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Colour layering and colour constancy

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In the philosophy of perception, a venerable tradition transfixes on *perceptual relativities*, the fact that in some sense the ways things appear to us in perception change as a number of perceptual variables — illumination, object orientation — are altered. That tradition has used this fact for many purposes: to argue for the epistemic thesis that we do not directly perceive an objective or mind-independent world, for the metaphysical thesis that properties such as colours are relative to perceptual circumstance or even mental, and so on. One way to claw back from these worries is to focus not on the ways perceived things vary across perceptual circumstances, but instead on the way they *don't*, to focus on *perceptual constancies*.[1] Stated loosely, the latter includes for example the respect in which experienced colours and shapes are relatively stable throughout our daily lives, despite continual variations in illumination conditions, the relative orientation and distances of objects, and so on. In fact some take constancies to be a core justification for direct realism and of an objectivist approach to the metaphysics of perceived properties.[2]

A dialectical gulf emerges if individuals on one side (*e.g.*, persons focused on perceptual relativities) yield to the temptation to explain away the opposing phenomenon (*e.g.*, perceptual constancies).[3] More modestly, those entranced by perceptual relativities may seek to

1. Another, perhaps more familiar, way is to account for these relativities in ways that do not conflict with direct realism or colour objectivism. I take one or both of these possibilities to provide motivation for adverbialism, representationalist approaches to perception, and so on.

2. For example, perceptual constancies are central to Smith's (2002) argument for direct realism, and Bradley and Tye argue that the "fact that objects appear to retain the same colour through a wide variety of changes in the illumination conditions (though certainly not all) strongly suggests that colours are illumination-independent properties of those objects" (2001, 480). Hilbert (1992) and Byrne & Hilbert (2003) offer colour constancy as one of the core motives for their view. See also Tye (2000). Similar arguments can be made by appeal to perceptions involving shape constancy, size constancy, and so on.

3. Russell responds to Dawes Hicks's (1912) tacit appeal to colour constancy by asserting that "A colour which presents a different aspect is a different colour, and there is an end of the matter" (1913, 79). Russell seems unwilling to consider the possibility that a colour can be constant despite the presence of perceptual relativities concerning it. See below for more detail.

explain constancies indirectly, for example by appeal to mental dispositions to make judgements, instead of directly by appeal to aspects of what is presently perceived. Within our focus of colour theory we see this in Cohen's (2008) attempt to explain colour constancies in terms of the mind's disposition to make counterfactual judgements about colour appearances. The converse can be found in colour objectivists like Byrne and Hilbert [B&H] (1997a, 2003; see also Hilbert 2005), who assert that colour relativities can be broadly (if not wholly) explained by the mind's disposition to misrepresent actual constant colours. For neither is the opposing phenomenon — constancy for Cohen, relativity for B&H — indicative of correctly perceived occurrent features; it is instead indicative of our perceptually representing something other than what is currently perceived.

I believe that our theoretical commitments have been exerting more influence than they have earned, that the phenomena of colour constancy and the relativities therein demand an approach that gives both equal footing. A core philosophical challenge, and the challenge that guides this work, is to articulate the respect in which both variable and constant elements of these perceptual scenarios are *present* and *integrated* in perceptual *experience*.[4] For ease of reference I will call this the *Variable-Constant Challenge* or simply the *VC Challenge*. My answer is drawn from the following thesis:

> *Colour Layering Thesis:* we can experience two colours along a single line of sight, one (opaque) colour through the other (transparent) colour.

Applied to colour constancy, the idea is that one of these colours remains constant, while the other varies, and we are able to experience precisely that. In such a case one experiences both a variable and a constant colour along the same line of sight, thus meeting the VC Challenge in a direct way.

We proceed as follows:

§1 A brief history of colour constancy and a contextual motive for the layering account are offered.

§2 Theoretical constraints that seek to avoid the dialectical gulf mentioned above are identified.

§3 An analysis of the concept *perspective on a colour* that can underwrite colour constancy is offered.

§4 The analysis from §3 is applied to colour constancy and the layering account is developed.

§5 The proposed account is contrasted with two alternative views.

§6 The discussion is summarized.

Some qualifications will be helpful.

The core sense of "transparent" relevant to the Layering Thesis is that in which transparent things are things that we can *see through*. This is often supplemented with a more physical or reductive meaning in which things are transparent to the extent that they *transmit* (as opposed to absorb or reflect) light that strikes them. The latter is crucial to optics and various discussions in colour perception. My focus will be on colour *experience* and as such the former is most relevant. To see why, consider for example describing experience representationally. Here, to experience something as transparent is most fundamentally to be in a visual state that represents that thing as something through which one can see. In doing so one need not visually represent the thing as something having such-and-such light transmission

4. A corollary to this challenge is the challenge of determining the extent to which each of these elements are mind-dependent. While I feel many strong pulls toward colour subjectivism, I believe that an accurate analysis of colour constancies and its relativities can remain neutral on this issue — see below. Note that by treating colour experience as central I am setting to the side approaches to colour theory that do not make this commitment.

properties, even though by hypothesis it in fact has those properties and its transparency is physically realized by them.[5]

In what follows I presume that, at least in the kinds of everyday colour experiences on which we will be focused, colour experience is both intentional and phenomenal: it involves experiencing a phenomenal colour (*e.g.*, a bluish quality) on objects, where those objects are typically taken (correctly or not) to be in the world outside ourselves.[6]

With respect to colour relativities I am interested in those that are inherently present during colour constancy perceptions (*e.g.*, illumination variations, filter variations such as the presence and absence of sunglasses, etc.). There is much to be gained in this context from focusing on factors that are exoskeletal. Additional, more subjective relativities—the possibility of spectrum inversion, intersubjective variabilities in unique hue perceptions, and so on—are a key piece of the puzzle that is colour, but affect our theorizing in different ways than are my focus.

Several issues regarding colour constancy will not be addressed. One of these is a distinct problem of perceptual ambiguity. For example I might experience the same stimulus at once as a differently illuminated but similarly painted wall and then as a differently painted but similarly illuminated wall. A full theory of colour constancy must give a satisfactory treatment of such ambiguities—I will not do so here. Another is the disunity in psychological accounts of colour constancy (see, *e.g.*, Chirimuuta 2008). If psychologists are not in agreement about how to characterize and interpret colour constancy, then the impact of their data (and theories) on philosophical accounts of the phenomenon cannot be straightforward. I cannot work through such issues in this work. Instead, I will offer a brief and selective reconstruction in §1 (and continued references throughout) with an eye on illuminating influential philosophical accounts of constancy, the importance of the VC Challenge, and my proposed solution.

5. These two senses of "transparent" are reasonably analogous to characterizing "water" in terms of its perceived properties (colourless, etc.) and its underlying physical structure (H_2O). See, *e.g.*, Westphal (1986), Gilbert (1987), and Hardin (1989) for a discussion of these and related issues with regard to colour.

6. Note that "intentional" in this sense is intended to be consistent both with representational and acquaintance-based approaches to perception. See below.

§1 A partial and evaluative history of colour constancy

At first pass, colour constancy occurs when one seemingly perceives a constant colour despite the presence of some "variability" in one's perception of that colour. Common examples include perceiving the colour of a hat both indoors and outdoors, both in daylight and in twilight, both with and without sunglasses, et cetera. During many changes of these sorts there is a sense in which one perceives the colour of the hat to be constant, *while* some aspect of one's colour perception changes. These are successful instances of colour constancy. By contrast, during the changes in which (by hypothesis) one in some robust sense fails to perceive the hat's colour to be constant we have constancy failure. I will characterize the phenomenon more precisely below. My present purpose is stage-setting, to summarize points of recent philosophical interest and their drawbacks.

Consider the definition of colour constancy given by B&H in their influential *Readings in Colour*: "Stability of the perceived color of a surface across changes in illumination and the consequent changes in the light reaching the eye" (1997c, 445; they acknowledge that the definition is not settled on p. 456). According to this definition what is variable in constancy scenarios is illumination, and although such variabilities "reach the eye" there is no commitment as to whether or not they are experienced. This is reflective of broad assumptions then present in scientific research on colour constancy, and it is doubly problematic. Let me explain.

§1.1 From computationalism to reflectance physicalism.

In much psychological and philosophical literature colour constancy is discussed by reference to variabilities in illumination. One motivation for doing so is because many examples of colour constancy involve seeing a thing's colour to be the same both when viewed indoors and

then outdoors, in direct light and in shadow, and so on. Another, less innocent, motivation is perhaps because this focus suggests a simple orientation to the theory of colour constancy: what is variable is the nature of the incident (*i.e.*, pre-reflected) light and what is constant is the object's or surface's propensity to reflect light (*i.e.*, its surface spectral reflectance profile, or SSR). This affords a straightforward empirical research programme for studying colour constancy.[7] What the eye receives from the world (*i.e.*, the colour signal) is light that has been reflected from the object seen. The nature of that reflected light is a function of *both* the nature of the incident light and the nature of the object's SSR. The computational task facing the vision system is to factor out these two contributions to the reflected light and track the latter. When and to the extent that it is successful, one perceives a constant colour despite the presence of an illumination variation; when and to the extent that it is not, one has no such perception. Thus emerges what I regard as the traditional computational approach to colour constancy, and the quest for understanding how and to what extent the vision system accomplishes this factoring-then-reflectance-tracking task.[8]

This fits nicely with a familiar approach to colour ontology: if what the colour vision system is trying to do and often succeeds in doing is track(ing) reflectances in the environment at the expense of incident illuminations, then, since what it is tracking must *by definition* be colours, colours are illumination-independent and intimately tied to reflectances.[9] Thus, to some, Reflectance Physicalism emerges as an eminently appealing orientation to colour ontology: it not only recovers our common sense belief that things in the world have colours and have them independently of how we are, it also fits nicely into a robust contemporary research programme in vision science. The approach faces many difficulties[10], but these virtues contribute to a theoretical "hard core" its adherents feel is worth defending.

7. Here are some examples: Land & McCann (1971), Land (1986), Brainard & Wandell (1988), Wandell (1989), Brainard, Brunt & Speigle (1997). Shevell & Kingdom (2008) is a worthwhile recent review of the wider literature. Other contributions will be referenced when appropriate.

8. Psychologists sometimes distinguish between mechanistic and computational approaches to colour constancy. The former focuses on the mechanisms of the vision system that are facilitating colour constancy (and is thus largely neurophysiological) and the latter on the computational problem of "factoring-then-tracking" that the vision system must to some extent be solving given that colour constancy exists (and thus involves more computation and physics than neurophysiology). However, as, *e.g.*, Brainard (2004) has emphasized, the two are merely focusing on different aspects of the same puzzle. Any plausible physiological mechanism is presumably implementing an appropriate computational solution (given the framework of cognitive science), and any computational solution could be utilized by a colour vision system, and one of them *is* being so utilized by our vision system.

   On the other hand there are differences in what is the focus of study within these approaches. For example those working within the mechanistic approach are often embroiled in how adaptation works in our vision system, whereas those working within the computational approach are embroiled in how illumination varies in a scene and how that connects to invariant reflectance profiles.

   I will emphasize the computational approach. This is primarily because of the influence the computational approach has had on philosophical theory, but also in part because there is no generally accepted model for adaptation in vision research. Perhaps the most popular one, von Kries adaptation, has fared poorly under scrutiny. In fact "[e]ach of the postulates of von Kries' adaptation have been subjected to sharply focused empirical test, and it is clear that each fails" (Brainard, 2004, 956).

