being phenomenally salient, and thus that the

two properties are not identical. This conclusion is further supported by computational models that explain the allocation of attention by appeal to ‘saliency maps’ (Koch and Ullman, 1985; Itti and Koch, 2001). The most natural interpretation of such models is that the salience of a stimulus causally explains why it becomes attended. The stimulus thus has to be functionally salient *before* it’s attended, and so before it’s phenomenally salient. So functional salience cannot be identical to phenomenal salience (or to attention, for that matter).¹³

How, then, are functional and phenomenal salience related? We hypothesize that phenomenal salience is a realizer property for the role property of functional salience. This hypothesis explains why changes in phenomenal salience are typically accompanied by changes in functional salience: changing a realizer property often changes how the system of which it is a part functions. It also explains why functional salience can arise in the absence of phenomenal salience: functional salience is multiply realizable, and phenomenal salience is only one of its potential realizers. Finally, it explains why phenomenally salient stimuli are always functionally salient: realizer properties generally cannot be instantiated independently of their role properties.

We further speculate that attention is a mechanism for increasing functional salience, and that *conscious* attention increases functional salience by way of increasing phenomenal salience. Consciously attending to a patch with 22% contrast will increase its phenomenal and functional salience, and thereby prioritize the experience of the patch for further processing.

While attention is one mechanism for increasing functional salience, it may not be the only such mechanism. Kerzel *et al.* (2011) ran a modified version of Carrasco’s famous paradigm, in which subjects were instructed to report which of two briefly presented stimuli, to the left or right of fixation, was higher in contrast. Unlike in Carrasco’s task, there was no cue to draw attention away from fixation. However, the two target stimuli to the left and right of fixation were accompanied by six other distractor stimuli, and one of the two target stimuli was made functionally salient by

¹³ On the topic of saliency maps, Block seems to express scepticism about the existence of (functional) salience as a genuine property that exists over and beyond such perceptible properties as contrast, speed and position:

In discussions of salience, there is often a conflation between salience as a perceptual property and the genuine perceptual properties that are involved in attracting attention, like high contrast or speed or sudden changes in position. We commonly speak of a saliency map in the sense of the map of locations in the visible environmental layout in terms of whether they are likely to attract attention. The perceptual properties here do not involve salience itself but rather differences with nearby locations in visible feature dimensions (Itti and Koch, 2000), for example in visible motion or appearance or disappearance. (Block, 2015, p. 23)

Yet while it’s true that functional salience is computed on the basis of perceptible properties such as contrast and speed, it doesn’t follow that it is reducible to these other properties. On our interpretation, functional salience is needed to explain what the various attention-attracting configurations of these perceptible properties have in common.



Figure 6 Displays from Kerzel *et al.*, 2011. One stimulus to the left or right of fixation was made functionally salient by being tilted 6 or 45 degrees. One stimulus to the left or right of fixation also differed in contrast (sometimes the tilted one, sometimes the other). Subjects were instructed to attend to the central fixation point and ignore orientation. The stimuli were briefly presented (70 ms), and subjects reported which stimulus (to the left or right of fixation) was higher in contrast. Subjects were more likely to report the tilted (*i.e.* salient) stimulus as being higher in contrast, and the effect was greater at 45 than at 6 degrees of tilt.

virtue of being tilted relative to the other stimuli (Figure 6). Although subjects were told to ignore orientation, Kerzel *et al.* found that subjects were more likely to report a stimulus as being higher in contrast when it was tilted, suggesting that functional salience causally impacts reporting behaviour. Moreover, the effect was larger when the tilt, and thus functional salience, was greater. There is, however, an obvious confound: the functionally salient stimulus might be drawing more attention, in which case this would just be another case of attention boosting contrast judgments. But when subjects were hooked up to an EEG during the task, the N2pc—an ERP component that is associated with selective attention—was not found.¹⁴ Kerzel *et al.* admit that the absence of an N2pc does not guarantee the absence of attention (see p. 4 of their article for discussion and references). But they note that the absence of attention is consistent with the task demands: because subjects were required to compare two stimuli, the task encouraged them to spread their attention evenly over both. Moreover, Kerzel *et al.* *did* find the N2pc in a control task that required subjects to judge the orientation of—and thus presumably attend to—the tilted stimulus.

