**Athens Institute for Education and Research**
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**ATINER's Conference Paper Series**
**PHI2013-0478**

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**Tae-Kyung Kim**
**PhD Candidate**
**University of York**
**UK**

Athens Institute for Education and Research
8 Valaoritou Street, Kolonaki, 10671 Athens, Greece
Tel: + 30 210 3634210 Fax: + 30 210 3634209
Email: info@atiner.gr URL: www.atiner.gr
URL Conference Papers Series: www.atiner.gr/papers.htm

Printed in Athens, Greece by the Athens Institute for Education and Research.


ISSN **2241-2891**
1/08/2013

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This paper should be cited as follows:

**Kim, T-K.** (2013) "**Colour Perception and Conceptual Contents**" Athens: ATINER'S Conference Paper Series, No: PHI2013-0478.

# Colour Perception and Conceptual Contents

**Tae-Kyung Kim**
**PhD Candidate**
**University of York**
**UK**

**Abstract**

Recently, colour physicalism has held a dominant position in explaining colours of objects. According to physicalism, the physical property of colour, called the surface spectral reflectance (SSR), concretely defines the colour of objects. Some physicalists believe that the content of colour experience is necessarily related to the physical property of colour. This account might prompt two claims. First, that colours are mind-independent properties of material objects. Second, that the physical property of colour is directly engaged in composing contents of colour experience. If these claims are true, then they might support the non-conceptualists' claim that the content of colour experience is sometimes non-conceptual.

In this paper, I critically examine and raise objections to this argument. First, I consider whether the content of colour experience is entirely defined by its physical property (SSR), with regard to the problem of colour variation. Second, I discuss whether the content of colour experience can be explained on a contextual level, rather than a physical level. I show that we perceive colours without depending on SSR, and use examples of psychology of colour perception.

I also claim that the content of our colour experience is not directly reflected in the physical properties of colours; rather it is closer to categorized contents, which involves concepts.

**Keywords:**

**Corresponding Author:**

**Reflectance Physicalism and Colour Variation**

There is evidence to suggest that it is a physical property of colour, the surface spectral reflectance, that concretely defines the colour of objects. According to this type of physicalism (Byrne & Hilbert, 1997 and 2004) the reflectance of a certain object is independent of any colour signal which is affected by different lights, and our visual systems (which perceive constant colour) are designed to detect this reflectance. This type of physicalism is very attractive to philosophers and psychologists because the prevalent view of colours – colours are belongs to objects – is underpinned by scientific theory. Moreover, this approach seems to provide ontological evidence of colours and give us a more objective explanation of visual perception than other approaches.

One of the strength of this kind of physicalism is that it explains the colour constancy phenomenon. For example, the faces of a white box may have two or more different colours under light (that is, its own colour and apparent colours); notwithstanding, we perceive the object as having one colour (white). This colour constancy is not explained by wavelength and amount of light, but it can be explained by surface spectral reflectance (SSR), which is an illumination-independent property.[1] If we can check the SSR of the faces of the box, we easily know what colour the box is. And the reason we perceive it as white is because it reflects a certain amount of light. Our visual systems are designed to detect such reflectance. According to Byrne and Hilbert (1997), the phenomenal character of colour experience is necessarily related to the physical property of an object. As such, colour experience can be explained in a physical way. If this is correct, then we can make a possible assumption that, first, colours are mind-independent properties of material objects. Second, the content of perceptual experience is dependent on the physical property of colours and our visual organs. Hence, physicalism shares basic ideas with non-conceptualists, and it also gives strong evidence to support them.

Nevertheless, there are some aspects of colour experience that cannot be explained sufficiently by physicalism. The biggest issue is perceptual variation. Perceptual variation is a phenomenon whereby perceivers have different colour experiences of the surface of an object even though they are in the same circumstance. Or, a subject may have two different colour experiences of the same surface of an object. The most typical example of this can be found in the 'Munsell Colour Chart' (see Chart. 1).

