Check for updates

Philosophy Compass 9/6 (2014): 382–391, 10.1111/phc3.12131

On Color Categorization: Why Do We Name Seven Colors in the Rainbow?

Yasmina Jraissati*
Department of Philosophy, American University of Beirut

Abstract

What makes it the case that we draw the boundary between "blue" and "green" where we draw it? Do we draw this boundary where we draw it because our perceptual system is biologically determined in this way? Or is it culture and language that guide the way we categorize colors? These two possible answers have shaped the historical discussion opposing so-called universalists to relativists. Yet, the most recent theoretical developments on color categorization reveal the limits of such a polarization.

What makes it the case that we draw the boundary between "blue" and "green" where we draw it? Do we draw this boundary where we draw it because our perceptual system is biologically determined in this way? Or is it culture and language that guide the way we categorize colors? To put it differently: Why do we name seven colors in the rainbow? Had the English language not included a word for "orange" or "violet," or had Newton not been an English-speaking scientist, would the colors identified in the rainbow have been different?

In a paper published in 2001, Davidoff describes the problem of color categorization in the terms of the Sorites paradox (Davidoff) – thereafter, the "Davidoff-Sorites" paradox. According to Davidoff, if our perceptual color space is continuous and there is no perceptual distance that is greater between certain colors, then our perceptual space does not feature boundaries along which one would categorize.

Take the 40 shades of color spanning over the hue dimension in the Munsell[1] system (Munsell), at a medium level of brightness (say, level 5). Perceptual uniformity (a feature of the Munsell system) implies that shade 1 is as similar to shade 2 than shade 2 is to shade 3, etc. Given that there is only a subtle difference between shade 1 and shade 2, to the extent that we name shade 1 "red," shade 2 also receives the label "red." To the extent that shade 3 is as similar to shade 2 than shade 2 is to shade 1, then shade 3 is also named "red." By the same token, shade 4 should be named "red" as well, and so on. Yet, take shade 10 for example. In the Munsell system, shade 10 is usually called "orange" in English, not "red." This implies that at some point of our color naming, something in the color's appearance makes of the term "orange" a more adequate label than the term "red." Why do we decide that a given shade should no longer be called "red," but "orange?" If the perceptual space is uniform, then the factor determining the boundary cannot be perceptual. For Davidoff, this factor is language use. People agree to name certain colors "red" or "orange." They will only discriminate between colors that they need to distinguish.

The answer to the question of categorization has historically oscillated between two options. On one hand, it was contended that language and culture determine the way we categorize colors (as with Davidoff). On the other, it was suggested that the way we categorize colors is a direct result of the makeup of our perceptual system. To put it differently: either a certain color belongs to category X because it is named "x" or we name a certain color "x" because it belongs to category X. In the first case, color categories are determined by language

© 2014 The Author(s)
Philosophy Compass © 2014 John Wiley & Sons Ltd

use, which is itself determined by the needs of a given population, dictated by the environment and culture. In the second case, biologically determined color categories pre-exist the color term, which merely emerges in a given language in order to pick out the category in question. Consequently, and if color categories are biologically determined, it is to be expected that the same color categories should be found universally, across cultures. If color categories are determined by language, however, they should vary with linguistic and cultural variations. For simplicity, in this paper, we shall refer to the first account of color categorization as (linguistic) "relativism" and to the second account as "universalism."

It should be noted that this initial dichotomous summary of the historical discussion between universalism and relativism sweeps away many important nuances. For example, it may well be the case that color categories are universal (hence "universalism") but that they are not biologically determined (a typically "relativistic" stand). Indeed, universalism is not exclusively accounted for by a reduction of color categories to biological mechanisms. However, historically, this is the line of reasoning that the main proponents of the universalistic view have adopted (Jraissati). In this paper, I will first briefly present the historical discussion opposing the main proponents of each view. Next, I will focus on the recent turn the discussion has taken.