It would be nice to see further evidence that functional salience is *directly* influencing contrast judgments in these tasks (*i.e.* without first influencing attention). But if the result holds up, it is important for two reasons. First, if subjects aren't attending to the stimulus, it is unlikely that it is phenomenally salient to them. The finding thus reinforces the idea that functional salience can be dissociated from phenomenal salience, and so that phenomenal salience is not the only realizer for functional salience. Second, the finding suggests that the relation between attention

¹⁴ An ERP (event-related potential) is a waveform of neurally generated electrical activity that is caused by a specific event. In the case of the N2pc, the specific event is selectively attending to a stimulus.

and functional salience is more complex than one might have supposed. If functional salience increases in the absence of attention, the relation between functional salience and attention certainly cannot be identity. Nor can it be a simple unidirectional causal relation in which attention causes functional salience and that's the end of the story. If Kerzel *et al.* are right, there are non-attentional mechanisms that also cause functional salience, and feedback loops whereby functional salience can itself cause attention. For example, a non-attentional mechanism might cause a unique stimulus among a group of distractors to be functionally salient, which in turn causes the subject to attend to the stimulus, making the stimulus phenomenally salient and boosting its functional salience even further.

9. Mental Primer

Assume we are right that attention increases phenomenal salience without increasing perceived intensity. How could direct realists and representationists explain such changes in phenomenal salience? Recall the two standard replies that are available to them: the selective attention reply and the illusion reply. In a case such as E_A and E_U , there is little hope for the illusion reply to gain a foothold. Unlike in the Tse illusion, there is no candidate for a property that is illusorily represented when the Gabor patch is attended—at least, not once we reject the Carrasco-Block claim that attention boosts perceived intensity. Moreover, it is highly implausible that every experience involving attention is illusory, which is what the illusion reply would require.

Can the selective attention reply fare any better? That obviously depends on whether direct realists and representationists can find a property of the Gabor patch that people are aware of when, and only when, they attend to it. Thinking up plausible candidate properties is not easy, especially given the evidence that attention doesn't boost perceived intensity. After all, it's not like attended stimuli appear to change colour or glow. Perhaps the most compelling suggestion to emerge from recent discussions is that attention makes you aware of more determinate versions of the same properties that you are aware of when you see a stimulus but don't attend to it (Nanay, 2009; Stazicker, 2011; Boone, draft). For example, perhaps E_A represents the Gabor patch as having a 16–28% contrast and E_U represents it as having a 10–34% contrast. In that case, attention would be responsible for making the perceived contrast of the Gabor patch more determinate.

Block (2015) challenges this suggestion on empirical grounds, but we want to focus on a more theoretical problem that Wu (2011) has noted for representationist appeals to visible properties in general, and that Watzl (2011, pp. 151–2) raises specifically for appeals to determinacy. The problem is that we can rig things such that when you attend to the stimulus, its visible properties change. For example, we can rig things such that when you attend to the 22% Gabor patch it becomes less determinate—perhaps because we blur the patch, move it further away from you, dim the lighting, or remove your glasses. We could thereby match the determinacy

you experience when you attend to the patch to the determinacy you experience when you don't attend to it. Yet there would nevertheless be a phenomenal difference between attending to the patch and not attending to it. So we can't explain that phenomenal difference—phenomenal salience—in terms of determinacy. Nor would it seem to help to substitute some other visible property, since we could always match the attended and unattended experiences of that property by altering the scene.

In reply, representationists and direct realists might try to find a visible property that can only be presented in attentive perception, such that merely changing the scene would never suffice on its own to present the property. There are various candidate properties they might propose, including the various types of salience, attention itself, and evaluative properties, such as importance or relevance. But a family of challenges awaits these candidates.

One challenge is that many (though not all) of these candidates conflict with a principal motivation for direct realism and representationism: the transparency of experience. According to this idea, perceptual experience makes us aware of things in the world—objects, colours, shapes, and so on—but it does not make us aware of our own mental states in addition. A perceiver who sees a tree might thereby be in a position to describe the shape of the trunk, the colour of the leaves, and the tree's distance from her, but there are no properties of her perception of the tree that she is positioned to describe in addition. Yet as Speaks (2010, pp. 331–2) notes, to perceive a stimulus as attended is to perceive it in terms of its effects on one's own mental states, violating transparency. And the same can be said for the proposal that perception represents stimuli as relationally salient. Given their endorsement of transparency, the idea that perceptual experiences make one aware of such properties is thus unlikely to appeal to direct realists or representationists.