9. Hilbert (1992) expresses sympathy with this particular line of reasoning. Perhaps colours are themselves reflectances, or are classes of reflectances (*e.g.*, Byrne & Hilbert, 2003, defend the latter). Regardless, there is no doubt that colour constancy and in particular something akin to the computational approach has been influential. For example see the quote and references in note 2. I generally resist giving much weight to the claim that colours have to be (or plausibly are) what colour vision systems track in the world. It is just as possible (and plausible) that such systems evolved to give their owners a more efficient class of properties — colours — with which to cognize about the world than the world itself contains. On such a view what such systems track in the world is (*e.g.*) reflectance information but what they construct and what gets used by the mind in which these systems are embedded are colours. See, *e.g.*, Hardin (1992). For my part both what is internally constructed and what external elements such systems track equally deserve the label "colours", but these considerations fall outside our present discussion.

10. Some well-known challenges to Reflectance Physicalism concern its treatment of metamers, normal intersubjective variations in colour perceptions, colour opponency, etc. Hardin (1988) is an obvious source.

§1.2 Problem one: Experiencing illumination variations & experiencing them as colour variations.

One might argue that what I have called the traditional computational approach to constancy is deeply flawed and that its purported support for Reflectance Physicalism is an illusion.[11] Consider the question "How does the nature of the incident light impact colour *experience* during constancy perceptions?". To this point nothing directly has been said about the matter. All that has been said is that illumination variations are "present" or "exist" or, as B&H say, they are "reaching the eye", but no mention of how those are present in experience, phenomenally or intentionally, has been offered. Yet we know that, in some sense, when I see something to be partly shadowed I see that something *and* that shadow. It is therefore not sufficient to say that the vision system factors out the incident and reflectance contributions to the reflected light and tracks the latter, for to some extent it is also tracking the former. What else could seeing the shadow mean other than seeing that illumination variation? The idea that the colour vision system's chief goal or achievement is to track reflectances is mistaken.[12]

Consider also the fact that illumination variations can yield perceived variations in colour, but need not thereby eliminate colour constancy. At times a room illuminated by a red twilight can still be seen to have its familiar surface colours *in addition to* the perceived red corresponding to the incident light. Thus colour constancy can involve perceived constant *and* perceived variable colours. Colour constancy, rather than supporting the idea that colours are illumination-independent surface features (*e.g.*, classes of reflectances), supports the idea that colours can be illumination-*de*pendent.[13]

In response one might suggest that the computational approach simply needs to be modified to allow that the vision system tracks not only reflectances but also incident illuminants, and Reflectance Physicalism needs to be supplemented with an appropriate account of *represented colour* (as opposed to actual colour), namely where represented but not actual colour is illumination-dependent.[14] But these concessions do not resolve at least one core challenge: in what respect is a constant colour present to one in experiences involving colour constancy? For example, during some constancy perceptions involving a partly shadowed surface it is not a stretch to suggest that I see the shadow to be *on* the surface of that thing. If I do see that surface to be uniformly coloured, then in what sense is that constant surface colour phenomenally or intentionally "present" to me in experience if I am seeing something else, something variable, to be on that surface?

The computational approach is designed to answer computational questions, not experiential ones. Thus when it is modified to allow for the dual-tracking of reflectances and incident illuminants, an account of how these elements are both experienced while a constant colour is also experienced does not suggest itself. Though illuminating in many other respects, we should not expect developments in computational psychology to straightforwardly deliver answers to such questions about colour experience. A Reflectance Physicalism that allows for represented colour to be illumination-dependent fares no better. If anything, it suggests that we experience not constant but variable colours, and if we don't experience constant colours in a wide range

11. Some may also object that my portrayal misrepresents the views of at least some computational theorists (for example see again Chirimuuta 2008). As stated earlier, my aim is to motivate influential philosophical views, in this case to explain why scientific research in colour constancy was thought to justify reflectance physicalism. A portrayal of the sort I have given is needed to explain the influence computational approaches to colour constancy have had on reflectance physicalists like B&H and Tye, regardless of the accuracy of that portrayal.

12. Jameson & Hurvich (1989) for example argued for this among other claims.

13. Arend & Reeves (1986), and Arend (1993) argue for the impact of illumination on perceived colour, although in my view do not offer a clear positive account.

14. Hilbert (2005) has effectively made this concession, although I will argue (§5) he has not conceded nearly enough.

of everyday scenarios, then colour constancy cannot be offered as a reason to be a Reflectance Physicalist.[15]

§1.3 Problem two: Colour constancy without illumination variation.
Matters are still more difficult, for a host of colour constancy perceptions have *nothing to do with illumination variations.* Look at a book through a pint of amber beer and at times you see not only the beer's amber but also the book's green (Image 1, Book through beer). The latter is a legitimate and straightforward instance of a constant perceived colour despite a straightforward and robust variation in one's perception of that colour, yet no illumination variation is responsible for these peculiarities.[16] I will call colour constancy cases of this sort colour *Filter* cases to distinguish them from colour *Illuminant* cases. They include constancy perceptions that arise by looking through sunglasses, tinted windows, fluids, and so on. Confining discussions of colour constancy to illumination variations is useful to some circumscribed projects, like that of a computational constancy theorist (*e.g.*, Wandell 1989) who is looking for algorithms that might indicate how visual processing deals with illumination changes and spectral reflectance profiles given the paucity of information contained in the colour signal. But anyone purporting to utilize or give an account of colour constancy *proper*, something philosophical concerns demand, can afford no such luxury. One's account must explicitly contain sufficient generality to incorporate both Illuminant and Filter cases.

§1.4 A resolution.
The beer case additionally brings with it an intriguing orientation to our challenge: what is present is the book's colour *and* the beer's colour, and the respect in which they are combined in experience is that

15. See, *e.g.*, Cohen (2008) and §5 below.

16. To be sure illumination variations are present and no doubt to some extent perceived. However, the point is that these illumination variations are separate from the kind of constancy perception generated by looking through the beer to the book. I will suppress this qualification throughout.

Image 1, Book through beer.

one is seeing the former *through* the latter. I suggest that "present" can here be read both intentionally and phenomenally. We are intentionally and phenomenally presented in experience with *layers of colour*, one through another. The idea is, at least logically, readily generalizable to Illuminant cases: in the twilight case we see the room's constant surface colours through the red of the twilight, and in the shadow case we see the object's constant surface colour through the colour of the shadow. This Colour Layering approach thus underwrites a general analysis of the respect in which constant and variable elements are phenomenally and intentionally present to one in experiences involving colour constancy. Let us flesh it out.

§2 Balancing theoretical pressures

The aim of this section is to tease apart the relation between colour constancy and colour ontology and epistemology on one hand, and colour constancy and colour experience on the other. It strikes me

that available accounts of constancy have each been formulated to support a particular ontology (§2.1). This is avoidable and I believe should be avoided if possible. The first stumbling block is to locate the VC Challenge and potential solutions to it squarely within our account of colour experience (§2.2). From here we can understand that problem on its own (§3), so to speak, and articulate a general solution while remaining quite neutral on commitments to colour ontology and epistemology (§4).

§2.1 Ontological bias.

Regardless of B&H's ultimate commitment to their definition of constancy ("Stability of the perceived color of a surface across changes in illumination and the consequent changes in the light reaching the eye"), that definition favours the constant element over the variable one. While the variable element (changes in illumination) is recognized as physically existing, the definition implies that it makes *no* impact on the perceived colour of a surface. As mentioned in the last section, this is easily seen to be inaccurate by reflections on perceptions of shadows. However, beyond that this definition biases us toward regarding constancy as supportive of objectivist views about colour. The reason is because, at minimum, on this analysis perceived colour is at least often illumination-invariant, and thus (assuming colour perceptions are often veridical) we have reason to believe that colour is illumination-invariant, a well-known tenet of objectivist colour views.

By contrast Cohen's (2008) account of constancy splits colour contents into "occurrent" and "counterfactual" ones. He claims that evidence of perceived colour variations are expressions of the former, while evidence of perceived colour constancies are expressions of the latter.[17] Roughly, the idea is that during constancy perceptions the experienced colours that are there before one (*i.e.*, occurrent or instantiated) vary across illumination changes, and evidence for constant colours in these scenarios is evidence of colours that are *not* before one but by hypothesis would be before one were circumstances different (*e.g.*, were illumination conditions to be altered). In this way the variable element in colour constancy is treated as primitive and constitutive of the colours one experiences before one, and the constant aspect is treated as a derived prediction about the colours one would experience before one in some other (related) circumstance. It is no surprise that Cohen (2009) elsewhere defends a colour subjectivist ontology, in his case holding that colours are defined relative to illuminations and a host of other factors.[18]

These are but two of the ways that colour constancy can be analyzed. It is instructive to highlight that each way embodies a bias that favours the broader colour ontology favoured by its authors. B&H's claim that in constancy scenarios experienced ("perceived") colours are stable or constant provides reason to regard colours as invariant across the changes inherent in the case (*e.g.*, illumination changes). Cohen's claim that in constancy scenarios experienced "occurrent" colours are variable provides reason to regard colours as variant across the relevant changes.

In reaction one might claim that these biases cannot be eliminated from philosophical endeavours, or perhaps they are welcome, or perhaps they are of little significance. For example, one might believe that an analysis of a notion like colour constancy can only be judged in a broader context that includes a particular colour ontology. In response one might worry that this commitment makes judgements about a proposed analysis hostage to a further judgement that is difficult to adjudicate, namely a judgement about the overall strengths of one colour theory relative to another. These are well-known problems in meta-philosophy. In this case we can do otherwise: we can formulate an analysis that does not straightforwardly favour one colour ontology over another. I will go further and formulate an analysis that does not

17. 'Evidence' for example includes data from everyday experience and from experiments such as those utilizing asymmetric matching tasks.

18. I take colour subjectivism to include relationalist views on which colours inherently or constitutively depend on the mind and the world (*e.g.*, Cohen 2009), and mentalist views on which colours inherently or constitutively depend only on the mind (*e.g.*, Hardin 1988, McGilvray 1994).

straightforwardly favour a particular perceptual epistemology (*e.g.*, acquaintance-based or representation-based). Such an analysis is worth considering for this reason alone. If in addition it explains the phenomenon of colour constancy at least as well as its competitors, then it deserves a privileged place in our discourse.

§2.2 Experiential realism & Present constancy.

An underlying philosophical issue in constancy research is, to speak loosely, whether the constant element is *perceptual/sensory* or *judgmental*. The idea is that in the former case the constant element is *present in* or *part of* perceptual phenomenology (or representational content or the items of acquaintance), whereas in the latter the constant element is *absent* but *inferred* from the colour elements that constitute perceptual phenomenology. I will call accounts which defend the former for a given case *experientially realist* or *Present* constancy accounts, and those that defend the latter *experientially anti-realist* or *Absent* constancy accounts. In case there is doubt, the distinction concerns how to characterize colour *experience* in constancy cases, and not necessarily how to characterize colour *ontology*.

Regardless of its adequacy, the B&H definition of constancy is experientially realist, for according to it in constancy cases there is "stability of the perceived color". By hypothesis a straightforward Absent account would contend that in constancy cases perceptual experience consists only of variable elements, and from these one infers, cognitively, some proposition about a constant colour, perhaps <that thing's colour is constant though not currently perceptually so> or <that thing's colour would be perceivably constant were it uniformly illuminated>.

A more sophisticated Absent view posits that the constant elements are in some sense absent yet still perceptual. One way of achieving this is to put the above propositions into perceptual content. Accounting for colour constancy by putting propositions of the latter (counterfactual) sort into perceptual content is precisely Cohen's proposal, rendering his account experientially anti-realist. Let me briefly elaborate. For Cohen, colour experience is split into experiences of the colours that are present before one (occurrent contents), and experiences of the colours that are not before one but would be were matters otherwise (counterfactual contents). He does not elaborate on how to characterize the phenomenal difference between experiences of these two kinds of contents, but presumably a colour that occurs in an occurrent content is experienced as *there* or *real* or *present before one*, whereas one that occurs in a counterfactual content is experienced as *not there/absent* but *potentially there*. Given this framework Cohen's key proposal is that in constancy cases variable elements of colour experience are found in occurrent contents, and constant elements are found in counterfactual contents. Thus, constant elements are not experienced as present (or occurrent) but as absent (or potentially present). It is therefore an Absent account, and given the importance of Cohen's work in philosophy of colour, it will serve as our main candidate for such an account. Accounts which leave the above propositions in cognition can in general be substituted at will in what follows.