1. A Historical Discussion

The way humans use color words in reference to color sensations has initiated a rich and ongoing discussion. Starting in the late 19th century, linguists and anthropologists looked with some amazement at ancient civilizations, Hellenistic (Gladstone) and Hindu (Geiger), for example, and primitive populations (Rivers), the color vocabulary of which did not comprise a word for blue. Based on an analysis of the literature, it was possible to confirm that this word was indeed not used. Based on the absence of the color term "blue," it was concluded that such populations could not perceive the color blue. In the background of this conclusion is at the time a widespread conflation of culture and biological race. The observed cultural differences were taken to be mere symptoms of biological inequalities. Given that the human race is one and that all races are bound to develop and reach the state of the White European Man, cultural differences are indicators of a biological under-development.

Thus, the (fallacious) conclusion (C) was taken to follow from the true premises (P):

P1: Color perception is grounded on biological mechanisms.
P2: We use words to refer to the things we see.
P3: The word blue is not used.
C: Therefore, the color blue is not perceived.

If we all saw the same things, there is no reason why we would not name the colors we see in the same way.

Clearly, proponents of the view above were mistaken. Not having a word "blue" does not imply that the color blue is not perceived. Independently of the currently available empirical evidence, the reasoning above is fallacious to the extent that there is no necessary connection between biology and culture. Thus, the question at the heart of the contemporary debate on color categorization is: If we all see the difference between shade A and shade B, why do English-speaking people name shade A "blue" and shade B "green", while the Berinmo name both A and B "nol" (Davidoff, Davies, and Roberson)? Starting with Boas, in the early 20th century (Boas), and then with Whorf (Whorf), one answer to this question is: The Berinmo language does not include different terms for "blue" and "green", simply because the Berinmo people do not need both terms. In 1969, Berlin and Kay offered a different answer to this question.

© 2014 The Author(s)
Philosophy Compass © 2014 John Wiley & Sons Ltd

17479991, 2014, 6, Downloaded from https://compass.onlinelibrary.wiley.com/doi/10.1111/phc3.12131 by HINARI-LEBANON, Wiley Online Library on [20/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

According to the basic color terms theory (BCTT, Berlin and Kay), a color vocabulary includes color terms that are basic and color terms that are not basic. When only basic color terms are considered, it appears that (i) there is a set of around 11 basic color terms that are found universally. The basic color terms are, in English: "black," "white," "red," "yellow," "green," "blue," "brown," "pink," "orange," "gray," and "purple." (ii) These terms and the categories they refer to emerge in a given lexicon following a somewhat constrained evolutionary sequence. In other words, not all languages feature the same number of basic color terms. However, when different languages feature the same number of basic color terms, the way these terms partition the human perceptual color space is very similar. Further, when new basic terms emerge in a language, they emerge following a certain order. Thus, a term for "red" will not appear in a language before both "black" and "white", and so on (following the sequence of basic terms above).

Cross-cultural data was gathered in the San Francisco bay in 1969 and around the world starting 1975 (see the World Color Survey: http://www1.icsi.berkeley.edu/wcs/). Today, 110 languages of non-industrialized societies have been surveyed. In the survey, participants are asked to name 330 color samples (all the colors of the Munsell array). Based on their responses, basic color terms are identified, and the term that is most frequently used in reference to a color sample retained. Next, all most frequently used color terms are projected on the Munsell array, yielding a so-called "mode-map." In this way, the extension of the different color terms can be obtained and the resulting space partitioning compared across languages. After naming the 330 color samples, participants are shown the array and asked to indicate the best example of the identified basic color terms, one at a time.

Most interestingly, participants who are native speakers of different languages, but the languages of whom include the same number of basic color terms, agree on the best example of corresponding categories. Also, participants who are native speakers of languages that have different numbers of basic color terms also seem to agree on the best example of corresponding categories. The World Color Survey (, Cook, Kay, and Regier) confirms the initial hypothesis offered by the 1969 basic color terms theory.

The claim according to which there exists a universal set of basic color terms, which refer in the same way, and which emerge in the language following a partially constrained order, is contingent upon several questionable assumptions. First, this universalistic claim presupposes the notion of "basic color term," the definition of which is problematic (see, for example, Hickerson; Lucy and Schweder; Crawford; Lyons; Saunders and Van Brakel). Second, it was recently argued that the best examples, or focal colors, which are said to be very similar across languages and structure categories, do not always yield similar space partitionings (Regier and Kay; Regier et al.).

