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A commentary on "What is it like to be a tetrachromat?" by Michael Newall

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Abstract
Analytical examinations of subjective experience are hampered by the first-person limitation described by Nagel (1974) in "What is it like to be a bat?". This comment compares two examinations on the nature of subjective experience: Michael Newall's (2025) analysis of tetrachromatic colour perception and Jordi Galiano-Landeira and Núria Peñuelas' (2025) exploration of AI phenomenological consciousness within panpsychism. Newall examined whether tetrachromats perceive entirely novel colours or finer gradations of known ones, using analogies with dichromats and empirical evidence. Newall argued for the possibility of novel colour experiences. Galiano-Landeira and Peñuelas proposed that the analog/non-analog distinction is user-dependent, implying that AI could be phenomenologically conscious despite digital information processing. Although both works stemmed from completely different starting points, they emphasize the continuity of experience besides the perceptual resolution, questioning anthropocentric and chauvinistic biases in phenomenal consciousness studies. The structuralist perspective on colour quality spaces is also discussed to further delve into tetrachromatic perception, suggesting that tetrachromats might experience both finer gradations and novel colours.

Keywords
Anthropocentric/chauvinistic biases · Colour structuralism · Perceptual resolution · Phenomenal consciousness · Tetrachromacy

1 Summary of "What is it like to be a tetrachromat?" by Michael Newall

Analogous to Nagel's (1974) seminal work, Michael Newall (2025) explored the perceptual experience of tetrachromats, individuals with a fourth type of cone cell that allows them to process additional wavelengths of light beyond the typical human trichromatic vision. As Macpherson stated, tetrachromats "see colours that normal human trichromats do not" (Macpherson, 2020). However, Newall asked whether these colours are *entirely novel* or merely *finer gradations* of trichromatic colours. The paper examined this question through the lens of tetrachromats' phenomenology and empirical evidence reported in the literature. Newall's analysis

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begins with an overview of the relevant aspects of visual processing before introducing a crucial case of tetrachromacy (i.e., cDa29). Then, Newall argued that the evidence from cDa29 case and other studies suggests that tetrachromats "with enhanced visual acuity do indeed gain the acuity through an ability to see novel colours" (Newall, 2025, p. 3).

Trichromats, i.e., standard human vision, have three types of cone cells in their retinas, each sensitive to a range of light wavelength: S (short), M (medium), and L (long). Colour information from the retina is processed through opponent channels: blue-yellow, red-green, and black-white. Due to the "on-off" nature of these channels, combinations within a channel (e.g., reddish greens and yellowish blues) are uncommon. Further processing occurs in the visual cortex. Tetrachromats, typically females due to the genetic encoding of M and L cones development on the X chromosome, possess a fourth cone type derived from a mutated M or L cone. However, the functional integration of this extra cone in the visual system remains unclear, raising the question of whether these cones are phenomenologically relevant. According to the author, for the mutant cones to be functional, they must contribute to at least one new opponent channel, requiring visual cortical adaptations to this new input as well. Such neuroplastic adaptations have been described in genetically modified mouse and non-human primate animal models, even in adult individuals, which expressed a mutant cone cell (Jacobs et al., 2007; Mancuso et al., 2009).

Newall focused on the case of cDa29 (Jordan et al., 2010), a genetically confirmed and functionally tested tetrachromat who could distinguish orange light (i.e., circa 590nm) to combinations of red (670nm) and green (546nm) light, an impossible task for trichromats. This suggests that cDa29's mutant cone cell is sensitive to orange-related wavelengths. To better understand cDa29's phenomenal experience of colour, Newall proposed an analogy between tetrachromats and trichromats, as well as between trichromats and dichromats. The latter, dichromats, have two functional cone cells, most commonly the S and M or L types. In this analogy, trichromats relate to dichromats similarly to how cDa29 related to trichromats, potentially offering trichromats an insight into tetrachromatic experience. In general, this analogy is articulated as follows: (i) "some wavelengths that the normal viewer sees as different in hue will appear the same hue to the dichromat", and (ii) "the normal viewer has phenomenal access to a larger number of colour categories, and can use these to quickly group and distinguish" (Newall, 2025, p. 10). Consequently, tetrachromats could possess an additional opponent channel, allowing for the perception of two new elementary colours[1].

