The Protophenomenal Structure of Consciousness, With Especial Application to the Experience of Color

Summary

Bruce J. MacLennan*

Computer Science Department
University of Tennessee, Knoxville
`maclennan@cs.utk.edu`

August 19, 1998

1 Introduction

This paper addresses the *principal problem of consciousness*, which is to reconcile our experience of subjective awareness with the scientific world view; it is essentially the same as Chalmer's "Hard Problem." This problem arises because subjective experience has a special epistemological status, since it is the personal (and private) substratum of all observation, whereas empirical science is typically based on common (nonpersonal, public) particular observations. Nevertheless, although subjective experience cannot be reduced to physical observables, we may have parallel phenomenological and physical reductions, which inform each other. However, naive introspection is treacherous since it may be unduly influenced by theoretical preconceptions, but phenomenological training aids unbiased (or less biased) analysis of the structure of consciousness. Through phenomenologically trained observers we may acquire unbiased (public) data about the structure of consciousness. (We use "phenomenology" and related terms in the sense of Husserl and Heidegger, that is, to refer to the analysis of the *phenomena*, the given (*data*) of conscious experience.)

---

2 Protophenomena

Such an analysis has led us to postulate *protophenomena* as the elementary constituents of phenomena [1, 2]. Each has the property of elementary (irreducible) subjectivity. Very simple examples of protophenomena include the experience of a spot of color at a particular location in the visual field and the feeling of pressure at a particular location on the skin. However, there are much more complex and subtle protophenomena, including elementary components of recognitions, judgments, expectations, intentions, moods and so forth. Further, protophenomena are very "small," in the sense that changes in the activity of individual protophenomena will not typically affect the macroscopic phenomenal state; nevertheless the state of consciousness is no more than the sum total of the states of all the protophenomena.

Protophenomena are postulated to be associated with *activity sites* in the brain, the "activity" (degree of presence in consciousness) of a protophenomenon corresponding to some physical variable at that site. (Protophenomena and their activity sites need not be discrete, but that seems the most likely possibility at this time.) There are a number of candidates for the activity sites, but their identity remains an open question. Some of the possibilities include synapses, neural somata and dendritic microtubules, but their exact identity is not crucial for the theory of protophenomena.

What is the ontological status of protophenomena; do they exist? It is best for now to treat protophenomena as "theoretical entities," analogous to atoms when they were first hypothesized. Theoretical entities are validated by the role they hold in the theory and by their fruitfulness for scientific progress. Ultimately, we may find that protophenomena exist individually (in the same way that atoms were found to exist), e.g. as properties of individual activity sites, or we may find that protophenomena exist only in the context of large numbers of activity sites, and thus that they are emergent properties, analogous to emergent physical properties. For now this is an open question.

Causal dependencies among activity sites suggest how protophenomena are integrated into a phenomenal world. Just as physical processes in an activity site depend on physical processes in other activity sites, as well as on extrinsic processes (e.g. in sensory neurons), so the activity of a protophenomenon depends on the activities of other protophenomena, as well as on variables that are not directly dependent on protophenomenal activity (i.e., variables associated with the external world). The dynamics of protophenomenal activity can be described by differential equations. In many cases the dependencies (the equations) are approximately linear, and protophenomenal activity can be described in terms of a *characteristic function* (often known as an "impulse response").

Protophenomenal dependencies establish connections among protophenomena and thereby assemble them into a phenomenal world. One way they do this is by establishing continuity through expectations. Another way is by means of conjunctive dependencies and by more complex temporal dependencies. As a result a phenomenal world may be described by a set of possible trajectories in protophenomenal state space.

In summary, the fact of phenomenal experience corresponds to a protophenomenon's activity, since that activity represents its degree of presence in conscious experience; the quality of conscious experience corresponds to the protophenomenon's dependencies, which relate it to other protophenomena.

3 Color and Spectral Inversions

As an example of the protophenomenal approach, we can consider the well-known problem of a spectral inversion. In brief, the problem is as follows: Although we agree on the names for various wavelengths, is it possible that you experience red wavelengths the same way I experience blue wavelengths, and vice versa? Before we can solve this problem we need a more accurate phenomenology of color. The plausibility of a spectral inversion derives in part from an oversimplified phenomenology of color, since we have imagined that color can be reduced to a single dimension (wavelength) but a phenomenological analysis shows it to be much more complex (see [3] and the references cited therein).

Setting aside many of the higher-level complexities of color (e.g. its emotional and cultural connotations), yet avoiding the trap of a one-dimensional view, we can observe that it has long been known that we can identify four pure hues, which are termed the "unique hues," an observation that has led to the double-opponent theory of color vision. In this theory the three color receptors (short, medium and long wavelength, henceforth S, M and L) are combined in various ways to yield three orthogonal axes. The light-dark axis is formed by $S + M + L$ and its opposite; the yellow-blue axis is formed by $M + L - S$ and its opposite; the red-green axis is formed by $S + L - M$ and its opposite (here we use a common form of the theory). The two zeroes on each of the two chromic axes (yellow-blue and red-green) define the four unique hues.

