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Block on Perceptual Variation, Attribution, Discrimination, and Adaptation

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The Border between Seeing and Thinking is an instant classic. Exploiting his unparalleled knowledge of cognitive psychology, neuroscience, and vision science in rigorous and subtle philosophical argument, Block provides a sweeping analysis of key aspects of perception. Scientifically astute and philosophically decisive, it constitutes the gold standard of how to do empirically informed philosophy of mind. It would be impossible to do justice to it. We will restrict ourselves to six key issues: borders, perceptual variation, attribution, discrimination, adaption, and singular content.

1. Borders and Joints in the Mind and Brain

Since his influential distinction between access and phenomenal consciousness, a distinctive feature of Block's methodological approach has been to find borders and joints and to then focus the discussion of the relevant issues around these borders and joints. *The Border between Seeing and Thinking* is the culmination of this approach. It is rich with discussion of such borders: most centrally the border between cognition and perception, but also the border between conscious and unconscious perception, and conceptual and non-conceptual content, to name just a few.

The approach of organizing debates around borders has become common in philosophy of mind largely due to Block's towering influence. Alternative approaches are focused, not on borders between say perception and other mental capacities, but rather, for example, on determining what is constitutive of perception, on specifying its fundamental nature, or on understanding its mechanism. No doubt, those focused on these projects make lots of distinctions along the way, some of which correlate with joints and borders, and of course, Block has lots to say about the nature of perception. So ultimately, the two approaches may converge. That said, there is a question to be asked about what can be gained from attempting to delineate borders. Here is why.

We can all agree that there are mental events that are primarily perceptual and others that are primarily cognitive. But if perception and cognition are intimately interrelated—not just functionally but also regarding their physical implementation (see Pessoa 2022, Pessoa et al 2022)—then the question arises whether there is a joint in nature that correlates with the distinction between cognition and perception postulated not just by Block, but by researchers from many different scientific domains. More generally if the borders of the mind are fuzzy and permeable in all directions with information processing circuits distributed, then the question arises of how much we can learn about the nature of perception from attempting to specify and delineate borders and joints in the mind and brain.

2. News and Perceptual Variance

One key feature of perception that Block barely addresses is its perspectival character: a subject who gains information about her environment via perception does so under specific perceptual conditions. Such perceptual conditions include her location relative to the perceived objects and features in her environment, the lighting conditions, the color context, and the acoustic conditions (reverberation, refraction, and diffusion features in our environment), to name just a few. Due to the perspectival nature of perception, the stimuli on which our visual system operate are perpetually in flux. Nonetheless, we see the uniform whiteness of the walls of our office and the rectangular shape of our desk.

The constancy mechanism of our perceptual system downplays perceptual variation that is due to changes in lighting conditions, changes in the spatial relation between the perceiver and the perceived features, and other such perceptual conditions. So it downplays changes in our sensory input that are due to the perspectival nature of perception. This allows us to focus on features in our environment that are relatively stable.

Our first question for Block is how these facts about perspectival variance and perceptual constancy square with his thesis that the primary goal of vision is to deliver news. One possible response is to say that delivering news is just one of many core functions of perception. Two further core functions include guiding action and tracking objects. Regarding these two latter core functions, the constancy mechanism minimizes most news, namely news that is due to changes in perceptual conditions.

A second possible response is to say that there is important news and fleeting news. News due to perceptual variation is fleeting news. The idea then would be that perception aims only at providing important news. Adopting this strategy would then of course require a principled distinction between important and fleeting news.

A complicating factor with this second approach is that occasionally, news that is due to perceptual variation is important. A freight train that is barreling towards one as one is taking a stroll on what one thought was a defunct train track is important news. Yet, the rapidly increasing perspectival size of the train is news that is due to perceptual variance. So in this case, we gain important news due to fleeting perspectival news. We are not questioning Block's idea that perception functions to deliver news. We note only that a specification of this idea is required to account for the fact that perception systematically downplays vast quantities of fleeting information about perceptual variation in favor of perceptual constancy.