Newall dismissed the possibility that cDa29's orange perception merely fills gaps between familiar trichromat colours, as cDa29 cannot match the sensation produced by certain orange wavelengths to any combination of red and green

[1] Each opponent channel corresponds to two elementary colours: for instance, blue-yellow and red-green.

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wavelengths. Newall concluded that cDa29 experiences an overlay between novel cone input and trichromatic colours. Newall asserted that,

> "All the possible shades between red and yellow can be located within the trichromat spectrum, even though trichromats cannot discriminate all of these. To be discernible from all these colours, the tetrachromat must experience them as a colour qualitatively unlike any of those colours. That is to say, they must be a novel colour." (Newall, 2025, p. 12)

According to Newall, this would explain cDa29's rapid accurate colour discrimination abilities, which surpass trichromatic capabilities.

Besides this analysis, Newall believed that scepticism towards the idea of tetrachromats experiencing novel colours stems from a type of chauvinism. Newall argued that the general opinion tends to avoid attributing entirely novel colour experiences to tetrachromats, abrogating instead an interpretation of enhanced discrimination among familiar hues. This chauvinism, Newall concluded, limits our understanding of the full phenomenological potential of tetrachromacy.

2 Summary of "Non-analogical panpsychism: AI may be phenomenologically conscious" by Jordi Galiano-Landeira and Núria Peñuelas

In contrast to other positions, Jordi Galiano-Landeira and Núria Peñuelas (2025) argued that AI *may* be phenomenologically conscious within a panpsychist framework. One of the most prominent challenges for panpsychism is the 'combination problem' (James, 1890; Seager, 1995), which questions how the microconstituent parts of phenomenal experience contribute to a unified macroconscious experience. According to some authors, this integration is only possible if the relationship between physical stimuli and the subsequent neural activity and phenomenal experience correlates analogically. If the covariation among these elements is non-analogous, such as in the case of digital correlations seen in traditional computers and AI, then, they argued, the resulting experience would fail to represent physical stimuli accurately. This loss of information implies that macroconsciousness in non-analog systems would be non-coherent.

Galiano-Landeira and Peñuelas (2025) challenged this view, arguing that the analog/non-analog distinction does not suffice to determine whether AI or, overall, systems with lower perceptual resolution than humans, can possess phenomenal consciousness. Galiano-Landeira and Peñuelas defended that the analog/non-analog categorization of a system is user-dependent, an idea previously discussed by Katz (2016). According to their argument, this user-dependence renders the

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analog/non-analog distinction futile when comparing systems with different perceptual resolutions because all systems are analog from their own subjective perspective.

This perspective implies that all phenomenological conscious systems display their phenomenological experiences as continuous, maintaining an analog relationship between physical stimuli, neural activity, and phenomenal experience from their point of view. However, the content of these experiences is indeed shaped by the system's perceptual resolution. For instance, while colour perception differs between trichromats and dichromats, with the latter being unable to represent certain aspects of visual reality which trichromats can do, this does not imply that dichromats lack colour-related phenomenal experiences. Both trichromats and dichromats are phenomenologically conscious, but the contents of their visual experiences differ, shaped by their colour perceptual resolution.

Through this analysis, Galiano-Landeira and Peñuelas (2025) argued that AI could also be phenomenologically conscious, as the analog/non-analog distinction is not an objective feature of the system but a user-dependent interpretation. Thus, if AI possesses perceptual continuity within its own framework, it could have a coherent phenomenological experience.

3 What is it like to be something else?

3.1 The first-person limitation and the continuous aspect of phenomenal experience

Both Newall (2025) and Galiano-Landeira and Peñuelas (2025) explored the first-person limitation in understanding the subjective experiences of entities with different perceptual resolutions. Both works explicitly reference Nagel's influential essay, "What is it like to be a bat?" (Nagel, 1974),[2] highlighting the challenge of imagining the experience of a bat without sharing its perceptual toolkit and resolution. Newall's main objective is to determine whether tetrachromats experience finer gradation of trichromat-known colours or entirely novel colours unknown to trichromats. Nagel could not communicate with bats, being unable to obtain a third-person perspective of how it might feel flying during nights while searching for food[3]. However, fortunately, we, humans, can communicate with each other, making subjective experiences more relatable even with differences in perceptual resolution.

