

Protoconsciousness, Qualia Dimensions and Neural Circuitry for Color Vision

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Abstract: *The various dimensions necessary for creating qualia like integration are known but why does specific causal structure feel like green or red? This article attempts to explain it and create mathematical framework for qualia. Russellian monism, Panpsychism, Pan-proto-psychism and Neutral monism are discussed briefly. A priori, the various dimensions responsible for generating rich human-like consciousness do not explain how something immaterial like consciousness is created without bringing in proto-consciousness. As an example, neural circuitry for color vision is mapped. Similar mapping needs to be done for phenomena listed in that section.*

Keywords: Integrated Information, Qualia map, multi-dimensional causal space, differentiation, temporal dynamics, irreducibility, firing rates, recurrence, attention, prior knowledge, hard problem of consciousness, mind-body problem, proto-consciousness, Russellian Monism, Panpsychism, Pan-proto-psychism, Neutral Monism

Section 1:

Important dimensions below are selected to create a multi-dimensional map [5] (OpenAI, 2026)

Integration (x_1)

Temporal Dynamics (x_2)

Discrimination (x_3)

Irreducibility (x_4)

Firing rates (x_5)

Recurrence (x_6)

Attention (x_7)

Predictive Processing (x_8)

Emotional Saliency (x_9)

Memory Coupling (x_{10})

Only important factors are listed above and the list is not all-inclusive.

Integration:

Integration is how much the system like brain is more than its parts and is quantified by Φ . A system can be conscious in many ways such as with different modalities like vision, auditory or somatosensory and with different sub-modalities like orientation or motion and dimensions like blue or green. Quality of consciousness may change depending on the rearrangement of neurons in the thalamo-cortical system. Integration controls both quantity and quality of experience. The quale of colour and the quale of detecting edges is different because of the different causal structure or informational relationship within the area and rest of the main complex. [3]

The many mechanisms of a complex, in various combinations, specify repertoire of states they can distinguish within the complex, above and beyond what their parts can do: each repertoire is integrated information – each an irreducible concept. Together they form a shape in qualia space. This is the quality of experience, and Q its symbol. [2]

Maximally irreducible conceptual structure (MICS) is the main concept in Integrated Information Theory (IIT). Conceptual Structure is the cause-and-effect relationship inside the system like brain. If you partition the system into

two parts and this cut destroys the causal power then the system is irreducible. Brain contains subsystems which overlap with each other. Only the subsystem with max Φ corresponds to phenomenal experience and is called Complex. Hence the word “maximally”. So apart from large Φ IIT equates MICS to phenomenological experience.

Temporal dynamics: [4]

Current theories assume qualia as a form of representation. Brain encodes modalities of the world like colours, sounds or sensations and conscious experience consist of accessing these representations. This is a static picture while conscious experience is dynamic. A mere pattern correlation reports seeing red without explaining there is a felt quale at all.

Rather than considering about internal representation of the brain we must consider the evolution of coherence of field.

The brain is continuously subject to perturbations arising from multiple sources:

- Sensory input, which introduces structured changes from the external environment
- Internal fluctuations, including spontaneous neural activity and ongoing cognitive processes
- Noise, both thermal and biological, which injects variability into the system

Without perturbation, a perfectly stable system would have no need to change, adapt, or reconfigure itself. Without such dynamics, there would be no unfolding process- no temporal structure- and therefore no experience. The world is not something the brain passively represents. It does not enter the system as a fully formed object to be encoded and stored. Instead, it acts as a source of **structured disruption**. Disturbance creates conscious experience by breaking the phase relationship (activity temporally aligned) in local area and restoring it. Experience is system's recovery after perturbation.

Differentiation: [3]

You are facing a blank screen which alternately turns on and off. You are to report light when the screen turns on and dark

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when the screen turns off. When you differentiate between screen being light or dark you are consciously doing it. A light sensitive device called photodiode is placed in front of the screen. It indicates when the screen is light and does not indicate when the screen is dark. The photodiode is “seeing” light/ dark just like you albeit unconsciously.

Information is defined as the reduction in uncertainty among number of outcomes when one of them occurs. It is measured as,

$$H = - \sum p_i \log_2 p_i \dots\dots \text{ where } p \text{ is number of possible outcomes.}$$

Tossing of a fair coin is 1 bit of information while rolling a fair die is 2.585 bits of information

When we consciously select an image from billions of images we are ruling out large number of states. So, the bits of information is extremely large. Differentiation is huge.