Yet, the interesting fact remains that there seems to be a pattern in the way the color space is partitioned across languages and in the way new terms emerge in a given language. It is based on this unique observation that proponents of the BCTT argue for a biological account of universal categorization.

2. Universalism and Biologically Grounded Categories

As soon as 1969, proponents of the BCTT tended towards a biological explanation of the universality of color categorization. What was mostly a vague suggestion then was more specifically spelled out in 1978 (Kay and McDaniel). Using the notion of unique hues, introduced by Hering in the late 19th century (Hering), proponents of the BCTT suggested that there seemed to be a biological grounding to the basic color categories' focal colors. According to Hering, our perceptual experience of color is characterized by six unique hues.

© 2014 The Author(s)
Philosophy Compass © 2014 John Wiley & Sons Ltd

17479991, 2014, 6, Downloaded from https://compass.onlinelibrary.wiley.com/doi/10.1111/phc3.12131 by HINARI-LEBANON, Wiley Online Library on [20/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Take orange or purple. Such colors are always perceived as a mixture of yellow and red or blue and red, respectively. On the other hand, the colors red, blue, green, yellow, black, and white are unique to the extent that there is a certain shade of red, which is pure and unmixed – the same being true of the other five colors. Furthermore, red and green, blue and yellow are opponent pairs to the extent that red and green cannot phenomenally mix, unlike blue and red, yellow and red, green and yellow or green and blue.

What started as a theory exclusively based on phenomenology and introspection, and then on behavioral data (Hurvich and Jameson), eventually led to a theory of vision, when De Valois and colleagues (De Valois, Abramov, and Jacobs) observed the existence of opponent cells at the early stages of light processing systems in monkeys. Like Hering had suggested, it seemed that some cells fire when stimulated by a green stimulus, and are inhibited when stimulated by a red stimulus. Grounding their argument on the existence of these R + G− and Y + B− cells (and vice versa), Kay and MacDaniel suggested that the universally observed focal colors of the basic color categories, the six first of which being none other than WHITE, BLACK, RED, GREEN, YELLOW, and BLUE[2] could be reduced to these clearly identifiable biological mechanisms. As for the remaining five categories, Kay and McDaniel suggested that they were combinations of the primaries.

For the following 20 years, the biological grounding of the universal focal colors was a key part of the universalist account of color categorization (Kay, Berlin, and Merrifield). Yet, as soon as the early 1980s, results in color vision research called this biological reduction in question. Indeed, as opposed to what was claimed earlier, it now seemed like the opponent cells at the early stages of the visual processing could not be accurately described in terms of R + G− and Y + B− (and vice versa). It rather seems like at this stage of the visual processing, there is mainly one opponent axis, which does not oppose two unique hues (Abramov; Abramov and Gordon; De Valois and De Valois; De Valois, De Valois, and Mahon). If we were to refer to these inputs in terms of color terms at all (which in itself is not justified), then the opponent colors at this stage of the visual processing could be best described as orange and teal. It would seem that this dominant axis would be modulated at a subsequent stage of the processing, so as to yield the expected two opponent channels RG and YB. However, this subsequent stage has not been observed and remains hypothetical.

Such a theoretical change when it comes to color vision bears important consequences on the BCTT. Since its first formulation in 1969 (more specifically since Kay and McDaniel's paper in 1978), the theory had accounted for universal categorization on the basis of a biological reduction. With the demise of the biological grounding of Hering's unique hues on low-level mechanisms, the theory loses the heart of its account of universal categorization.

In 1997, in a note to a paper, Kay and colleagues acknowledge the limits of their proposal (Kay et al. 53). Admitting that universal color categories did not have an observable biological grounding, they however maintain that these categories are grounded on Hering's unique hues, in a phenomenal sense. More specifically, there are unique hues, which are phenomenally particular, that determine universal focal colors and categories.