For example, when subjects are asked to select a pure yellow colour (one which is not mixed with any other colours), their selections were hugely different. Human beings have a common visual mechanism (that includes cone cells, retina, and so on.). But although we have the same cone cells, there is an

[1]All objects reflect light. However, the amount of reflected light or the reflected wavelength is not the colour of the object. 'The surface spectral reflectance (SSR) of an object is given by specifying, at each wavelength in the visible spectrum, the percentage of light the object reflects at that wavelength' (Byrne and Hilbert 1997: 265). The SSR of an object does not change even if the object is taken from indoor illumination to a sunny outdoor place.

inappreciable difference in the amount of photopigment in an individual's visual system. This might explain the individual's different perceptions of the same colour physically. However, one worry is whether the neuro-biological property of vision is a property of the feasibility conditions for perception. Rather, it seems that 'it is just a necessary condition for colour perception' (Kim, 2008: 62). Also, it still remains a problem even if the difference can be explained by neuro-biological condition, because we name a certain colour of object 'yellow' even though there is an individual difference in the yellow we see. If we suppose that an experience of the colour 'yellow' is altered by the amount of photopigment in a subject's visual system, and that naming a certain colour is just conventional, then the colour terms that we use are undiscriminating. If so, colours might not exist ontologically (Hardin, 1993). In addition, there is the problem that various colour experiences do not all apply to one object. If we believe only one colour experience is proper to a certain object, then we might say the others are wrong experiences.

Hardin (2003) also draws on this issue, although he is concerned with the contrariety of the physicalism. He claims that most physicalists are caught between incompatible demands of common-sense realism. He explains:

> One is that colours should be features of the surface of objects that are independent of human perception. SSR satisfies this demand. The other one is that colours are normally what we experience them to be. This requirement is not met by SSR. In particular, the phenomenology of colour, including relations that colours bear to each other, is not well modelled by features and relationships among SSR (2003: 201).

There are two possible solutions to this difficult issue in Physicalism. One simple solution uses an analogy of a similar case that is solved in physical way.[1] The other appeals to the *normality* of colours. Physicalists postulate a *normal* condition and a *standard* perceiver to support reflectance physicalism (Millikan 1984, Block 1999; Rumelin 2006). In the next section, I critically examine these possibilities.

## Physical Solutions for Colour Variation

The individual-difference observed in colour experience is not only the problem for reflectance physicalism. In addition, there is the problem of explaining the nature of colour. Suppose that subjects K and S are standard perceivers.[2] When these subjects see a ripe grapefruit, both are able to

[1]Byrne and Hilbert use the example of thermometers as an analogy to colour variation (Byrne & Hilbert, 2004).

[2]The term 'standard perceivers' is used in a statistical sense. A standard perceiver is in normal case that is distinguished from the minority group who have quite opposed colour vision. See, for more detail, Millikan (1984), Block (1999), Rumelin (2006) and Kim (2008).

discriminate it as the yellow which is applicable to D/10 in the Munsell chart (see Chart 1.). But, suppose K and S are asked what shade the yellow. Perhaps, K answers that it is reddish yellow, while S answers that it is pure yellow. In this case, we can draw the following propositions:

(1) K and S perceive the same surface (of the object) differently.
(2) The surface of an object does not have two different shades simultaneously.
(3) We cannot name either K or S as a privilege perceiver because both are standard perceivers.

A physicalists, or any other type of philosopher, might not deny the above propositions. But the problem is that these propositions cannot be all true. (2) might lead us to think one of the perceivers has an incorrect experience of the surface. If so, (3) is also controversial. Of course, these problems are not unanswerable. The solution could be that: (a) Both K and S represent the colour of the surface correctly; or (b) One of them represents it correctly, but the other does not; or (c) both are wrong (Hardin, 1999). Which of these answers is correct? The important point is that both perceivers have different shades of the object, even though they roughly perceive it to be in the category ‘yellow’. Hence, the object that corresponds to the both experiences cannot be explained by its physical properties. Even so, this is not to say that physicalism can solve this problem adequately.

Let us consider the case for (a) again. If we relativize the problem, then perhaps we can say that the fruit looks reddish yellow to K in a certain circumstance, but it looks pure yellow to S in another circumstance. Nevertheless, the problem remains that the surface of the object does not have the two different shades.