I will shortly propose a novel Present account of colour constancy. I do so because the Present accounts available are to my mind inadequate, and their distinctness from colour ontology has not been articulated. As a result the full power of Present accounts remains underappreciated.

The chief difficulty for a Present account is to accommodate the fact that the variable element in constancy scenarios is not merely "reaching the eye", but impacting colour experience — hence B&H's definition does not meet this challenge. If a constant colour is experienced across something like an illumination variation, and the illumination variation is experienced, then the same determinate colour must be present in experience (not merely in the world), but somehow differently present. This is to say that there must be distinct *perspectives on* the experienced colour, and that this colour and these perspectives must be reflected in experience, where 'perspectives on' is little more than a term for the difficulty we wish to overcome. By hypothesis the experienced colour of my hat is constant when viewed indoors and then outdoors. However, it is somehow experientially different: when

viewed indoors the experienced colour is experienced from one perspective, and when viewed outdoors it is experienced from another perspective. Similarly for the book: by hypothesis the experienced green is constant across the image, but experienced from different perspectives because of the beer. To be explicit, the point isn't that by hypothesis the objective colour of the hat/book is constant, it is that by hypothesis the experienced colour is constant — the issue is one of colour experience, not of ontology. This is the required orientation for persons who are interested in developing a Present account of colour constancy. What we need is an appropriate *analysis* of the concept *having a perspective on a colour (in experience)*. I will suggest one shortly.

The broad point of developing an account of Present constancy is not to imply that all colour constancy cases are Present constancy cases. It is instead to put forth an experientially realist account alongside an experientially anti-realist one (perhaps Cohen's) and consider the vast array of colour constancy cases with the aim of categorizing some (or none or all) as experientially realist and some (or none or all) as experientially anti-realist. I cannot engage in this broader project here, for it is an immense one. My personal view is that many colour constancy cases should be interpreted realistically, and at least some anti-realistically, and I will indicate this where appropriate. My primary interest is in the narrower task of putting forth a more credible account of Present constancy than is currently available, in particular one that is less biased in favour of colour objectivism.

§2.3 Permissive and realistic.

I therefore wish to offer an analysis of colour constancy that is both experientially realist but broadly theoretically permissive. It is experientially realist in that constant colours are present in experience (not merely counterfactually postulated) in at least some colour constancy scenarios. It is theoretically permissive because it is consistent with not only objectivist but also subjectivist colour ontologies and with various perceptual epistemologies. The account centers on analyzing the concept *having a perspective on a colour*. It is to this that we now turn.

§3 Perspectives on colours

There is a conceptual problem underlying an experientially realist or Present understanding of colour constancy, the problem of articulating viable candidates for the concept *perspectives on a colour*.[19] For experienced colours to be in some sense constant and in some sense variable is for us to have varying perspectives on a single colour, where both the constant and variable aspects are identifiable in colour phenomenology. I aim to provide a fruitful analysis of this concept. To be forthcoming, the proposed analysis derives directly from the Layering Thesis. The analysis is fruitful because it requires few assumptions, does not offend against the fundamental challenge for any such an analysis (see §3.1), and elucidates the nature of colour constancy experience. We apply this analysis to colour constancy in §4.

§3.1 Fundamental tension.

Understanding the concept *perspectives on a colour* is particularly problematic given the following tension. On one hand there is intuitive motivation to say that we can have various perspectives on a given

19. This is the core lesson I take from Hilbert (2005) and Kalderon (2008). See also Broackes (2009) and Gert (2010). To my mind all of these contributions are very worthwhile, but none of them develop the notion in a manner that is satisfactory. Kalderon's notion, *presentational aspect*, is not explicitly defined in the work and postulated to resolve the tension between metamers and constancy. It is not developed sufficiently to be used here. Broackes's ideas, presented in the final sections of his marvelous paper, are explicitly speculative. They make some use of colour layering, but are not systematic enough to extract a clean analysis, and are specifically tailored to illuminate experiences of colour dichromats. The views of Hilbert and Gert are discussed in §5.

Another alternative applies the notion of a *mode of presentation* to colour (*e.g.*, Chalmers 2006 and Thompson 2006, 2009). I regard this as an Objectivist alternative. Further, this notion is typically introduced in contexts distinct from that of the present contribution, for example to accommodate the possibility of spectrum inversion. As remarked at the outset, the relativities central to constancy perceptions are not subjective in the way that those relevant to spectrum inversion are. This means that the solution to one should or at least could be distinct from that of the other. We should for example be able to formulate solutions to the VC Challenge that do not commit us to anything with regard to spectrum inversion. We will therefore not consider modes of presentation in any detail.

colour, as indicated for example by phrases like "this blue thing looks blue in daylight, purple in red light, and so on".[20] For ease of reference call this *The Objectivist's Sentiment*. Although this intuition doesn't entail a realist or objectivist view about colour, it is suggestive of one. If colour is a property of a thing that one can have different perspectives on across distinct contexts (*e.g.*, under different illuminations), then colour is invariant across these contexts (*e.g.*, illuminations). That is, what is changing across these contexts is not the colour but merely the perspective one has on it. In this way colour is more objective than what is variable across these contexts. Hence the sentiment is suggestive of a degree of colour objectivism.

On the other hand there is intuitive motivation to deny that we can have perspectives on a given colour, to say for example that if something appears blue at one time, and purple at another, then we haven't witnessed different perspectives on the object's blue colour, but instead the perceived colour itself has changed. A denial of this sort is put forth by Russell in a general form when he declares that a "colour which presents a different aspect is a different colour, and there is an end of the matter" (Russell, 1913, 79).[21] Call this *Russell's Sentiment*. Here is one way to develop Russell's thought. Consider the various properties that have been offered to describe colours, most famously hue, saturation, and lightness [HSL].[22] Using such sets of properties we can define a colour space that by hypothesis uniquely locates each colour at a point in that space. Given a colour we can consider altering an "aspect" of it, for example its hue, saturation, or lightness. However, such an alteration does not involve presenting a different aspect of or perspective on that colour, but instead involves moving from that colour to a distinct one. Thus, Russell claims, the idea of colours having aspects or properties is coherent, but these properties do not generate the ontological space to introduce the notion of there being various perspectives on a single colour. Instead the recognition of colour properties like HSL does the reverse: it reinforces the intuition that there is only one perspective to be had on a colour, "and there is an end of the matter!"

It is no surprise that whereas the Objectivist's Sentiment is suggestive of colour objectivism, Russell's Sentiment is suggestive of colour subjectivism. If anytime an aspect of a colour changes the colour itself changes, then whenever variations in perceptual context impact experienced colour, as illumination variations often do, that impact is arguably not merely on experienced colour, it is on colour simpliciter. This outcome is naturally allied with subjectivist views, since peculiarities of individual perceivers can impact experienced colour.

One way to react to the tension between the Objectivist's and Russell's Sentiments is to concede defeat and allow the respective parties to part ways. Here each party operationally assumes that colours do (or do not) admit of perspectives, and utilizes that assumption in formulating a theory of colour. The resulting theories can then be compared and hopefully a victor will emerge. Unfortunately, judging which theory is victor will be difficult, given that each side will see a crucial assumption that the other has made as illicit, and hence be apt to not find the explanations and analyses that assumption is utilized for compelling.[23] While this dialectical standoff might seem unavoidable and unresolvable, consider a different reconstruction.

The Objectivist's Sentiment allows that a single colour (blue) can give rise to different colour experiences (blue, then purple) in various contexts, and asserts that this is a legitimate sense in which we can have different perspectives on a colour. Applied to colour constancy this yields an Absent or experientially anti-realist account, for the stability of the colour on which the subject has different perspectives is not reflected in successive experiences, it is instead postulated as

20. Cf. Dawes Hicks (1912), Burnyeat (1979/80), Dummett (1979), Demopoulos (2003).

21. I take this quoted remark to have a general appeal. It in no ways requires sense-datum theory and is more appealing for colour (even today) than for shape.

22. Kuehni (2003) surveys an impressive range of colour spaces that have been proposed since antiquity.

23. See Brown (in preparation-a) for a detailed example.

underlying or giving rise to these experiences. Thus the blueness of the blue object is only experienced when the object looks blue. When it looks purple, blue is not present in experience in any straightforward sense; its existence is a postulate, whether legitimate or not, that outstrips experience.

I suggest that what is most objectionable to the adherents of Russell's Sentiment is not the fact that the Objectivist view appeals to a conception of *perspectives on a colour*, but the Absent character of that conception. The reason is plain: an Absent conception of *perspectives on a colour* cannot in any direct way provide evidence for one actually having different perspectives on a colour. The Russellian Sentimentalist thus views the conception as inherently question-begging, and any colour objectivism founded on it as inheriting this.[24] But this concern, legitimate as it is, does not license the conclusion that any "colour which presents a different aspect is a different colour". It instead motivates a preference for a Present conception of *perspectives on a colour*, a conception that places both the stable colour *and* the varying perspectives one has on it in experience simultaneously. To date neither the Russellian nor the Objectivist has provided a means of doing this, setting the stage for a dialectical gap: the Russellian maintains that evidence for there being perspectives on a colour must be drawn from colour experience, and finding no model for this rejects such perspectives; the Objectivist maintains that perspectives on a colour must be possible, and finding no model for extracting this from experience opts for an Absent conception of such perspectives.

24. A classic dispositionalist response is to utilize the Objectivist's conception and identify one of the variable experienced colours with the real colour of the thing (*e.g.*, the one experienced in "normal conditions"). The Russellian Sentimentalist's response (defended, *e.g.*, in *Problems of Philosophy*, by Hardin, 1988 and elsewhere, and Cohen, 2009) is to deny that there is any principled means of sustaining such a claim. I do not wish to contribute to this debate, although I am inclined to side with Russellians. My point is that this response, whether acceptable or not, concedes that there is not a constant colour in one's phenomenology across the relevant circumstances and then seeks to find a way around the ensuing problems. I aim to not make this concession.

In a manner of speaking, our parties are now conceptually disengaged from each other. However, rather than viewing this as an unavoidable outcome from philosophical debate, this resconstruction of why that disengagement arose suggests how reengagement is achievable — via a Present conception of *perspectives on a colour*.

§3.2. Perspective through interdependence.

Rather than explore various means of generating a Russell-friendly analysis of the concept *perspectives on a colour* let me state my proposal, that embodied by the Layering Thesis:

> *Colour Layering Thesis:* we can experience two colours along a single line of sight, one (opaque) colour through the other (transparent) colour.

The Thesis intrinsically contains an analysis of *perspectives on a colour*: when you experience one colour through another you are not experiencing either colour *simpliciter,* you instead are experiencing each colour from a perspective, the opaque colour through this particular transparent one, and the transparent one by experiencing this particular opaque one through it. One's experience of each is interdependent on one's experience of the other. And as one experiences differing opaque colours through this transparent colour, one gets differing perspectives on the latter; and vice versa.

