Distal Content in Informational Teleosemantics: Challenges from Colour Constancy and Colour Chemistry

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Abstract

In general, visual experiences represent determinately. And visual experiences, generally, represent properties of distal objects like their colour, shape, and size, but they do not, generally, represent properties of proximal states like that of incoming light or the retina. By making perceptual constancies central to perceptual representation, Peter Schulte extends Karen Neander's Causal-Informational Teleosemantic theory in order to accommodate these facts. However, by appealing to the psychophysics and chemistry of how light-related properties interact to produce stimulation to the visual system and how the visual system processes such input to produce experiences, I argue that Schulte's theory fails to accommodate the facts of distality and determinacy.

1. Introduction

In general, visual experiences represent determinately. That is, there is a fact of the matter as to whether the experience represents this or that *representatum*. Also, visual experiences, generally, represent properties of distal objects like their colour, shape, and size, but they do not, generally, represent properties of proximal states like that of incoming light or the retina. These facts of distality and determinacy need to be accommodated by any psychosemantics of visual experience. By making perceptual constancies central to perceptual representation, Peter Schulte extends Karen Neander's Causal-Informational Teleosemantic theory in order to make these accommodations. However, I will argue that the distality and determinacy facts remain problems for Schulte's theory.

In Section 2, I present the way Schulte employs perceptual constancies to extend Neander's psychosemantic theory in order to solve what has been called the Distality Problem. In Section 3, I explain the inverse projection problem—the way the distal properties of the environment entangle when they interact to produce input to the visual system. In Section 4, I describe, very generally, mechanisms of perceptual constancy—the way visual systems attempt to disentangle the visual input in order to accurately represent distal properties. In Section 5, I argue that Schulte's appeal to perceptual constancies fails to preserve the determinacy of experience and save the theory from the Distality Problem.

2. Informational Teleosemantics and the Distality Problem

2.1 Informational teleosemantics

In 'Toward an Informational Teleosemantics' and her book *A Mark of the Mental,* Karen Neander develops an extensive theory to naturalize perceptual intentionality: roughly, the content of a perceptual representation is that to which the perceptual representation's producing system functions to respond. Peter Schulte appeals to perceptual constancies to solve an outstanding problem for the theory while maintaining its core. Given the recent rise in advocates for the centrality of constancies to perception, for example in (Burge [2010]), this is a welcome approach to traditional psychosemantic problems.

Schulte's ([2018], p. 351) version of Neander's core theory, which he later builds on, is given by Informational Teleosemantics:

> IT: If R, which is an R-type event or state, is a perceptual representation, then R has the content <something D is present> if and only if the R-producing system, S, has the function to produce tokens of R in response to tokens of the external state—something D is present—in virtue of its D-ness.

The right-hand side of the bi-conditional involves the notion of response functions that systems have—functions 'to respond to something by doing something' (Neander [2017], p. 126). Neander understands responding causally such that 'to respond to something…is to be caused by something to do something' (p. 127). The causation is singular, opposed to general (p. 143), and is property-sensitive (p. 159).[1] Explaining property-sensitive causation in Lewisian, counterfactual terms, Neander states[2]:

> [Where *c* and *e* are events,] *c* causes *e* in virtue of *c* being a [D]-type event rather than in virtue of *c* being a Q-type event if and only if:
> i. *c* causes *e* […] and
> ii. had *c* instantiated [D] but not Q, *e* would have occurred, and
> iii. had *c* instantiated Q but not [D], *e* would not have occurred. (Neander [2017], p. 271)

Property-sensitive causation and responses can be illustrated by considering the responses of Neander's stalking-horse, the sensory-perceptual states of certain toads. These states involve certain neurons, T5(2) cells, in the optic tectum of the visual system of such toads. After activation, they generally result in prey-catching behavior. What do these states respond to?

[1] Neander's theory is in terms of events while Schulte's extension is generally in terms of states. I will by-pass the difference, employing both states and events.
[2] Neander also cashes out property-sensitive causation in terms of Woodward's interventionist theory. My argument extends to this, also.

When there's the event of a worm moving past, causing T5(2) activation, does the event cause the activation in virtue of the worm's being food, being a worm, or having some low-level property cluster (in particular, being small, elongated, and moving parallel to its axis of elongation (SEM[3]))? With respect to the first counterfactual of Lewis's account, had the object that moved past been a piece of cardboard, and so not a worm or food, but still SEM, then T5(2) activation would have occurred. Now the second counterfactual: had the object that moved past been food but not SEM, then T5(2) activation would not have occurred. The truth of these counterfactuals is confirmed empirically, and is plausible pre-theoretically (Neander [2017], Chapter 5). Thus, T5(2) activation is caused by the event of the worm moving past in virtue of the worm being SEM, opposed to being a worm or being food.

IT states that a visual system has the 'function' to respond to things. Understanding the function of a trait aetiologically (that is, in terms of the effects of past instances of the trait) a trait (token t of type T) 'has the function to ϕ iff (1) earlier tokens of T have ϕ-ed and (2) the fact that earlier tokens of T have ϕ-ed helps to explain why T was selected for' (Schulte [2018], p. 351).

Specifically, a sensory-perceptual system has the function to produce R-type states in response to D-type events, in virtue of their D-ness if and only if 1) earlier sensory-perceptual systems were singularly and property-sensitively caused to produce R-states by D-events, in virtue of the events' D-ness, and 2) the fact that earlier sensory-perceptual systems were so caused helps to explain why the sensory-perceptual system was selected for. Call this the Function Condition. Given this function of the R-producing system, the state R, if it is a perceptual representation, has the content <something D is present>. Next, Schulte addresses a condition for R being a perceptual representation.

[3] This is Schulte's ([2018], p. 353) acronym.

2.2 The distality problem

IT requires supplementation since it faces the Distality Problem: IT does not rule out a T5(2) state from representing its more proximal causes. Generally, T5(2) states are caused by prior brain states, which are caused by the stimulation of retinal cells, which are caused by certain arrays of incoming light, which are caused by the joint interaction of surface properties of objects and how those objects are illuminated. Neander ([2017], p. 219) accepts that the visual system has the function to respond to all these things since 'responding to variations in patterns of light that hit the retina is the means by which a visual system responds to visible features of distal objects. And…if a system was selected for doing one thing *by* doing another then it was selected for doing both'. For example, the toad's visual system was selected for producing T5(2) states in response to SEM objects by producing T5(2) states in response to certain arrays of incoming light. So, it was selected to do both, and so it has both response functions, and so it represents both SEM objects and certain arrays of incoming light, according to Neander's theory. Similar lines of reasoning for other proximal conditions or states lead to substantial indeterminacy in the content of representational states, like T5(2).

Neander ([2017], p. 222) proposes a solution to the Distality Problem. However, Schulte argues for its inadequacy, and instead, reviving an idea by Dretske ([1986]), attempts a solution that appeals to perceptual constancies. Schulte ([2018], p. 360) glosses constancy states as perceptual states which 'track' certain properties, like size, shape, motion, and colour, by remaining invariant as these properties remain invariant under variation in proximal stimulation brought on by variation in external and internal conditions. Schulte ([2018], p. 360) gives an example of size constancy: 'the toad's visual system normally produces +T5(2) in response to an elongated object with a height of 1 cm when the object is rather distant […] as well as when the object is very close […] despite the fact that the vertical size […] of the object's retinal image is 2° in the first case and 32° in the second'.

