

Perceptual Categorization and Perceptual Concepts

Abstract: Conceptualism is the view that at least some perceptual representation is conceptual. This paper considers a prominent recent argument against Conceptualism due to Ned Block. Block's argument appeals to patterns of color representation in infants, alleging that infants exhibit categorical perception of color while failing to deploy concepts of color categories. Accordingly, the perceptual representation of color categories in infancy must be non-conceptual. This argument is distinctive insofar as it threatens not only the view that *all* perception is conceptual, but also views that restrict the Conceptualist thesis to perceptual *categorization*. However, I contend that it fails at two stages. Block's arguments for the perceptual representation of color categories in infancy, and against color concept deployment in infancy, are unpersuasive. Thus, Block has not vanquished Conceptualism. I draw out implications for debates about the perception-cognition border and for the question of whether explicit categorization occurs in perception.

Keywords: Perception, Concepts, Perception-Cognition Border, Categorization, Color Perception

1. Introduction

What is the role of concepts in perception? *Conceptualism*, as I'll understand it here, is the view that at least some perceptual representations are partly constituted by concepts. Specifically, certain token perceptual representations have, as constituents, tokens of the same representation-types canonically used in reasoning and inference. Recently, the debate over Conceptualism has taken on broader philosophical significance, with several theorists suggesting that the distinction between perception and propositional thought (Carey 2009: 7-10; Burge 2010: 540), or the perception-cognition border more generally (Block 2023), consists partly in the fact that perceptual representations are constitutively non-conceptual. So, understanding the role of concepts in perception is deeply important for understanding the architecture of the human mind.

The present paper considers a prominent recent objection to Conceptualism due to Ned Block (2023). Block's argument appeals to patterns of color representation in infants, alleging that infants exhibit categorical perception of color while failing to deploy concepts of color categories. Thus, perceptual representation of color categories cannot require the use of concepts. I argue that Block's argument fails at two stages: His empirical case for both (i) the perceptual representation of color

categories in infancy, and (ii) the lack of color concept deployment in infancy, is unpersuasive. Thus, Conceptualism survives Block's challenge.

I proceed as follows. Section 2 distinguishes two versions of Conceptualism: Total Conceptualism and Weak Conceptualism. The former claims that *all* perceptual representation is conceptual, while the latter claims only that perceptual *categorization* is conceptual. While most traditional arguments for non-conceptual perceptual representation target Total but not Weak Conceptualism, a significant feature of Block's argument is that it threatens both. Section 3 assesses Block's view that infants deploy perceptual representations of color categories and argues that the evidence does not favor this view over alternative models that do not posit perceptual category representations. Section 4 assesses Block's claim that infants do not consult information about color when forming expectations about objects, and thus do not deploy color concepts. I argue that the balance of developmental evidence does not motivate this claim, since it fits at least as well with the view that infants spontaneously conceptualize objects' colors, but only find certain color changes surprising. Section 5 observes that the failure of Block's argument offers comfort both to Weak Conceptualists and, perhaps surprisingly, to *Non-Conceptualists* who consign explicit categorization to post-perceptual cognition.

2. Conceptualism and Perceptual Category Representation

2.1. Strong vs. Weak Conceptualism

Some have held that all perceptual representation is conceptual. In particular, for any property F, perceptually representing F requires possessing and deploying a concept of F (Peacocke 1983; McDowell 1994; Brewer 1999; Connolly 2011; Mandik 2012). Call this view *Total Conceptualism*. The polar opposite of Total Conceptualism is *Total Non-Conceptualism*. According to Total Non-Conceptualism, there is *no* property F such that perceptually representing F requires possessing and

deploying a concept of F. Obviously, there is a vast middle ground: views on which *some* but *not all* perceptual representation is conceptual. This section explores options in this middle ground.

Debates over Conceptualism presuppose an operative notion of “concept.” There is little agreement about how to understand this notion (Laurence & Margolis 1999; Machery 2009). However, here I will assume a representational account (Margolis & Laurence 2007), on which concepts are mental representations that are constituents of thoughts, and which prototypically function in central cognitive processes like inference, practical reasoning, and planning (Block 2023: 166).¹ When I speak of the *concepts* a subject possesses, I will mean the mental representations at her disposal for such processes. Thus, concepts are representation-types, tokens of which are constituents of thoughts. Our question is whether tokens of these same representation-types can also be constituents of perceptual representations.

Although Total Conceptualism can be motivated in various ways (Mandik 2012: 618), the most influential arguments for it appeal to the epistemic role of perception. Roughly, for a mental state to provide reasons for belief for a subject, its content must be characterizable using concepts the subject possesses. Since perceptual states patently provide reasons for belief, their contents must be characterizable using concepts the subject possesses (McDowell 1994; Brewer 1999). Note, further, that the most straightforward explanation of why perceptual states would be constrained to represent contents characterizable using concepts the subject possesses is that perceptual states are simply composed of concepts deployed (i.e. “tokened”) by that subject. Thus, if a subject perceptually represents some property F, then she must deploy a concept of F.

¹ Proponents of representational accounts differ, however, on whether it is *essential* to concepts that they play this role in cognition. Block answers affirmatively (2023: 166), while others demur (e.g. Quilty-Dunn 2020, 277). I set this issue aside for present purposes, and simply grant that concepts constitutively function in reasoning and inference. After all, it is an independently interesting question whether concepts in this sense ever intrude into perception.

However, Total Conceptualism faces various challenges. Gareth Evans's *fineness of grain* argument alleges that perception distinguishes and represents more determinate shades of color than we have concepts for. Thus, the perceptual representation of color outstrips color concepts, so color perception is at least partly nonconceptual (Evans 1982: 229; Peacocke 1992, 2001a; Heck 2000). Roskies (2008) has argued that if all perception were conceptual, then we would have no adequate account of the learning of basic lexical concepts, saddling us with an extreme form of concept nativism. And still others argue that Total Conceptualism conflicts with evidence that perceptual representation occurs in perceivers who lack canonical conceptual capacities, such as capacities for logically structured thought (e.g. Peacocke 2001b; Burge 2010; Block 2023).²

While I will argue that Conceptualism survives Block's challenge, I do not aim to defend Total Conceptualism. I assume that there are cases in which a subject perceptually represents property F without deploying a concept of F. Rather, I am interested in whether *all* perception is non-conceptual, or whether perception might involve some hybrid of non-conceptual and conceptual representation (Peacocke 1992: 88; Mandelbaum 2018; Quilty-Dunn 2020). Why might one seek such a hybrid account?