Newall (2025) attempted to circumvent this first-person limitation by leveraging empirical evidence reported by Jordan and colleagues (2010) about cDa29 and phenomenological reports from other tetrachromats (Jameson et al., 2015, 2020;

[2] Newall's work, titled "What is it like to be a tetrachromat?", mirrors the structure of Nagel's seminal work.

[3] To avoid any controversy, Batman's unlikely existence will not be considered as a source of valid information about what it feels like to be a bat while still maintaining humanity.

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Jameson & Winkler, 2014; Jordan & Mollon, 1993). Moreover, Newall used the analogy between dichromats and trichromats to illustrate how tetrachromats might experience colour. Since most humans are trichromats, we can relate to the potential differences in colour experience by comparing their vision to that of dichromats. In any case, Newall acknowledged the persistence of the first-person limitations, quoting:

> “Unfortunately, she [cDa29] cannot describe how her colour vision compares with ours, any more than we can describe to a dichromat person what red looks like”. (Greenwood, 2012)

Newall (2025) argued that scepticism about tetrachromats perceiving novel colours, rather than just finer gradations, is rooted in a form of chauvinism. However, even with Newall’s thorough reasoning, it is ultimately impossible to fully prove whether tetrachromats experience entirely new colours from a trichromat perspective. Newall’s argument strengthens the plausibility of this conclusion over the simple improvement of finer gradations and significantly contributes to the debate on subjective experience.

Similarly, Galiano-Landeira and Peñuelas (2025) argued that denying the possibility of AI being phenomenologically conscious, based on the premise that human phenomenal consciousness is analog, is an anthropomorphic argument. This is, at some extent, akin to Newall’s observation about the scepticism towards novel colour experiences in tetrachromats. Taking the ‘standard’ human experience as a starting point is understandable because of the first-person limitation, but it should not lead to the outright denial of the subjective experiences of bats, digital AI, or subjective differences with tetrachromats. We must accept our empirical limitations, reasoning through arguments and the limited evidence, and being aware of the axioms we accept as truths: for instance, human consciousness might not be the only form of phenomenal consciousness.

Galiano-Landeira and Peñuelas (2025) argued that the analog/non-analog distinction is user-dependent, making it futile to interpret the experiences of one entity through the perceptual resolution of another. Galiano-Landeira and Peñuelas claimed that, because all experiences are *experienced* as continuous from a user-dependent perspective, all entities could compose an analog, and thus, coherent macroconsciousness through phenomenal microconstituents. They illustrated this using the dichromat-trichromat comparison: Dichromats would interpret trichromats’ perceptual resolution as analog, as they would not be able to detect differences between their colour visual perceptual resolution and the trichromats one. Contrarily, trichromats would interpret dichromat’s perceptual resolution as non-analog, because they can detect that their colour visual perceptual resolution is different to the dichromats one. Nevertheless, as previously discussed, the fact that dichromats fail to represent some information of the colour visual spectrum does not mean that they are unable to build up a coherent phenomenal experience. Newall noted:

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> "The dichromat viewer still sees most of the spectrum as being coloured [continuous experience], but not with all the colours that the ordinary viewer sees, and accordingly, they are not able to make as many colour distinctions as can an ordinary viewer [analog/non-analog interpretation]." (Newall, 2025, p. 10, brackets are my own emphasis)

From the dichromat's perspective, their experience is continuous and, thus, analog. Newall's analogy extends this comparison to the trichromat-tetrachromat scenario: While trichromats would interpret tetrachromats' colour visual perceptual resolution as analog, tetrachromats would interpret trichromat's one as non-analog. This is similar to what Hardin probably meant in this hypothetical 'visual superwoman':

> "[C]onsider a hypothetical visual superwoman with an extra cone type and three chromatic opponent systems, two just like ours and a third, call it the"c-d" opponent system, involving cross-connections between the regular three cone types and the new cone type. She understands our color vocabulary very readily and can use it as well as we, but she pities our visual degeneracy, for she is a tetrachromat" (Hardin, 1993, p. 116).