Irreducibility:

Irreducibility is information of the complete system like brain above and beyond the information of its components. If the causes and effects are reducible to the components of the system, a system which has no interaction among components, the integrated information is zero. Unification of

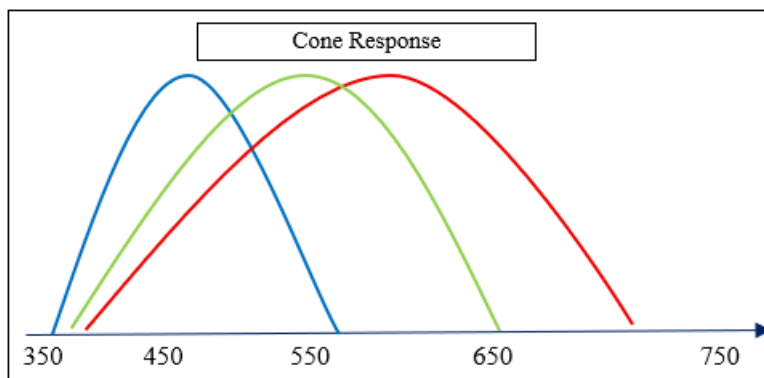
consciousness is irreducibility of each experience to non-interdependent subsets of phenomenal distinctions. [6]

Firing Rate: [21] (OpenAI, 2026)

Firing rates of neurons determine which qualia will be created. We will take an example of firing rates for colour perception.

Light falls on the retina after passing through cornea, pupil and lens. Retina contains rods and cones (L, M, S) the cones of which are responsible for detect colour. L cone detects long wavelengths (red), M cone detects medium wavelength (green) and s cone detects small wavelengths (blue). Signal then moves through bipolar and ganglion cells. Optic fibre carries the signal further to Lateral Geniculate Nucleus (LGN) in thalamus. LGN to primary visual cortex (v1). Primary visual cortex detects edge, orientation and contrast of visual stimuli. v2 detects contours, textures and more complex patterns. v4 is responsible for colour perception.

v4 area is integrated with v1, v2, v3, Inferotemporal cortex (face recognition), Posterior parietal cortex for attention and spatial location, Prefrontal cortex for working memory and attention, Pulvinar (visual attention and coordination) etc. So, colour processing doesn’t happen in v4 alone but in the causal structure mentioned above through integration.



Graph 1 (only illustration)

There is no one fixed firing rate for one colour but colour processing takes place across population of neurons.

Recurrence:

Recurrence is the bidirectional flow of electric signals along axonal fibres connecting different brain areas. The architecture serves in integrating the functions of various modalities of cortex and thalamus. By maintaining attention and short-term memory, recurrence might serve a central role in generating phenomenal awareness predominantly seen in vertebrate telencephalons [23].

It also has been proposed that if a network develops an attractor (equilibrium) state either through attention or feedback loops then message identified each time by the network becomes representation of previous message leading to generation of qualia. The author gives an example of olfactory qualia. The message obtained every time the output is feedback builds upon previous message. The first message identified as “identity”, the second message as “inner form” and the third message is “likeness” as the network progresses to attractor state [22].

Predictive Processing:

According to Predictive Processing to cycles run concurrently – an outward- looking cycle of prediction aiming at environmental stimuli and an inward-looking cycle aiming at our own changing biological states. According to the article, merging ‘what I am seeing’ in exteroception and ‘how I am responding to that seeing’ in interoception gives us the feeling of warmth quale that we consciously experience. Qualia are not generated by properties of the stimulus, but rather by the subtle complex of reactive dispositions of the perceiving subject. The warmth quale arises from a number of predispositions and memories of earlier experiences. The reactive dispositions comes first and we tag things which evoke those responses as warm. However, we are not normally aware that reactive dispositions come first and qualia follow and therefore project the quale of warmth from ourselves on the world [24][25][26].

Mathematically,

$$X(t) = (x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10} \dots \dots \dots x_n)$$

Section 2

Proto-consciousness:

Russellian Monism [8] –

Russellian monism unites three core theses:

structuralism about physics, which states roughly that physics, at least current physics describes the world only in terms of its spatiotemporal structure and dynamics. According to Chalmers, basic particles are characterized by their tendency to interact with other particles. Their mass and charge are specified but all that a specification of mass ultimately comes to is a tendency to be accelerated by certain forces [7].

realism about quiddities, which posits that there are *quiddities*, that is, properties that underlie the structure and dynamics physics describes. Those properties surely ground the most basic physical dispositions that physics describes, in the way a ball's spherical shape definitely grounds its disposition to roll when pushed. These underlying properties are often called *quiddities* [9] [10]

quidditism about consciousness, which posits that quiddities are relevant to consciousness. For example, consider the taste of coffee or brilliant red sunset or hearing a bird song. There is always *something it is like* to have phenomenal experience [11]. The quiddities possibly can be relevant to consciousness by founding phenomenal properties or phenomenal properties may be founded by quiddities together with structural properties of physics.