3. Discrimination and Attribution

Block argues that "all the markers of perception [rivalry, pop-out, illusory contours, processing speed, and adaption]... involve perceptual attribution" (p. 144). A further question for Block is: what is attribution? The term "attribution" is a philosophical term of art, championed primarily by Burge (2010). It is not used in vision science, and it is not obvious what if anything it would correlate to in any of the many branches of vision science. The same holds for neuroscience. In discussing the work of psychologists and neuroscientists, Block reports them as making claims about attribution.[1] But among the authors he cites, we could not find one who makes claims about attribution, though there are many claims made about generalization, identification, recognition, classification, and categorization. For example, he cites Thoen et al (2014) in support his claim that "different perceptual systems can prioritize attribution and discrimination in different ways" (p. 148). But while Thoen et al. discuss recognition, they do not discuss attribution, and Block does not consider recognition necessary for attribution.

As we will argue, vision science does not support the idea that "all markers of perception … involve perceptual attribution", on any notion of what attribution might be. We will argue that perception is fundamentally a matter of discriminating. At its core perception is difference detection over some dimension. That dimension could be time or space, it could be the frequency spectrum of light or sound, positions along the body, or molecules in the air, to name just a few. To detect difference, one needs a discrimination mechanism. In short, no difference, no discrimination, no perception. If there is no discrimination, the neural activity is unmodulated. Discrimination is essentially comparative: discriminative sensitivity is the ability to distinguish between stimuli of different kinds, where one of those stimuli might be a null-stimulus. Detection is discrimination between a stimulus and a null-stimulus, that is, the absence of the relevant stimulus. If a perceiver discriminates a stimulus from a null-stimulus, she detects the stimulus.

[1] Here and throughout, with "attribution" we mean perceptual attribution.

We will discuss discrimination in more detail in the next section. Here we will take a closer look at Block's notion of attribution. This much is clear: Block holds that perceptual attribution is non-conceptual seeing-as and that it has iconic format. But what does this entail and what does it map onto in vision science models of perception? There are many ways that Block specifies attribution. Here is the one that we find the most promising and that runs throughout his book:

> Attribution is an activity in which a feature is assigned to an *x*, where that *x* could be an object, an event, a region in space, to name just a few examples.[2]

Formulated in terms of representation, the idea is that to attribute is to represent *x* as *F*. This way of understanding attribution is built into the idea of perception as seeing-as, and it marks a clear distinction between discrimination and attribution. After all, when we notice the difference between two features in the environment there is no need for these to have been first attributed to an object, event, or area in space.

> Discrimination is an activity in which two particulars, or a particular and a null-stimulus in the environment are distinguished, where those particulars could be features, objects, or events.

So to attribute *F* is to represent *x* as *F*. So there must be an *x* to which the *F* is attributed. By contrast, on the discrimination view, there does not need to be an *x* to which the *F* is attributed. *F* could be represented without representing any *x* as *F*.

One might challenge the discrimination view by asking how the content <F> could have accuracy conditions. In response, while truth conditions require a sentence-like structure such as <x is F>, accuracy conditions do not. For the content <F> to be accurate, there simply needs to be an F in the perceiver's environment.

A more important difference between the attribution view and the discrimination view is what the relation is between representation, attribution, and discrimination. On the discrimination view, sensory discrimination of features, objects, and events in the environment grounds their representation. There is a thicker kind of discrimination on which we discriminate between features we have already represented, but that kind of discrimination is not sensory discrimination. Block does not deny that sensory discrimination is an important part of the perceptual mechanism. One question for Block is where sensory discrimination fits into the idea of representing *x* as *F*.

Now, Block concludes his discussion of attribution and discrimination modestly: "[A] number of considerations suggest that there is no strong reason to favor either attribution or discrimination as more basic than the other" (p.144). However, he makes many claims that are in tension with this modest conclusion. For example, he argues not only that perception is typically attributive, but argues further that most cases of discrimination require attribution: "to discriminate red from green one must in the general case, visually attribute color" (p. 148). While Block allows for exceptions to the general rule, he suggests in this passage and elsewhere that most cases of discrimination require first having attributed properties to the environment so as to be able to then discriminate those attributed properties. In response, we do not see why this would be the case. As Block acknowledges elsewhere, we do not need to first represent <*x* is green> and <*y* is red> to discriminate green from red. As we argue, discriminating the green stimulus from other stimuli is required to represent green.

[2] Thanks to Block for email confirmation that this is how he understands attribution.