3. The Importance of the Prototype

In 1969, as the common patterns in space partitioning are being uncovered, the BCTT operated within a classical set theory: a given color chip of the Munsell array either belonged or did not belong to a given set or category, say "red." As soon as 1975, this approach to color categories was however modified (Kay), mainly in light of Rosch's work on basic level categories and prototypes. Rosch suggested that natural kind terms, such as color terms, had fuzzy boundaries (Rosch, "Natural categories"; Rosch "Principles of categorization"; see also

© 2014 The Author(s)
Philosophy Compass © 2014 John Wiley & Sons Ltd

17479991, 2014, 6, Downloaded from https://compass.onlinelibrary.wiley.com/doi/10.1111/phc3.12131 by HINARI-LEBANON, Wiley Online Library on [20/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Mervis and Roth). Therefore, it is not the case that a given color either belongs or does not belong to the category RED. Rather, a given color belongs to RED to a certain degree. The category extension is structured by the central prototype, the category's best example. The further you move away from the center towards the periphery, the less the color is a good representative of the category, the lower its degree of membership.

In the case of color categories, Rosch argued further that the best examples or prototypes were natural. In support of this claim, she argued that prototypes had cognitive advantages that could only be accounted for by their innateness. The results of her studies with the Dani, a population of New Guinea the color vocabulary of which included only three basic color terms (standing for BLACK, WHITE, and RED) were taken to show that prototypes were more easily learned and associated to new color terms than non prototypical colors, and most importantly, prototypes are remembered independently of language (Rosch, "The case of Dani colour names").

When it comes to their approach to category structure, proponents of the BCTT owe much of their conceptual apparatus to Rosch. It is based on her work on categorization that they contended that categories were structured by natural focal colors, or, borrowing the expression from Rosch, on prototypes. For that reason, the loss of the biological grounding of prototypes provided by Hering's unique hues is a serious blow to the universalistic account of categorization. If prototypes are not biologically grounded, in what sense are they natural? Indeed, not only did the revision of the standard theory of vision questioned the possibility of biologically reducing prototypes to unique hues, but behavioral results also shed doubt of the cognitive advantages the prototypes were taken to have since Rosch.

Relativists have maintained, contra universalism, that prototypes are merely an epiphenomenon of categorization (Roberson and Davidoff). According to relativism, categories are structured by their boundaries, which separate members of the category from non-members of the category. In this perspective, the prototype is nothing but the category's topographical center. Consequently, prototypes cannot be natural: they are not innate, nor do they have the cognitive advantages Rosch believed them to have.

In support of their claim, Davidoff and colleagues tested the Berinmo, a population of Papua New Guinea, the color vocabulary of which comprised five basic color categories, as identified by the BCTT's criteria (Davidoff, Davies, and Roberson; Roberson, Davies, and Davidoff). More specifically, Roberson and colleagues reproduced Rosch's experiments with the Dani (Rosch; "The case of Dani colour names"), but could not replicate her results. Knowing that this was the first attempt to reproduce Rosch's experiments, the fact that the results were negative was significant.

In response, studies in the early 2000s by proponents of the BCTT aimed at showing that although the prototypes may not be grounded on identifiable low-level biological mechanisms or may not be cognitively advantageous, they remain the determining feature of color categories. Statistical analyses of the choice of prototypes across the studied languages of the WCS were designed so as to argue for the legitimacy of the notion (Regier, Kay, and Cook). However, in the absence of a theory that would explain why prototypes are universal, and therefore how they determine categorization, the notion of prototype, as it was understood since the early 1970s lost its substance.

4. The Recent Turn of the Discussion: The Limits of the Dichotomy

What makes it the case then, that we draw the boundary between "blue" and "green" where we draw it? In the early 2000s, the possibility that categories are determined by prototypes is seriously questioned. Prototypes are not straightforwardly grounded on low-level biological

© 2014 The Author(s)
Philosophy Compass © 2014 John Wiley & Sons Ltd

17479991, 2014, 6, Downloaded from https://compass.onlinelibrary.wiley.com/doi/10.1111/phc3.12131 by HINARI-LEBANON, Wiley Online Library on [20/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

mechanisms of the visual processing. Although proponents of the BCTT acknowledging this fact maintained that prototypes were grounded on Hering's unique hues in a phenomenal sense, this proposal raises other questions: Are Hering's hues biologically determined at all, and if yes, at what stage of the processing? Furthermore, not only do prototypes seem to have been deprived from their biological grounding, but also prototypes have been challenged as a notion playing a key role in color categorization. If, as Roberson and colleagues suggested in opposition to Rosch, prototypes are not more easily learned and are not independent of language, then what are they? The possibility that categories are structured by their boundaries through language use gains credibility.