A second challenge is that it is questionable whether we really are aware of any of these properties in perception. Even apart from considerations about transparency, many philosophers and vision scientists believe that the properties that can be visually perceived are circumscribed. They include colours, shapes, motion, and the like, and perhaps even emotions or edibility, but exclude many 'higher-level' properties that don't seem to earn their keep in explanations of purely visual phenomena (Burge, 2010; Block, 2014; but see Siegel, 2010). It would be very surprising, for example, if scholarliness were a visible property, and the same is arguably true of evaluative properties such as importance or relevance, as well as the various types of salience. Stimuli *are* functionally and phenomenally salient, but perception does not *represent* functional or phenomenal salience. Or so it seems to us. At the very least, anyone who wants to defend direct realism or representationism by appeal to the controversial thesis that perceivers are aware of such sophisticated properties incurs a debt to defend that thesis. This challenge thus imposes a substantial burden on representationism and direct realism even if it doesn't undermine those views outright.

Finally, insofar as perceivers *can* be aware of these properties in attentive perception, we do not know of any reason to think that they cannot *also* be aware of

them in non-attentive perception. For example, although we doubt that evaluative properties such as importance, or any type of salience, are represented in visual perception, we see no reason to think that *if* they could be represented in visual perception, they could only be so represented when attended. It might be replied that some properties—such as the property of being attended—can be veridically perceived only when attended. But that is compatible with such properties being non-veridically perceived when unattended, which (given the Wu-Watzl objection) is all that is needed to undermine the representationist/direct realist thesis that phenomenal salience can be fully explained in terms of the perception of such properties.¹⁵

We know of one other representationist/direct-realist strategy to explain phenomenal salience. Wu (2011) contends that the phenomenal salience of a stimulus is only noticeable when you think about it—that is, when you think something like ‘I’m attending to *that* stimulus’. And this leads him to suggest that phenomenal salience is explained by the phenomenology of demonstrative thought. For Wu, phenomenal salience thus emerges as cognitive, not perceptual. It’s a piece of cognitive phenomenology. This is supposed to save representationism about perception, which is only committed to explaining perceptual phenomenology. Yet Wu’s proposal faces the problem that demonstrative thoughts themselves piggyback on perception. Imagine that there are two dots on a large screen in front of you and nothing else. You fixate half way between them and attend to one dot and then the other while thinking ‘I’m attending to that dot’. There is a phenomenal change that occurs as you shift your attention between the dots that Wu wants to explain at the level of demonstrative thought. But what makes your demonstrative thought of one dot differ from your demonstrative thought of the other? The obvious suggestion is that your perception of the two dots changes, and your demonstrative thoughts inherit their contents from your perceptions. But if your demonstrative thoughts only differ in virtue of your perceptions differing, then phenomenal salience needs to be grounded in perception after all.

This brief tour through various direct realist and representationist treatments of phenomenal salience, along with the challenges they face, has been rather cursory, and there are surely positions and replies we have failed to consider. But we think we have said enough to motivate an alternative way of thinking about phenomenal salience. Our recommendation is to identify phenomenal salience with

¹⁵ It is admittedly a bit odd to think of conscious perception as misrepresenting the allocation of attention, but we think this oddity traces to the initial implausibility of attention being represented in conscious perception at all. In fact, Speaks (2010, p. 331) interprets the oddity as *evidence* that attention cannot be represented in perception. Speaks reasons that because it is a general truth that representation requires the possibility of misrepresentation, it follows that a stimulus could only be perceptually represented as attended if it could be perceptually misrepresented as attended—i.e. if it could be perceptually represented as attended when it was not, in fact, attended. But since it is hard to imagine this latter possibility, Speaks concludes that attention is not represented in perception at all.

mental primer, a qualitative feature of experiences that is caused by conscious attention and realizes functional salience but does not in itself represent or make one aware of anything. As we understand it, mental primer has a functional correlate, but no correlate that would make direct realists or representationists happy. It changes how things appear, but without changing how things appear to be.