Given that proximal states tend to vary during invariance in distal states and that perceptual states track distal, but not proximal, states in cases of perceptual constancy, Schulte states:

> [Premise 1:] there is no single type of retinal stimulation pattern which normally causes the toad's visual system to produce T5(2) activation; … [Conclusion:] Hence, the only external state that qualifies as a normal cause of T5(2) excitation, that is, as a cause that is always present in normal situations, is the distal state [of a SEM object being present]. Or, to formulate the point in terms of response functions, it seems that the toad's visual system has the function to generate +T5(2) tokens in response to SEM objects, but not the function to generate +T5(2) tokens in response to any particular type of proximal stimulus. If this line of argument generalizes, the distality problem for (IT) is solved. (Schulte [2018], p. 361)

The single function to respond to the distal state plugs into IT to yield a single, determinate representation of the relevant object as SEM.

To evaluate Schulte's view, functions and normal causes need to be bridged. Following Neander ([2017], p. 136), 'the normal cause…is the triggering cause implicated in the response function'. In simplest terms, there's the historical circumstance where one state D was a triggering cause[4] of the relevant visual system's production of the sensory state R, and where this causation led to the natural selection of the visual system. Call this the 'function-conferring circumstance'. A normal cause of a representational state is a triggering cause which is of the same type as that which was operative in the function-conferring circumstance.

Returning to Schulte's argument, the following evolutionary scenario suggests that Premise 1 is only true, and Schulte's solution to the Distality Problem is only applicable, under certain conditions. This minor objection is meant to clarify the role perceptual constancies are

[4] Per Dretske's distinction ([1988]), putting a key in the ignition and turning it is a triggering cause of the car starting. How the engine and systems of the car are designed and assembled specifies a structuring cause.

intended to play in Schulte's theory. Suppose there is a set of individuals in a species, and they share a common visual system. Consider the following causal chain: a distal state D, in virtue of its D-ness, causes a proximal state, P_2. Then P_2, in virtue of its P_2-ness, causes the visual system to produce R. Suppose that the individuals' visual system has a mechanism to deliver perceptual constancy. That is, for a range of environmental conditions, R would 'track' D, in that R would remain invariant with invariance in D, even if there were variation in proximal states, P_i. However, suppose that, even though there are many possible environmental conditions which can lead D to cause various proximal states, P_i, for whatever reasons, the environmental conditions are constrained in such a way that the D-P_2-R chain is the only chain that occurs for the individuals.[5] Suppose the set of individuals are the ancestors of many generations of descendents, where ancestors and descendents share the same visual system and live in the constrained environmental conditions where only the D-P_2-R chain was produced. Suppose that, by satisfying the details of the Function Condition, the relevant visual system is naturally selected and therefore acquires the response function to produce R. Since, in the function-conferring circumstances, R is only caused as a result of D and P_2, the only normal conditions for R being produced are via the above D-P_2-R causal chain. For the relevant descendents, the visual system has a capacity for constancy, in that R would track D if there were variation in proximal states. However, the perceptual constancy is never exercised in the function-conferring circumstance. Call this evolutionary scenario the Invariant Proximal History.

Even if, long after the function-conferring circumstances, the constancy capacity were exercised, such that R was invariantly produced when the range of environmental conditions

[5] To fix ideas, D might involve a determinate colour, C, and the proximal states, P_i, might be light approaching the retina. Though an object may be C, variation in environmental illumination-conditions will cause variation in the P's. However, in the scenario under discussion, the environmental illumination would remain constant, yielding a constant P. Section 3 has further details.

expanded and various types of proximal states, P_1, P_2, $P_3 \ldots P_n$, resulted from D, these other proximal causes are not normal. Normal situations only involve one type of distal state (D) and one type of proximal state (P_2).[6] So, contrary to Premise 1, for the Invariant Proximal History, there indeed is a proximal state that is always present in normal situations, and the appeal to constancy mechanisms does not help solve the Distality Problem here.

In contrast, Schulte's solution would have bite for an evolutionary story in which the function-conferring circumstances involve various proximal states, ranging from P_1, P_2, $P_3 \ldots P_n$, the relevant visual system has a constancy capacity, and this capacity is 'exercised' in the function-conferring circumstances such that R is produced by the visual system as a part of various types of D-P_i-R causal chains.

In this Variant Proximal History, it is clearer how Premise 1 is true: in the set of instances of causation in the function-conferring circumstances, there is no obvious single type of proximal state common to all instances of causation. And as for the Conclusion, D appears to be the only cause that is always present in the function-conferring circumstances. If there is a Breadth Requirement which holds that a state 'qualifies' as a normal cause only if it is always present in each instance of causation in the function-conferring situations, then it appears that only D is the normal cause and that the relevant visual system only has the function to respond to D by producing R. In contrast, in the Invariant Proximal History, D and P_2 equally satisfy the Breath Requirement and are both normal causes.

This is a minor complaint about Schulte's appeal to constancies to solve the Distality Problem, only meant to highlight the role constancies play. There are likely modifications Schulte can make to his theory to avoid perceptual response-functions in Invariant Proximal

[6] This assumes that the relevant response function does not change, even though they can, in general. There can be function persistence for any number of reasons, for example if the trait comes to play certain roles in embryological development (Griffiths [1992], p. 126). Thanks to an anonymous referee for information on this matter.

Histories where constancies are not exercised. Or he could bite the (admittedly small) bullet. However, as his theory stands, it seems that his solution to the Distality Problem requires variation in proximal states in the function-conferring circumstances in order to allow specifically for the exercise of constancy capacities in those circumstances. Thus, in the rest of the paper, I will take Schulte's theory to involve circumstances of Variant Proximal History.

To solve the Distality Problems (in such Histories), Schulte proposes that a perceptual state is both representational and has content that is determinately about the distal environment, for example that something D is present, only if the state is the product of a constancy-involving sensory system. Schulte adds two other supplements to IT: a perceptual representation represents the most natural of its normal causes, and it represents the most immediate of its normal causes (Schulte [2018], pp. 363-67). This avoids a problem introduced in (Dretske [1986]) where the disjunction of the proximal would satisfy, to the same degree as the distal, the Breadth Requirement for a constancy-produced perception. Additionally, the immediacy condition is meant to rule out states which are too distal. I will return to the supplements' details later. But the complete theory, IT+, combines IT and the naturalness and immediacy conditions.

To summarize, the Distality Problem forces revisions on IT. As a solution, Schulte restricts perceptual representations to states produced by perceptual constancies, and appeals to the Breadth Requirement in a Variant Proximal History. In what follows, I will argue that Schulte's solution leaves perceptual content indeterminate since there is proximal stimulation which satisfies the Breadth Requirement. To make this argument, I will appeal to empirical details about the challenges faced by, and the mechanisms employed by, the visual system in processing the input from the external world. To this end, the next section introduces a general computational challenge that sensory systems face in processing the input from, and producing accurate representations of, the external world.