Moreover, perceivers discriminate features in the environment. The statistical regularity of features in the environment constitutes the basis for segregating input into objects (e.g., Geisler, 2008) and representations (e.g., Saffran, Aslin, and Newport, 1996). In these cases, discriminating features in the environment precedes attributing them to objects or events. Rao and Ballard (1999) showed that, after exposure to natural images, a hierarchical network model with recurrent connectivity developed receptive fields like those of simple-cells in V1. Thus, preferences of neurons early in the visual processing reflect the statistical regularities in the environment. In short, features are in the environment and statistical regularities are extracted from the environment. Since the features are already in the environment, there is no need to attribute them. Block does not deny that features are in the environment. So the questions arise: Given that features are in our environment, what empirical evidence is there that we do not simply discriminate the features in our environment? What empirical evidence is there that in most cases of perception we discriminate features that were first attributed?

There are passages in which Block seems to suggest that attribution is detection:

"A simple attributor could be a device whose sole sense organ is a light-sensitive photocell. If a photon hits the light-sensitive element it fires. And we can imagine that downstream mechanisms use the firing as an indication of light. One could regard this mechanism as attributing without discriminating. It could be said that the detector attributes but does not categorize and so makes a poor comparison to perceptual attribution. Instead of a photocell, we could consider a telephone keypad. There are 12 buttons, each of which emits a distinct tone. A defender of discrimination as basic could claim that pressing one of the buttons discriminates between that button and others—or no buttons. And the defender of discrimination could say that the photocell detector discriminates between something and nothing. But then the claim that discrimination is basic would seem more of a postulation than a claim about what is substantively fundamental to perception.

A simple discriminator could be an exclusive-or gate that fires when its two inputs are different and does not fire when its inputs are the same. A see-saw (teeter-totter) would be an example if we take one of the sides moving into the air as firing" (p. 142f).

Here, Block suggests that there is a difference between detection and discrimination in that the mechanism of detection has one switch, while the mechanism of discrimination has two: a one-switch mechanism is activated in the presence of only one stimulus *A*, thus attributing *A*; a two-switch mechanism is activated in the presence of stimulus *A* and stimulus *B*, thus discriminating *A* from *B*.

Putting aside the fact that a null-stimulus is a stimulus, this model does not fit with the neurobiology. It presupposes that receptors are specialized in a way they are not. The very same receptors ground both detection and discrimination. Sensory receptors are the only channel through which a stimulus can impact the perceptual system. A receptor is sensitive to a narrow range of stimuli, be it a specific band of light wavelengths, a range of pressure waves, or set of molecules, or some other stimuli. In response to the stimulus, a signal is generated, that is, there is a change in voltage across the receptors cell's membrane. That signal in its simplest form is a function of the stimulus intensity. In short, the neurobiology of detection and discrimination is the same. The same holds further downstream. Neurons in area V4, an area deep in the visual ventral stream respond vigorously to certain preferred stimuli and very little or not at all to other stimuli (e.g., Desimone & Schein, 1987). Not only are the same sensory receptors involved in detection and discrimination, so are the same downstream neurons. So there is no sense in which there is a mechanism for detection that is distinct from a mechanism for discrimination.

Further, if attribution were simply detection, as the passage suggests, then attribution would be discrimination on standard models of perception. After all, as Block acknowledges, detection is a form of discrimination, namely, the case in which a stimulus is discriminated from a null-stimulus (p. 143). Indeed, Block's simple attributor is discriminating the presence of light across time. The light-sensitive element does

not fire if no light is present and fires when light is present. Thus, the mechanism is discriminating the presence of light from the null-stimulus. Further, we can detect a feature without attributing that feature to an object. So given how Block understands attribution, it cannot be detection. So much for attribution as detection.

Block posits that Bayesian theories of perception "treat[s] attribution and discrimination as distinct processes" (p. 143). But "attribution" is not a term used in Bayesian theories of perception, and it is unclear what it would map onto. Bayesianism provides a way to assign probabilities to hypotheses on which we can then update in light of new evidence. "Detection" and "discrimination" are used to describe tasks in which a subject is asked whether a stimulus is present or not. If a perceiver has two hypotheses "x is red" and "x is not red" and assigns higher probability to the hypothesis "x is red", then this can count as discriminating red from not red, and thus as detecting red. One could argue that assigning a high probability to "x is red" is attributing red to x, but that is not a term used in the theory. Insofar as "discrimination" is a task in which there are multiple hypotheses between which the subject needs to choose, where those hypotheses could be "x is present" and "x is absent", detection is a kind of discrimination in Bayesian theories of perception.[3]

Before concluding this discussion, we should note that there are other ways that Block specifies attribution. Here are a few:

1. Attribution is non-comparative.
2. "Categorical representation is part of the mechanism of attribution" (p. 145).
3. Attribution involves identification (p. 151).