This analysis of *perspectives on colours* is ontologically very liberal. It is consistent with colours being mental, nowhere instantiated, mind-independent, and inherently relational. It is consistent with colours being primitive or reducible to some physical property. It is consistent with colours themselves being definable by reference to hue, saturation, and lightness alone, or by reference to higher-dimensional structures, or with colours not having intrinsic features. It is also consistent with various colour epistemologies, in particular making no commitment to colours being experienced via acquaintance or representation. Finally, it is independent from various other colour phenomena. For

example, it can be held with or without commitment to the possibility of spectrum inversion, it is consistent with the existence of simultaneous and successive colour contrast effects (even when those effects occur in constancy scenarios), and so on. What this proposal requires is the application of the distinction between transparency and opaqueness to colour. Although some developed colour theories may reject this application, there is no *antecedent* reason why most if not all colour ontologies and accounts of colour experience cannot provisionally accept it. The Layering Thesis entails a conception of *perspectives on colours* that is broadly theory-neutral.[25]

This analysis arguably also satisfies Russell's Sentiment. My suggestion is *not* that experiencing something to be purple now and blue earlier provides evidence for our having different perspectives on a colour. It is also *not* that there are features of some colour itself that can be modified to generate perspectives on it. In the context of colour layering, the aspects of a perceived colour that can be changed without changing the colour itself are aspects belonging to some distinct colour that one is either looking through to the target colour, or seeing behind the target colour. I suggest that even Russell would be challenged to reject the proposal.

§4 Layered experience and colour constancy

§4.1 Taking stock.

We seek an account of colour constancy that meets several constraints:

25. A full detailing of how this account is consistent with various colour ontologies, epistemologies and additional colour phenomena has been excised due to length considerations. My point is not that all ontological and epistemological views and all accounts of particular colour phenomena will accommodate the Layering thesis with the same ease or in the same way. My point is merely one of consistency. For ease of discussion I will largely focus on colour objectivism in the text and often presuppose representationalism. Where it seems particularly helpful to re-assert intertheoretic consistency I will do so, usually in footnotes.

(1) Illumination variations must not only "reach they eye", they must be something that we can experience *and* something that can yield variations in experienced colour (§1).

(2) Colour constancy can occur as a result of filter variations in addition to illumination variations (§1). Our account should be general enough to explain both, and to explain experiential similarities between them.

(3) Theoretical permissiveness: colour constancy should be expressible in virtually any colour ontology and colour epistemology. An account that is consistent with and expressible within various ontologies and epistemologies is, all else being equal, preferable (§2).

(4) Experiential realism: by hypothesis experienced constant colours need not merely be experiences expressing a counterfactual colour; they can be experiences of colours that are before one (occurrent or present colours). For ease of reference the latter are deemed instances of *Present constancy* (§2).

(5) (4) demands an analysis of *perspectives on a colour* where both that colour and those perspectives are reflected in experience. Non-question-begging analyses must satisfy Russell's Sentiment (§3).

Some readers may object to one or more of these constraints. At this point I will presume each constraint has adequate merit.[26]

§4.2 Layered constancy.

The conception of *perspectives on a colour* derived from the Layering Thesis yields an account of colour constancy that meets these constraints. The account can be simply stated. Assume a subject experiences two

26. Cohen (2008) identifies some desiderata for accounts of colour constancy, all of which are met by the account that follows. To maintain a reasonable length I leave these details to the reader.

colour layers: one opaque colour through one transparent colour. Assume one of these layers changes, the other remains constant, and the subject experiences exactly that. It follows that the subject has engaged in an experientially realistic colour constancy scenario: the constant colour is a constituent of what she experiences. Call it a *Layered (Constancy) scenario,* and the experiences such a subject undergoes *Layered (Constancy) experiences.* The constant colour is not inferred from what she experiences; it is not explained by postulating an expressed counterfactual content. The constant colour is simply a constituent of experienced colour. Thus, (4) is satisfied. (5) is satisfied by virtue of the account deriving from the Layering Thesis, which itself satisfies (5).

Furthermore, given that this conception of constancy only rests on a conservative extension of the Layering Thesis, it is as easily formulable in subjectivist colour ontologies (*e.g.*, sense-datum theory) as in objectivist ones (*e.g.*, objectivist physicalism), and amenable to a variety of perceptual theories (*e.g.*, representationalism, indirect realism, naïve realism) and perceptual phenomena. For example, it does not matter whether the layers are sense-data or physical objects, or whether one's perceptions are best described via representation or acquaintance. All that matters is that one engages in experiences of colour layers in which one of the layers remains constant while the other changes. The dictates of (3) are thus met.

Finally, it should be obvious that this account has the generality needed to accommodate (1)&(2). *If* we treat illuminants, filters, and (non-filter) surfaces as colour-bearing entities[27], and treat illuminants and filters as transparent and surfaces as opaque, then we can explain both Illuminant and Filter constancy cases as instances of Layered Constancy (satisfying (2)), and we can treat experienced illumination variations as variations in experienced colour (satisfying (1)). Regarding (2), the point isn't that all Filter and Illuminant cases will be exactly similar. We should expect that some Filter and Illuminant cases will involve perceptually similar experiences, some will not. These similarities and differences will have to be itemized and incorporated into a full theory. The point is that the Layering account explains both Filter and Illuminant cases as instances of the same phenomenon, and has the resources to accommodate cases where the involved experiences *are* perceptually similar.

While Layering Present constancy is simply stated, the extent to which it occurs may require extended discussion. It is reasonable to posit that the book-beer image can prompt perceivers to engage in Layering Present experiences in which the perceiver experiences both the green of the book and the amber of the beer along the same line of sight.[28] I presume that this suggestion is not overly controversial, nor is the suggestion that various Filter cases — constancy cases involving opaque objects that are viewed through colour filters — are *prima facie* susceptible to a layering analysis. The extension of the account to Illuminant cases may be more controversial, so I will treat the matter separately (§4.4.1). This being said, we should accept that, moving forward, the extent to which perceivers engage in Layered experiences in constancy scenarios (as opposed for example to Cohen-style counterfactual ones) is subject to further experimental and theoretical study. As mentioned in §2, the primary role of this philosophical contribution is not to settle this issue, it is to articulate a model that satisfies the above goals, has adequate explanatory power (see below) and fares at least as well as its rivals (§5). Let me proceed, therefore, to increase the account's flexibility.

§4.3 Deviations from complete layered experiences.

Further support for our account emerges when we consider the various possibilities it predicts. To this point we have focused on layered

27. In the case of subjectivist views like (*e.g.*) a sense-datum theory that identifies colours with features of sense-data, we would treat mind-independent entities like filters, illuminants and non-filter surfaces not as distinct colour-*bearers* but as distinct *causes* of differerent colour-bearing sense-data, or as entities erroneously *represented* as colour-bearers by sense-data, or both.

28. I say that the image "can" induce such experiences because I believe that it need not do so. The qualification is needed because of the role perceptual ambiguity can play in these contexts. However, as mentioned at the outset, incorporating perceptual ambiguity into this discussion must be dealt with in another work.

scenarios in which the subject distinctly experiences two complete, layered colours (*e.g.*, the green of the book through the amber of the beer). Call these *complete* layered experiences. Here are some alternatives:

A. *Layering failure:* the subject experiences not distinct colours along the line of sight, but one fused colour.[29]

B. *Incomplete layered experiences:* the subject completely experiences one of the layered colours, but only partially experiences the other.

§4.3.1 Layering failure

Image 2 (Fusion) is of what we would pretheoretically call a yellow book as seen through a blue transparency. I offer it as an image that can induce an experience of layering failure. Notice the small yellow strip at the bottom. That is of the book without the mediated blue transparency. Despite my best efforts I cannot experience the rest of the scene as consisting of a yellow book behind a blue transparency, I instead only experience green. The book and transparency contributions to colour have been fused together in experience. Thus no experienced layering occurs (with regard to these elements). As a result no experienced constancy occurs between the lower strip of the book and the rest of it. One could guess that a constant yellow is present, and thus report colour constancy, but such a report would not be a mere description of one's experience, it would instead be the result of a substantive inference from what is experientially present. If one applies Cohen's notion of a counterfactual colour content to the case, one might search for a situation in which this image prompts one's

29. An additional kind of layering failure occurs when one experiences one of the colours and not the other, as for example when the "transparent" colour sufficiently occludes the opaque one — these are aptly called cases of *Complete Occlusion*. This can also occur via adaptation, for example when a lightly saturated filter that spans one's field of view becomes invisible due to adaptation. In either case what is absent is the experienced variability definitive of the kind of colour constancy that is of philosophical interest (see §1 again). Thus this kind of layering failure is tangential to our discussion.

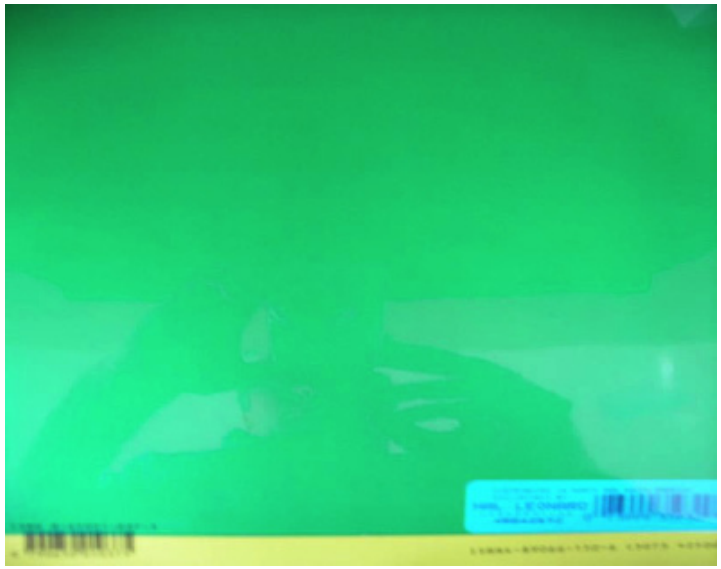

Image 2, Fusion.

visual system to express a counterfactual content of the loose form <That book would look yellow were matters otherwise>. Even here, the yellow of the book is not occurrently experienced; it is not present in or among the colours one now experiences.

I do not take the fact that this is a *prima facie* case of layering failure to be controversial.[30] This is not to say that the mechanisms of the vision system that subserve these layering failures are well-understood. It is not to say that the boundaries between when experienced fusion will occur and when experienced layering will occur are well-defined. On the contrary I expect vagueness is as forceful here as in heaps and colour category boundaries. Finally, this is also not to say that whether we should interpret this fusion as an instance of misperception is

30. This is not to say that one could not deny that there is layering failure here. Presumably (*e.g.*) some naïve realists committed to non-relational colour objectivism would do precisely that. However, the burden would be on those naïve realists (or whomever) to make their case. See Brown (in preparation-b).

uncontroversial. This last issue is in particular *very* controversial for philosophy. For example, a colour subjectivist (*e.g.*, sense-datum theorist, relationalist, etc.) may assert that no misperception is present: you experience green because that is the colour being perceived. A representationalist colour objectivist may do the opposite: you experience green because you are in a green-representing state, despite the fact that there is yellow and blue and no green before you. My point is that this vagueness, potential misperception, and our present ignorance of the underlying visual mechanisms should not be taken to undermine the *prima facie* difference between experienced fusion and experienced layering, and the direct means by which this distinction illuminates whether or not there is Present colour constancy.

§4.3.2 Incomplete layered experiences

Image 3 (Scene through blue glass) is an image of a parking lot as seen through what we pretheoretically designate as a highly saturated blue pane of glass. I propose that it is inappropriate to describe a typical colour experience of this image as only containing various different shades of blue. It may be that the image can induce such an experience in us, but I instead offer this as an image that can prompt us to experience partial layering success and constancy success involving the transparent colour. Experiencing colour layers in this case is (I propose) comparatively simple: one experiences the glass and the objects in the parking lot as distinct, and experiences them to have distinct colours (*i.e.*, at least distinct colour instances). The challenge is to correctly detail this experience.