3. Inverse Projection Problem

3.1. Inverse projection problems

Constancy is an achievement on the part of the visual system because the visual system faces what are commonly called inverse projection problems: though the objects of sight are generally distal, the visual system only directly interfaces with proximal stimulation (Palmer [1999], p. Chapter 1).

To understand a particular type of inverse projection problem that the visual system faces, let's start with a simple model of sight, psychophysics, and the features of light. First, we distinguish the 'illuminant' (the light source) from the 'illumination' or, more technically, the 'illuminance' (a property of an object). To see the distinction, an illuminant might shine very brightly towards some object, but a filter blocks most of the light from reaching the object. Thus, the illuminant is high in intensity or total energy, but the light striking the object—the illuminance—is not.[7]

Many objects have a 'surface spectral reflectance' (SSR or reflectance, for short)—a disposition to reflect a certain proportion of the total amount of light striking them. SSR's differ in the total light energy they reflect in a way similar to how illumination and illuminance differ in their total energy. Prima facie, SSR's are colours and the more light-reflecting an SSR, the lighter it is and the less light-reflecting, the darker it is. Later, this identification will be complicated. And, in Section 5, further details of illuminances and SSR's will be addressed, and dispositions to do more than reflect light will be discussed.

[7] For simplicity, I omit the details of more precise quantities like flux and power and the measurement of quantities per unit time, per unit area, and per unit angle.

Light reflected off on an object, given its SSR, might interact with some intervening medium (the 'transmittance') between the viewer and the object. The portion of light that finally strikes the retina—the 'spectral return' (also known as the colour signal or just the return)—is determined by the illuminance, the SSR, and the transmittance.[8] It has an overall intensity (its 'luminance').

The spectral return is the mathematical product of the illuminance, SSR, and transmittance (Wandell [1995], Chapter 2). This creates an 'inverse projection problem' for the visual system since, roughly, all the visual system has direct access to is the return. If it aims to calculate any or all of the illuminance, reflectance, and transmittance out in the world, it faces a mathematically underdetermined problem: too few known variables to calculate a unique solution.

Let's look at a simple example of when the returns reflected off objects conflate the effects of the illuminance and the reflectance. A white object in normal daylight will reflect a very different array of light into the eye than the light reflected by another white duplicate object in very dim lighting. Though the SSR's of the objects are the same in both conditions, the different illumination intensities result in different luminances of the reflected returns and thus different inputs to the visual system. Additionally, the white object in dim lighting can reflect a return with the same luminance as a gray object in bright light. Each input available to the visual system has entangled illuminance and reflectance, and the challenge is to disentangle, in a sense, this confounded projection of the distal environment into experiences such that the white objects look white in both illuminance-conditions and the gray object looks gray and not like the white objects.

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[8] There are many further factors and complications like florescent materials and the role of scene geometry which are being left out for simplicity.

If the visual system had direct access to the return reflected from the distal environment, then it would already face one inverse projection problem produced by the three confounders—the reflectance, illuminance and transmittance. However, the return stimulates photoreceptors in the retina and from there the visual system processes these retinal signals to produce our perceptions. But because of the way the photoreceptors respond to light, the properties of the return are confounded such that two different returns can produce the same photoreceptor responses (as two different reflectances in different illuminances can produce the same return). So there are multiple levels of input-conflation—one at the return, another at the retinal cells, and more in addition—which an ideal visual system would 'undo' to output accurate representations of the distal environment.

Moving forward, I will make some simplifications. First, I will idealize that the retinal photoreceptors are 'transparent', meaning that it is as if the visual system has direct access to the return and isn't hampered by limitations like having only four receptor-types spread across the retina. Thus the proximal stimulation to the visual system will be identified with the spectral return. Additionally, I will only consider situations where there are reflectances and illuminances which contribute to the inverse projection problem; I omit other confounders like transmittances, etc. which also contribute to the inverse projection problem. Also, the illuminant, illumination and illuminance will be treated as the same, though as noted above they can come apart. Finally, discussion will be limited to colour-involving inverse projection problems, though there are many others.

With some psychophysics introduced, a note about colour is in order. Colour metaphysics and realism raise thorny issues. However, since IT+ concerns the most immediate, natural, normal causes of perpetual representations, the view is neutral about the existence and nature of colours.[9] Thus, for simplicity, and following Schulte and Neander, I will write as if colours are the salient distal causes of ‘colour’ experiences, but as will be seen, the issues concern distal and proximal physical, chemical, and psychophysical properties and states, however colour fits in.

Colour constancy addresses the inverse projection problem. If a subject’s experiences were only determined by the returns of the aforementioned white objects, then, since the returns are different, the objects would look different; having a more intense return luminance, the first white object would look lighter in colour than the second. This is a failure of colour constancy and an instance of illusion. Colour constancy would ensure, at least to some degree, that when the distal colour remains the same, the colour experience remains the same even as the illuminance and proximal stimulation change. How colour constancy is achieved will be discussed in Section 4.

3.2. Stage-setting

Before I begin, I need to complicate the conceptions of experiences, perceptions and perceptual states which have been employed so far. Take experiences. Some are representationally complex in that they represent multiple properties. When an experience represents both some colour and some illuminance of an object, we can say that part of it represents the colour of the object and another part represents the illuminance of the object. However, one ‘minimal’ part of the experience will represent only colour and not the illuminance. One part representing property P and another part representing property Q is distinct from what the Distality Problem poses—one part indeterminately representing P and Q.

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[9] Neander recognizes this in her own theory and says that there might not be colours, only ‘kolors’, which are whatever properties our visual systems have the function to respond to. Her theory might, then, be not about colours, but instead about ‘kolors’ (Neander [2017], pp. 163–67).

In this paper, the focus will be on how a minimal, representational part of a total experience has determinate distal (in particular, colour) content.

Additionally, a note on typing experiences, perceptions, perceptual states, et cetera. Again, taking experiences as an example, whether a system falls to the inverse-projection problem or overcomes it (that is, exhibits perceptual constancy) depends on whether the same or different *types* of experiences are tokened relative to proximal stimulation. Schulte ([2017], p. 350) writes of syntactic typing of states. On certain conceptions of mental and brain states, this can be assimilated to typing perceptual states according to patterns of neuronal spiking, as in Neander's discussion of the toad case. In my examples, the focus will be on personal-level, conscious, phenomenal experiences, which will be typed phenomenologically (roughly) by how things look to the experiencing subject or by what it is like for the subject to undergo the experience. To bridge the gap, my argument requires a weak phenomenological-neurophysical assumption: there is a one-to-one relationship between types of phenomenal experiences and types of internal neurophysical events for a very constrained set of circumstances. My cases will involve considering the experiences for a single subject which are tokened over very close times or across very close possible worlds. Thus, I require only that, under such conditions, sameness in phenomenology of experiences entails sameness in their associated internal neurophysical events and vice versa.

Both approaches type states independently of their content so that the states can be compared prior to the adaptation specified in the Function Condition, and so prior to experiential content being set.

Thus, we will consider how minimal parts of states, typed phenomenologically, are affected by changes in various proximal and distal states. Then we will ask whether instances of these states being caused in the pre-adaptation past support response functions with respect to distal or proximal properties, given the Function Condition and the Breadth Requirement.