Each of these ways of specifying attribution could distinguish attribution from discrimination:

1. Perceptual attribution is non-comparative, while discrimination is comparative.
2. Perceptual attribution requires categorization, while discrimination does not.
3. Perceptual attribution involves identification, while discrimination need not.

However, while Block holds that perceptual attribution is often non-comparative, he allows for many exceptions (1). He does not think that perceptual categorization is common (2). And he uses "identification" to refer to a cognitive rather than a perceptual act (3). So while being non-comparative, categorical, and involving identification make several appearances in Block's discussion of attribution, none are constitutive of attribution as Block understands the term.

4. Cases of Discrimination without Attribution

Block mentions repeatedly that he cannot think of a case of perception in which there is discrimination without attribution. We are puzzled by this claim. If attribution is an activity in which a feature is attributed to an x (be it an object, event, region in space), then any case of feature perception without that feature being attributed to an x is a case in which we discriminate two features without attributing those features. We do not see any good evidence why there could not be a creature that sees only features. More specifically, there are many cases of human perception in which there is no sense in which a feature is attributed to any x, be it an object, event, or region in space. Here are a few examples:

In the two-interval-forced-choice (2IFC) method, observers view two successive slides shown briefly and report whether a stimulus appeared in the first or second interval. The stimuli could be anything -- e.g., dim color patches or flashes of light). The task requires discriminating, for each interval, whether something or nothing appeared. There is no evidence that the feature is attributed to anything.[4]

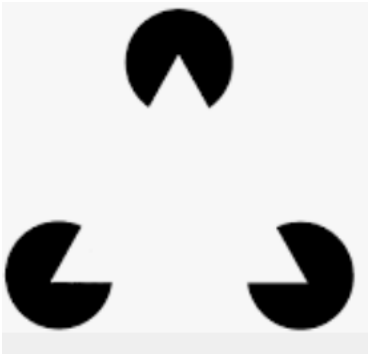
[3] We are indebted to John Morrison for helpful email exchanges on these matters.
[4] See Davies 2021 for discussion of many further examples that are cases of discrimination without attribution.

Another example is ganzfeld perception, in which we perceive an expanse of color that fills out our visual field. In a ganzfeld, we are not attributing a feature to anything (Hochberg, Triebel, & Seaman, 1951). Similarly, if we perceive the blue color of the sky, there is no evidence that the color is attributed to an object or event. Although in this case, one could argue that the color is attributed to a region in space.

If we move beyond vision, cases of feature perception without that feature being attributed to anything abound. A noise can be heard without attributing that noise to anything, be it a time, place, object, or event. In olfaction and gustation it is similarly possible to smell or taste features without attributing them to anything.

Of course, all these cases can be massaged so that an x is postulated to which the feature is attributed. However, if that is the approach, then the claim that such cases involve attribution becomes *ad hoc*. Indeed, it becomes impossible to cite empirical evidence that could decide the matter.

We do not deny that many cases of perception involve attribution. Human perceivers often attribute features to objects, events, and regions in space, especially in vision. Other clear cases of attribution are those in which at least one of the features perceived is not in the environment. There are many such examples (though all include discriminating at least one stimulus, and so none undermine the thesis that perception is fundamentally a matter of discriminating). Here are a few. Consider the Kanizsa Triangle illusion.



[Figure 1 – Kanizsa Triangle Illusion]

Perceivers typically report seeing a white triangle. However, there is no triangle in the picture. On the basis of the discriminated sensory input, perceivers attribute triangularity. So the stimulus on which the visual system operates is not of a triangle. But based on discriminating the stimulus provided, triangularity is attributed.

A different example is a case in which we see something through thick fog and given the shape discriminated, we may attribute that what we are seeing is a cow. However, the stimulus provided is not sufficient to discriminate a cow from its surrounding. A further example is a case in which we see dots organized roughly in a circle shape. We are not perceptually related to a circle, but we attribute circularity to our environment.

What these three examples have in common is that they are each a case of attributing a determinate feature to something in the environment that could be singled out in any number of ways. Now, one could argue that all features perceived are to some extent constructed in the perceptual process. In other words, one could argue that all cases of perception are to some extent like the three examples above. Block, however, does not hold such an idealist view. He argues, and we agree, that in most cases of perception, the features perceived are in the environment.