First, even if Total Non-Conceptualism offers a *coherent* picture of the perception-cognition interface, some have argued that the most *empirically plausible* model of that interface construes perceptual states as partly conceptual. Such arguments are typically framed on the assumption that differences between conceptual and non-conceptual representations correspond with differences in *representational format*—i.e., the “code” in which the representations encode their contents. For instance, it is claimed that non-conceptual representations are standardly iconic or analog, while conceptual

² Regarding the epistemic role of perception, Total Non-Conceptualists typically hold that perceptual states can epistemically support corresponding beliefs even if the two differ in content (Evans 1982: 227-228; Burge 2003; Beck 2020). For example, perhaps perceptual state E warrants the belief that p provided that E's content implies p (e.g. Byrne 2005). This condition can be met even if the subject lacks concepts necessary to characterize E's content.

representations are discursive or language-like (Fodor 2007; Heck 2007; Gauker 2011; Block 2023). If perception outputs representations in the same format utilized by cognition, then such representations could be immediately used in reasoning without needing to “translate” them into a new format (Fodor 1983: 40, 97; Mandelbaum 2018: 271; Quilty-Dunn 2020: 274).

Hybrid Conceptualists have also adduced evidence for their view. Mandelbaum argues that a hybrid Conceptualist model best explains our abilities for ultrarapid categorization, such as recovering an item’s basic-level category following a masked presentation of only 13 ms (Mandelbaum 2018).³ Others appeal to hybrid models to explain the integration of high-level categories (e.g. alphanumeric categories) within perceptual object representations, and their use in perceptually reidentifying objects over time (Quilty-Dunn 2020; cp. Green & Quilty-Dunn 2021).⁴

However, if someone claims that certain perceptual representations are conceptual, the obvious question to ask is: *which ones?* According to one hybrid model, concepts are needed only when perception engages in *abstraction*—i.e., explicit representation of abstract kinds or categories, beyond the representation of their instances or determinates. When perception explicitly represents such abstract categories or kinds, it does so by deploying concepts of them. However, perceptual representation of fine-grained or determinate features (e.g., specific colors or shapes) needn’t require deploying concepts of those features. Call this view *Weak Conceptualism*. According to Weak Conceptualism, perceptual representation of the category *dog* would be conceptual, while perceptual representation of an individual dog, or its determinate shape and texture, is potentially non-conceptual.

Some hybrid Conceptualists seem inclined toward Weak Conceptualism. For instance, Mandelbaum (2018) construes the debate between Conceptualism and Total Non-Conceptualism as hinging on the question of whether perceptual categorization occurs:

³ See Block (2023: ch. 8) for objections to this argument; see Mandelbaum (2024) for a reply.

⁴ See Block (2023: ch. 5) for objections to these arguments; see Green (2023) and Quilty-Dunn (forthcoming) for replies.

As I will use the term, “conceptualists” are theorists who maintain that categorizing a visually presented stimulus (henceforth: categorizing) occurs perceptually, so that perception outputs an already conceptualized representation. In contrast, “non-conceptualists” propose that the outputs of perception are non-conceptual representations, which entails that categorization must occur post-perceptually. (267)

On Mandelbaum’s view, then, categorization occurs in perception, and this suffices to show that Conceptualism is true. Thus, he must assume that perceptual categorization requires concepts.⁵

One might also take Weak Conceptualism to be supported by format considerations. It has been argued that some prominent models of iconic format, including Block’s, do not permit iconic representation of certain abstract categories (Beck 2023; Green 2023: 488; Gross forthcoming). If one believes that categorical representation is paradigmatically discursive, and that the non-conceptual/conceptual distinction roughly tracks the iconic/discursive distinction (see above), then one might be drawn to the view that perceptual representation of abstract categories is conceptual while other perceptual representation needn’t be.

Weak Conceptualism doesn’t claim that *all* perceptual representation of determinate features is non-conceptual, only that such representation isn’t *required* to be conceptual, while perceptual representation of abstract categories is so required. Weak Conceptualists may vary on the modal strength of this requirement. Perhaps it is a metaphysically necessary generalization, or perhaps it is a contingent law of human psychology. For present purposes, this won’t matter. Block’s challenge to Conceptualism stems from putative real-world cases in which human perception represents categories without deploying concepts of those categories. If this argument succeeds, then both versions of Weak Conceptualism are refuted.

Note that there are versions of Conceptualism even weaker than Weak Conceptualism. It might be claimed that only *some* kinds of perceptual categorization require concepts. For example,

⁵ However, Mandelbaum is primarily concerned to argue that “basic-level” categories are perceptually represented conceptually (2018: 274). He does not discuss perceptual representation of color categories.

perhaps perceptual representations of “high-level” categories (e.g. natural or artificial kinds) are conceptual, while perceptual representations of “low-level” categories (e.g. shape or color categories) are not.⁶ Since Block’s argument centers on the perception of color categories, it does not challenge this hybrid form of Conceptualism.

There is principled reason to focus on Weak Conceptualism here. It is a natural hybrid form of Conceptualism, and it is genuinely threatened by Block’s argument, while alternative weaker forms of Conceptualism are not. Moreover, as we’ll see below, it marks a form of Conceptualism that *is* threatened by Block’s argument but *not* by traditional Non-Conceptualist challenges, such as the fineness-of-grain argument. So, by focusing on Weak Conceptualism, we highlight Block’s novel contribution to the Conceptualism debate.