Trichromats, like myself, cannot experience certain colours or shades accessible to tetrachromats, but this does not imply that trichromats lack continuous colour perception or that they are incapable of having phenomenal experiences. Both Newall (2025) and Galiano-Landeira and Peñuelas (2025) emphasize that subjective experience is inherently user-dependent. Consequently, interpreting other entities' experiences requires acknowledging the limitations of first-person perspectives and avoiding the bias of human-centric analog/non-analog distinctions.

3.2 Phenomenal colour experience as the contrasting of cone cell information

Newall's (2025) main objective was to analyze whether tetrachromats experience finer gradations of trichromat-known colours or completely novel colours. To explore this, Newall used an analogy between dichromats and trichromats to draw comparisons with trichromats and tetrachromats. Specifically, how many new colours do trichromats experience compared to dichromats? According to Newall, the addition of a new cone cell, as in the transition from dichromacy to trichromacy, *might* introduce two elementary colours. For instance, deuteranopia dichromats lack the M cone, which means that they are unable to fully detect green-related wavelengths (figure 1). Introducing the M cone to deuteranopia dichromats converts them to trichromats which would allow them to perceive two new colours: green, because it matches the peak sensitivity of the M cone, and red, because the opponent channel needs to contrast L cone-derived red

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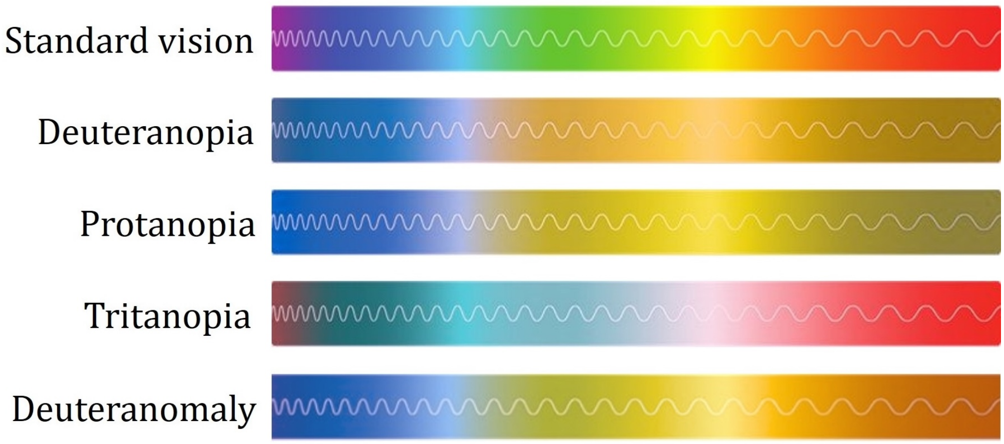

Figure 1: Colour visual phenomenal spectra for standard vision (i.e., trichromacy), and different types of dichromacy: deuteranopia (lack of M cone cells), protanopia (lack of L cone cells), tritanopia (lack of S cone cells), and deuteranomaly (L' cone cells over M cone cells). The figure was created using Fiji (Schindelin et al. 2012) with the "Simulate Color Blindness" plugin.

information against M cone-derived green information in order to fully perceive the red colour. But the emergence of one or another colour depends on the peak sensitivity of the novel cone cell, and how the opponent channels are rearranged. Tritanopia dichromats lack the S cone cell, which means that they do not detect the blue-related wavelengths (figure 1). Since the peak sensitivity of both M and L cone cells are much closer to each other than to S cone cells, tritanopia dichromats mainly experience red and a bluish green. Adding the S cone cell enables the emergence of perceiving several different colours, including pure blue, pure green, and yellow, due to the greater contrast between the blue-yellow and red-green opponent channels.