In a paper arguing for this idea, Davidoff presents the problem of color categorization in the terms of the Sorites paradox (Davidoff). How does one escape this Davidoff-Sorites paradox when categorizing colors on a daily basis? More specifically, if color constitutes a perceptual continuum, if there are no boundaries in that continuum and our color space is perceptually uniform, then the only way one should be able to categorize is with the help of factors that are external to perception. As we have seen, for Davidoff, such factors are language use. Simply, a given linguistic community agrees on what shades to include in what categories based on their needs. There is no category prior to language. Unlike what the BCTT suggested for over three decades, categories do not pre-exist language. Color terms are not introduced in language to merely pick out a perceptually determined category. If that were the case, there wouldn't be a problem of categorization, no Davidoff-Sorites paradox to escape from. Indeed, if categories pre-exist language, then this implies that the perceptual space is inherently categorized. However, this cannot be the case. First, the notion of prototypes on which this approach rests has been questioned. Also, the variability observed across languages cannot be denied and suggests a more complex picture (Regier and Kay).

More clearly, if there were a set of categories that were perceptually determined prior to language, then why don't all languages of the world feature the same number of categories? To illustrate: If Hering's unique hues were these language independent prototypes of universal categories, then why are there languages that have less than six color terms, some of which including two or more of Hering's unique hues?

The problem with the universalistic account of categorization seems to lay precisely in this rigidity. It is to this rigidity that the most recent account of universal categorization remedies. Davidoff is right, when he claims that in the absence of natural prototypes, our perceptual space being continuous and uniform, there is no escape from the Davidoff-Sorites paradox without the help of language. But what if our perceptual space was *not* continuous? In 2007, Regier and colleagues present a new account of universal categorization based on the empirically grounded assumption that our color space is irregular (Regier. Kay, and Khetarpal, also see Jameson and D'Andrade)

The irregularity of the perceptual space refers to the fact that due to the structure of our visual input system, our sensitivity to different areas of the color spectrum varies. Our sensitivity thresholds in the blue-green area are higher than in the red-yellow-green area. Consequently, an objective distance between two colors in the blue-green area is not perceived like a distance of the same magnitude in the yellow-red-green area (MacAdam; Churchland). Thus, our perceptual space is not uniform. In some areas of the space, where our thresholds are low, we can discriminate colors more finely; colors in the green-yellow-red area, are perceived as being closer. Such areas are "perceptually salient" for Regier, Kay, and Khetarpal. As a result, they argue that some colors, such as white, black, red, yellow, then green and blue, are more perceptually salient than others.

Although this observation re-establishes the role of Hering's unique hues in the BCTT to some extent, alone, it is however not enough to account for categorization or to answer the

© 2014 The Author(s)
Philosophy Compass © 2014 John Wiley & Sons Ltd

17479991, 2014, 6, Downloaded from https://compass.onlinelibrary.wiley.com/doi/10.1111/phc3.12131 by HINARI-LEBANON, Wiley Online Library on [20/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

objections raised above. Even if there were a set of most perceptually salient colors, why would the corresponding color categories emerge gradually in the lexicon and not all at once? Taking the irregularity of the perceptual space as their starting point, Regier and colleagues hypothesize further the existence of an endowed capacity to categorize to account for universal categorization. It may indeed be observed that natural categories group together items that are maximally similar to each other, and separate items that are maximally dissimilar. Given that the relations of similarity between the colors in perceptual space are not homogenous, such an optimal categorization capacity could quite simply account for universal categorization. First, white and black, which are both perceptually salient and most dissimilar, would emerge. Then emerges red, which is perceptually salient and most dissimilar from white and black, and so on.