2.2. *Perceptual vs. Cognitive Categorization*

Total Non-Conceptualists commonly disagree with Weak Conceptualism about the stage at which categorization occurs. Such theorists often claim that categorization proper occurs not within perception, but within cognition (e.g. Gauker 2011: 1). Perception represents particular values along perceptible dimensions, while cognition has the job of “chunking” values along these dimensions into discrete determinable categories. This view is especially salient in discussions of color perception. For example:

At the level of experience, I am sensitive to...all manner of differences in the light, sound, pressure, temperature, and chemistry of the objects affecting my senses. I nonetheless have a limited conceptual repertoire for categorizing these sensory differences.... At the sensory level I can discriminate hundreds of different colors. At the conceptual level I operate with, at best, a few dozen categories for the colors I experience. (Dretske 1995: 18)

⁶ See Siegel (2010: 97) for the distinction between high-level and low-level properties. Alternatively, one might suggest that perceptual representation of *sortal* categories (*dog* or *tree*) is conceptual while perceptual representation of *non-sortal* categories (*sand* or *water*) is not. In line with this, some hold that representation of sortal categories marks a greater psychological achievement than representation of non-sortal categories (Strawson 1959; Clark 2000).

I...want to insist that, if there are conceptual elements that occur in perceptual experience, they are not color concepts like *blue*: I see no reason to suppose that, in the strictest sense, anything ever looks *blue* to anyone. (...) What I am denying is that there is anything common to my perceptual experience of the clear blue sky and the deep blue sea. (Heck 2007/2023: 121)

Note that a Total Non-Conceptualist might claim that determinable color categories are *implicitly* represented in perception thanks to representing their determinates. Nonetheless, on these versions of the view, perception does not *explicitly* represent color categories.

What is an “explicit” category representation? For present purposes, I’ll understand explicit category representation on the model of Dretske’s (1981: ch. 7) notion of *extraction* (cp. Matthen 2005: ch. 3; Kulvicki 2007). A representation R *extracts* a category C when either R, or a separable constituent of R, represents C and does not represent anything else, or anything more specific. The sentence “the spotted leopard is lying in the green grass” possesses separable constituents that represent the properties *spotted* and *green*, and nothing more specific. The constituents are separable insofar as they can remain unchanged while other constituents of the sentence are altered (see: “the spotted owl is perched atop the green tree”). Thus, the sentence extracts, and so explicitly represents, the properties *spotted* and *green*. Conversely, a photograph of a spotted leopard lying in the grass has spatial parts that depict the leopard and the grass, but arguably no separable constituents that extract the properties *spotted* and *green*, since the parts of the photograph that encode (say) the grass’s greenness *also* encode more specific information about its determinate *shade* of green.

Thus, according to common Total Non-Conceptualist views of color perception, perception does not explicitly represent determinable color categories. Chunking the shades into determinable categories both (i) belongs to postperceptual cognition, and (ii) is accomplished using concepts.

Importantly, while Block is a Total Non-Conceptualist, he rejects both (i) and (ii). He claims that perception explicitly represents color categories, but denies that these representations comprise color concepts. He invokes a distinct type of representation—*perceptual category representation*—which

differs both from perceptual representation of fine-grained features and from concepts (Block 2023: 266). The notion of perceptual category representation is intended to have broad application. For instance, one might perceptually represent the categories *agency* or *causation* without having concepts of them. However, Block thinks color perception offers the strongest case for thinking that someone can have a perceptual category representation of F without having a concept of F.

Because Block embraces explicit perceptual category representations, it is imperative that he defend their non-conceptuality. For on Block's view, perception is constitutively non-conceptual, non-propositional, and iconic, and this grounds the border between perception and cognition.⁷ So, beyond the particular question of whether perception is conceptual or non-conceptual, the status of perceptual categorization is important for analyzing the joint in the mind between perception and thought.

Most traditional anti-Conceptualist arguments target only Total Conceptualism. For example, even if the fineness-of-grain argument demonstrates that perception of determinate shades of color is non-conceptual, it leaves open whether perceptual representation of color categories like redness or blueness (assuming it occurs) is conceptual. And one might grant that perceptual representation occurs in primitive creatures without granting that explicit perceptual representation of abstract categories occurs in such creatures.

A particularly interesting feature of Block's argument is that, if it succeeds, it refutes Weak Conceptualism alongside Total Conceptualism. For the argument turns on alleged cases in which a subject perceptually represents a category F without deploying a concept of F. Thus, Block's argument poses a deeper threat to Conceptualism than the traditional challenges, because it threatens to show that one of the most natural hybrid versions of Conceptualism is unworkable.

⁷ For alternative views of the perception-cognition border, see Beck (2018), Green (2020), Montague (2023), and Nes (2023).

Furthermore, Weak Conceptualists can arguably accommodate other data often taken to support Non-Conceptualism. For instance, some have claimed that perception differs from canonically conceptual processes like deductive inference insofar as it cannot represent logically complex contents such as disjunctions or negations (Burge 2010: 540; Block 2023: ch. 4). As Geach (1967) observed, “In the sensible world you will find no specimens of alternativeness and negativeness” (22-23). However, the claim that perception deploys *some* concepts doesn’t entail that it deploys *all* concepts, including concepts of logical connectives. Weak Conceptualists hold that perception deploys tokens of certain representation-types that, when tokened within cognition, can combine with logical operators to encode logically complex contents. Perhaps these representation-types do not function this way when tokened within perception. However, concepts needn’t figure in logically complex structures *every time* they are tokened, even if we grant that they must be *capable* of doing so. So, it’s hard to see how the lack of logical complexity in perception could suffice to refute Weak Conceptualism.

I turn now to Block’s argument.