Let us consider (b). This solution implies that either K or S perceives the colour of the fruit correctly. However, here we need to set a certain condition so that one of them must be a *standard* perceiver, even though both are normal perceivers. We would also need to determinate the criteria for the classification of a standard perceiver. This might be determined by looking at a large number of people. However, the criterion for a ‘normal’ perceiver is not so easily obtained. How can we pick out one normal perceiver from a great many people? In addition, what is the normal condition for the colour ‘yellow’? The criterion of the normal perceptual condition is too wide to reflect the fine-grained shades of yellow.

Further, if the normal criterion defined too widely, then it would be hard to determine a normal standard which can define a certain colour. Yet, if it is defined too narrowly, we encounter a situation whereby most people may not have a standard of normal perceptual condition. The idea of normal condition seems arbitrary.[1]As such, the conditions for a ‘normal perceiver’ have the same

[1] There can be non-arbitrary conditions like ‘natural daylight’ (Allen 2010). However, there is one point that claims our attention that such natural daylight only can be expressed in physical terms such as ‘cd’, ‘lm’, or ‘lux’. Although such daylights exist, the problem of whether we

problem. It is hard to say that both perceivers have correct experiences of the surface colour of an object, hence, we should say that one of them might be wrong. It is surely arbitrary to claim that one of them is a privilege perceiver.[1] Of course, the selection of one perceiver as 'normal' is not simply random, because it appeals to the majority, but it falls prey to being simply arbitrary; it is difficult to say that the criterion has a certain conventional standard. Yet, what concerns us is not the problem of finding a normal standard for a general definition of the colour. Rather, the point is that colour perception cannot be explained by SSR if there is no general standard by which we can judge which colour experience is correct. However, physicalists believe that colours are not properties perceived by standard perceivers. Physicalists appeal to a kind of normality that is independent from perceivers; so, they claim that normal observers - who are naturally selected by evolution and have a normal perceptual system - are able to detect real colours correctly in normal condition.[2] Physicalists utilize a concept of 'Normality' to express this idea, rather than 'normality', because it might be arbitrary to set up normal environment and normal perceiver. But it might not be arbitrary to accept an assumption that there is a privileged class of Normal perceivers in the history of evolution in colour perception. Tye (2006) says the following:

> Today, those among us who have a Normal colour detection system and who use it in a Normal environment track the colours accurately. To know who such people are, we would need to know much, much more about the evolution of colour vision than we know today (Byrne & Tye 2006). Perhaps we will never know the relevant facts. Still, there is a fact of the matter as to who counts as Normal by Mother Nature's lights. So, even though it would indeed be arbitrary for us now to pick out certain humans and say that they get the fine-grained colours right, still there is a clear-cut privileged class of Normal perceivers and no deep problem posed by true blue (2006: 175).

In the next section I will critically examine this assumption and how it explains individual difference in perceiving colours.

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can detect such light epistemologically still remains. Also, the amount of natural daylight is variable according to changes in temperature or magnetic field.

[1] According to Block (1999), if both perceivers are different in age, gender, or race, it is like ageism, sexism and racism. Hardin also claims that 'if this question is to be answered at all, it can be answered only by convention.'(1988: 80)

[2] The capitalized 'Normal' is distinct from the word 'normal'. The notion of Normality was developed by Millikan (1984). Normality is a state which is designed by natural selection and is used for explaining whether such a system is successful.

**Different Sensitivity? Or Different Stimulus?**

Byrne and Hilbert believe that colours are a type of SSR and that 'this physical property of colour necessarily goes together with the phenomenal character of colour experience' (1997: 267). This explains the individual-differences of colour experience in terms of physicalism. How is this made possible?

One possibility is that the individual-differences of colour experience could be on two different levels. One of these is a broad colour (coarse-grained) level - like 'red' - and the other is a narrow shade (fine-grained) level - like 'scarlet red' (Block, 1999: 46 and Tye 2006). Physicalism explains the broad level by ontological property SSR and the narrow level by epistemological property. This discrimination, used in explaining colour experience, might solve the problems of (1) the individual-difference of colour experience and (2) the fact that an object seems to have two different colours simultaneously. The reason why our perceptual system is reliable on the broad level, but unreliable on the narrow level, is that the 'visual system is not evolutionarily designed to detect such fine-grained level of shade reliably' (Tye, 2006:177). For example, in the evolutionary approach colour constancy is considered to have fulfilled its role in the faculty of sight both historically and successfully. However, constant colour belongs to the coarse-grained level, like 'yellow', not the fine-grained level, like 'yellow D/10' or 'reddish yellow'. The colour 'yellow' looks different on the fine-grained level because the wavelength of 'reddish yellow' has different wavelength from 'greenish yellow' according to available light, whereas the constant colour 'yellow' can be sufficiently explained by SSR even though its apparent colour can be changed by illumination.