Although the analogy is not perfect, there are important respects in which mental primer is similar to the primer you would apply when preparing to paint your house. For one thing, both paint primer and mental primer make a functional difference. Paint primer seals up the surface to support the paint. Mental primer prioritizes stimuli for action and cognition. Moreover, while paint primer and mental primer change the way things look, they each do so only indirectly. Paint primer is applied underneath an exterior coat of paint and so is not directly seen, though its application does make a difference to the overall look of the painted surface. Similarly, mental primer does not alter what is perceived or represented, though it does alter the overall phenomenal character of an experience. Mentally primed stimuli are consciously experienced differently than unprimed stimuli, but do not appear to change their properties as a result of being primed.

Mental primer is similar to mental paint insofar as it is not reducible to objects of awareness or representational content. But as Block understands mental paint, it is contingently used to represent properties of stimuli. For normal human perceivers, phenomenal contrast represents contrast; phenomenal motion represents motion; phenomenal red represents red; phenomenal green represents green; etc. These representational relations are contingent because things could have been otherwise. Phenomenal red could have represented green and phenomenal green could have represented red. But they exist all the same. Mental primer, by contrast, does not represent anything, not even contingently. Phenomenal salience is thus different from phenomenal red and phenomenal green. It realizes functional salience, but it does not represent functional salience or any other property.

Block overlooks the possibility of mental primer when he writes, 'Whatever understanding of salience the salience objection appeals to, salience must be or be associated with a perceptual property, i.e., a property that is genuinely represented in vision' (2015, p. 22). We agree, of course, that salience is a perceptual property in the sense of being a property of the visual system. But we deny that all properties of the visual system are, or are associated with, representational properties. In denying that salience is a representational property, we join Block in rejecting representationism. In denying that salience is *associated with* representational properties, we diverge from Block in rejecting mental paint in favour of mental primer.

To avoid confusion, it is worth emphasizing that a belief in mental primer does not carry an automatic commitment to *qualia*, which Block defines as phenomenal character that 'goes beyond the intentional, the cognitive, and the functional' (Block, 1996, p. 19). Mental primer clearly goes beyond the intentional, but because it realizes a functional property, functional salience, it is open to functionalists to

try to explain mental primer in terms of its functional role. This may not be easy since there are forms of functional salience that are unconscious. But it is open to functionalists to try to find fine-grained functional roles that distinguish conscious realizers of functional salience from their unconscious counterparts. Whether or not this can be done will inevitably be controversial, just as functional explanations of phenomenal qualities are, in general, controversial. There are well-known problems for functionalist treatments of phenomenal character. Our present point is only that mental primer doesn't create any special new challenges for functionalism.

The notion of mental primer can be developed in different ways, some of which are already familiar from the philosophical literature on attention. For example, Watzl (2011) argues that conscious experience has a centre–periphery structure, and that attention alters this structure by shifting attended stimuli from the periphery to the centre of experience. If you're listening to a band, you can toggle your attention between the piano and the saxophone, alternately bringing one into the centre of your conscious experience and relegating the other to the periphery. Likewise, Watzl would maintain that the 22% Gabor patch has a more central position in the conscious field in E_A than in E_U . As Watzl understands it, the structure of conscious experience is not reducible to what is perceived or represented. There need be no difference in the properties that one is aware of when attention shifts and conscious experience is restructured.¹⁶ Thus, we take Watzl's proposal to be a specific way of developing the notion of mental primer. For Watzl, a stimulus is mentally primed—it increases in phenomenal salience—when it is shifted towards the centre of conscious experience.

At this moment, we do not mean to endorse Watzl's or anyone else's specific account of mental primer. Our point is only that mental primer of *some* sort is needed to explain the phenomenal difference between experiences such as E_A and E_U if the Carrasco–Block interpretation of that difference in terms of perceived intensity is not empirically viable.

10. Conclusion

We agree with Block that attention alters the phenomenal character of perceptual experience. There is a phenomenal difference between E_A and E_U . We also agree with Block that this phenomenal difference cannot be reduced to what is perceived or represented. But whereas Block maintains that attention alters phenomenal character at least in part by altering objective appearances such as perceived contrast, we have argued that attention only alters phenomenal and functional salience. It

¹⁶ We say there 'need be' no difference in the properties one is aware of on Watzl's view because Watzl (forthcoming) accepts Block's interpretation of the Carrasco results, and thus thinks that there often are such differences. Obviously, we disagree with Watzl on this point.

primes stimuli for action and reflection, but without changing the properties they appear to have.

Jacob Beck

Department of Philosophy and Centre for Vision Research
York University, Toronto

Keith A. Schneider

Department of Biology and Centre for Vision Research
York University, Toronto

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