Panpsychism [12] –

Panpsychism is a compromise between complete physicalism on one end and dualism on other. It literally means everything has consciousness and consciousness is ubiquitous in natural world. In *Constitutive Panpsychism* facts about animal and human consciousness are not fundamental but are built from more fundamental form of consciousness such as micro-level consciousness. In *Non-Constitutive Panpsychism* facts about human and animal consciousness are fundamental [13]. According to Emergent Panpsychism, micro-level conscious entities give rise to human minds and sustain them throughout their existence [14][15].

Pan-proto-psychism

Panpsychists think that consciousness is fundamental and omnipresent whereas Pan-proto-psychist think Proto-consciousness is fundamental and omnipresent. The properties of latter are called proto-phenomenal properties.

According to Chalmers and Goff, a fuller definition of “proto-phenomenal properties” would define them as properties that in certain combinations transparently account for the existence of consciousness, in the sense that one could in

principle move a priori from knowing the relevant facts about proto-phenomenal properties to knowing the relevant facts about phenomenal properties [13] [16] [17].

We know that consciousness exists and we can experience it. Something intangible like consciousness cannot be produced by physical, mechanistic hydro-carbon and other molecules. So, (proto) consciousness exists everywhere and is responsible for building sophisticated human-like consciousness. (OpenAI, 2026)

Combination problem [18]

The combination problem is stated as micro-level entities have their own consciousness but somehow brain combines these consciousnesses to form rich, human-like consciousness. Integration as discussed earlier in the article combines micro-consciousnesses into human-like consciousness.

Neutral Monism [20] –

The distinction between monism like idealism or materialism and Neutral monism is that the Neutral monism is neutral between the two. Russell, for instance, describes neutral monism as the view that “*both mind and matter are composed of a neutral-stuff which, in isolation, is neither mental nor material*” [19].

Section 3

Neural Circuitry for Colour Vision:

According to the opponent's colour theory when “red” neurons are worn out “green” quale is seen as shown in Figure 2 below. The “black” neurons are inhibitory neurons. As long as red neurons are firing inhibition does not allow green neurons to fire. After red neurons are worn out there is disinhibition and green neurons start firing producing green quale. As all L, M, S cone oscillations overlap for some frequencies, inhibition is required among all three colours.

This is true for opponent's colour theory, however, to produce colours like yellow both red and green neurons need to fire. In the Figure, only yellow light triggers R1 and G1 to generate yellow quale. R1 and R2, G1 and G2, B1 and B2 seem redundant but there is no way, for example, for R2 to both inhibit and excite G2 when required. Hence a separate R1, G1, B1 for normal vision while R2, G2, B2 are for after images.

There should be a more parsimonious circuit than figure 2 because after images do not seem to have any evolutionary advantage. Why would nature spend extra neurons and circuitry for after images?

The figure does not show recurrence or other dimensions but just the basic circuitry for normal colour vision and after images.