4. Colour Constancy

In this section, I give an example of how a visual system might tackle the inverse projection problem and achieve, some degree of, colour constancy. This example will provide a general idea of how numerous constancies are achieved and will be employed to challenge Schulte's account.

4.1. Constancy mechanisms

As a strategy to resolve the inverse projection problem, a visual system can, figuratively, make sub-personal 'assumptions' about the proximal stimulation and the distal environment. This notion of sub-personal 'assumptions' or 'unconscious inference' was heralded by Hermann von Helmoltz in the nineteenth century (Helmholtz [1924]; Palmer [1999], pp. 122–28; Gilchrist [2006], pp. 13–17), and has gained its modern face in computational approaches to vision.

Let's start with some psychophysical stipulations. Suppose illuminances and illuminants have a maximum intensity of 10, in some unit of measurement. And suppose reflectances range from 0 to 1, in some unit of measurement. White objects have reflectances close to 1, black objects have reflectances close to 0, and grays are naturally distributed in between. Suppose there are two adjacent surfaces A and B, and they completely fill the viewer's field of view. A has a reflectance of 1. B has a reflectance of 0.5. The entire scene is illuminated by a diffuse, even, equal-energy (that is, white) light such that both surfaces have an illuminance with an intensity of 6. Call this the Two Surface Case.

To fix ideas, suppose this illuminance has the intensity of normal daylight. And suppose to us and anything else that represents the scene veridically, A looks white and B looks middle-gray. Correspondingly, such veridical viewing-subjects have a total visual experience, E, which has two minimal parts, E1 and E2. E1 is caused by surface A and its properties. E2 is caused by surface B and its properties. Given what we know it is like to see white objects and middle-gray objects, we can type each experience phenomenologically and say that E1 has the phenomenology characteristic of experiences caused by white objects. Call this type of phenomenology white-ish, following David Chalmers's ([2019]) phenomenal character-naming convention. And E2 has the phenomenology characteristic of experiences caused by middle-gray objects—a middle-gray-ish phenomenology. Since, in the present debate, our experiences specifically are paradigms of mental representations, for the aforementioned viewing-subjects, E1 represents A as white, and E2 represents B as middle-gray.

The light reflected to the eyes constitutes a return array. In the Two Surface Case, corresponding to each co-planar region, A and B, of the scene, there are two regions of this return array which are, heuristically, the projection of A and B onto a 2-D surface right before the viewer. Call α the region of the return array which is projected from A, and call β the region of the return array which is projected from B. Since illuminances and reflectances combine multiplicatively as linear systems to produce return luminances (Wandell [1995], Chapter 2), the luminance at α equals 6 since it is the product of the reflectance of A and the illuminance of A. And the luminance at β equals 3 since it is the product of the reflectance of B and the illuminance of B. If, as I've been assuming for simplicity, the proximal stimulation is identified with the return, then the returns at α and β compose the total proximal stimulation to the visual system.

With the case laid out, let's first consider a Constancy-Free Subject who does not employ a constancy mechanism. What experiences might she have of A and B at t1? According to Schulte, without a constancy mechanism, her experiences would not be determinately representational. However, even without content, we can consider the phenomenology of her experience (or instead consider brain states, typed syntactically or in some other content-independent way). Ultimately, the particular phenomenology of an experience is not central to the issues of constancy and causation. Whether an experience exhibits colour constancy or not is only a matter of the variation or sameness in the phenomenology of the experience (when the experience is typed phenomenologically), relative to the proximal stimulation. This is the case regardless of the particular phenomenology. For the Constancy-Free Subject in the Two Surface Case, let's assume that, under the conditions at t1, she has a white-ish experience caused by A's being white and a middle-gray-ish experience caused by B's being middle-gray.

Now, suppose at some later time, t2, the original uniform illuminance is halved to an intensity of 3. Thus, the return-luminances at α and β are halved to 3 and 1.5, respectively. Without a colour constancy mechanism, the Constancy-Free Subject's experiences are determined by the return/proximal stimulation. Thus, with these changes in the illuminance, the phenomenal experiences change. Supposing we can put a measure on the phenomenology of experiences, then for the Constancy-Free Subject, the phenomenologies of the experience caused by A instantiating its properties and the experience caused by B instantiating its properties will halve in correspondence with the luminance- for example the former experience will now be approximately a middle-gray-ish experience.[10]

[10] I am idealizing that phenomenology falls off linearly with return luminance. The important thing is that the experiences differ at t2 compared to t1: a failure in constancy.

What colour constancy mechanism might provide achromatic colour constancy for the Two Surface Case at t2, in light of the fact that the visual system is limited to an illumination-reflectance confounding return? I will consider an early hypothesized constancy mechanism, called The Highest Luminance is White Mechanism (HLisW Mechanism), which makes a subpersonal 'inference' from features of the proximal stimulation to the outputted experience. (Gilchrist [2006], Chapter 9; Foster [2011], p. 676).

The Constancy-Free Subject's experiences change from t1 to t2 in correspondence with the change in the return/proximal stimulation- more specifically, in correspondence with the change in the absolute values of the luminances of each region of the return array, α and β, from 6 to 3 and from 3 to 1.5, respectively. However, relative luminances of the regions remain the same through t1 to t2 since α's luminance remains twice that of β's. By 'inferring' from, or having evolved to be affected by, the luminance-relationships between regions of the return array, instead of the absolute values of the luminances, the HLisW mechanism can output the same type of experience at t2 as it did at t1, when it makes, roughly, the following 'assumptions': First, it assumes that the illumination is uniform across the scene. Thus, if regions of the return array differ in luminance, then this must be the result of a difference in the reflectances of the surfaces.[11] Second, it assumes that there is always a white surface which corresponds to the region of the return array with the highest luminance. Additionally, it assumes that the degree to which luminance values differ at regions of the return array is mirrored by the degree to which reflectance values of surfaces differ, and vice versa. Thus, if a Constancy-Having Subject's visual system employs the HLisW Mechanism by following the assumptions and reacting to luminance-relationships, the experience caused by A instantiating its properties will still be

[11] Again simplifying, matters just include reflectances and illuminances, and not transmittances, fluorescents, etc.

white-ish. And the experience caused by B instantiating its properties will still be middle-gray-ish.

Given what Schulte has presented about perceptual states and constancies, there does not seem to be a reason to deny that the Constancy-Having Subject's experiences are representational. Though I will support this further at the end of the section, for the time being let's assume that the white-ish experience is E1 and represents the reflectance of A as 1 (white), and the middle-gray-ish experience is E2 and represents the reflectance of B as 0.5 (middle-gray).[12] Thus, the HLisW Mechanism provides colour constancy for the scene at t2 by using the luminance relationships, which remain invariant over t1 to t2, as a 'surrogate' for the invariant colours of A and B. Call this an instance of the Proximal Surrogate Strategy.