When we experience layers while looking at this image here is how I suggest we describe what we experience. We experience the glass's colour.[31] It is a saturated blue. We also experience the various lightnesses of the objects in the parking lot. (If you doubt this spend a moment looking at those objects, after which it should be easy to start distinguishing if not ordering the different lightnesses of the various

31. Again, a subjectivist, like the sense-datum theorist, will substitute "the proximal sense-datum's colour" for "the glass's colour", and so on for what follows.

Image 3, Scene through blue glass.

objects in the lot.) What we do not experience is the full colours of the objects in the lot: their hues (and possibly saturations) are not experienced. Nonetheless, these various lightnesses are experienced as features of the objects in the lot, not as features of the glass.[32] The experienced colour of the glass is not infected by these various lightnesses; the latter are colours seen through the glass's blue. Thus the glass is experienced to have a constant shade of blue — Present colour constancy obtains.

There are many aspects of this description that dissenters and skeptics will find troublesome. While I naturally sympathize with the description, what is of primary importance to philosophical discourse

32. A subjectivist sense-datum theorist may prefer a slightly different description according to which the "full" colours of the distal opaque sense-data *are* experienced. That is, the transparent sense-datum is some particular shade of blue, but the opaque sense-data seen through the blue are by their nature only partial colours, *i.e.*, these sense-data *only* have lightness values, but not hues (or saturations). Either way Present constancy obtains and it obtains because of layering.

about colour constancy is that we have a viable model for how we can experience colour constancy in the presence of experienced colour variation. Such a model has been offered. If the description of this case that the model affords is inadequate, then perhaps there is no Present colour constancy in this case (as Cohen would argue), or perhaps a forthcoming account of such experience will fare better. I cannot adjudicate that dispute. However, I will make one further qualification in support of my description.

On my description, when this image induces a layered experience of objects and colours, while the nature of the transparent colour is fully present in experience, the natures of the opaque colours are only partially present — in particular their lightnesses are. One can speculate as to the determinate colours (*e.g.*, the hues and saturations) of the objects seen through the transparent colour, but in a fundamental sense they are not present in experience, only their lightnesses are. It is important to recognize that no attribution of error is needed to understand this kind of experience. Here are two means of inserting error. One might deny that one can have a layered experience when viewing this image, in which case the surfaces seen through the glass are all experienced as having varying shades of blue. Reflectance physicalists would be inclined to attribute error to such an experience, for the objects in the lot presumably are not all blue; colour relationalists need not attribute error here, for the colours of the objects in the lot can be relative to factors like context of viewing. Secondly, one might accept that one can have a layered experience when viewing this image, but suppose that we are experiencing the surfaces seen through the glass to only have varying shades of grey. Here error would arguably be present for an objectivist, for at least some of these objects are likely not grey.

Alternatively, we can ascribe no error. Suppose that during a layered experience we are only experiencing the lightness values of these opaque colours, and simply not experiencing their hues or saturations. Perhaps our vision systems are attributing a constant colour *c* to the glass, various lightness values to the objects seen through the glass, and *not* attributing hues or saturations to the latter, because the hues and saturations of the latter are being occluded in a way that prevents our vision systems from correctly discerning those values. Perhaps we experience precisely that. There is no antecedent reason why we cannot experience only part of a thing's colour, no reason why we are bound to say that when we experience a thing to have some colour property (*e.g.*, a lightness) we must experience it to have a fully determinate colour. By hypothesis the facts are straightforward: the glass is blue; and the objects seen through it have various colours, all of whose hues and saturations are arguably occluded but whose lightnesses are not. When we have a layered experience when viewing this image our experience can be interpreted as recovering exactly this, and nothing more, and when it is so interpreted no perceptual error occurs. This outcome is valuable for representationalists (for it pushes us to consider that such experiences are extremely accurate) and for acquaintance-based views that exclude accuracy and error from experience. It is also formulable within sense-datum theory and other subjectivist views — although whether it would be welcomed by advocates of such theories I will not pause to consider.

To respect symmetry we should consider the reverse possibility, where the natures of the opaque colours are fully present in experience while the natures of the transparent ones are only partially present. I submit that this can occur when the transparent colour is only lightly saturated, making it difficult for one's vision system to recognize that colour. It can also occur when adaptation factors out the transparent colour or some portion of it, in particular when a lightly saturated transparent colour spans one's field of view for some period of time (*e.g.*, when one puts on sunglasses). Given the latter it is difficult to provide images for these effects. Nonetheless, although adaptations of this sort are only partially understood,[33] that they can occur is not in serious doubt.

33. See again Brainard (2004).

§4.4 Extension to Illumination

Some readers may worry that while the Layering approach is intuitive for Filter cases, its application to Illumination cases is unintuitive and potentially problematic. A layering analysis of Illumination cases entails that: experienced illuminants and (non-filter) surfaces are colour bearers[34]; these illuminants are transparent, and surfaces are opaque; we experience these illuminants by looking through them to these surfaces, and experience these surfaces by looking at them through these illuminants. Present colour constancy obtains when one of these remains constant; the other varies, and precisely that is experienced. While this application is logically straightforward, there are reasons for concern. Before considering objections, let me motivate the full account.

§4.4.1

Applying the division between Complete layered, Incomplete layered, and Fusion experiences to Illumination cases is logically straightforward. Finding cases that potentially instantiate each is also not difficult.[35] Scenarios in which subjects are able to describe the colour of the illuminant *and* the colours of surfaces exist (*e.g.*, that's a black phone under a yellow light) and are evidence for the presence of multiple colours along a line of sight. This must be explained in some way. Cohen would argue that one colour (a blackish-yellow) is occurrent, and any expression of a black simpliciter, or a yellow simpliciter, is an expression of a counterfactual content. An experientially realistic account in which a constant colour is before us in experience (or occurrent) must appeal to alternative resources. A layering analysis is at least credible if not satisfying: the illuminant and surface colours are experienced simultaneously along a line of sight, and this is achieved because the former is transparent, the latter opaque, and the latter is seen through the former. Thus it is not implausible to hold that Complete layered instances of colour constancy exist.

Fusion experiences would involve the subject experiencing a single colour along a line of sight that fuses together the illumination and surface contributions to the colour signal. This would typically mark an instance of constancy failure in computational psychology, and do so in the Layering account also. It is well-known that without adequate cues subjects are unable to make the distinction between illuminant and surface contributions to experience, but instead experience a conflation of the two (*e.g.*, aperture colour experiences arguably routinely prompt this). Thus, Fusion experiences that involve illuminants instead of filters plausibly exist.

Regarding Incomplete layered experiences, candidate stimuli that can generate experiences containing full transparent and partial opaque colours, and partial transparent and full opaque colours, are avilable. Regarding the former, consider an illumination scenario analogous to the Glass-Parking lot image (see Image 4), where on my analysis the full colour of the illuminant is experienced but only the lightnesses of the surfaces are. Regarding the latter, and by analogy with various sunglass cases, the full colour of a lightly saturated red light that is illuminating all the objects in one's field of view will be difficult to experience, particularly after a few seconds, yet the full surface colours of objects in the scene may nonetheless be experienced. Thus the layering analysis can again be used, including the analysis of experiences of partial colours that it affords.[36]

34. Or, for the subjectivist, causes of, or erroneously represented as, colour bearers.

35. Recall the additional category, Complete Occlusion, where the proximate layer completely occludes the distal one. Extremely bright lights achieve this, *e.g.*, a bright white light, particularly when one's eyes are dark-adapted, completely occludes distal surfaces, at least for a time. Here the light is momentarily functioning as an opaque entity as opposed to a transparent one.

36. In theory scenarios can also have multiple colour layers, *e.g.*, two filter colours and one surface, one filter one illuminant, and one surface, etc. Note that subjects' ability to accurately describe their experiences may be limited without adequate training and instructional prompts.

Image 4, Audience through green light. Performa, 2009. Photo by Paula Court.

§4.4.2 Objections

Here are some (of many) general objections to a Layering interpretation of Illuminant cases:

1. We have not been thinking of Illumination constancy cases as layered, and we've been thinking about them for some time. Similarly, we have been aware of layered colour experiences for some time (*e.g.*, by looking at books through beer), and Illuminant cases do not seem like this.

2. Which of the occurrent photons are being seen through to surfaces; which are not?

3. Where is the transparent illuminant experienced as being?

4. If light is coloured, then daylight is a (yellowish-)white light. We generally do not experience the daylit world as though we are looking through a white transparent colour. Hence the Layering account makes an incorrect prediction.

A detailed discussion of these and other concerns would require a work of considerable length. Let me therefore only briefly remark on how they can be addressed, and then turn to contrasting the Layering account with some recent alternatives.

As discussed in §1, the idea that Illumination variations merely "reach the eye" is no longer a live option in discussions of colour constancy. At least some of the illumination variations relevant to constancy are typically experienced, hence we all must offer accounts of constancy experience that capture this. This makes worries like 2. have little force, for all must address the difficult question of which occurrent photons are being experienced. What the Layering approach adds to this is the claim that the experienced photons are experienced in a particular way—as transparent.[37] Regarding 3., experienced illuminants can be thin sheets (*e.g.*, flat shadows) or thicker volumes (*e.g.*, volume shadows), depending on the case. What defines these boundaries may be taken to be the extent of what we experience, or something more objective if available. Either way, this may be difficult to assess, and inherently vague, but all accounts of constancy will be subject to these problems (lest they, *e.g.*, deny the existence of volume shadows). Here is one of several possible responses to 4.: experienced illumination variations involving white light typically involve incomplete layered experiences, where the lightnesses, but not the hues or saturations, of the transparent colours are experienced, and the complete colours of distal surfaces are experienced.

37. As long as by "transparent" we mean "can see through" there is no conceptual difficulty with this idea (see opening section). If one wishes to extend the meaning of "transparent" to "transmits light in appropriate ways" some technicalities may arise. However, they are not obviously insurmountable. Consider a thin shadow on a wall. If we identify the shadow with some portion of the incident light, say, a thin film of photons about to strike the wall (a class whose members are constantly changing), then my account would deem that thin film of photons to be "transparent". The light reflected from the wall to the perceiver travels through the region of space occupied by the thin film of photons. In this sense the thin film of photons *transmits* the reflected light, and hence satisfies even the transmission sense of "transparent".

1. is a general objection and hence demands slightly more attention. I accept that my proposal is a significant reorientation from most but not all existing views.[38] However, that this analysis has eluded us should not be a surprise; colour constancy has been an extremely difficult topic for scientists for some time[39], and not actively studied by philosophers until recently. In psychology, for example, layered visual experiences — *scissions* — have been of particular interest since the 1970s.[40] Here the focus is often on perceptual cues that are likely to prompt subjects to experience a transparent (or translucent) film before an opaque surface. The stimulus might for example be a flat, single-layered surface, and thus when an experience of layering is induced the experience might be deemed "illusory".[41]

With regard to 1., a key issue is whether or not layered experiences must be straightforwardly introspectively accessible as such (*e.g.*, whether or not experiences expressing layered contents are straightforwardly introspectively accessible as such). If yes then the fact that Illumination cases have not been theorized as layered counts against the current proposal, but if not then this fact has little negative impact on the current proposal. Scientists working on scissions are naturally often interested in scenarios where it is obvious to the subject that layering is experienced, so that these scientists can safely assume that they are studying experiences of layering. But scientists are also aware of how, in "traditional…paradigms, it can often be difficult to determine whether scission is occurring" and are actively developing new paradigms to minimize the problem (Anderson 2008, 241).

I suggest that some layered experiences will be obviously such to perceivers, but some other layered experiences may not be obviously such to perceivers, where what is "obvious" can vary depending on factors like background knowledge, training, priming, and so on. A Layering approach to Illumination cases would place many standard constancy cases in the realm of layered experiences that are not obviously such for most people. I see no reason why this would count against its tenability.

