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If the explanation is to be successful, it must be clear that the *how* explains the *what*.

In his article, Palmer (1999) wrestles with the problem of relating the what and how of color experience. In particular, he considers if color experience can be fully explained by the action (the how) of relational processes. To link the explanation to the experience of color (the what), Palmer considers whether the relations inherent in the relational processes can be fully determined by behavioral testing. He concludes (in the last two paragraphs of sect. 3.3) that because some aspects of experience seem inaccessible to behavioral testing, we may never be able to correlate the phenomenology of experience (the what) to the biological mechanism producing experience (the how). As a result, we may never be able to determine which biological mechanisms, relational or others, are responsible for our ability to have experiences.

Many commentators took exception to Palmer's arguments. The writers that I most agree with all take the view that by considering only the relations of colors to other colors, Palmer has not included a sufficiently complex web of relationships to fully define the experience of color (see Hardin 1999; Jakab 1999; MacLennan 1999; Myin 1999; Pauen 1999; Schröder 1999; Tolliver 1999; Van Gulick 1999; Viger 1999). Although the commentaries are clear on this point and on its implications, I believe that further analysis of the arguments can provide an even better understanding of what qualia are.

***1. Color room argument.*** One approach Palmer uses in his study is the color room thought experiment. In this thought experiment, a person inside a room follows a rule book and performs calculations on input numbers to obtain an output of a letter string. The person doing the calculations does not know that the input and output data represent a color.

Intuition tells us that none of the processes occurring in the color room produce consciousness of seeing the color represented by the input number set. Certainly the person in the room does not see the color. One could even argue that if the person did know by name what color the number set represented, he still would not experience seeing the color. The only place remaining where consciousness might be constructed would be in the calculations themselves. This would result in "a second stream of consciousness in the agent to which he had no access" (Schröder 1999, para. 1). The calculations producing this consciousness would presumably need to be analogous to the processing normally occurring in our brain when it is presented with color stimulus.

What would these calculations have to achieve in order to experience color? At the very least, they would have to know that the numbers represented a color (so the numbers could be distinguished from input data representing sounds and pains). Knowing that something represents a color is only meaningful if one already knows what a color is. Knowing what a color is cannot be achieved by attaching a linguistic word name to the color. Telling a blind person the name of a color does not help that person to know the color. To know a color, one has to experience the color. This returns us to the original problem of what it is to experience a color. One thing that is known about experiencing a color is that it makes the color information available for our use. For this to be the case, knowing a color through experience must require knowing (non-linguistically) how to use the color information. One example would be the use of color to help distinguish object boundaries and simplify object identification.

This utility view of qualia also appears in Myin's (1999) statement that the conscious content of experience guides the subject's actions. Therefore, at the very least, it seems as though calculations capable of producing consciousness of color qualia must be able to identify the information as color information and must know how the information is useful to the organism.

***2. Isomorphic arguments.*** Several commentaries on Palmer's isomorphism discussion provide further support for a utility view of the experience of qualia. The commentators argue that all experiences can influence behavior. If true, no alteration of experience can produce an isomorphism. MacLennan (1999) objects to Palmer calling the reversal of white and black an isomorphism, because he believes there are relational differences that will show up in behavior. Imagine if the experience of white and black were reversed. When trying to sleep in a dark room, one would experience the most brilliant possible white spread over the entire visual field. Such a situation would be intolerable and we would draw away from the extreme brightness to protect our vision. In a different example, Pauen (1999) considers the impossibility of reversing pain and joy without behavioral impact. In his commentary, he indicates that a child with this reversal could not tolerate his mother's hug.

These arguments provide support for the view that the experiences of qualia are neither arbitrary nor behaviorally neutral. The experiences of pain, joy, heat, cold, hunger, brilliant white, and others provide guidance essential for self-preservation. In 1644, Descartes expressed this view when he wrote (in Descartes 1644/1931, Second Part, Principle III)

> it will be sufficient for us to observe that the perceptions of the senses are related simply to the intimate union which exists between body and mind, and that while by their means we are made aware of what in external bodies can profit or hurt this union, they do not present them to us as they are in themselves unless occasionally and accidentally.

It is clear that Descartes intended this statement to be about qualia (note the examples given at the end of Principle XLVIII in the first part of his book).

***3. Conclusion.*** What then are qualia? I believe, based on the above, that it is reasonable to equate the experience of a quale to the meaning of that perception to the perceiver. What we experience when we experience a pain or the color red is the meaning of that perception. The meaning identifies the perception by making us aware of its utility and importance to us.

Understanding qualia is difficult not only because we do not know how they are produced but also because we do not know what is produced. Cognitive science is faced with the problem of converging on both answers simultaneously. It doesn't appear that the information in this commentary guarantees a convergence but, if by studying behavior we can learn enough to define qualia in general, this knowledge may enable us to identify the physical processes capable of producing experience. If we can learn to make that discrimination, then study of the physical processes should be able to fill in the details.