The phenomenal colour experience between deuteranopia/protanopia dichromats more closely resembles that of trichromats compared to tritanopia dichromats (figure 1). This aligns with the observation that deuteranopia/protanopia dichromats cover more of the trichromat wavelength spectrum than tritanopia dichromats. This emphasizes the importance of contrasting distinct peak sensitivities for the emergence of colour perception. In the case of cDa29 tetrachromat, the additional cone cell (L') is situated between the M and L cone cells in terms of peak sensitivity. Given the close proximity of M and L peak sensitivities, L' peak sensitivity does not add much more covering of the wavelength spectrum. How then could the information from the L' cone cell be arranged in the opponent channel processing? From my opinion, L' integration into the opponent processing system might be summarized in two possibilities: (i) the information from L' could act as a regulator of the red-green channel without the forming a new opponent channel,

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or (ii) the creation of, at least, a new channel. I argue for the latter because non-human primates exhibit flexibility in opponent channel development, with some species displaying different channels between males (dichromatic, green-blue opponent channel) and females (trichromatic, blue-yellow and red-green opponent channels) (Casagrande et al., 2009). This opens the scenario for a reconfiguration of the opponent channels in tetrachromats. I suggest as a possibility the following reconfiguration: blue-yellow, reddish orange-green, red-orange. In this configuration, yellow and reddish orange would arise from the combined information of the reddish orange-green and red-orange channels, respectively. Consequently, drawing from this scenario, I propose that the addition of L' cone cell would bring a finer gradation of colours around L' peak sensitivity, and potentially a novel orange-like colour that trichromats cannot distinguish due to their lower resolution in that range. Findings in deuteranomalous trichromats reinforce this conclusion. Deuteranomalous trichromats possess an L' cone cell over an M cone cell, meaning that one of the opponent channels contrasts L versus L' information. These individuals exhibit a more restricted red and green colour experience compared to standard trichromats (figure 1). Nevertheless, consistent with the conclusion of this work, they display a finer gradation resolution around the L/L' peak sensitivity (Bosten et al., 2005).

Newall (2025) did not discuss structuralist views on the phenomenal quality of colours, which posit that "the whole structure of quality space affects the phenomenal character of each individual experience" (Fleming & Shea, 2024, p. 904). This view could suggest that, at some extent, *all* colours experienced by tetrachromats are novel, just as trichromat colours are novel to dichromats. Although Newall cleverly excluded this line of reasoning to maintain the manuscript's focus, I believe it offers an intriguing perspective. The nature of opponent colour channels is fundamentally about contrasting cone-derived information. This concept of 'information' could be considered in Shannon terms as a decrease of uncertainty (Chambert-Loir, 2022). The decrease of uncertainty would happen when more different cone cell outputs are considered and contrasted to each other, leading to a more defined colour. This means that the whole colour spectrum would be reconfigured with the addition of a new cone cell. Dichromats and trichromats comparison illustrates this: all shades are, at least, slightly different. While deuteranopia and protanopia spectra are similar due to overlapping M and L peak sensitivities, subtle differences arise in most of the shades, being only some of them equal probably when the information coming from M and L cone cells is exactly the same. Reusing again the dichromat-trichromat analogy for trichromat-tetrachromat comparison suggests that tetrachromats could experience a completely different colour spectrum by contrasting more wavelength information than trichromats. From a structuralist point of view, I believe that tetrachromats might not experience *all* colours as new ones but would experience significantly finer gradations and possibly quite a few new colours, particularly around orange.

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4 Concluding remarks

Newall (2025) and Galiano-Landeira and Peñuelas (2025) both examined the first-person limitation in understanding phenomenal experience, as beautifully highlighted by Nagel (1974) in “What is it like to be a bat?”. Both works oppose chauvinist and anthropomorphic stances unfortunately derived from this first-person limitation. At some extent, both works defended that phenomenal experience is *experienced* in a user-dependent continuous manner, without gaps. Beyond the comparison between both works and for the sake of the discussion, I believe that Newall’s argument and reasoning is compelling. Nevertheless, I propose that cDa29 might be experiencing both finer gradations and, likely, new colours, based on the dichromat-trichromat analogy and the peak sensitivity of the new cone cell. In addition, I claim that structuralist views could further illuminate this phenomenon by positing a restructured colour spectrum, potentially yielding more novel colours than Newall initially suggested.

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