The HLisW mechanism, employing the Proximal Surrogate Strategy, captures the basic idea behind many models of colour constancy, from earlier theories like the Retinex and Gray World Theories (Land & McCann [1971]; Buschbaum [1980]) to more contemporary computational approaches. For example, Brainard (Brainard and Freeman [1997], p. 1395) describes the Bayesian statistical approach he helped initiate as an advance on past approaches like '[t]he gray world, subspace, and physical realizability algorithms [which] work by extracting a summary statistic from the sensor responses and then using this statistic to estimate [surface reflectances] ...[Instead] [t]he Bayesian framework provides a prescription for how to use all of the information … contained in the sensor responses'.[13,14] The summary statistic of, or the

[12] The experiences needn't have this content which, mirroring that of our phenomenological experiences, is used to fix ideas. There only needs to be constant content across t1 to t2 for a single type of evolved perceiver. A single phenomenological-type of experience can have different content when tokened for different types of evolved perceivers.

[13] More precisely, the statistic is used to estimate the illuminant and this estimation is used to estimate and experientially represent surface reflectance. Here, Brainard's algorithm discounts the illuminant. See footnote 15.

[14] This 'assumption' metaphor takes a Bayesian cast when the proximal stimulation is modeled by the likelihood, the assumption is modeled by the prior, and the combination of the posterior and a decision rule models the output of the visual system (Brainard [2009]; Mamassian, et.al. [2002]; Geisler and Kersten [2002]).

information contained in, the sensor responses (that is, proximal stimulation) is the feature of the proximal stimulation at work in the Proximal Surrogate Strategy. Constancy-involving visual systems use this feature to recover some degree of colour constancy, instead of relying on the most basic aspects of the proximal stimulation, as the constancy-free visual system does. The different approaches Brainard mentions differ in which feature(s) they employ to achieve constancy.

However, for the HLisW Mechanism, if the external environment conflicts with the 'assumptions', then these features of the proximal stimulation no longer correspond to the invariant colour properties, and reacting to them no longer provides colour constancy; illusions result instead.

Before we turn to failures of colour constancy, a note is in order. As might have been noticed, the experience of the illumination or illuminance was not addressed. I will remain silent on illumination or illuminance perception and experience. The focus will be on colours, and variation and constancy in colour. Given that experiences are often complex, as discussed earlier, I will assume the minimal colour-representing parts of experience can be studied without addressing the illumination-representing parts, if there are such.[15]

4.2. Illusions

A visual system that employs the HLisW Mechanism as its sole constancy mechanism will cause illusions in some circumstances. The mechanism assumes that, and delivers colour constancy via the Proximal Surrogate Strategy only when, the illumination is uniform across the scene and there is a white surface. However, suppose that at some time t3, A and B remain the

[15] The scientific literature on colour lacks consensus about the experience of illumination. See Gilchrist ([2006], Chapter 8). For example, some models of colour constancy work by 'discounting the illuminant', such that the visual system only experientially represents the surface colour of things and the illumination/illuminance is a confounding factor that needs to be done away with.

same colours they were at t1 but change non-uniformly in illuminance such that A has an illuminance of 3 and B has an illuminance of 9. α's luminance would be 3 and β's would be 4.5. Given the HLisW Mechanism, B would be represented as white and A would be represented as grayer. Thus, this Constancy-Having Subject would be subject to a colour illusion. Call this combination of reflectances/colours, illuminances, luminances, and experiences for the Constancy-Having Subject the Illusion Case

For illusions like the Illusion Case, the more the world lives up to the assumptions, the more constancy/less illusions will result from a constancy mechanism, and vice versa. Thus, depending on the extent to which they overcome inverse projection problems, perceptual constancies come in degrees, ranging from, at least conceptually, 'perfect perceptual constancies' to 'imperfect perceptual constancies'. If the Constancy-Having Subject only employs the HLisW Mechanism, then only a narrow range of conditions, like those at t1 and t2 in the very simple Two Surface Case, will allow for colour constancy. Natural environments will cause very many illusions. However, this does not undercut the constancy present for this subject in some conditions and how the HLisW Mechanism sheds light on constancy mechanisms.

I return to whether the Constancy-Having Subject has determinate representational experiences. One might object that the sensory states produced by a visual system that only employs the HLisW Mechanism are not representational, or at least not determinately so. The poverty of the system might be blamed. Though I disagree, the objection could be conceded. However, the key feature of the Two Surface Case and HLisW Mechanism is that they provide a simple model of the more general Proximal Surrogate Strategy. A much more complicated visual system which employs the Proximal Surrogate Strategy could be substituted instead. Given that the Proximal Surrogate Strategy and visual systems' uses of complex properties of the proximal stimulation are leading ways of modeling actual constancy mechanisms, we should expect actual, uncontroversial cases of determinate perceptual representation produced by constancy mechanisms to employ the Strategy. The details of what features of the stimulation a more realistically modeled visual system uses to achieve constancy would be too complex for present purposes, but the basic idea is captured by the HLisW Mechanism. Thus, I will continue to employ it as my example, but a complex mechanism producing uncontroversial determinate perceptual representations could be substituted.

This provides a basic idea of many types of colour constancy mechanisms. The HLisW Mechanism, as applied to the Two Surfaces Case, will provide the basis for the counterexample I will pose to Schulte's IT+.

5. Indeterminacy Challenge for IT+

5.1. The persistence of the distality problem

In his appeal to constancies, Schulte did not address their mechanisms. In this section, I argue how, in light of mechanisms like that above, an appeal to constancies does not solve the Distality Problem since the Breadth Requirement is satisfied by the proximal stimulation.

Return to the Constancy-Having Subject who employs the HLisW Mechanism as its only constancy mechanism. We saw that the relative luminance values between the regions of the array—a relational property of the regions—remains the same since, through t1 to t2, α's luminance remains twice that of β's.

Through this simple constancy mechanism, the challenge for Schulte arises. If we are considering variations in α, where this region is specified in terms of absolute values of luminances, it is true that, between the Constancy-Having Subject's veridical tokenings of E1 at t1 and t2, there is no common return/proximal stimulation. However, between the E1 tokens, there is a common higher-degree and relational property of the return regions (the property of having the highest luminance value) or a higher-order and relational property of the absolute values of the luminances of the return regions (the property of being the highest luminance value).[16]

For the Constancy-Having Subject whose only colour constancy mechanism is the HLisW Mechanism, E1's are tokened under multiple illumination-conditions in which the relevant object is white—this is in virtue of the relevant higher-order, relational property of the luminances of the return regions. This is unlike the Constancy-Free Subject, where E1 is tokened under only one illumination condition in which the relevant object is white- the illuminance at t1. However, as in the Illusion Case, E1 is tokened for the Constancy-Having Subject when a distal surface isn't white but the relevant higher-order property obtains. But, for the Constancy-Having Subject, there is no circumstance in which E1 is tokened because whiteness is instantiated by a surface but the relevant relational property is not had by the return-region α. Veridical tokenings of E1 are preceded by both the proximal, relational property and the distal whiteness.

I have so far typed E1 and other experiences by their phenomenology. However, E1 remains the same over t1 and t2 even if it is typed as a neurophysical state. This follows from the assumption in Section 3.2 that, for a single subject, over very short differences in times, sameness in phenomenology of experiences entails sameness in associated internal neurophysical states and vice versa.

We turn now to the Variant Proximal History for the Function Condition and the function-conferring circumstances of the ancestors of the Constancy-Having Subject. For each instance of singular causation in the function-conferring circumstances where whiteness caused

[16] The higher-degree or higher-order difference is likely insignificant.