It should be noted that one seeming advantage of the attribution view over the discrimination view is that the attribution view solves the binding problem from the outset. After all, if the fundamental form of perception is to attribute features to some *x*, then there will not be a question as to which features in the environment are bound with which *x*. Friedman-Hill, Robertson, and Treisman (1995) report a case study in

which damage to the parietal lobe caused the miscombination of color and shape. In fairness, it should be noted that on the attributive view, there can be such miscombination, but the view seems to rule out the possibility of cases in which a subject represents features and objects and there is an open question as to which features are bound with which objects. It seems philosophical views should not be in the business of ruling out the possibility of such cases. The binding problem is a genuine problem in vision science and Block discusses it in various contexts in his book. If the solution to it is built into the fundamental structure of perception from the outset, then it would seem that vision science is dealing with a problem that does not genuinely exist.

As the examples above show, we can detect or discriminate features without having attributed them to an object or event. The binding problem arises because there is often a genuine question which object, event, or region in space (if any) instantiates relevant features discriminated in the environment. If such features could not be discriminated without first having been attributed to an object or event, the binding problem would never arise. It seems that having a built-in solution to the binding problem is not in fact an advantage of the attribution view, rather the attributive view dispenses with the problem without solving it.

Now, one could argue that the issue about whether perception is fundamentally a matter of discriminating or attributing is a terminological one. But Block devotes ten pages of his book entirely to this issue, so we assume that is not his stance. There is a clear difference between the two in so far as attribution requires binding a feature to an x whereas discrimination does not. We conclude with a question: if perceived features are in the environment and if there are features that are not features of objects, events, or regions of space, what is the evidence that we can only discriminate features once they have been attributed to objects, events, or regions in space?

5. Discrimination is Necessary for Perception

Block has it that there can be cases of perceptual attribution without discrimination. What would attribution without discrimination be? Consider a simple case of perception in which there is just one incoming stimulus A. Would Block say that a case of attribution without discrimination is a case in which the subject attributes a feature to the world without having discriminated that incoming stimulus A and without having discriminated any other stimulus?

In response, we argue that there can be no such case that qualifies as perception, since any case of perception requires sensory input, and we discriminate sensory input. Features, objects, and events are particulars in the world that impact our receptor neurons, thereby triggering perceptual discrimination. There can be no perception without this minimal stimulus impact. More formally, the argument is as follows:

Premise 1:	If a subject *S* is perceiving, then there is sufficient sensory input to *S*'s perceptual system.
Premise 2:	If there is sufficient sensory input to *S*'s perceptual system, then sensory receptors of *S*'s perceptual system transmit a signal to downstream neurons.
Premise 3:	If sensory receptors of *S*'s perceptual system transmit a signal to downstream neurons, then *S*'s perceptual system discriminates.
Conclusion:	If a subject *S* is perceiving, *S*'s perceptual system discriminates.

We see no need to stipulate that the perceiver attributes features at any stage of this process. We will give support to each premise in turn.

In support of Premise 1: No perception is possible if the sensory system has not at the very least been affected by a stimulus. If the sensory receptors are unaffected, then no information enters the relevant perceptual system,

and perception does not occur. Now there can be sensory input without perception: if the sensory input is below the receptors' threshold and so insufficient to transmit a signal downstream, there is no perception. However, if the subject is perceiving, there must be sensory input. So sensory input is necessary but not sufficient for perception.

One might ask whether the information could not have entered the system by some other route. In response: no doubt, a perceiver can imagine a scene, and the content of her imagination might affect how she processes perceptual information. Similarly, her beliefs might affect how she processes perceptual information. But if no perceptual information entered the perceptual system, then she is not perceiving. So, a case in which the sensory receptors remain unaffected can never be a case of perception.