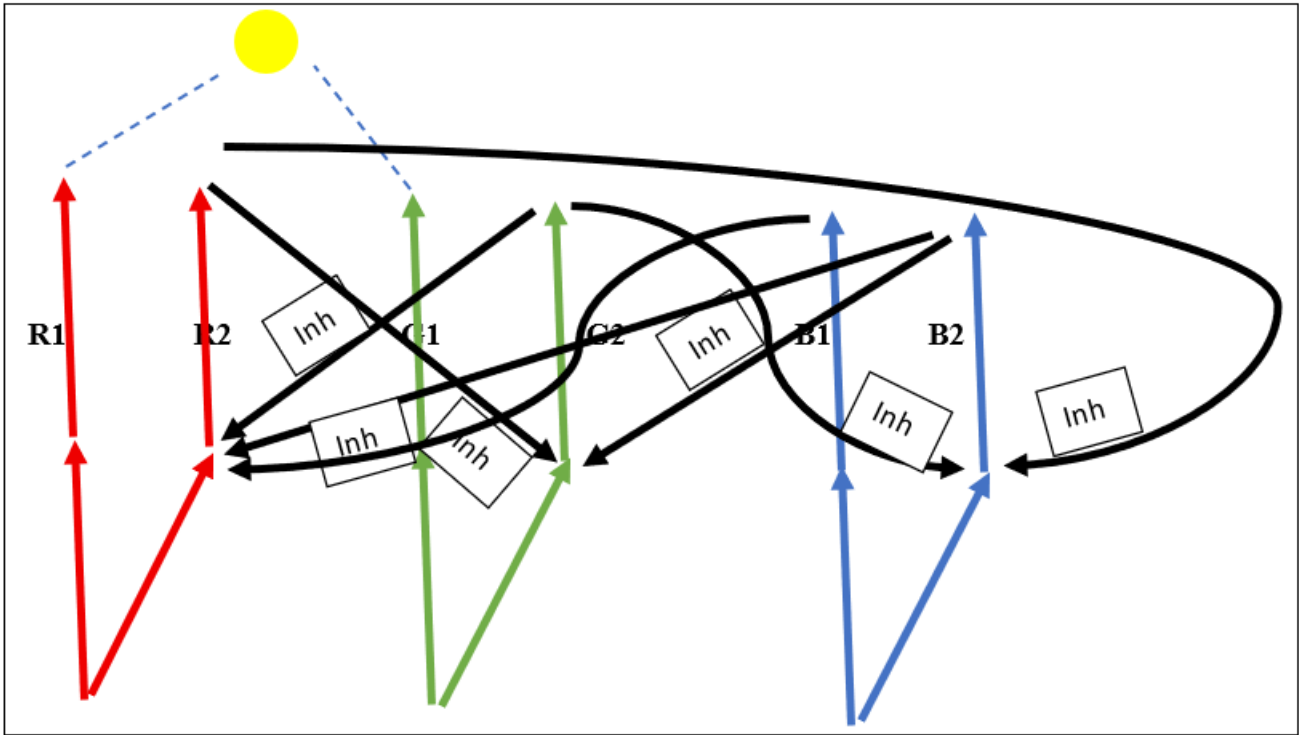


Figure 2

Alternatively, when we are observing a green stimulus, the yellow-blue opponent colours remain neutral producing no qualia and red which is green's opponent colour is too weak to see red + green colour. When green neurons are worn out, yellow-blue channel still remains neutral and the weak red

colour is seen as an after image. Alternative figure is shown below. This is a much more parsimonious explanation of colour vision and its after image. The inhibition is not required like Figure 2.

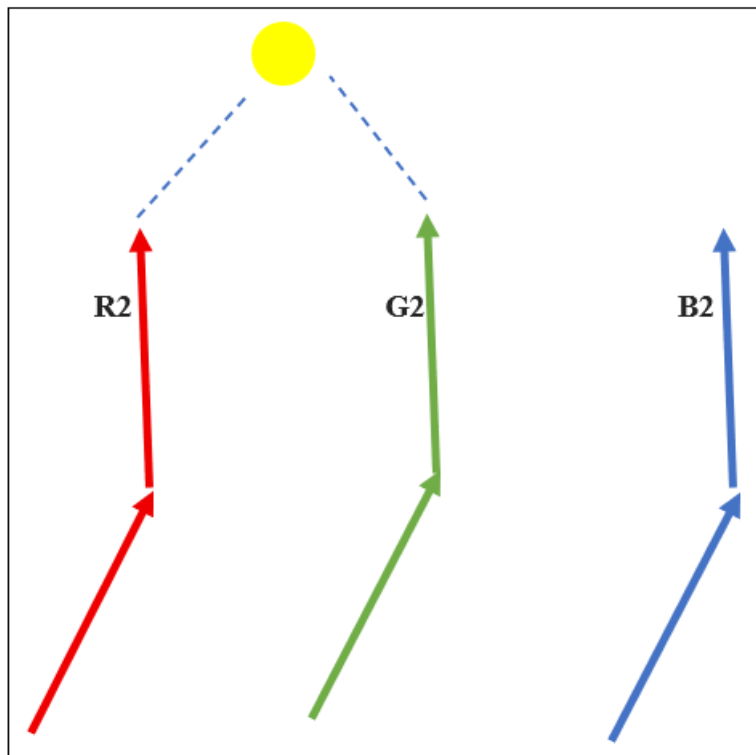


Figure 3

Apart from afterimages, orientation adaptation, stereopsis, colour constancy, motion after effect, crowding, face inversion effect, change blindness, blindsight, binocular rivalry, visual agnosia, mental imagery etc. need to be mapped to get a rough architecture of visual cortex.

Conclusion

The factors discussed in the article above explain rich conscious experience emerges from "proto-consciousness".

Any amount of integration, temporal dynamics, differentiation, irreducibility or recurrence etc, would still require the basic seed of experience on top of which the rich, full human brain-like consciousness develops. Physics gives structure, causal relationships with different parts of the brain responsible for different modalities but subjective, qualitative experience is pervaded, I believe, by proto-consciousness everywhere. A loose analogy would be mass and charge. Just like objects have mass and charge there is also the rudimentary seed of experience as a building block of higher consciousness. Combination problem should vanish with integration of various modalities and sub-modalities.

A priori, the various dimensions responsible for generating rich human-like consciousness do not explain how something immaterial like consciousness is created without bringing in proto-consciousness.

The plausible neural circuitry for color vision is speculated in section to show how rich human-like consciousness builds on top basic proto-consciousness. Eventually, the goal is to map the neural circuitry to visual cortex and then the entire brain.

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