If a layered experience is not obviously a layered experience to the perceiver then it will be difficult to assess that this is obtaining, as opposed to the perceiver having a non-layered experience. Psychophysicists will naturally have much to add to this discussion. However, their efforts hinge on an adequate model for predicting when experiences of layering occur, and they are by their own admission currently struggling to construct a general, unified theory that predicts when an obviously layered experience will occur for subjects. Such a theory may *but need not* generalize to cases when layered experiences occur but are not obvious to subjects. In any case, a theory of the latter sort is what would be needed to test a Layering approach to Illumination cases. Thus, I submit that while 1. is a legitimate concern, *at this stage in our collective understanding* it does not significantly detract from the worth of the current proposal. These general remarks can be buttressed by a concrete counterexample and then a remark on how the Layering analysis connects to some empirical literature.

Casati (2009) rejects the general transparency of shadows but is not concerned specifically with colour constancy. Here is the core argument:

(1) "[S]hadows can be seen as shadows even though they do not straddle a luminance boundary."

38. The proposed view is somewhat similar to that of Mausfeld (2003) and Webster (2009) but differs under fine-grained analysis. The relationship between colour constancy and experiences of layering has received some recent interest (*e.g.*, Khang & Zaidi 2002a,b). See also §5.

39. For example, in *Colour for Philosophers* Hardin calls colour constancy "far from properly explained", and doesn't propose to resolve the matter (1988, 82). See again Shevell & Kingdom (2008) for a recent review.

40. Metelli (1974) is a classic work. Anderson (2008) offers an alternative and summarizes some seemingly fatal problems for Metelli's view and the views based on it. Kingdom (2011) is an excellent review article.

41. Khang & Zaidi (2002a,b) are notable exceptions. They used computer simulations of actual layered stimuli, allowing them to test for the accuracy of subject (behavioural) reports of layering with regard to the stimuli. Whether or not, on a deeper level, these perceptions might be considered "illusory" I cannot pause to consider.

(2) "[B]ut straddling a boundary is [required[42]] for a transparent surface to be perceived."

(3) "Hence the general case of shadows' being transparent is not viable." [2009, 9]

Three remarks are relevant. Firstly, a Layering approach to Illumination cases also rejects the general transparency of shadows (in agreement with (3)), in particular in fusion cases. The issue is whether or not shadow cases involving constancy can also be non-fusion, and if so whether or not labeling the shadow 'transparent' is appropriate. Casati's argument says nothing about the matter and in this regard it is tangential to our discussion. Secondly, while (1) seems correct, much hangs on how "seen as" is to be interpreted, and Casati gives no guidance on how to interpret this notoriously thorny phrase. Thus the significance of (1) for our discussion is difficult to assess. Finally, (2) is a theoretical postulate which Casati defends by appeal to two psychological accounts of transparent perception (Metelli 1974 and Kitaoka 2005). Although the details of these accounts are interesting, space prevents a thorough discussion of them. For our purposes it is adequate to recognize that: (a) there isn't unanimous agreement about what triggers transparency experiences in the psychological literature (see above); (b) psychological accounts are typically not taken to be fully general, contrary to what is implied by Casati; and (c) psychological accounts are typically focused on finding cues for when it is straightforwardly introspectively obvious to subjects that they are undergoing a transparency experience, which is a constraint that we would have to move beyond to assess a Layering approach to Illumination cases. Thus although Casati's discussion is interesting and informative, it and others like it should not cause us to recoil from the Layering account.

The empirical literature on colour constancy is vast, and as noted at the outset the phenomenon itself is in some cases differently conceived by different scientists (see again Chirimuuta 2008). Given the philosophical nature of this work, I will settle for the plausible consistency of the Layering account with some key empirical results, noting that the experiments from this literature were not designed with a Layering hypothesis in mind.[43] Suppose that the Layering analysis is correct of a significant number of constancy cases, and hence that experiences of layering in those cases are not obviously such to average perceivers. In tests for this we would expect instructional effects, since subjects' descriptions of, or behaviours with regard to, what they are experiencing could likely be pulled toward or away from the layered aspect of what they experience or from one of the layers toward the other. We find significant instructional effects in the empirical literature on colour constancy (see, *e.g.*, Arend & Reeves 1986, and Arend 1993). Given layering during constancy we would expect there to be persistent residual evidence of the distinctness of the transparent and opaque layers. For example, aspects of the illuminant and surface contributions to colour experience should resist reduction to one another, and they at times do (*e.g.*, Logvinenko & Maloney 2006). Given layering during constancy we would expect that a perceptual match between two adjacent layered elements requires matching two layers of colour information, and that a perceptual match between a layered stimulus and a nonlayered one would be impossible, yielding at best partial matches. Further, if subjects are not given the capacity to manipulate both layers when searching for a match (*e.g.*, in asymmetric matching tasks), then in general we should expect precisely what we find, namely that approximate matches are all that is achievable for standard stimuli.

The Layering analysis can thus be used to generate an interpretation of notable aspects of the empirical data on colour constancy. To empirically test it we have to construct paradigms designed to bring out the extent to which postulating two (full or partial) colours along a line of sight is helpful in predicting and explaining subject responses. I know of none that attempts this. The Layering analysis therefore

42. Instead of 'required' the text states 'requested'. I presume it is a typographical error.

43. As mentioned above, a notable exception is Khang & Zaidi (2002a,b).

cannot be quickly dismissed by any claim, such as 1., to the effect that that analysis should have emerged as a plausible contender by now. Rather than pursue objections further let me summarize the section and proceed to contrast this account of constancy with two of its rivals.

§4.5 Summary & Explanatory power.

The division between Complete layered, Incomplete layered, and Fusion experiences is not merely predictable within a Layering approach to constancy, it finds support in specific Filter and Illumination cases that are otherwise difficult to explain. Beyond this the division can be incorporated into different colour ontologies and epistemologies in various ways (the details of which I leave for another work), and the division greatly increases the power of the Layering account. Let me remark on the last point.

The recognition of two forms of layered experiences — Complete and Incomplete — considerably increases the explanatory power of the account. Cases where the filter/illuminant colour and surface colour are distinctly discernible suggest Complete layering. Cases where one can discern a filter/illumination variation across some opaque surface, but not fully discern the filter/illumination colour, or vice versa, suggest Incomplete layering. The crucial achievement is that in all such cases there is no need to attribute the filter/illuminant contributions to what is experienced *to the opaque surface*. If one can distinguish a filter/illuminant contribution to colour experience *from* an opaque surface contribution, one can attribute the former to the filter/illuminant and the latter to the surface, full stop. This is so even if one cannot discern a complete colour for one or the other. This permits us to hold that one has differing perspectives on the constant colour without violating Russell's Sentiment: the target (surface or filter/illuminant) colour is experientially constant despite an experienced colour variation, where the variation is *not* explained as involving a changed aspect of the target colour but is instead explained by reference to a distinct colour one also experiences along the same line of sight. We thus have a general model that meets the five constraints outlined above, and that can in theory readily apply to seemingly all Illumination cases (including all shadow cases) and Filter cases.

The point is not that all constancy reports are indicative of Layered constancy experiences — some may well be indicative of counterfactual constancy contents. It is that Layered cases plausibly exist, and our task looking forward is to determine their extent while striving to satisfy, as much as is reasonable, our five constraints. Let us finally consider some alternative accounts in detail.

§5 Alternative views

I have emphasized the difference between the layering and counterfactual accounts of constancy, and the fact that the former is consistent with various colour ontologies and epistemologies, in particular with both colour subjectivism and objectivism. This being said, there is no doubt that constancy is of most interest to colour objectivists. I take what has preceded to undermine any straightforward argument from constancy to objectivism. It is, nonetheless, worth seeing how the Layering account fares against two objectivist accounts, for in my judgement it fares rather well. I have elected to focus on two recent and excellent contributions: David Hilbert (2005) and Joshua Gert (2010).[44]

There is now general agreement that, in contrast to some earlier accounts (see §1, references in note 7, and below), illuminant variations are not simply "discounted" by the vision system, but instead are regularly experienced by us. Both the proposals of Hilbert and Gert make this accommodation while maintaining a form of objectivism, but neither have homed in on the fact that the problem is more general than this. The challenge for objectivists isn't merely to accommodate experienced illumination variations into our account of colour constancy, it is to at minimum satisfy (1),(2),(4)&(5) from the last section. (3), the commitment to theoretical permissiveness, is to

44. In addition to articles discussed earlier, recent writings in which colour constancy plays a significant role include Burge (2010), Gert (2010), Hilbert (2005), Jagnow (2010), Kalderon (2008), Matthen (2010), Maund (2012), Noë (2004), Smith (2002). I am forced to select from this impressive list of works but a few on which to focus.

my mind preferable but can be momentarily set aside, given the objectivist interests of our targets.

§5.1 The Minimalist solution (illumination variation as brightness variation). We can view Hilbert (2005) as trying to solve the VC Challenge by making the smallest possible deviation from older "discount the illuminant" views.[45] On his approach "colour appearance" is represented colour, colour as it is represented by some perceiver in some circumstance. It need not constitute actual colour. He begins by claiming that "in addition to delivering information about the reflecting properties of objects the visual system also delivers information about the way in which those objects are illuminated" (p. 150). We assume that by 'delivers' he means that the vision system makes illumination information available to the agent for conscious perception. Hilbert then argues that this illumination must be represented as a "property of the object" as opposed to "a property of the light source", and says that one "consequence of this…is that the colour appearance of an object must have more than the traditional three dimensions of variation" (pp. 150–151). The implied usual three dimensions are hue, saturation and lightness [HSL].[46] He is unfortunately somewhat vague on what the extra dimension(s) are and how they are related to represented colour *proper*, making his solution difficult to assess. I therefore must make what I hope are judicious interpretive decisions. As I (and Gert, 2010, 673–6) read Hilbert his idea is that the vision system represents colours to be the kind of thing that can be variously illuminated, in which case the extra dimension is "illumination of colour *x*", where *x* is still uniquely specifiable in a suitable HSL space.

Note that the claim that the light illuminating an object must be represented as a "property of the object" as opposed to "a property of the light source" is a false dichotomy that excludes by fiat the option defended here, namely that the illuminant is represented as what it is: its own ontological entity.[47] This forced-choice makes Hilbert's claim that the illumination is represented as a property of the object seem more natural than it is, and plays nicely into his overall solution, which is designed to preserve reflectance physicalism. On this solution colours are *still* classes of reflectances/productances, located in an HSL space. The perceptual variabilities in constancy cases do not undermine this, but instead force us to recognize that when we represent colours we do not *solely* represent them, but instead represent them to be illuminated in some way. Crucially, these illuminations do not alter colours themselves, only the way colours are presented to us in a given circumstance. Thus the idea that illuminants are coloured is still excluded from Hilbert's account.

On my reading this account has the advantage of fundamentally incorporating into colour perception and experience the idea that we can and always do have a particular perspective on a colour — colours are never (or rarely) experienced *simpliciter*, but are instead only experienced as illuminated in some way. In this regard Hilbert has made a

45. Most readers will be familiar with the reflectance physicalist approach defended by Hilbert alongside Byrne (*e.g.*, Byrne & Hilbert, 1997a, 2003). On this view colours belong to surfaces, films, volumes, and light *sources*, but not to light itself (2003, 11). *E.g.*, the sun has a colour but the light it emits does not. This does not prevent us from representing illuminants to be coloured (1997a, fn 15; 2003, 54), it simply prevents those representations from being veridical.

46. For convenience I will presuppose HSL as the standard colour space. In general the reader may substitute this for her preferred three-dimensional model. Hilbert makes no firm commitments on the appropriate extra-dimensional model, but mentions as a possibility Fairchild's (1998, 107–9) account involving brightness, lightness, colourfulness, chroma, and hue. Fairchild's model is worth analyzing on its own terms, for I believe it too contains some of the weaknesses the present account has been designed to avoid. The same dangers no doubt hold of various other models. Thus while I invite the reader to substitute for HSL her preferred three-dimensional model, note that some models, even three-dimensional ones, may not fit cleanly into the Layering Thesis. Unfortunately, I must leave these modeling troubles to another time.