## Newton's colour circle and Palmer's "normal" colour space

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**Abstract:** Taking the *real* Newtonian colour circle – and not the one Palmer depicts as Newton's – we don't have to wait 300 years for Palmer to say no to the Lockean aperçu about the inverted spectrum. One of the aims of this historical detour is to show that one's commitment about the "topology" of the colour space greatly affects Palmer's argument.

Palmer's argument is connected to his view about the topology and ontology of colour space(s). First, I show that his conclusions about the Newtonian colour circle are problematic because of the faulty historical reconstruction. Next, the changing ontological status of his proposed "normal" colour space is discussed.

***1. The Newtonian colour circle.*** Palmer claims that Newton's colour circle is a model of colour experience (Palmer 1999, p. 924). As I will show, this is a factual mistake (cf. Newton 1704/1730/1952). Also, Figure 1 of the target article is *not* a Newtonian colour circle. Instead, the Newtonian colour circle is shown in our Figure 1 here.



https://doi.org/10.1017/S0140525X04280049 Published online by Cambridge University Press

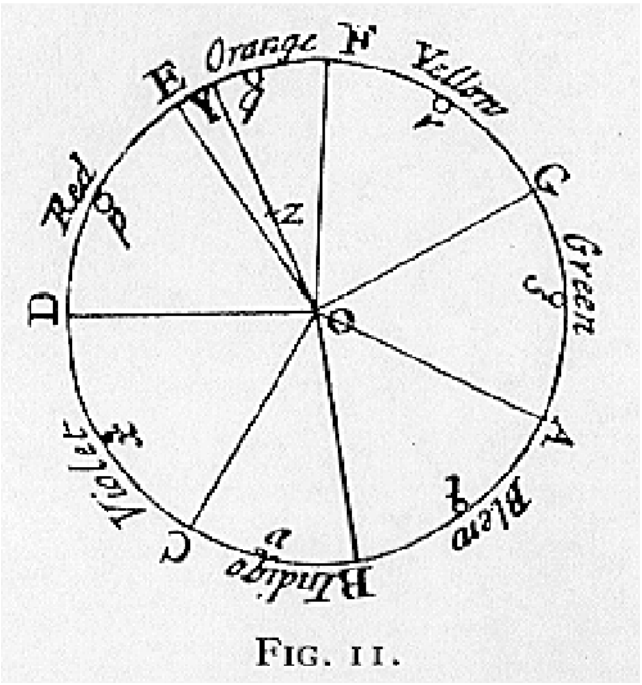



Figure 1 (Zemplén). Newton's Colour Circle from the fourth edition of the *Opticks* (1730/1952, p. 155) "With the Center O and Radius OD describe Circle ADF, and distinguish its circumference into seven parts . . . , proportional to the seven Musical Tones or Intervals of the eight Sounds, *sol, la, fa, sol, la, mi, fa, sol* . . ."

Specifically, the following facts about Newton's colour circle should be noted:

1. Newton's colour wheel (Newton 1704/1730/1952, p. 155) was created by simply joining the two ends of the prism's spectral image of the Sun, with white (light!) in the middle (O).

2. This circle does not contain nonspectral colours, unlike Figure 1 in Palmer (sect. 1.1, para. 1.)

3. The colours are designated to *bands* of the circle. There are *regions* of colours, where the colour-names are the colours of the (seven) bands of the rainbow, and the widths of these bands correspond to certain numerical ratios. The Pythagorean influence is clearly seen in Figure 2, where the "confines of colours" are shown drawn on the spectral image.

The colours in Newton's colour circle correspond *neither* to all the colours seen (not even in the hue dimension), nor to symmetries in the colour space claimed by Palmer; the blue band, for example, is partly opposite to the red band and partly opposite to the orange band. The red-green and the yellow-blue axes are not present.

Thus, the conclusions Palmer draws based on this example are challenged. Newton's analogy with the musical notes suggests that spectral colours are characterised both by the actual colour and the bandwidth. If one of us has an "inverted" colour space, the boundaries of the coloured bands will not always be in the same position for me as they are for you. An inversion of colour experiences would therefore be recognised already by similarity judgements, contrary to Palmer's claim (sect. 1.1, para. 4). This seemingly uninteresting bit of history shows that choosing certain colour wheels, spaces, or solids already determines what sorts of answers we get to Palmer's questions.

***2. The status of the "normal" colour space.*** Palmer moves on from the pseudo-Newtonian colour circle and proposes a colour solid representing the "normal" colour space (Fig. 2 of the target article). But what is the epistemic status of this colour solid? Palmer is inconsistent and seems to waver, sometimes claiming that it is close to being a fundamentally correct system about colour experience (sect. 2.3, para. 8; see also the commentary by Saunders [1999]), at other times backing out (sect. 1.6, para. 4; sect. R8, para. 1), admitting that other colour spaces are equally at hand (sect. R2). If Palmer (rightly) backs out, then what's all that fuss about in section 1? Why does he bring in basic colour terms (BCTs) to break the three remaining symmetries of a model that has no special epistemic status? He should leave out all this business (and much of sect. 1) about basic colour categories (BCCs) and BCTs, especially as he himself does not trust them (sect. 1.4, last para.; sect. R2, para. 1; sect. R8, para. 6).