E1 (when either phenomenologically or neurophysically typed), the above patterns exist between tokenings of experiences, distal properties, higher-order return properties, and lower-order return properties. And the experiences counterfactually depend on the higher-order properties of the proximal stimulation instead of the lower-order properties or absolute values; the higher-order properties are operative in the property-sensitive causation of IT+. Thus, the proximal stimulation's instantiation of higher-order properties satisfy the Breadth Requirement. Therefore, the relevant colour-constant visual system has just as much a function to respond to the proximal stimulation, as it does to respond to the distal.

5.2. Rescue by naturalness versus colour chemistry

Section 2 noted that, according to IT+, the most immediate and most natural property which satisfies the Breadth Requirement is represented by experience. Appealing to the immediacy condition would not block my objection since being more immediate just is being more proximal. However, one might object that Schulte's naturalness condition favors the distal events and properties over the proximal ones as what's represented in experience: the distal colour is a more natural property than the complex, relational property of region α of the return array which is operative in the HLisW mechanism.[17] The underlying assumption would be that, because the relevant proximal properties are relational or complex, they are more unnatural than the less relational or complex distal properties.[18,19]

The first response to this objection is that it is not obvious that this assumption is true. First, Schulte ([2018], p. 363) supposes that there is a 'close link between naturalness and nondisjunctiveness' and suggests 'we can solve the distality problem by identifying the content of a perceptual state with its *most natural* (least disjunctive) normal cause'. But it is not clear how the proposed proximal properties are disjunctive and thereby unnatural because of their

[17] Thanks to an anonymous referee for this objection.
[18] I will focus on the relationality of the relevant properties instead of their complexity.
[19] Thanks to Kevin Lande and Jacob Beck for helpful discussions on this section.

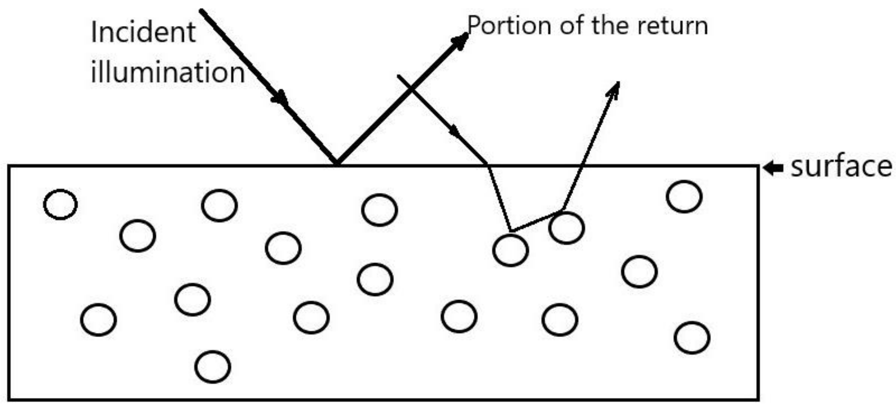
disjunctiveness. Second, as John Hawthorne ([2001], p. 399) notes, 'certain relations count as highly natural. Many of us will think that various spatio-temporal and causal relations—is the cause of, is spatially separated from, is later than—are highly natural'. Maya Eddon ([2017], p. 3163) goes further: 'canonical examples of perfectly natural relations are the spatiotemporal distance relations'. If relational properties and non-relational properties can both be perfectly natural, then it's not the case that the latter is always more natural than the former. But the general worry is that it is unclear that relationality 'decreases' in lockstep with increased' naturalness.

For the more substantive response, suppose for the sake of argument that more relational properties are less natural. I will argue that this does not favor the properties involved in the distal causes of experience since, once the details are spelled out, such properties are often as relational as the proposed proximal properties.

One argument for the natural and non-relational nature of the distal properties should be set aside—one that proceeds from a conception (often associated with the thesis of Revelation (Johnston [1992])) of colours as non-relational, intrinsic, and perfectly natural. As noted before, IT+ is officially neutral about colour but committal about the causes of perceptual states. So, this is, in the first instance, an issue about the properties involved in the appropriately distal causes of experience, and not necessarily an issue about colour. So even if colours are non-relational and perfectly natural, this does not settle the matter. However, I will continue, following Neander and Schulte, to frame these issues about distal causes and what experiences represent in terms of colours.

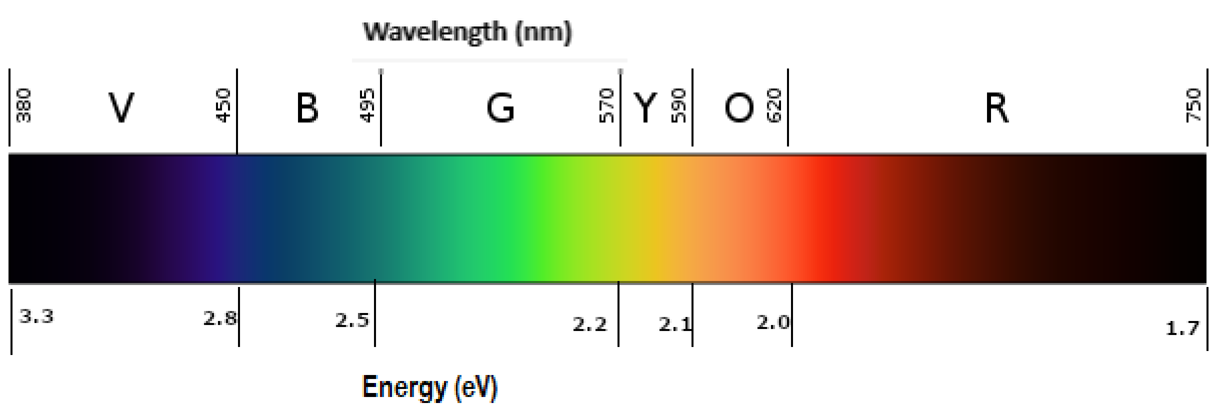
To begin the response, first, we need to zero-in on where to look for the appropriately distal causes of perceptual representations. They will reside between the least proximal portion of the return—call it the 'tail' of the return—and the event of the illumination's striking of the relevant object. If the surface of an object is the outermost layer, at the air-object interface, then for many cases of colour for solid objects, the appropriate level of distality will not just be found at the surface. It will also be found in a second layer which is composed of matter and which has just as much extent (often on the order of micrometers) as is necessary for the incident illumination to interact with said matter to produce the return.[20] See Figure 1.

Figure 1: Light-Object Interaction



Features of light-related phenomena are relevant to the goings-on in this second layer. In Section 3 the intensity of light-related phenomena and associated achromatic colour was introduced. Now we turn to chromatic colour and its associated psychophysics. Visible light, qua wave-phenomenon, has wavelengths from about 400–700 nm and frequency from about 750–400 THz. And, qua photon, it has energy from about 1.77–3.1 electron volts (eV). See Figure 2.

Figure 2: Visible Spectrum



Adapted from Linear Visible Spectrum. In Wikimedia Commons. Retrieved Dec 30, 2020, from https://commons.wikimedia.org/wiki/File:Linear_visible_spectrum.svg

[20] Alternatively, the surface could be the outermost and second layers.