47. We certainly conceive of the world as working this way, namely as the physical substance light being what illuminates and thereby makes visible to us the ontologically distinct hats and horses in scenes. There are no doubt interesting and only partially understood issues in physics concerning how illuminants and hats interact, but we nonetheless accept the occurrence of such interactions and feel no pressure to collapse illumination into a property of hats (or horses).

core, Russellian-friendly, reorientation needed to meet the VC Challenge. However, he has not gone far enough: his solution is not generalizable to Filter cases, and even within Illuminant cases it seems restricted to achromatic illumination variations. Let me explain.

Hilbert's solution is not generalizable to Filter cases because the solution is explicitly defined by reference to illumination variations. He may see this as a virtue, perhaps because the computational approach to constancy that he has advocated for years is typically defined by reference to Illuminant cases.[48] It is fair to demand more. There are various Filter and Illuminant cases that are perceptually similar, and the general phenomenon of colour constancy is operative in both domains. Thus, accounts that contain the generality to recover these facts should be preferred, all else being equal, to ones that do not. The point is not to demand that all Filter and Illuminant cases are treated *exactly* the same (*e.g.*, in the beer-book image the transparent colour has well-defined depth boundaries which will be absent in many Illuminant cases). The point is that our account should contain a level of generality that can apply to both domains and explain what they have in common, and then contain lower-levels of generality that bring out any ineliminable differences between Illuminant and Filter cases that are discovered, or between particular cases, and so on. Hilbert's solution is not robust enough to facilitate this.

Furthermore, Hilbert's proposal to increase the number of dimensions of colour appearance beyond the "traditional three" is too limited. His focus is almost exclusively on shadow perceptions and more generally on constancies with achromatic illumination variations. This restriction supports thinking of the variabilities in constancy cases as mere variations in how "brightly" or "dimly" a colour is illuminated (Hilbert, 2005, 150). This perhaps suggests Hilbert's view, that we should stick to a single represented (surface) colour but increase the number of represented colour dimensions: if what needs explanation is how brightly or dimly lit a colour is, then moving from 'x is represented as blue' to 'x is represented as a brightly/dimly lit blue' is appropriate.

However, this analysis is not powerful enough to accommodate the fact that the experienced variations in Illumination cases go far beyond how brightly and dimly lit colours are, and instead include experienced variations in at least hues (but perhaps also saturations). In red twilight there is no doubt that I experience redness, and that this is not explainable in terms of how brightly or dimly lit my room is. If colour constancy is occurring, which it can in such cases, then we are obliged to explain how the constant white of my wall is experienced with respect to the redness I also experience — we must to solve the VC Challenge. What we need is not to increase the number of *dimensions* of experienced colour, from three to four or five, we need to increase the number of experienced *colours* from one to two. While this possibility is perhaps easy to overlook when focused on the idea that colours can be more brightly or dimly illuminated, it is impossible to miss when focused on Filter cases and constancy scenarios involving chromatic variations more generally.[49] Consider a final challenge for Hilbert, one targeting the inference from constancy to reflectance physicalism.

Recall the connection between reflectance physicalism and constancy from §1. On traditional "discount the illuminant" accounts of

48. Note that since constancy experiments began being performed using computer screens the potential to conflate Illuminant and Filter cases has increased dramatically.

49. Instead of the dimension "more or less brightly illuminated", consider an analogue dimension "more or less revealed", constructed specifically to be conceptually distinct from illumination. It may be that on further analysis admitting colour layers is not enough to capture some aspect of phenomenology concerning colour revelation, *e.g.*, that a transparent or opaque colour is more or less revealed in some context. In this case the Layering approach could be supplemented by some such analogue of Hilbert's idea. However, firstly, this outcome would not affect any of the arguments offered here for the inadequacy of Hilbert's proposal or the strengths of the Layering approach. At worst this would show an incompleteness to the Layering approach as presented. Secondly, on a more realist reading of the Layering approach, during incomplete and completely occlusive cases (see §4) a dimension of the revelatory sort is already contained in the account. As such, any suggestion that an additional revelatory dimension is mandated would require distinct and to this point unarticulated motivation.

constancy it was *assumed* that illumination variations were not widely experienced[50], and to the extent that they were, such perceptions were deemed erroneous. This analysis of colour constancy suggests a B&H-style colour ontology according to which surfaces, films, volumes, and light sources are coloured, and illuminants are not. Constancy is indeed one of the chief justifications offered for their view, and cases in which illumination is experienced are deemed erroneous.[51] The difficulty is that once "discount the illuminant" accounts are rejected (on grounds that illumination variations are widely experienced, and hence such experiences should not by an objectivist be categorized as erroneous), the support constancy provides for reflectance physicalism is in doubt.

Hilbert's (2005) more recent proposal provides a way around this conclusion, at least in part. If illumination variations are widely experienced, but not experienced as variations in *colour proper*, then a conception of constancy that captures this might still support reflectance physicalism. Hilbert's suggestion that illumination enters into experience not as variation in colour proper but as variation in how brightly or dimly colour is illuminated meets this constraint. On this view experiences of illumination variations in general need not be erroneous (for colours are correspondingly more brightly and dimly illuminated), thus avoiding the problematic assertion to the contrary seemingly present in B&H's earlier view. Hence, were Hilbert's suggestion adequate, the inference from constancy to reflectance physicalism could, all else being equal, be broadly sustained.

It should be clear that these virtues hinge *precisely* on characterizing experienced variations in constancy scenarios as primarily and fundamentally consisting of experienced variations in how brightly or dimly some thing is illuminated. Unfortunately, the experienced variations in constancy scenarios are much broader than this: they involve experienced variations in hue and thus colour proper (in both Illuminant and Filter cases), and at least in principle need not involve experienced variation in illumination (in Filter cases). Thus, the above means of reasserting the inference from constancy to reflectance physicalism should be rejected. Here is the broader narrative.

> The lesson is that experienced hues [and thus colours proper] do change across variations in at least some constancy cases. The challenge is to incorporate this into our theory of colour experience and assess its impact on what constancy might tell us about colour ontology. Here are two options. The first concedes that experienced hues do change in relevant cases and concedes that there is no experienced constancy in hues. Any account of constancy based on these constraints will be of an Absent sort. Unfortunately for the objectivist, no Absent account can provide straightforward evidence for colour objectivism; on the contrary such accounts are grist for Russell's subjectivist mill. In response objectivists can provide other arguments for their view, and undermine the evidence constancy provides against their position. This is not only an odd position for objectivists to be in, it also demands a rather powerful argument to the effect that all of the experienced variations in colour proper found in constancy cases (or at least in Illuminant cases) are erroneous. It is fair to say that B&H have not provided such an argument, and I know of no means of formulating one on their behalf. The other option is to concede that experienced hues do change in relevant cases but resist the implication that there is no experienced constancy in hues — that is, to find a viable Present account. The Layering analysis is a natural candidate, but we should be cautious in assessing the impact on colour ontology.

50. Recall B&H's 1997c definition of colour constancy (§1).

51. Here is the relevant argument B&H offer for reflectance physicalism. When searching for the physical property with which to identify colours, "it is of course the object that looks colored (more strictly, its surface), and so the relevant physical property must be a property of objects (more strictly, surfaces)" (2003, 9). They then claim that colour constancy supports their view, for given constancy, and "[a]ssuming that our perceptions of color are often veridical, we therefore need a physical property of objects that is largely *illumination-independent*" (ibid). Light *in addition to* surfaces is not seriously considered. Instead, they assert that to the extent that we represent illuminants as contributing to colour (1997a, fn 15; 2003, 54), those representations are erroneous. Also see Hilbert (1992).

Since the Layering analysis is consistent with a host of colour ontologies it is difficult to argue that constancy provides evidence in favour of objectivism. Further, the way in which the Layering analysis is consistent with objectivism supports the existence of illuminant colours, and thus stands in tension with anti-illuminant colour views like reflectance physicalism. I therefore see no comfortable seat on which B&H can rest.

In summary, Hilbert (2005) has taken a crucial step, for the idea that we can have different perspectives on colours is what is needed to solve the VC Challenge in an experientially realistic way. But what is needed is much broader than the perspectives afforded by "colours being differently illuminated", it is perspectives afforded by looking at one colour through another. Hilbert's important but conservative deviation from "discount the illuminant" approaches falls short of the advance needed to fully meet our challenge.

§5.2 The Appearance solution (separating colours from HSL properties). Gert (2010) has put forth a conception of experienced colour that allows for considerable variation across perceptual contexts and nonetheless keeps colours as constant, illumination-independent features of surfaces. In his words:

> Colours are categorical properties of surfaces, and they are picked out by the ways in which they make those surfaces appear in different viewing conditions. One immediate corollary of this view is that colours cannot be characterized by giving precise coordinates in HS[L][52] space — nor by any minimal extension or variation on these dimensions. [p. 681]

The thought is that as contextual factors vary (*e.g.*, illumination, angle of viewing, one's perceptual apparatus, etc.), the colour appearances of surfaces vary, and those appearances indicate or "pick out" what objective, stable surface colours underlie them. The notion of a *colour appearance* is undefined and is used to generate the possibility of having different perspectives on a colour, for a single colour gives rise to various colour appearances in various contexts.[53] This much is not novel, but is instead familiar, at least from early modern subjectivist and dispositionalist views. What is novel is (a) Gert's concession that we cannot sustain the dispositionalist idea that the true colour of a thing is the one that is picked out by the colour appearance experienced in normal conditions, while (b) resisting the threat of colour subjectivism. This is achieved by divorcing colours from the HSL features that seem inherent in experienced variations in colour appearances. If a colour doesn't itself have a set of HSL features, then it can be "picked out" equally correctly by various HSL-defined colour appearances. Exactly *how* this is done must be spelled out (and we will not pursue the matter here), but in any case Gert has created a conceptual space for doing so that to my mind is novel.

A brief comparison with Hilbert's view is instructive. Ontologically, both agree that colours are illumination-independent features of surfaces (filters, etc.), however whereas for Hilbert colours have HSL properties, for Gert they do not but are instead *merely categorical*. Experientially, Hilbert has added dimensions beyond HSL to colour appearance, whereas Gert has not. However, because for Gert colours are merely categorical properties, he can allow colour appearances to vary *en masse* without incurring the charge that experiences involving

52. Gert prefers referring to HSB instead of HSL space (Brightness instead of Lightness). This has no impact on our discussion, so I will continue to refer to the latter.

53. It is difficult to avoid quantifying over colour appearances within Gert's view. Thus, for ease of explication I will implicitly do so in what follows. There are important questions concerning the ontological and epistemic relations between colours and colour appearances. *E.g.*, are colour appearances caused by the former or are they simply ways colours present themselves to the world? There is an ontological simplicity to the latter, but given that elements distinct from a surface colour can affect colour appearances (*e.g.*, illuminations, filters, natures of vision systems, etc.) there is at least some pressure to accept the former. I leave these difficulties in the hands of this view's defenders. In personal correspondence Gert (May 2012) has told me that he is tempted to interpret appearances adverbially, but admits to not having worked out the details.

these various appearances are largely erroneous — colours don't have HSLs, so massive variations in HSL appearances need not fail to "pick out" stable colours.

I take it that Gert's view can accommodate variations in colour experience due to illumination and filter changes, and accommodate them in the same way when necessary: they induce changes in colour appearances but not in colours. Constraints (1)&(2) are thus plausibly met. The account also delivers an interpretation of colour constancy: the same colour can be "picked out" by various HSL-imbued colour appearances, and thus a wall's colour is constant across illumination variations and variations in colour appearance. However, this interpretation of constancy is not an experientially realist one.