In order to offer support to their hypothesis, Regier, Kay, and Khetarpal test this model on artificially created languages. On the basis of a modeled irregularity of the perceptual space and capacity to optimally categorize, the artificial color categories were shown to emerge in the lexicon in the order in which they appear in natural languages. The model seems to correctly predict universal categorization.

However, there are several limitations to this account. First, the model does not go beyond the category BLUE. Based on the irregularity of the perceptual space and optimal categorization, only the first six categories of the evolutionary sequence (WHITE, BLACK, RED, YELLOW, GREEN, and BLUE) are accounted for. Yet, in most industrialized languages, and according to the BCTT itself, there are presumably 11 basic categories or more. How about BROWN, PURPLE, GRAY, ORANGE, and PINK? How do they emerge in the lexicon?

More importantly, from a theoretical perspective, the new account of universal categorization dilutes the notion of prototype and seems to attribute to boundaries a role in categorization. Finally and connectedly, the notion of optimality introduces some relativity to language. To explain, it should be remembered that traditionally, the BCTT universalistic account of categorization rested on the notion of focal color, and following Rosch, of prototypes. However, if universal categories are to be accounted for by an endowed capacity of optimal categorization, and if optimal categorization means grouping together most similar items, and separating most dissimilar items, then what seems structural in this account are the boundaries at which colors are being discriminated. The notion of perceptual saliency, which stands for a theoretical substitute of prototypes, does not play the same role as prototypes. The possibility of looking for a grounding of prototypes in biological mechanisms indicated that color prototypes were conceived as absolute, natural reference points in the color space, attributed to human visual experience by the structure of our perceptual system. In contrast, perceptual saliency is relative by definition. The fact that some colors are more salient than others implies that saliency is a matter of degree. Correspondingly, the fact that saliency results from more or less tight similarity relations implies that what is salient are different areas of the space and not a clearly defined prototypical point or narrowly determined area. Finally, which categories are mostly optimal essentially depends on the number of categories already encoded. If there are only two categories, then the most optimal categories are WHITE and BLACK. If there are only three categories, then the most optimal categories are WHITE, BLACK, and RED.

The possibility that external factors played a role in the number of categories encoded in a given language was never excluded by the BCTT. However, in the most recent theoretical framework, it takes on a different signification. Indeed, in 1969, Berlin and Kay had suggested that the reason why different languages have different numbers of basic color categories might have something to do with the industrialization of society. This implied that existing natural prototypes, and consequently, pre-linguistic color categories, were just

© 2014 The Author(s)
Philosophy Compass © 2014 John Wiley & Sons Ltd

17479991, 2014, 6, Downloaded from https://compass.onlinelibrary.wiley.com/doi/10.1111/phc3.12131 by HINARI-LEBANON, Wiley Online Library on [20/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

waiting to be picked up by a color term, the moment such a color category would gain relevance for a given community. With the notion of a relative perceptual saliency, and that of optimality, there is no natural prototype, no pre-linguistic color categories. More specifically, a given category *becomes* optimal in a certain color space partitioning. Thus, the category BLUE is not optimal in a system where only WHITE and BLACK are categorized. BLUE becomes optimal after categories WHITE, BLACK, RED, and YELLOW have been encoded. The fact that BLUE can only emerge within certain conditions implies that before WHITE, BLACK, RED, and YELLOW are encoded, there is no BLUE category. This important consequence may at first be overlooked, as the notion of perceptual saliency may appear to simply be an adaptation of the notion of prototype. However, what the notion of perceptual saliency coupled with that of optimality implies is that contra what was first suggested, it is no longer the case that "we name a certain color "x" because it belongs to category X": There is no category X prior to its becoming optimal.

Yet, it seems that the alternative account of categorization, according to which a certain color belongs to category X because it is named "x," is also challenged. We have seen that Davidoff's solution to the Davidoff-Sorites paradox raised by color categorization rested on language use. However, we have also seen that the Davidoff-Sorites paradox had as a premise the continuous and uniform nature of the perceptual space. If the space is not continuous, if there are areas in the space that are salient at different degrees, then there must be a perceptual constraint on color categorization. Such a consequence is more than relativists were historically willing to concede.