Nevertheless, physicalism is still not sufficient to explain why two standard and normal perceivers like K and S have two different experiences of the same surface of yellow in the normal viewing condition. Are these two different experiences right? Both K and S represent the surface as yellow, but they represent it differently on the fine-grained level. The same surface of the object cannot be both 'reddish yellow and 'pure yellow' simultaneously. Also, because of the fact that our visual system has not been designed to detect such fine-grained colours, we cannot define whether K or S represents it correctly, even though we know all the facts of vision evolution.

Byrne and Hilbert (2004) use an analogy to solve this issue in physicalism. They found a similar case in the representation of thermometer. Let us examine table 1. Suppose that thermometer B can measure below the decimal point, but A cannot. As time goes on, B shows a very subtle difference from t1 to t3. Strictly speaking, these two thermometers calibrate different temperatures, but even so, we do not say that A shows an inaccurate measurement; B just discriminates the temperature more precisely than A. Hence, these two thermometers are compatible without contradiction. Like this, the individual differences of colour perception on the fine-grained level are not significant because they are just the individual-differences of colour sensitivity. Hence, their colour experiences are also compatible like these thermometers. The difference between K and S's experience of colour also can be explained as table 2.

In this example, how can the difference of discrimination ability of colour be explained by SSR? The only common element in the table is that the perceivers are seeing SSR 2 as pure yellow. However, K's experience of yellow embodies much more narrow content, while S's experience embodies only pure yellow from SSR 1 to SSR 3. If this is correct, they perceive the same colour, but their contents of the perception are different. However, we do not need to believe that one of them misrepresents the yellow colour (Tye 2000). The delicate difference between the two perceivers is just a difference in the range of the SSRs. Hence, it also can be explained as the difference in sensitivity, just like the thermometers. Both perceived yellow correctly, but K is just better at discriminating the colour yellow than S. If this is right, the case of K and S might not be a counterexample of reflectance physicalism.

This analogy highlights the physicalists' belief that the problem of colour variation is not an ontological but an epistemological matter. Physicalists claim that colour variation shows that it is hard to impute the colour of a surface to a particular colour. It seems that a particular colour looks like a different colour according to perceivers or conditions, but it is similar to the case where a straight stick looks bent in water (Tye, 2000:153-155). This means that it is the same colour. However, Hardin (2003) claims that the analogy is inappropriate because it is only an optical illusion, the stick is not actually bent. The different colour experiences of the same object cannot be mistaken experiences in this way, and neither can they be corrected. In the case of the stick, we can take it out of the water and measure its angle to prove that it is 180 degrees. That is to say, there is a general, standard, and common criterion of whether the stick is bent or not. But, is there any criterion like this in colour perception?

Physicalists may answer that we can check the SSR of the target surface. But a problem comes up that colour experience is just an optical illusion if it does not correspond to SSR. Also, there is no criterion for discriminating an illusion from *genuine* experience because SSR does not always cause the same experience. If this is correct, can we find the evidence that we perceive colours without depending on the physical property SSR?

In the next section, I will consider other colour experiences that can be perceived on contextual level, rather than physical level.