For each of the illumination, illuminance, SSR, and spectral return, in addition to its overall energy, there is a measure of what proportion of that total energy exists at each wavelength. This can be graphed with a spectral diagram, where the x-axis provides the wavelengths (or frequencies or energies), and the y-axis provides the relative proportions, or in some diagrams the absolute value, of the quantity on the x-axis.

Equal-energy illumination, with an equal amount or equal proportion of its total photons distributed between 1.7 and 3.1 eV, will be of particular interest. The curve of its spectral diagram is a horizontal line. When the total intensity of the illumination is high, it normally looks white.

The proper distal cause concerns the chemistry of colour, unpaired valence electrons in atomic and molecular orbitals, and the energies between them and photons. I will argue that the energy-related properties relevant to the production of the return are relational in a way that is very similar to the relational properties of the proximal stimulation discussed in my counterexample.

The relevant details for present purposes: when electrons gain energy, they transition to higher orbitals and absorb photons, and when they lose energy, they transition to lower orbitals and emit photons. Photons, electrons, orbitals, and the energy levels of atoms and molecules, can only have discrete amounts (or quanta) of energy. A change in energy is like stepping up or down the rung of a ladder: changes between rungs are unavailable. Thus, for a given electron, the only photons that can be absorbed and transition the electron are those with energy exactly corresponding to the energy that the electron can gain, i.e. corresponding to the energy-difference between two rungs on the energy ladder. Therefore, particular energies of an incident illumination are selectively absorbed by electrons in the second layer of an object in the process of Selective Absorption by Electronic Transitions (SAET). The non-absorbed illumination is transmitted throughout the second layer, and eventually exits the object, thereby forming the tail of the return.

Let’s consider a simplified case of SAET, drawing from Kurt Nassau’s ([1983]) landmark exposition of the chemistry of colour. Consider an un-illuminated object composed of one type of atom. Suppose the atoms in the second layer are in a state of lowest energy (the ground state) where the electrons have their lowest energies and occupy the single, lowest available orbital. Suppose each atom has vacant, higher-energy orbitals. Suppose there are two such orbitals: one orbital (O1) is 2.2 eV above the orbital containing electrons, and the other (O2) is 3.0 eV above the orbital containing electrons. Supposing there are enough unpaired electrons, they have the potential to transition to either O1 or O2, gaining either 2.2 or 3.0 eV of energy. When an equal-energy illumination strikes the object, penetrating to its second layer, the components of the incoming light with 2.2 eV of energy and 3.0 eV of energy will be absorbed, transitioning unpaired valence electrons to O1 and O2; the remaining components of the original incident light are not absorbed, instead transmit through the second layer, and interact with, but are not absorbed by, surrounding atoms, until they exit out of the surface of the object as the tail of the return. Figure 3 shows the energies of 2.2 eV and 3.0 eV that are absorbed by the atoms of the object. Figure 4 shows the complementary energies which are not absorbed and therefore constitute the return.

Figure 3: SAET Absorption Diagram

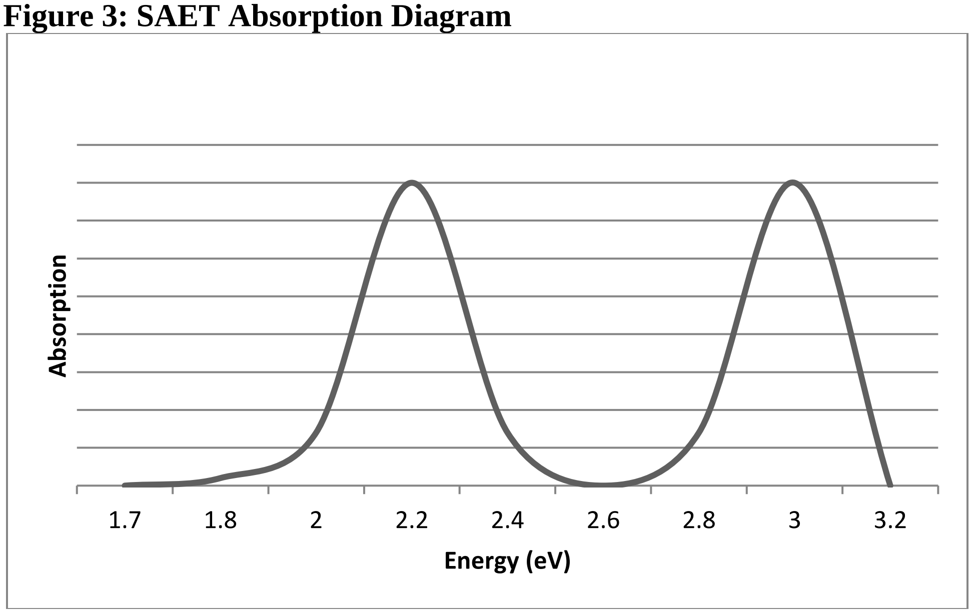
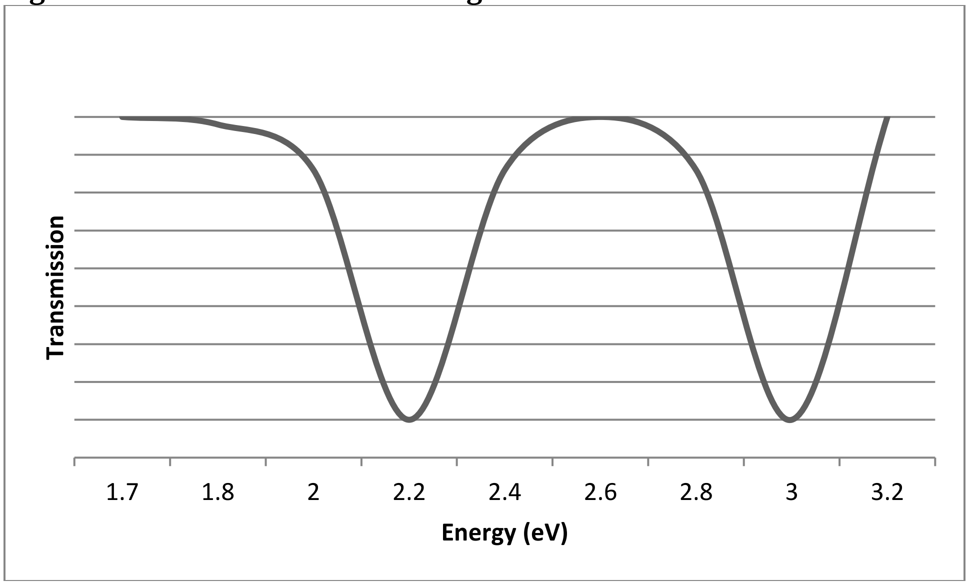


Figure 4: SAET Transmission Diagram



There is an additional aspect of photon absorption. Vibrational and rotational interactions associated with the bonds between the atoms composing molecules result in quantized absorptions, where these absorptions are substantially weaker than absorption by electronic transitions (Nassau [1983], p. 85). However, each electronic energy level has potentially hundreds of vibrational energy levels, which in turn have hundreds of rotational energy levels (Tilley [2011], p. 312). These additional absorptions explain why the curve in Figure 3 does not peak only at precisely 2.2 and 3.0 eV, but instead involves smooth bell-curves (Nassau [1983], p. 84).