Moreover, the use of this particular colour space is a source of self-contradiction. To save some symmetries for later, to rule out individual differences within an equivalence class of perceivers, and to preserve the validity of the model, Palmer claims that three symmetries are "likely to escape detection . . . except in most precise psychophysical tasks" (sect. 1.3, para. 4), which is why he turns to BCCs. On the other hand, in responding to Cohen, Palmer writes: "such transformations [slight rotations, stretches, squeezes put forward by Cohen to show that nontrivial transformations are not precluded] would, in fact, be behaviourally detectable in appropriate psychophysical tasks" (p. 984, sect. R8, para. 5). This is contrary to his claim in the target article, and his Figure 7 – where equivalence classes of colour perceivers are grouped – can be seen as pictorial proof of this. In the response Palmer therefore admits that interpersonal distribution of unique hues does show up. But, "if there are objective differences in the relational structure of our experiences . . . appropriate behavioral methods can clearly detect them" (p. 938, sect. 3.4, para. 5). To say that these individuals then belong to different equivalence classes is begging the question – as it doesn't specify just how large is large enough for the differences, and the uncontrollable mushrooming of equivalence

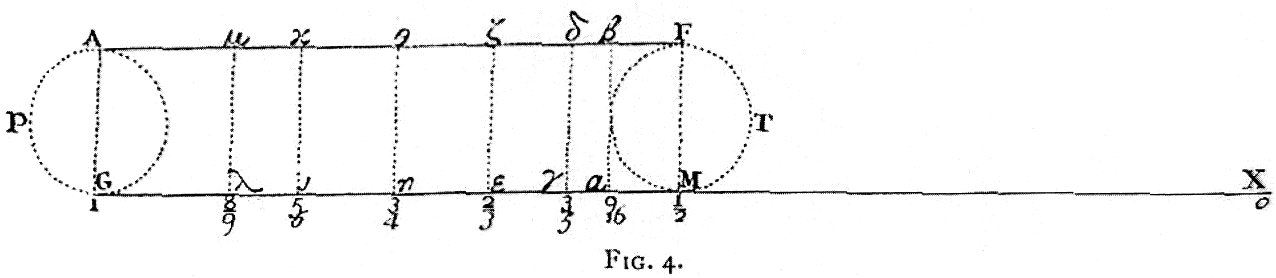



Figure 2 (Zemplén). The harmonic ratios of colours in the spectrum (Newton 1704/1730/1952, p. 127): "Let GM be produced to X, that MX may be equal to GM, and conceive GX, λX, ιX, ηX, εX, γX, αX, MX to be in proportion to one another as the Numbers, 1, 8/9, 5/6, 3/4, 2/3, 3/5, 9/16, 1/2, and so to represent the Chords of the Key, and of a Tone, a third Minor, a fourth, a fifth, a sixth Major, a seventh and an eighth above that Key: And the Intervals Mα, αγ, γε, εη, ηι, ιλ, and λG, will be the Spaces which the several Colours (red, orange, yellow, green, blue, indigo, violet) take up" (Newton 1704/1730/1952, pp. 126–28).



https://doi.org/10.1017/S0140525X04280049 Published online by Cambridge University Press

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classes endangers Palmer's whole isomorphism constraint! (The possibility described in Billock & Tsou's commentary is not discussed by Palmer.)

But what if he is serious about this specific model (which he should not be; see, e.g., Jameson & D'Andrade 1997)? This would mean that though Palmer at times sounds like a naive Popperian falsificationist (sect. 1.2, last para.), he opts for a particular colour space without considering the counterarguments, and ascribes to the model an ontological status which it surely does not deserve.

Also, though Palmer's rejection of the objectivist paradigm (e.g., commentaries by Ross 1999; Malcolm 1999) is well-taken, he should not be blind to similar critiques of neurophysiological reductionism, which he clearly embraces (sect. R3; see also, e.g., Dedrick 1996). He might even start rephrasing the Lockean riddle: if for the Newtonian (objectivist) there is a one-to-one correspondence between colour and refrangibility, or SSR (i.e., position in the rainbow), and if Palmer believes in a different one-to-one correspondence between perceived colour and neurophysiological states, then these states should be substituted in the phrasing of the Lockean riddle!

ACKNOWLEDGEMENTS

Support from the OTKA Grant F 046354, and the Magyar Postdoctoral Fellowship are acknowledged.

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**Stephen E. Palmer has declined to respond to the above continuing commentaries.**



https://doi.org/10.1017/S0140525X04280049 Published online by Cambridge University Press