## Colour Perception and Its Context

If we assume that people have the same visual organs and they are *normal* perceivers, then they have the same representational contents of the same colour. However, there is evidence that this assumption is too sweeping. For example, it has been claimed that the Eskimo people can classify and perceive more various categories of the colour 'white' than other people. According to Block (1999), if we suppose that such people have normal colour vision, then we would say that they have the same representative content of white. If Eskimo people and we have different colour experience of the same object, this implies that physicalism gives us an inappropriate explanation of colour experience. This is the main weakness of physicalism. Let us consider other cases. According to colour simultaneous contrast phenomenon, colours are not intrinsic properties of objects, but are a relationship between the object with the perceiver or outer properties (Cosmides & Tooby 1995). This phenomenon highlights that the appearance of colour is different according to the colours that lay behind the one we are looking at. Colours are seen in isolation by the naked eyes. Let us consider picture 1. Here, the grey colour on the left side looks lighter than it really is. And the grey colour on the white background looks darker than it really is. However, the reality is that they are the identical. According to its context, the grey colour looks different to perceivers even though it has the same physical property. This Phenomenon implies that perceiving colour is dependent on a relative relationship, not an absolute relationship. Therefore, 'since instances of colour are not normally seen in isolation by the naked eye, the viewer is always subject to these effects' (Gagnon, 2011). The above case shows that the contexts of a colour are involved in creating a subject's fine-grained level of experience. Of course, the physicalists might say that the grey colours look the same on a coarse-grained level; however, the important point is that the grey colour looks different depending on a subject's experience. This phenomenon cannot be explained through physical properties; i.e. the general or physical explanation of colours does not always correspond to the content of colour experience. Of course, physicalists might say that the grey looks different because the given condition is different. However, as they claim, the Normality of our vision has been evolutionarily designed to detect mind-independent and illumination-independent properties of colour. The above case happens under the same illumination but different circumstances. If physicalism is right, then does the grey, which has the same SSR in both contexts, cause the same content of experience in the different circumstances?

Let us return to the case of K and S. Both have different experiences under the same conditions. Moreover, K's experience of yellow has been changed according to the time. We need to pay attention to this. Of course, sensitive perceivers like K might have vivid colour experience on a fine-grained level. However, according to the opponent process theory of vision, opposing colours such as blue-yellow, red-green and white-black cannot be experienced simultaneously. That is to say, physical objects cannot have both opposing colours simultaneously;[1] there is no surface stimulus which can emit two different wavelengths. The definition of colour in physicalism is the physical property 'SSR' which corresponds to a certain shade. However, K's altered content of experience cannot be explained using physicalism. That is to say, K and S's different colour experiences can be explained on a fine-grained level and sensitivity to colour terms, but K's content of experience is hard explain in

[1]Tye uses this theory to explain colours objectively. (Tye 2000: 159-161).

physical terms, even though she is a standard perceiver. The problem here is that the physicalists believe that only the SSR of objects is the absolute condition for colour perception. If we are able to discriminate a certain colour from other colours without relying on SSR, then we have to reconsider whether ‘colours = SSR’. For instance, the colour ‘orange’ is more similar to the colour ‘yellow’ than the colour ‘blue’, and it is classified as a mixed colour (Hardin, 1988). The issue is that the structure of the colour ‘orange’ cannot be explained by reflectance properties. The wavelength of orange light is 590nm. However, this wavelength cannot be explained by mixed wavelength (yellow 577nm + reddish wavelength). In the same way, SSR cannot explain the structure of perceptual experience.

If this is correct, how can we choose an orange colour without such properties? There is evidence that the colour of displayed fruit is biased by the *conceptual knowledge* of the typical colour of that fruit (Hansen, Olkkonen, Walter & Gegenfurther, 2006). Let us consider picture 2. On the left side of the picture, we do not know whether the orange coloured fruits are oranges yet. Also, each fruit’s colours are slightly different. If we look closely at some part of the orange coloured fruits on the right side, we can see easily that these are oranges. However, some of them look different from what we think of as the colour ‘orange’ - they look more like the colour of yellow grapefruits than oranges; however, we still perceive them as being orange. Also, each orange may have a different SSR. Some of them may have quite different wavelengths from a standard orange colour. One issue might be that we perceive them as orange even though they have different SSR because the contexts in which fruits and perceivers are involved tell us that they are oranges. This shows that colour sensations are not determined by the ‘incoming sensory data alone, but are significantly modulated by high-level visual memory’ (Ibid). Let us consider picture 3.