For many visible objects, the distal cause of the just-too-proximal tail of the return and, ultimately, of the relevant experience, has been ascertained. It is the absorption of some of the energy of the incident light and transmittance of the rest (two sides of the same coin) via the excitation of electrons, vibrational energy levels, and rotational energy levels.

The causation involved in SAET is property sensitive, involving relational properties. For simplicity, let’s just consider the electrons’ role, for to establish this minimal relationality is sufficient for present purposes; matters only become more relational when states of electrons are connected with the associated rotational and vibrational states. It is in virtue of certain properties of the relevant electrons that certain photons are absorbed and not others. However, it is not in virtue of the non-relational energy of an electron that it absorbs a photon with a given energy, but instead it is in virtue of the relation of the electron's energy (or the orbital it is in) to the energy of other orbitals. An electron which has 2 eV in energy, but which only has an unfilled orbital available to it which is 4 eV higher in energy will not absorb a photon with energy in the visible spectrum. But an electron which has 2 eV in energy and which has an unfilled orbital available to it which is 2 eV higher in energy will absorb a photon of exactly 2 eV. The event of absorption of some, and transmission of the rest, of an incident light's photons occurs in virtue of a relational property, for example, of the form 'being exactly X eV lower in energy', which obtains between an ordered pair consisting of an electron and an orbital.[21]

The relational properties involved in the appropriately distal events are very similar to the relational properties of regions of the return array—both involving relative energies. Recall that the region of incoming light labeled α had the property of having the highest luminance value relative to the other regions. This is a measure of the relative photonic energy at a region of the return array. These similarities in the proximal and distal, causally-relevant properties would make it very implausible that one is more natural than the other, whether naturalness is understood as non-disjunctive, non-relational, or something else. And counting and comparing the –adicity of the relational properties would not be promising: I have used very simple examples of the distal and proximal causes. Anything remotely realistic is much more complex.[22] Thus, appeal to the 'most natural normal cause' does not appear to help Schulte's theory avoid the Distality Problem.

A final response on behalf of Schulte: The above appropriately distal cause involves an occurrent property. However, one might instead propose a certain disposition, where the

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[21] The relational property involved in the event of absorption will be much more complex, including factors like the electron being unpaired, the rotational and vibrational states associated with the energy difference, and more.

[22] Less idealized, the proximal stimulation is not identified with the return but instead involves states of retinal photoreceptors. The relational properties will be between the neural signals of the photoreceptors, instead of the photonic energy of regions of the return array.

property I proposed is merely the causal base of that disposition. As the response continues, if the disposition were a surface spectral reflectance, which is typically thought to be intrinsic, then such a disposition would provide a more natural distal property.[23] I will argue that the SSR is not helpful because, roughly, reasons to think it is relatively natural because it is intrinsic or less relational are countered by reasons to think it is relatively unnatural because it is disjunctive.

First, let's simplify to make discussion of the SSR more manageable. There are two aspects to the way a SSR manifests: the reflection and the proportion of light energy at each wavelength in the visible spectrum. To avoid complexities about reflection,[24] I will focus on the remainder of the SSR when we abstract away from the reflection component. This is something like a disposition to merely effect light- the thing that is common to the disposition to reflect, the disposition to transmit, and the disposition to emit a certain proportion of light at each wavelength. Call the SSR minus the reflection component the 'SSR$^{\sim}$'.

The SSR$^{\sim}$ is a disposition with diverse causal bases. One basis was already introduced: the energy of electrons. It is in virtue of this (via the mechanism of selective absorption) that certain objects have the SSR$^{\sim}$ disposition. However, a very different basis of the SSR$^{\sim}$ is the size and shape of matter which is approximately on the order of the wavelength of visible light (Tilley [2011], Chapter 3). It is in virtue of this basis (via causing components of light to constructively or destructively interfere) that certain objects have the SSR$^{\sim}$ disposition. From discussion of the SAET, the vibrations and rotations of bonded atoms, analogous to the mechanics of particles joined by a spring, are two additional bases. The effect each basis has on an SSR$^{\sim}$ depends on the specific strength of the chemical bonds and the weight of the atoms (Nassau [1983], pp. 65-74). Numerous other diverse bases for SSR$^{\sim}$ exist.

The heterogeneity of the above bases is akin to the heterogeneity of the bases of fragility. Objects A and B might both be fragile, for example, sharing the same manifestation condition of

[23] Thanks to an anonymous referee for this suggestion.

[24] Such complexities include the scale at which reflection arises, the notion of reflection operative in SSR, and whether reflection itself is multiply realized.

shattering when struck. A is fragile in virtue of one basis: irregular bonding structure of its atoms (a geometrical atomic feature). B is fragile in virtue of a different basis: weak intermolecular bonding (a feature of how valence electrons are shared, for example). Other similarly fragile objects can have quite different bases. Thus, fragility is a disposition that is multiply realized by many heterogeneous bases, where the disjunction of these bases is at least coextensive with the disposition.

SSR$^{\sim}$ is also a disposition that is multiply realized by many heterogeneous bases. A broad disjunction of bases is, at least, coextensive with the SSR$^{\sim}$.

Though the reflection component of the SSR was avoided because of some complexities, SSR also has heterogeneous bases, just in virtue of the heterogeneous bases of the SSR$^{\sim}$. Whatever is added to the story to distinguish the SSR from the related dispositions to transmit light or emit light, the above bases will not thereby become somehow unified. Note that the multiple realization of SSR is distinct from the familiar claim that each determinate colour is multiply realized. Because of phenomena like metamers, reductive physicalists about colour often identify each determinate colour with a set or disjunction of SSR's, where the SSR's are the heterogeneous bases of the realized colour. That position is neutral as to whether SSR's themselves are multiply realized.

Section 5.2 concerns the appropriately distal causes of experience. The introduction of SSR's was meant to provide an intrinsic, distal property that is a more natural alternative to the relational, 'lower level' electronic and atomic properties invoked in SAET. In turn, the SSR would be more natural than the proximal relational properties which, when instantiated, the visual system employs to produce constancy-involving experiences. However, the multiple realizability of SSR's undercuts what was hoped to be gained from their intrinsicality since there is considerable debate whether multiply realized properties are natural. One camp in the literature, exemplified by Jaegwon Kim ([1992]) and David Lewis ([1994]), argue that multiply realized properties are relatively unnatural given the relationship between them and the disjunction of their bases. Those like Fodor ([1974]) and Antony and Levine ([1997]) disagree.

This suggests that the relative naturalness of multiply realized SSR's is no less controversial than the relative unnaturalness of relational, 'lower level', electronic properties. Thus, there is insufficient reason to think that either type of distal property is more natural than the proximal properties operative in constancies. The Distality Problem remains.

6. Conclusion

In attempting to solve the Distality Problem, Schulte modifies Neander's Informational Teleosemantics by incorporating perceptual constancies and the Breadth Requirement. I have argued against Schulte's theory. By appealing to inverse projection problems and the constancy mechanisms employed by visual systems to avoid these problems, I argued that there are cases in which Schulte's theory fails to privilege the distal over the proximal stimulation as the object of experience and leaves perceptions representationally indeterminate.

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