3. Color Categorization in Infancy

Block’s argument rests on two clusters of findings concerning the color processing abilities of infants. First, infants 4-months-old and older exhibit categorical perception of color: roughly, increased sensitivity to color differences across color category boundaries versus differences within categories. Second, however, infants 6-12 months in age allegedly don’t use color to individuate objects or form expectations about them. Thus, Block contends that infants 6-11 months of age perceptually represent color categories without deploying concepts of color categories. Therefore, a subject can perceptually represent a category F without deploying a concept of F. This conclusion threatens Weak Conceptualism because Weak Conceptualists hold that all perceptual category representation is

conceptual. If color perception offers a case of perceptual category representation that is *non*-conceptual, then Weak Conceptualism fails.

I will argue that Block's empirical arguments for both:

- (a) perceptual representation of color categories in infancy, and
- (b) lack of color concept deployment in infancy

are unconvincing. Thus, Block has not vanquished Weak Conceptualism.

Let's start with (a). Block adduces two forms of evidence that infants perceptually represent color categories. The first involves habituation: Babies are repeatedly shown a stimulus of one color until they get bored of it, then they are shown a test stimulus of a new color. The question is whether they look significantly longer, or "dishabituate," to the test stimulus. The key finding is that infants as young as 4 months will dishabituate to a test stimulus belonging to a different color category from the habituation stimulus, but not to one that falls within the same category (Bornstein *et al.* 1976; Franklin & Davies 2004; Skelton *et al.* 2017). Using this novelty-preference paradigm, Skelton *et al.* (2017) found that infants 4-6 months of age were sensitive to categories roughly corresponding to yellow, green, blue, purple, and red.

However, a problem with appealing habituation evidence in this context is that when infants see the test stimulus, their impression of novelty is not directly determined by their *perception* of the earlier habituation stimulus, but by their *memory* of it. This raises the possibility that categorical sensitivity might arise in working memory rather than perception (Huttenlocher *et al.* 2000; Franklin *et al.* 2005). This would be problematic for Block, since, by his own lights, working memory is not purely perceptual, but rather a hybrid of perceptual and cognitive representations (Block 2023: 258). Thus, if the evidence shows only that infants have color category representations in working memory, then it would fail to settle whether the relevant representations are perceptual or cognitive.

Moreover, there is independent evidence that categorical effects on color recognition in adults are stronger when items are retained in working memory, and grow more pronounced with increasing memory load (Bae *et al.* 2015; Hardman *et al.* 2017; see also Bae & Luck 2018). Thus, the habituation results cannot isolate categorical sensitivity in perception proper. Tellingly, Skelton *et al.* (2017: 5549) take their results to bear only on infants' "recognition memory" for colors, not perception.

Fortunately, Block's second line of evidence implicates perception more directly. Franklin *et al.* (2005) showed 4-month-olds a colored patch against a differently colored background of the same luminance. Critically, infants moved their eyes to the patch more rapidly when the patch and the background differed in color category (blue versus green) than when they had different shades within the same category, even when the two were otherwise equidistant in color space.⁸ Plausibly, the patches are detected more rapidly in the different-category condition than the same-category condition because they appear more dissimilar from their background.

These findings suggest that infants are perceptually sensitive to color categories: surfaces from different color categories appear, *ceteris paribus*, more dissimilar than surfaces from the same color category. But should we further conclude that infants *perceptually represent* color categories? Block suggests that the answer is yes, because greater sensitivity across categorical boundaries than within categories is plausibly underpinned by perceptual representation of the categories themselves. He writes:

What is a perceptual category representation? One definition often given is that, for perceptual categories, discrimination across boundaries is more fine-grained (i.e., more sensitive to objective differences) than discrimination within boundaries. (...) Such definitions, though, may be less fundamental than another approach based on perceptual attributions of the

⁸ Ensuring that such stimuli are "otherwise equidistant" in color space is a nontrivial challenge. Bornstein *et al.* (1976) tried to equate within- and between-category differences by rendering them equally different in wavelength. However, not all wavelength differences are equally perceptually discriminable, raising doubts about whether these stimuli were adequately controlled. Franklin *et al.* (2005) instead equated within- and between-category differences in CIE color space, which corresponds better (though still not perfectly) with perceptual dissimilarity, as indexed by just-noticeable differences.

categories themselves. Better discrimination across than between borders may be just an index of those categorical representations. (Block 2023: 271)

The idea, I take it, is that surfaces from the same color category appear more similar than otherwise equidistant surfaces from different color categories *because* the former are represented as sharing a property that the latter are not—namely, their color category. Call this the *perceptual categorization hypothesis*.

However, the perceptual categorization hypothesis is not the only viable explanation of the relevant patterns of perceptual similarity. Perceptual *sensitivity* to categories doesn't imply perceptual *representation* of categories (cp. Gross forthcoming). An alternative account, which I'll call the *perceptual magnet hypothesis*, claims that color perception is biased toward certain reference points in color space, which function as “magnets” for perception of surrounding shades (Kuhl 1991; Feldman *et al.* 2009). On the perceptual magnet hypothesis, what is perceptually privileged is not the color categories themselves, but only certain focal shades of color, which “attract” perception of surrounding shades.

Because the light received at the retina conflates information about a surface's spectral reflectance with the spectral power distribution of the illuminant, it is generally agreed that the visual system must conform to certain assumptions or “biases” in computing the most likely color of a perceived surface. Many of these assumptions are likely innate, though potentially modifiable by learning (Marr 1982; Pylyshyn 2003). The assumptions may include priors over possible illuminants (e.g., a “daylight prior”—Brainard *et al.* 2006). But crucially, they may also include priors over the possible colors of things. The latter sort of prior would effectively bias the visual system toward certain color shades and away from others.