In support of Premise 2: A sensory receptor is activated when it is impacted by a sufficiently intense stimulus. If the intensity of the stimulus equals or exceeds the threshold of the relevant sensory receptor, the receptor transmits a signal to neurons downstream. For instance, in the retina rod and cone photoreceptors transmit signals to neurons downstream (i.e., horizontal cells, bipolar cells, amacrine cells), prompting retinal ganglion cells to transmit signals to visual neurons in the thalamus, which in turn transmit signals to neurons in the visual cortex. It is possible to elicit a response in certain sensory receptors even using exceedingly low-intensity stimuli. In vision, the threshold for a rod receptor response is below one photon per rod (Dey et al., 2021).[5] In audition, energy on the order of of 10^{-18} Joule is sufficient to evoke responses from individual receptors (inner hair cells).[6]

There is significant flexibility as to which downstream neurons ultimately receive the sensory information transmitted from the sensory layers. In fact, sensory regions appear sufficiently flexible to successfully process multi-modal signals. For instance, visual inputs surgically re-routed to the auditory pathway are processed similarly to how they are processed in visual cortex (Sur et al., 1988; Sharma, et al., 2000). Even in intact brains, stimuli across modalities elicit widespread activity throughout the brain (Fishman & Michael 1973; Niell & Stryker 2010; Steinmetz et al., 2019). These facts do not challenge Premise 2. After all, in all these cases sensory input was transmitted to neurons downstream and all we need for perception is input from some receptors to some receiving perceptual processing area downstream.

In support of Premise 3: To discriminate we need three building blocks: (1) sensory receptors, (2) downstream processing of the information they transmit, (3) a response that exceeds threshold. The sensory receptors transduce the signal so that neurons can send it higher in the system. Could the system process information that entered via the sensory receptors without discriminating that information? In response, no. If there is above-threshold activation, then the perceptual system will discriminate. This is the case, even if the stimulus is uniform. After all, the perceptual system will discriminate the uniform stimulus from how things were before this stimulus started. That is a case of detection.

Block cites the ganzfeld case as if it were a problem for the discrimination view. But in fact, the ganzfeld effect is evidence for the discrimination view and evidence against the attribution view. A ganzfeld is a homogenous field of fog-like light. In discussing ganzfelds, Block seems to be talking about detection, which,

[5] The threshold for a rod receptor response has long thought to be one photon based on research with a small stimulus (Hecht, etal., (1942). In light of research on full-field stimulation and contemporary knowledge regarding convergence in the rod pathway, it has recently been discovered to even less than that (e.g., Dey et al., 2021).

[6] For example, for a 1000-Hz tone at the absolute hearing threshold, the sound energy entering the ear canal is the product of the energy per cm^2 (10^{-16} Joule/cm^2, Green and Dai, 1991) and the average ear canal cross-section area (roughly 0.5 cm^2), or 0.5 x 10^{-16} Joule. Assuming that this energy is equally distributed over the 100 hair-cell receptors within the critical band centered on 1000 Hz, the energy per receptor would be about 0.5 x 10^{-18} Joule.

as he acknowledges elsewhere, is just discrimination.[7] Discrimination can happen over any dimension. One important such dimension is time. Let's assume that at time t_1, we see a regular scene. At time t_2, we see a ganzfeld. So at t_2, we detect the fog-like expanse by discriminating it from the null-stimulus at t_1.

A null-stimulus is a relative term. If at t_2 a perceptual system detects stimulus A, then the null-stimulus at time t_1 is the absence of A. The null-stimulus need not be the absence of any stimulus. It is the absence of the stimulus that gets detected at t_2. Of course, the perceptual system does not need to represent the null-stimulus as such. The point is that if a system detects A, it must be able to differentiate the occurrence of A from when A was not occurring.

How does the ganzfeld effect support the discrimination view? When one sees a ganzfeld case there is a change, namely before and after the subject is exposed to the ganzfeld. That change allows the perceiver to see the ganzfeld. Due to lack of any further change, the sensory system shuts down and the ganzfeld effect sets in. No new stimulus impacts the sensory receptors and so no signal is transmitted to downstream neurons. Without discrimination of something new, perception ceases. So the ganzfeld effect supports the thesis that if there is no difference, there can be no discrimination, and so no perception. On the attribution view, the relevant color is attributed, and it is unclear why the ganzfeld effect sets in.

To clarify: the thesis that there can be no perception without discrimination does not imply that all aspects of perceptual representation are due to discrimination. It implies only that there can be no case of perception that does not include discriminating at least one stimulus from another, where one of the two stimuli could be the null-stimulus.

6. Adaptation without Attribution

Block holds that one of the markers of perception is adaptation. One reason why Block argues that attribution is critical for perception is that he holds that it must be involved in adaptation. As he puts it: "The mechanisms of the repulsive effects of adaptation described earlier (in Chapter 2) all depend on attribution" p. 144. Moreover, he argues that in adaptation we attribute without discriminating (p. 145). If, as Block argues, adaptation is a marker of perception and adaptation depends on attribution but does not involve discrimination, then—if true—this would imply that attribution, but not discrimination is a key feature of perception.