On the left side, where there is no cross section of the grapefruits, then we may perceive oranges. On the right side, we definitely discriminate oranges from grapefruits. However, on the right the colour of the oranges looks less orange than on the left. Nevertheless, the reason why we perceive the oranges as orange in colour - even though they look far from orange - is that we can distinguish them from the bigger and brighter grapefruit. This phenomenon is irrelevant to SSR, but it *is* relevant to its circumstance. There is also evidence that an ambiguous brown-purple colour looks more brown when in the semantic context is ‘chocolate’, and the same colour looks more purple in the context of ‘eggplant’ (Kubat, Mirman &Roy, 2009). If so, SSR is neither a criterion for discriminating colours nor a property for composing colour experience.

## Conclusion

In perceiving colours, neurophysiological properties and the scientific analysis of light are necessary conditions, but they are not properties that compose the content of colour experience. If our contents of colour experience are composed by the physical properties of objects and our visual organs, then subjects may consider these properties to compose experience epistemologically. But, are subjects aware of how visual neurons respond to stimulus while they are perceiving colours?

The problem with physicalism is that it tries to prove that ‘colours = SSR’, and that SSR directly causes the content of experience. However, perceivers can have different colour experiences of the same surface colour, even though that colour emits the same SSR. Moreover, we sometimes perceive colours without dependence on SSR. For instance, the structure of the colour ‘orange’ cannot be explained by its reflectance property. Rather, it is grasped through the context that the subjects and the objects are involved in. There is also experimental evidence that colour perception is altered by *learning hue categories*, and not by SSR (Özen, 2004).

It seems that physicalism tries to show the ontological status of colours by reference to physical properties. However, the way we approach to colours is through experience. If the content of colour experience is not explained in a physical way, then the ontological status of colours may be threatened. If so, physicalists should reconsider their definition of colours.

**Chart 1.** *Munsell Colour Chart*

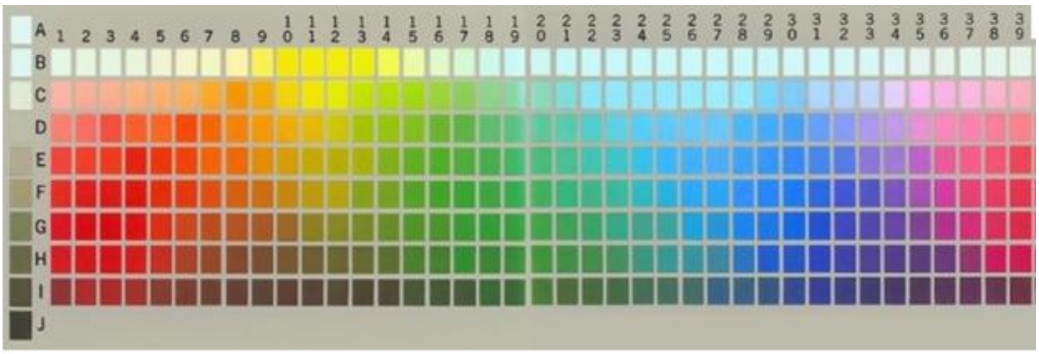


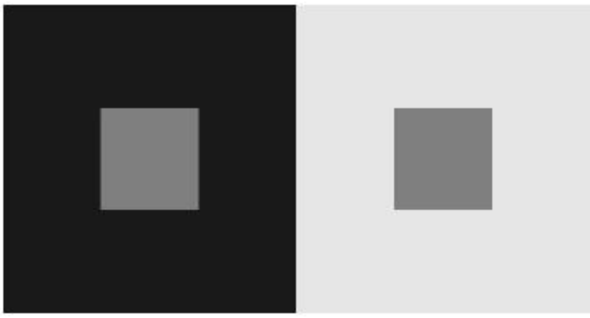

**Table 1.** *Thermometers*

| | t1 | t2 | t3 |
|---|---|---|---|
| Thermometer A | 25 | 25 | 25 |
| Thermometer B | 24.8 | 25.0 | 25.2 |

**Table 2.** *Colour Experience of Two Perceivers*

| | SSR 1/ t1 | SSR 2/ t2 | SSR 3/ t3 |
|---|---|---|---|
| S | Pure Yellow | Pure Yellow | Pure Yellow |
| K | Reddish Yellow | Pure Yellow | Greenish Yellow |

**Picture 1.** *Simultaneous Contrast Phenomenon*



**Picture 2.** *Oranges*

**Picture 3.** *Oranges and Grapefruits*

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