Suppose, then, that the visual system's innate prior for surface color is non-uniform, treating some shades as more likely than others. And suppose that it assigns higher probability to certain focal shades (which happen to fall near category centers), and progressively lower probability to colors further away from focal shades (which happen to fall near category boundaries) (Bae *et al.* 2015: 17-

18).⁹ If so, we would predict a “shrinking” of perceptual similarity space around focal shades (category centers) and an “expansion” near category boundaries (cp. Feldman *et al.* 2009). Shades that are far from category centers should tend to be perceived as closer to the focal shades than they really are, due to the biased prior. Moreover, because category boundaries involve shifts in the direction of perceptual attraction from one focal shade to another, shades straddling the boundary will be “pulled” in different directions, appearing more different than they really are (see figure 1 for illustration). For instance, when a surface is just barely on the blue side of the blue/green category boundary, it will tend to be perceptually represented as bluer than it really is. Such biased perception would render it more perceptually dissimilar from a shade on the green side of the boundary than a physically equidistant shade on the blue side of the boundary. Thus, the surface should stand out more against a green background than against a blue background, and infants should be faster to detect it. However, these effects needn’t involve explicit representation of color categories: There need be no representations that encode, say, *blue* or *green* without encoding anything more specific. We need only assume that perception assigns higher probabilities to focal shades than to non-focal shades.

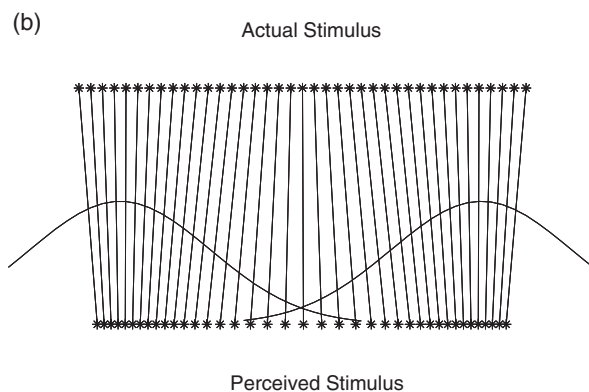


Figure 1. Illustration of the perceptual warping posited by the perceptual magnet hypothesis. The actual stimulus (top) consists of evenly spaced stimuli along some

⁹ While it is natural to hypothesize that focal shades/category centers should correspond to the “unique” hues (pure blue, pure green, pure red, and pure yellow), there may be exceptions to this rule. For example, Witzel & Gegenfurtner (2018) found that pure red was shifted away from the center of the redness category toward yellow. Moreover, shades of certain binary hues (e.g., orange or purple) might function as focal shades as well.

physical dimension (e.g., color). The nonuniform prior (depicted by the curves in the middle) distorts perception of the stimuli so that differences between stimuli within a category are typically perceived as smaller than they really are, while differences across category boundaries are exaggerated. *Source: Feldman et al. (2009). Reprinted with permission of the American Psychological Association.*

Consistent with the perceptual magnet hypothesis, there is evidence that perceptually-based color judgments are biased toward focal shades. Bae *et al.* (2015) showed participants a colored square and asked them to indicate its shade by clicking on the appropriate location on a color wheel. They found that even when the square and the color wheel were both visible for the entirety of each trial, responses were biased toward shades that a separate group of participants rated as the best exemplars for various color terms. These biases toward focal shades were even stronger if the colored square disappeared prior to presentation of the color wheel, suggesting that the bias toward focal shades is present in perception but grows stronger in working memory (cp. Davies *et al.* 2003; Hardman *et al.* 2017).

Bae *et al.* (2015) offer a model involving explicit representation of color categories alongside noisy point estimates of determinate shades. However, they observe that their data are also explainable by appeal to biased priors without explicit representation of color categories: “[F]rom a more typical Bayesian perspective, a nonuniform prior over hues—with higher probabilities at focal colors—might produce the effects without an explicitly categorical encoding of each instance. We cannot exclude this possibility based on our current analyses” (18). Note that I am not claiming that the data *refute* a perceptual categorization hypothesis. It is simply the availability of this alternative model that I wish to emphasize. If the evidence can’t distinguish between the perceptual categorization and perceptual magnet hypotheses, then it doesn’t establish that infants perceptually represent color categories.

Thus, I contend that Block has not established that color categories are perceptually represented in infancy, since the categorical perception evidence can also be explained by the perceptual magnet hypothesis, which doesn’t commit to perceptual representation of color categories.

Weak Conceptualists claim only that *perceptual representation* of color categories requires color concepts, not mere *perceptual sensitivity* to color categories. So, if infants do not perceptually represent color categories, then it is irrelevant to the truth of Weak Conceptualism whether they possess or deploy concepts of color categories. The Weak Conceptualist may hold that *other* categories (e.g. causation, animacy) are perceptually represented via concepts, while color categories are not perceptually represented *at all*.

4. Color Concepts in Infancy

I turn to Block's case for (b), the lack of color concept deployment in infancy. He cites a range of violation-of-expectation (VOE) studies suggesting that infants fail to use color information to form expectations about objects after they vanish behind an occluder, even though they use information about other properties for these purposes. Here are two representative examples.

First, Wilcox (1999) showed infants events in which an object passed behind a barrier and then an object (either the same or different) emerged on the other side. When the barrier was too narrow to conceal two objects, 7.5-month-old infants looked longer if the object that emerged differed in shape or kind from the object that disappeared, but not if the two merely differed in color. Only at 11.5 months did they evince surprise at color changes. Block writes: "The natural interpretation is that there is normally a failure to *notice* the color change—and therefore a failure to deploy color concepts—before 11.5 months" (2023: 280).

Second, Tremoulet *et al.* (2000) showed 12-month-old infants events in which an object emerged from behind a screen before returning behind it. Next, another object, which differed in either shape or color, emerged from behind the screen and returned. Finally, the screen was raised to reveal either two identical objects (the "unexpected outcome") or two objects with the appropriate shapes or colors (the "expected outcome"). Tremoulet *et al.* found that when the objects had differed

in shape, infants looked longer toward the unexpected outcome than the expected outcome. However, they did not look longer toward the unexpected outcome when the objects merely differed in color. Thus, the infants were evidently surprised by changes in shape, but not by changes in color.