In response, we agree with Block that adaptation is a key marker of perception. Indeed, adaptation can occur at the earliest stage of the perceptual process, namely the functioning of the neurons at the lowest level of the visual system and even the level of sensory receptors. However, even in perceptual adaptation cases, we must discriminate. Moreover, evidence supports that many adaption cases are purely discriminatory. It is not obvious that they involve attribution on any of the ways one might understanding attribution.

To illustrate, let's use a few of Block's key examples: "In adaptation to red, an extended period of attribution of red or repeated attributions of red shifts the balance of the red / green channel toward green. An extended period of attribution of high numerosities raises the threshold for attribution at high numerosities" (p. 144).

We can all agree that adaptation raises the threshold for detecting features, but there is no need to stipulate the philosophical construct of attribution to explain such cases. A better way is as follows: an extended period of exposure to red or high numerosities raises the threshold for detecting red or high numerosities. Indeed, most cases of adaptation (perhaps all?) can be accounted for within the framework of discrimination, without any need to posit attribution.

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[7] "Of course, it is always open to an objector to insist that in a ganzfeld perception there is discrimination between something and nothing, between one color and another or between the portion of surfaceless fog on the left and the portion of surfaceless fog on the right or between the surfaceless fog now and the surfaceless fog a second ago. (See Schellenberg, 2018, p. 27, for this line of thought.) But without some actual evidence for mechanisms of discrimination in the ganzfeld perception, this sounds more like postulation than like a substantive thesis" (p. 145).

To say that no discrimination is occurring (as Block claims) suggests that due to the adaption process, the discrimination system got shut down. But there is no reason to think that it would. Adaptation brings about a reduction in responsivity to a specific stimulus. Due to the adaptation, the relevant sensory receptors or neurons are not behaving in the same way to the incoming signal as they would have had the adaptation not occurred.

So the information that the sensory receptors or neurons transmit to downstream neurons will be different than if they had not been affected by the adaption process. In short, not only do perceptual adaptation cases necessarily involve discrimination, one can explain adaptation cases without the perceiving subject attributing at all. One discriminates with adapted neurons. Due to having been affected by adaptation, neurons discriminate differently. But they are still discriminating.

This argument about neurons generalizes to adaptation at other stages of sensory processing: Adaptation can happen at sensory receptors (as in dark adaptation), opponent-process mechanisms responding to color (Hering, 1964) cortical neurons responding to tilted bars (Jin, et al., 2005), and faces (Leopold, et al., 2001; Rhodes, et al., 2007).

Now let's assume for the sake of argument that adaptation cases necessarily involve attribution, as Block argues. Even if this were the case, any adaptation cases involve discrimination as well, and they involve discrimination at a more fundamental level. After all, the perceptual system needs to operate on some incoming stimulus for the mental event to qualify as a perception. All perception, including adaptation cases, involve discrimination.

Block knows the empirical literature in and out. That said, when it comes to attribution and discrimination, we believe that he gets things wrong. However, giving up the idea that there can be attribution without discrimination does not affect Block's key insights. So he would lose little to accept that perception is constitutively a matter of discriminating. We suggest that he does.

7. Singular Content

Our final questions for Block concern his discussion of singular content. Block discusses the matter of whether perception is fundamentally a matter of discriminating or fundamentally a matter of attributing in the context of a discussion of whether perceptual content is singular or entirely general. It might be helpful to explain how the two issues are connected. Schellenberg argues that perceptual content is singular because perception is a matter of discriminating particulars in the environment (for details, see Schellenberg 2018, p. 24f). So she argues that perception is individuated by its causal source in that perceptual content is constituted by the perceived particulars. This argument hinges on the fact that perception is stimulus dependent. If Sam is seeing a tree, the stimulus that her neural system processes stems from the tree perceived. Due to perceptual content being individuated by the perceived particulars, perception grounds demonstrative reference, justifies beliefs formed on the basis of perception, and provides us with knowledge of the particulars perceived (rather than knowledge of qualitatively identical particulars). It is important to note that one can accept that perceptual content is singular for reasons other than these. Moreover, one may be able to accept that perception is fundamentally a matter of discriminating without accepting Schellenberg's argument for perceptual particularity. But if there is a connection between perception being a matter of discriminating and perceptual content being singular, then it would be along the lines above.