The problem of a spectral inversion can be recast in terms of inversions between the poles on one or more of these axes or in terms of exchanges between two or more of the axes. However, we will show by phenomenological analysis that such spectral inversions are impossible, that is, that abnormal neurological connections would lead to abnormalities in conscious experiences that could be detected by the subject. Here the arguments will be summarized briefly.

First, it is fairly obvious that dark and light have phenomenologically distinct characters, and hence are noninterchangeable: in the dark, forms and hues are indistinguishable, but not in the light.

Second, phenomenological analyses of color from ancient times to our own have observed that yellow is intrinsically brighter than blue (the neurophysiological reason being the large overlap between $S + M + L$ and $M + L - S$). Hence, blue and yellow are phenomenologically similar to dark and light, and hence noninterchangeable. Therefore, in a case of abnormal vision, whatever receptor combination has the largest overlap with $S + M + L$ will be experienced as phenomenal-yellow, and if this does not correspond to spectral-yellow then the anomaly will be detectable.

The case of a red-green inversion is more subtle, but phenomenological analysis again exposes a difference. For example, Goethe observed that green is a phenomenological mixture of yellow and blue, whereas red results from an "augmentation" of yellow and blue. Further, the experience of "unique red" is nonspectral; that is, it cannot be created by monochromatic light, whereas experience of the other three unique hues (including green) can. (The well-known studies of Berlin and Kay also support the phenomenal differences between red and green.)

Finally, the red-green axis cannot be exchanged with the yellow-blue, because the former is less similar to light-dark than the latter. This phenomenological fact, which has been recognized since ancient times, is consequence of $S + L - M$ ("red") having a smaller overlap with $S + M + L$ ("light") than does $M + L - S$ ("yellow").

As a result of this neurophenomenological analysis, we can begin to understand the topology of color. First we have the three axes, which define three polar oppositions: light-dark, yellow-blue, red-green. Superimposed on this structure are relations of similarity: yellow is most similar to light, and blue is most similar to dark. Green is most similar to yellow and blue and is intermediate in its similarity to light and dark. Red is similar to yellow, but not to blue. These conclusions are objective in that they result from observations made independently by many phenomenologists over the centuries.

Finally, we will consider several more examples of abnormal or nonhuman color perception. For example, if we have $S + M - L$ instead of $M + L - S$ in the yellow-blue channel, then spectral blue-greens will be experienced as yellows, and spectrally orange light will be experienced as green. On the other hand, if we have $S + M - L$ and $M + L - S$ (two asymmetric channels) for the chromic channels, then color phenomenology will have several detectable anomalies: there will be two spectral unique hues (as opposed to three) and one whole phenomenal color quadrant (purple) will be nonspectral (unexperiencable with monochromatic light).

Many other neural anomalies can be hypothesized. However, if a sensory system is too different from our own, we may be neurologically unable to imagine the experience, although we can describe its topology. Since imaginal areas have parallel structures to perceptual areas, we have limited ability to imagine qualia that are distinctly different from what we can perceive.

4 Conclusions

The protophenomenal perspective has several benefits. First, it allows the fact of conscious experience to be integrated into scientific theory without denying or distorting the nature of that experience. Second, it permits a form of reduction of the more complex to the simpler while acknowledging the complexity of phenomena and avoiding naive introspectionism. Third, it permits a detailed account of the structure of conscious experience.

Of course, many open questions remain. For example: What are the activity sites and what sorts of physical systems can be activity sites? (This has implications for nonbiological consciousness.) What distinguishes conscious from nonconscious neural activity? Are protophenomena emergent? (This has implications for degrees of consciousness.) Are protophenomena qualitatively exhausted by their mutual dependencies (structuralism)? What can we say about the boundaries and unity of consciousness? Finally, much detailed neurophenomenological work remains to be done before we will understand the detailed structure of consciousness.

5 References

1. MacLennan, B. J. (1995). The investigation of consciousness through phenomenology and neuroscience. In *Scale in Conscious Experience: Is the Brain Too Important to be Left to Specialists to Study?*, ed. by J. King & K. H. Pribram (Hillsdale: Lawrence Erlbaum).

2. MacLennan, B. J. (1996). The elements of consciousness and their neurodynamical correlates. *Journal of Consciousness Studies* **3**: 409–24. Reprinted in *Explaining Consciousness: The Hard Problem*, ed. by Jonathan Shear (Cambridge: MIT Press).

3. MacLennan, B. J. (1998). Finding order in our world: The primacy of the concrete in neural representations and the role of invariance in substance reidentification. *Behavioral and Brain Sciences* **21**: 78–9.