What should we conclude from these findings? Block writes:

The upshot is that at 12 months, babies fail to use color information in forming expectations in a circumstance in which they can use shape information. I am not arguing that...the representations of shape are concepts. The point rather is that even the smidgen of evidence in this experiment for concepts of shape does not apply to representations of color. (2023: 289)

I take Block to have something like the following argument in mind:

1. If infants deploy concepts of both an object's pre-change color and its post-change color, then they should notice and conceptually represent the color change.
2. If infants conceptually represent the color change, then they should find the situation surprising and look longer relative to events without color change (either because they infer that a new object has appeared, or they determine that an object has undergone an unexpected transformation).
3. Hence, because infants fail to look longer toward events involving color change, we can conclude that they are not deploying color concepts.

Before assessing this argument, let me bracket one important issue. It might be argued that even if infants *were* surprised by color changes, this still wouldn't indicate that they represented color conceptually. For, infants' expectations about objects and their properties might themselves be non-conceptual. Crucially, however, Block's argument only has dialectical relevance on the assumption that infants' expectations are (or at least plausibly are) conceptual. If they are *non*-conceptual, then the debate over Conceptualism is unaffected no matter how the data turn out: Regardless of whether infants are surprised by color changes, the findings would fit with Non-Conceptualism and fail to support Conceptualism. Since the VOE evidence bears substantively on the Conceptualism debate only if infants' expectations about objects are at least plausibly conceptual, I will operate under this assumption in what follows.

The Wilcox (1999) and Tremoulet et al. (2000) studies seem to suggest a simple contrast between color and shape: Infants are surprised by shape (or kind) changes, but not by color changes. However, the evidence is not actually this straightforward. One complication is noted by Block himself (2023: 280-281). In a follow-up to Wilcox’s (1999) study, Wilcox and Chapa (2004) found that 7.5-month-old infants *did* look longer toward color-change events when they were shown that the color of an object was predictive of its function (see also Wilcox *et al.* 2014). Here, infants were familiarized with both a red container that was used to pour salt and a green container that was used to pound a peg into a box. After familiarization, the infants looked longer when a red ball passed behind a narrow barrier and a green ball emerged. Thus, infants *can* use color to form expectations about objects, at least when appropriately primed to do so (cp. Lin *et al.* 2021).

Regarding Wilcox’s function-priming results, Block writes:

Training can lead infants under 11 months old to notice color, but it does not follow that before training they noticed color or that if they had not received the training they would have noticed color. It certainly does not follow that without training they have concepts or proto-concepts of color even as a temporary property of things. Without training, infants under 11 months do not notice color and so do not have color concepts or protoconcepts and so do not have conceptual perception or protoconceptual perception. With training, they may have protoconcepts of color, but these protoconcepts may only play a role in cognition, not in perception. (2023: 281)

Block is surely correct that it does not *follow* from the Wilcox and Chapa (2004) results that infants have color concepts before training.¹⁰ However, one might still regard this as the most reasonable explanation of the data. Granted, it is *possible* that the infants only acquired color concepts once they were shown that color is predictive of function. However, this account posits a giant cognitive leap—*acquiring* color concepts—when only a modest one is needed. Specifically, the infants may have

¹⁰ Here, Block speaks of both concepts and “proto-concepts” of color. Unfortunately, he does not explicate the notion of proto-concepts, so it’s unclear how they are supposed to differ from concepts proper. (Perhaps the idea is that unlike concepts, proto-concepts do not function to combine with logical operators.) In any case, I should flag that one might hold that infants *do* regularly use color representations to form expectations about objects, but that the relevant representations are not *concepts*, but *proto-concepts*. However, the proponent of such a position would still owe us an argument *against* treating the relevant color representations as concepts. So, the mere availability of this alternative position cannot constitute a convincing argument against Weak Conceptualism.

possessed color concepts all along, but the training simply primed them to use these concepts since it signaled the relevance of color in the context of the experiment. Since the second hypothesis posits a less dramatic cognitive leap during the experiment, it is plausibly to be preferred.

In any case, the main issue vis-à-vis Weak Conceptualism is not whether infants *possess* color concepts, but whether they *deploy* color concepts whenever they perceptually represent color categories (as Block notes later on (2023: 291)). And Block's evidence may still seem to indicate that they don't do the latter. For suppose that the infants in the Wilcox (1999) and Tremoulet et al. (2000) experiments perceptually represented the objects' color categories. The fact that they didn't use these categories to determine what the objects should look like after emerging from behind the occluder seems to suggest that they were not deploying concepts of color categories *in that context*, even if they could have deployed such concepts in other contexts. Thus, the perceptual representations of color categories deployed within the experiment couldn't have been conceptual.

However, there are two problems with this argument. First, a concept might be deployed in one task but fail to be deployed in another task performed concurrently or shortly afterward. Specifically, infants might have deployed color concepts in perceptual categorization (i.e. in the perceptual attribution of color categories) but not in forming expectations about how the objects would evolve over time, even though both tasks were performed in close succession.¹¹ This proposal would seem admittedly *ad hoc* in the absence of evidence that young infants possess color concepts, since we would be ascribing color concepts solely to accommodate the categorical perception evidence, and apparently for the sole purpose of rescuing Weak Conceptualism. However, as just discussed, infants *do* use color to form expectations about objects when appropriately primed (Wilcox

¹¹ Block appeals to evidence that infants not only fail to use an object's color in forming expectations about that object, but also fail to use it to predict the occurrence of an event involving a distinct object (viz., an interesting toy appearing off to the side) (Hochmann 2010). However, a parallel concern arises here. It is possible that infants deploy concepts in perceptual categorization but nonetheless fail to use them to predict events involving other objects, even though both tasks are performed in close succession.

& Chapa 2004; Wilcox et al. 2014). So, on the assumption that such abilities involve the deployment of color concepts, the ascription of color concepts to infants is independently motivated. And if color concepts are indeed present, then it is not absurd to suggest that they might be deployed for one task but not another.