Block's focus throughout is on issues in philosophy of mind. It is neither on the epistemological role that perception plays in justifying beliefs and yielding knowledge about particulars in our environment nor on the role it plays in grounding demonstrative reference and bringing about singular thoughts. So it is not surprising that he has little patience for the idea that perceptual content is singular.

There is much with which we agree in Block's discussion of singular content. For example, we agree that "perception has no access to the distinction between qualitative and numerical identity" (p. 127). However, accepting this does not conflict with accepting that perceptual content is at least in part constituted by the particulars perceived. After all, on any view according to which phenomenal character supervenes on or is grounded in representational content, there can be aspects of perceptual content that are not revealed in phenomenal character. So the fact that we do not have access to the numerical identity of the perceived particulars does not imply that the perceived particulars do not constitute perceptual content. In fairness, Block acknowledges that his appeal to what we have access to is not "much of an argument against the singular content view" (p. 127).

Block argues that the singular content view is less "plausible when one considers cases in which one perceives motion without perceiving an object moving". Here again, we agree with Block that singular content views on which features are not particulars in the world will face such counterexamples. But as Block acknowledges, a singular content view like Schellenberg's can accommodate such cases. As she argues, the particulars perceived include not just objects and events but also features (where those features are not universals, but rather particulars in the environment). Block addresses this argument in the following passage:

"To be fair to Schellenberg, she offers an argument that we see instances of properties. Her argument is that when we perceive the shape of the cup, the shape must be causally efficacious since we cannot see what does not causally impinge on us (Schellenberg, 2018, pp. 145–150). However, this argument assumes her view of causation as based in property instances. There are alternative pictures of perceiving the shape of the cup, some of which postulate instances of shapes and others of which do not.

One alternative picture is that I see the cup, attributing a shape property to it. It is in virtue of the shape property of the cup that I see it as having that shape. What is causally efficacious in this case is the cup's having a certain shape, or, alternatively, the cup itself, and it is causally efficacious in producing the perception in virtue of some of its properties but not others. There is no need to appeal to property instances on these accounts" (p. 129f.).

The alternative view Block outlines here seems to be that objects have properties, which in turn is best understood as the idea that objects instantiate properties. If that is the idea, then it is just a version of the view Schellenberg defends. After all, an object having a certain shape is to say that the object instantiates a certain shape, which is a causally efficacious feature in the environment. It is a feature that produces a stimulus, and it is a feature that we can discriminate. Block has it that features are in the environment to which we are perceptually related and that features are universals. But presumably he does not hold that universals are in our environment. Something has to give.

Now Block takes issue with Schellenberg's particularity argument as follows: "My capacity to discriminate and single out M&Ms for purposes of eating them is a capacity to discriminate and single out whatever M&Ms are ready to hand and would make suitable snacks. When this capacity successfully singles out a particular M&M, the resulting state is not constituted by that particular M&M, since the same capacity might have singled out a different M&M" (p. 131).

In response: the fact that the same capacity could single out any particular M&M does not imply that the resulting state is not constituted by the particular M&M perceived. Indeed, it is crucial that the capacity to discriminate and single out particulars of a certain kind is a general capacity. It is general in that it could be employed to discriminate and single out any suitable particular. This generality of capacities is a key feature of Schellenberg's view. It is central to her argument that perception is representational.

Block moves from noting that capacities are general in this way, to arguing that there is a weak and a strong sense of discriminating and singling out. But contra Block there is no weak and strong sense of discriminating and singling out. Capacities are general on any reasonable understanding of capacities. If we

employ a capacity to discriminate and single out whichever particular of the right kind is present (if any), the ensuing perceptual state is constituted by that particular (for details of this argument, see Schellenberg 2018, 24 f.).

We see no reason why Block must deny that perception has singular content. Not only is the idea that perceptual content is singular compatible with his key commitments, it would make his view more attractive to epistemologists and philosophers of language, or indeed anyone concerned with questions of how perception grounds demonstrative reference, yields singular thoughts, fixes the reference of singular terms, provides us with knowledge of particulars in our environment, and justifies singular thoughts about particulars in our environment.

Our job has been to criticize, but in ending we would like to note that we are sympathetic to most of Block's account. We are grateful for the opportunity to engage with his work.

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