If colour experience is described by reference to colour appearances, and those appearances are variable in Filter and Illuminant constancy cases, then where is the constant colour in one's experience? The constant colour is still *in the world*, for it is partially responsible for and is "picked out" by its appearances. But Gert has not put forth an account of colour *experience* that forces us to hold that the constant colour is experienced in addition to these colour appearance variations. The contrast with Hilbert's view brings this out particularly well.

Hilbert wants constant colours to be constituents of constancy experience, hence his attempt to accommodate the experienced variations in constancy scenarios in terms of a colour being differently illuminated. On this view one can hold that in Illuminant cases the subject's experience is constituted by the same colour, despite it being differently illuminated and experienced as such — what is dropped is adherence to the traditional three dimensions of colour. Such an experientially realist account is seemingly unavailable to Gert. On Gert's view in an Illuminant case we experience changing colour appearances, a varied flux of HSL properties, and each of these "picks out" the same categorical colour. However, there is nothing in the colour appearances to ensure that the purported fact that the same colour is picked out by these various colour appearances is itself part of one's experience. That is, constant colours appear to be *at best* inferred from experience as opposed to contained in it. There may be ways to rectify this problem, one of which is to bite the bullet and reject experiential realist demands, but as it stands Gert's proposal avoids rather than solves the VC Challenge in an experientially realist way. As such, conceptual disengagement between him and his Russellian counterparts threatens.

Another cost of Gert's view is that colours are no longer the properties that intrinsically have HSL. Instead the HSL properties are possessed by colour appearances (however these entities are explicated). Colours are mere *categorical* properties. For example, no instance of the property BLUE has a hue, saturation, or lightness, only blue appearances do. An instance of BLUE can present itself to us by giving rise to a variety of colour appearances, depending on the perceptual circumstance. Divorcing HSL from colour is non-trivial. It is no accident that colours have been associated with HSL properties for some time. At least on one deep-seated intuition we take colours to have HSL properties because when we see, reflect on, talk about, dream about, paint with, and otherwise work with colours, we take ourselves to be engaging with properties that have (at least) HSL features. We may be wrong about this, but accepting this as an error is, as I stated, non-trivial, and needs to be won through a powerful argument.

One could for example imagine Cohen welcoming much of Gert's analysis. Colour experience is highly variable in constancy scenarios, and many of these experiences are equally veridical. Since there is no constant (occurrent) colour in these experiences we should, says Cohen, here parting ways with Gert, admit that colours themselves are variable in constancy scenarios. What reason, Cohen will ask, is there to add that there are, beyond this, categorical colours that are "picked out" by these appearances but otherwise not clearly *part* of colour experience? If such colours are spoken of or seemingly prompted by experience they are just as easily accommodated by postulating counterfactual contents (or by "coarse-grained" colours, see Cohen, 2009, chpt. 4) as by postulating actual, categorical

colours. Without an experientially realist account of colour constancy, objectivists face the prospect of having an experientially unmotivated ontology.

By way of summary, consider the tension that leads to Gert's excising HSL properties from colour, and how that tension is resolvable without such a drastic proposal. The tension is between: (a) surfaces have constant HSL colours, and (b) the relativities in constancy scenarios involve variations in HSL. B&H resolve this tension by reinterpreting (b) and claiming that when the relativities in constancy scenarios involve HSL variations, those variations are represented but not actual. Gert resolves this tension by divorcing HSL properties from constant colours, thereby rejecting (a). But there is another route that accepts both (a) and (b) as stated and keeps colours as the bearers of HSL features — it is the solution embodied by the Layering Thesis as applied to colour objectivism. According to that view surfaces have constant colours, and the relativities in constancy scenarios involve variations in HSL features. However, the latter occur not because surface colours do not themselves have stable HSL properties but because *they are not the only things in one's line of sight that do*. Assuming that filters and illuminants have HSL properties, and that in constancy scenarios we are viewing the (complete or partial) HSL properties of some surface through the (complete or partial) HSL properties of some (one or more) illuminant/filter, the perceived variations resulting from illumination/filter changes require perceived and actual variations *and* constancies in HSL properties. The tension between (a) and (b) is resolved by recognizing that along one line of sight we are perceiving at least two sets of (complete or partial) HSL properties, one constant surface colour set, and one or more variable illuminant/filter set. We therefore maneuver our way through this tension to a natural solution not merely by accepting the idea that we can have perspectives on constant colours but by correctly explicating it. Neither Gert nor Hilbert have adequately done so.

§6 Conclusion

On the present view the fundamental philosophical challenge colour constancy poses is one for our understanding of colour experience. My proposed adjustment is the application of a suitable notion of experienced colour layering to constancy scenarios, an application that I have admittedly only sketched. Beyond this, colour constancy and perceptual constancies more widely may be used to bolster other theses such as direct realism or colour objectivism.[54] The account of colour constancy on offer suggests that these arguments will not likely be compelling. For example, a conception of experienced colour layering is as easily formulable within a sense-datum theory (indirect realism) that asserts that colours belong to sense-data (subjectivism), as it is within a direct realist colour objectivism. I regard this as a positive development. *All* philosophical theories of colour perception must explain the nature of constancy experience, and the flexibility in this account permits its use for these ends. How the account should be developed when situated within differing epistemologies and ontologies may be a subtle matter, but that it can be situated within a wide array of views is not in doubt.

Since colour objectivists have had a particular interest in constancy, I examined how objectivists should frame their view in response specifically to it. The discussion is important because early accounts of constancy supposed that only illumination variations were relevant (not filter variations), and that we could characterize constancy by reference to an ideal case in which those variations were not perceived. This relegated the variable element in constancy experience to instances of experienced illumination variations, and relegated those instances to forms of perceptual error. These suppositions are no longer tenable, and the impact on objectivist accounts of constancy is non-trivial. If we add to this that objectivists typically seek Present or experientially realist accounts — roughly, accounts in which constant colours are present in experience as opposed to arising in (sub)

54. See references in note 2 for examples.

personal judgements based on what is present in experience — then the Layering account of constancy appears strong relative to its rivals. At minimum, to accommodate constancy objectivists should add illuminants to their standard list of coloured things (surfaces, films, volumes, light sources).

I have throughout emphasized that the Layering account of constancy is not being offered to explain *all* constancy cases. It explains a host of Filter cases and credibly explains many Illuminant ones. However, my primary aim has been to articulate this option and its strengths, so that moving forward we can proceed through different constancy cases or types of constancy cases to assess whether a Layering analysis or one of its rivals should be employed. An important class of rivals is what I have called Absent or experientially anti-realist accounts (*e.g.*, Cohen 2008). Stated loosely, on these views constant colours are not present in experience but are (sub)personally inferred from what is present. In Cohen's case variable colours are occurrent in experience and the world during constancy perceptions, and constant colours are not. However, to explain constancy data Cohen postulates that our perceptual states express a counterfactual content that asserts that a colour like (or even the same as) one of the occurrent ones would be experienced were matters otherwise. Perhaps some constancy data should be explained this way, but I suspect much should not. As with much experience, considerable vagueness will be confronted at attempts to precisely delimit the Present and Absent cases. This should not persuade us to abandon the distinction any more than I am willing to abandon the claim that today my grandfather is both alive and bald. In any case, the issue can only be addressed with clear alternatives in place, and putting forth a more credible experientially realist alternative has been one of my core aims. As a means of situating Cohen's counterfactualist proposal going forward, consider the following.

Although I didn't engage in a thorough discussion of Cohen's (2009) broader view (but instead only discussed his account of constancy), layered colours create a challenge for him. Cohen conceives of individual colours as relations between surfaces, conditions of viewing, and subject peculiarities, where conditions of viewing includes illumination and (it seems) filters[55], among other factors. The account is inspired by a strict reading of colour experience, to code into colour ontology all the subtle variations in experience that arise as contextual factors change. Unfortunately, putting illumination and filters *into* the relata of relational colours and experiences of them is at least on first pass at odds with the idea that the beer (or sunglasses) and the book have distinct colours, and that we can experience both of them as having distinct colours along a line of sight. Cohen's colour ontology and the conception of experience that is its inspiration are thus in seeming tension with not merely the Layering analysis of constancy but with otherwise uncontroversial cases of experiences of layered colours like the beer-book case. It may be that sometimes (*e.g.*, Image 2, Fusion) the illuminant/filter contributions are fused in experience with the surface contributions, but it is equally compelling that at other times they are not. It is difficult to appreciate this difference, let alone accommodate it, from within Cohen's relationalist colour ontology and the conception of colour experience from which it derives.[56]

Given these points the significance of Cohen's counterfactualist account of constancy can be more fully appreciated. It was initially useful primarily as an account that undermines the inference from constancy to colour objectivism. While it can still do this, given the above it is not needed for the task and its limitations are more apparent. Perhaps more importantly, given the Layering account of constancy the counterfactualist account remains not as the account that allows us to avoid the inference from constancy to objectivism, but instead as one that pushes the inference from constancy to relationalism. I take this latter inference to be worth pursuing, but now avoidable by colour subjectivists who feel it prudent to search for a Present account of colour constancy.

55. See, *e.g.*, Cohen (2009, 33), where he includes "lighting" and "tinted sunglasses" in "viewing conditions". The inclusion of filters is not given extended discussion in the work.

56. See Brown (forthcoming) for discussion.

The discussion deepens considerably when we recognize that the same objective stimuli can plausibly induce successive experiences of experientially realist and anti-realist sorts. For example, I might experience the same stimulus at once as a differently illuminated wall (and hence by hypothesis engage in a layered experience) and then as a differently painted wall (and hence by hypothesis not engage in that specific kind of layered experience). Either may elicit behaviour indicative of constancy from subjects, but whereas behaviour elicited by the former would be associated with Present cases, those elicited by the latter would be associated with Absent ones. This kind of perceptual ambiguity was introduced at the outset, where I remarked that it will be dealt with in another work. And so it will. I mention it in closing to indicate how fundamentally this form of ambiguity infects our analysis not of the difference between Present and Absent constancy, but of their prevalence, and perhaps also of the relation between colour experience and reality.

Suppose, in conclusion, that the Layering analysis of colour constancy is correct for a wide range of constancy cases. Constancy experiences occur throughout our perceptual lives. Since we typically only see light when we see surfaces, and can only see surfaces when they are illuminated, it follows on the present view that in colour vision the default perceptual state is one of seeing one (full or partial) colour through another (full or partial) colour. It is a state in which two distinct ontological properties are given simultaneously, or more precisely are given from the same line of sight. This makes the epistemic task of accurately disentangling these elements not merely one that must be faced from time to time, but one so prominent that our vision system's solution to it is plausibly part of the fabric of the system itself. To my mind this is the core philosophical lesson to be learned from colour constancy. We have been plunged into a world of colour without being told that we rarely if ever will look to a location and experience just one of them.[57]

57. Drafts of this paper were presented at the Central APA, at a Dubrovnik colour conference (organized by Mohan Matthen and Nenad Miscevic), at the University of Pittsburgh Centre for the Philosophy of Science, in Mazviita Chirimuuta's graduate course in Philosophy of Colour in the University of Pittsburgh, at the University of Glasgow Philosophy Department, at the Brandon University Faculty of Arts Seminar Series, and at the University of Manitoba Philosophy Department. I owe a great debt to these audiences. Anonymous referees provided very helpful comments, only some of which have been explicitly addressed to this point. Special debts are owed to Ori Beck, Mazviita Chirimuuta, Jonathan Cohen, Fiona Macpherson, Wayne Wu, and my thoughtful students at Brandon University. Finally, thank you to Jessica Palmieri, Performa and Paula Court for permission to use Image 4.

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