Second, even if infants fail to be *surprised* by a given color change, this doesn't necessarily show that the change wasn't *noticed*. Perhaps infants ordinarily conceptualize the colors of objects, and these concept deployments allow them to notice many color changes, but they only find certain color changes *salient* or *important enough* that they look longer toward them (Maule et al. 2023: 95). Consistent with this, there is evidence that even without special training or priming, infants are surprised when an object changes color behind an occluder provided that the change is sufficiently salient. After describing this evidence, I'll argue that it fits nicely with a model on which infants spontaneously conceptualize colors, but only find certain color changes important enough to warrant surprise.

One challenge in comparing infants' responses to changes along different dimensions (e.g., color and shape) is that even if both changes are perceptually detectable, we cannot be sure that they are equally salient to the infant. If, say, a shape change is more salient than a given color change, then it would not be shocking if infants look longer toward the former than the latter, and this certainly would not show that infants fail to form expectations involving color.

In an important study Block doesn't mention, Kaldy and Blaser (2009) attempted to calibrate the salience of color and shape changes to determine whether infants would still fail to be surprised by color changes even when the color and shape changes were made equally salient. In an initial experiment, infants were shown a pair of objects differing in either color or shape. In the shape case, the "baseline" object was a simple shape and the "comparison" object was a more complex shape of the same color. In the color case, the baseline object was a yellow object and the comparison object was a redder object of the same shape. The authors measured 9-month-old infants' initial looking

preferences—the proportion of trials on which they looked first toward the comparison object. This enabled them to identify shape and color differences that produced the same level of initial-looking preference—the rationale being that these shape and color differences were plausibly equally salient to the infant.

Next, in a second experiment with a new group of 9-month-olds, Kaldy and Blaser investigated whether infants would be surprised by both color and shape changes provided that they were equated for salience. The infants were first familiarized with both a baseline object and a comparison object differing in either color or shape, seeing each object twice in isolation. (These stimuli were chosen based on the results of the first experiment.) At test, the infants saw either the baseline or the comparison object pass behind a screen for 2 seconds. The screen was then removed, revealing either the same object or the other one (figure 2). Crucially, the infants looked significantly longer when the revealed object differed in *either* shape or color. In fact, if anything, their reactions to color changes were stronger than their reactions to shape changes since their surprise at color changes persisted across three test trials while surprise at shape changes abated after the first test trial (Kaldy & Blaser 2009: fig. 6). Thus, when baseline perceptual salience is properly controlled between color and shape changes, younger infants *do* show surprise at color changes, finding them at least as surprising as shape changes. In a recent review, Maule *et al.* (2023: 95) take these results to suggest that 9-month-olds can use both color and shape in object reidentification.

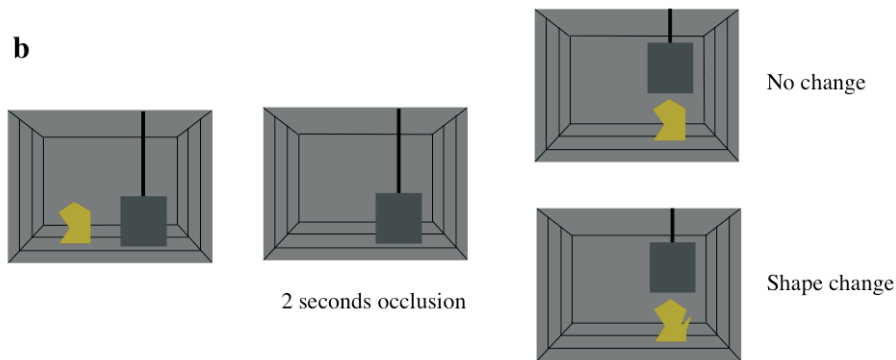


Figure 2. The sequence of a test trial in Kaldy and Blaser (2009). The object is shown on the left, then moves behind the screen, after which the screen is removed. The revealed object was either unchanged, or differed in either shape or color. This figure only shows the shape-change condition. *Source:* Kaldy & Blaser (2009). Reprinted with permission of John Wiley and Sons.

Another study reinforces the point that infants notice and react to sufficiently salient color changes. Woods and Wilcox (2010) used the narrow-screen task from Wilcox (1999) to assess whether 7.5-month-old infants would react to color changes when they covaried with luminance changes. (The rationale was that in ecologically normal conditions, color and luminance changes are highly correlated.) Infants saw a ball pass behind either a wide or narrow barrier, and then a new ball of either the same or different color and luminance emerged. The authors found that infants indeed looked longer toward a differently colored object when the color change was combined with a change in luminance, though not when color or luminance changes occurred in isolation (see Bremner *et al.* (2013) for complementary findings involving combinations of color and shape changes).

At one point, Block considers the possibility that infants might fail to notice color changes because color is a less salient property than shape. He writes:

The results just described involve a contrast between color on the one hand and shape and kind on the other. Perhaps color just isn't as salient as shape and kind? Perhaps...but that isn't an objection. Rather if true it may provide an explanation of why the infants normally lack color concepts and have such a stark case of non-conceptual perception. (291)

However, the present point is *not* that color is simply less salient than shape. Rather, it is that when the salience of each change is appropriately controlled, color and shape are on a par. Both types of change elicit surprise in infants. Overall, then, the evidence does not indicate that infants flatly ignore color when forming expectations about objects. Appropriately salient color changes elicit longer looking times in infants below 11-months of age, and this does not require special priming. Accordingly, we have grounds to reject Block’s claim that for infants below 11 months, “even the smidgen of evidence...for concepts of shape does not apply to representations of color” (2023: 189).

Let’s return now to the cases where color changes *fail* to elicit increased looking times, such as Wilcox (1999) and Tremoulet *et al.* (2000). We can distinguish three models consistent with that evidence, differing on the source of infants’ lack of surprise.

Model 1: Infants did *not* conceptualize the objects’ colors, did *not* notice the color changes, and thus were not surprised by the changes.

Model 2: Infants *did* conceptualize the objects’ colors, but nonetheless did *not* notice the color changes, and thus were not surprised by the changes.

Model 3: Infants *did* conceptualize the objects’ colors, *did* notice the color changes, but nonetheless were *not* surprised by the changes.

Model 1 attributes the lack of surprise to infants’ failure to conceptualize the objects’ colors, which accounts for their failure to register the color change. Model 2 suggests that infants succeeded in conceptualizing the objects’ pre- and post-change colors separately, but failed to perform the comparison process needed to notice the *change* in color, and so weren’t surprised by the change. Model 3 suggests that infants succeeded both in conceptualizing colors *and* noticing the change, but failed to exhibit surprise because the change was not deemed sufficiently important—perhaps because it was not deemed to threaten the object’s continuity over time or to signal the appearance of a new object. (After all, even if infants regularly notice changes in perceived color, they may often be prepared to discount these changes in determining object continuity. For they may be accustomed to the fact that an object’s apparent color can change when it passes from light to shadow, or between

illuminants, without the object losing its identity (cp. Beck 2023).) Model 2 rejects premise 1 in Block's argument above, while Model 3 rejects premise 2.

The fact that Block's evidence is consistent with any of Models 1-3 is problematic for his argument, since only Model 1 would threaten Weak Conceptualism.¹² However, I think matters are worse than this, because the evidence just discussed actually favors Models 2 or 3 over Model 1.

Recall that Block grants that young infants *sometimes* form expectations about color—namely, after special training in which color is linked to function (Wilcox & Chopa 2004). So, assuming again that these expectations are conceptual (see above), it follows that infants at least sometimes conceptualize color. However, a crucial question is whether infants *spontaneously* conceptualize color without any special reason to do so, or they *only* conceptualize color when specifically cued that color is relevant. The former view would fit better with Models 2 and 3, which locates infants' failures in the Wilcox (1999) and Tremoulet *et al.* (2000) studies somewhere downstream from conceptualization (either in noticing the change or being surprised by it). The latter view would fit better with Model 1: Unless they are specifically cued to the relevance of color, they don't deploy color concepts. So, given the absence of such cueing in Wilcox (1999) and Tremoulet *et al.* (2000), no color conceptualization occurred.

At this point, the evidence from Kaldy and Blaser (2009) is especially important. This study did not specifically cue infants to the relevance of color—it was not selectively primed, and was not linked to any particular function. Nonetheless, infants did form expectations about color upon seeing the object pass behind the occluder. Alongside the other studies mentioned earlier (Woods & Wilcox 2010; Bremner *et al.* 2013), this result supports the spontaneous conceptualization view over its competitor. Infants spontaneously conceptualize color, making the property available for forming

¹² Moreover, recall that Model 1 *only* threatens Weak Conceptualism on the assumption that color categories are explicitly represented in perception. I argued earlier that Block has failed to establish this claim.

expectations about objects, and this requires no particular training regimen. However, if a color change is not sufficiently salient, then either it is not noticed or it is not deemed significant enough to threaten the object's continued identity. Accordingly, we have reasons to favor Models 2 or 3 over Model 1.

Thus, Block's VOE evidence is consistent with Weak Conceptualism, even if we grant that infants perceptually represent color categories. This challenges Block's case that infants ordinarily fail to deploy color concepts. I suggest that a *more* plausible view, given our current state of knowledge, is that infants *do* ordinarily deploy color concepts, but are selective about which color changes they notice or find surprising. However, at minimum, the foregoing discussion illustrates that the evidence regarding infants' use of color in object reidentification is inconclusive. It does not decisively support *or* refute the view that infants regularly apply color concepts to perceived objects.

Summing up, Block's argument poses a powerful challenge to Weak Conceptualism. However, the challenge can be resisted. Block's arguments for both (a) perceptual representation of color categories in infancy and (b) lack of color concept deployment in infancy face difficulties. As regards (a), I've argued that there is a viable alternative explanation of the evidence—the perceptual magnet hypothesis—that does not posit perceptual representation of color categories, but only perceptual biases toward focal shades. As regards (b), I've argued that there is evidence *against* Block's claim that infants ordinarily fail to deploy color concepts when reidentifying objects or forming expectations about them. Accordingly, even if infants do perceptually categorize color, the evidence fails to demonstrate that these categorizations occur without color conceptualization.

5. Conclusion

If Block's argument fails, then Weak Conceptualists may find solace. The infant evidence does not convincingly show that a subject can perceptually represent a category while failing to deploy a concept of that category. Interestingly, however, Weak Conceptualists are not the only ones who should

welcome this outcome. According to traditional versions of Total Non-Conceptualism, explicit categorization (i.e., forming a representation of a category that encodes nothing more specific) falls within the province of cognition, not perception (Dretske 1981, 1995; Heck 2007/2023; Gauker 2011). The discussion of section 3 underscores just how difficult it is to gather unambiguous evidence for explicit categorization in perception: Mere perceptual *sensitivity* to categories doesn't imply perceptual *representation* of categories. Accordingly, while Weak Conceptualism hasn't been refuted, a central tenet of Weak Conceptualism (that perception explicitly represents categories) is harder to establish than one might have thought, and categorical perception of color likely cannot serve to *motivate* Weak Conceptualism. Nonetheless, one might speculate that alternative forms of perceptual categorization, such as perceptual representation of causation or animacy (Kominsky & Scholl 2020; Westfall 2023), could be on firmer empirical ground.

The foregoing discussion also has implications for disputes about the perception-cognition border. Block suggests that perception is constitutively non-conceptual, and that this helps to ground the boundary between perception and cognition. However, traditional arguments for non-conceptual perception fail to target the most empirically plausible versions of Conceptualism, which hold that perceptual categorization (or at least some forms of it) requires concepts, though not *all* perception does. Infant color perception comprises Block's primary case for thinking that perceptual categorization doesn't require concepts. I've argued that this argument is unconvincing. To refute these contemporary forms of Conceptualism, the Total Non-Conceptualist must either (i) mount a stronger argument for thinking that perceptual categorization doesn't require concepts, or (ii) abandon Block's notion of perceptual category representation, and seek to relegate explicit categorization to post-perceptual cognition.¹³

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