The discussion opposing relativists to universalists has been extremely polarized. Relativists claimed that categories were determined by their boundaries and resulted from discrimination between colors based on language use and cultural needs. In this context, prototypes were just an epiphenomenon with no structuring role in categorization. Universalists claimed that categories were determined by their universal prototypes, which, it was assumed for several decades, could be reduced to biological mechanisms. However, the most recent universalist account dilutes the notion of prototypes. Although it is still claimed that what determines, or at least guides optimal categorization are perceptual constraints, the non-uniformity of the perceptual space also suggests that what is perceptually salient is not a narrowly determined area in space, like the prototype was believed to be. Further, the notion of optimal categorization rests on the similarity arising between the colors of a given category, but also on the dissimilarity arising between colors of one category and colors of another category. The notion of dissimilarity is more akin to that of discrimination at category boundary, on which rests the relativist account of categorization. Finally, the new universalist categorization account precisely allows for some flexibility, and makes room for the role of language in categorization. Although it is not possible today to say that universalists and relativists finally agree on a compromise, it is fair for us to conclude that as things stand today, it seems that perceptual constraints and language both have a role to play in categorization (Regier et al.). What remains to be determined is exactly what role these two factors play and how their interaction takes place.

Short Biography

Yasmina Jraissati's research lies at the interface between philosophy and cognitive psychology. The question of the factors underlying color categorization have guided most of her work, and she has authored and co-authored papers on this topic for *Journal of cognitive and culture, Croatian Journal of Philosophy, International Studies in the Philosophy of Science, and Philosophical psychology*. She argues that factors underpinning categorization are most likely both cultural or

© 2014 The Author(s)
Philosophy Compass © 2014 John Wiley & Sons Ltd

17479991, 2014, 6, Downloaded from https://compass.onlinelibrary.wiley.com/doi/10.1111/phc3.12131 by HINARI-LEBANON, Wiley Online Library on [20/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

linguistic and perceptual. Part of her current work seeks to propose such a categorization model. Connectedly, Jraissati is interested in the phenomenon known as categorical perception and in the role of color in cognition. Before coming to the American University of Beirut, where she currently teaches, Jraissati held a Fyssen Foundation fellowship and was a research fellow at the Center for the Study of the Senses, Institute of Philosophy, School of Advanced Study, University of London. She holds a PhD in Philosophy and Cognitive Sciences from the Institut Jean Nicod, EHESS, ENS, CNRS, Paris, France.

Notes

* Correspondence: Department of Philosophy, American University of Beirut, PO Box 11–0236, Riad El-Solh, Beirut 1107 2020, Lebanon. Email: yasmina.jraissati@gmail.com

[1] The Munsell color model, like most color models, represents our color experience in a three-dimensional space. The three dimensions are hue, saturation, and brightness. Hue is represented on a circle: red, followed by yellow, green, blue, purple – and then red again. These are the five primaries of the Munsell space. Brightness is represented on a vertical axis that passes through the center of the hue circle. At the top is white and at the bottom black. Between the two extremes are eight shades of gray. Thus, the different colors of the circle can be represented as having different levels of brightness. Finally, saturation lies between the central axis and the outer skin of the three dimensional solid. The further outward the color, the more intense or saturated it is. The further inward the color, the less intense or less saturated is the color. The Munsell system is characterized by perceptual uniformity: the perceptual distance between one pair of colors, and the adjacent pair of colors, in all three dimensions, is the same. The Munsell array evoked in this paper, refers to a Mercator projection of the Munsell solid, representing the 40 most saturated colors of the color space, ranging from red to red (passing by the other four primaries) on the *x* axis and over eight levels of brightness on the *y* axis, including white at the top and black at the bottom. Thus, in the Munsell array, only the variations on two dimensions of the solid are represented: hue and brightness.

[2] Following Berlin and Kay's suggestion, in this paper, we use capital letters to refer to Berlin and Kay's universal categories, e.g., WHITE. Color terms in a given language are between quotes, e.g., "white" in English, while the color is referred to with a term in lowercases and no quotes, e.g., white. Note that the universal category WHITE and the term "white" in English do not necessarily have the same extension. In a stage 1 language, which only has categories WHITE and BLACK, given that basic color categories are taken to partition the space jointly, the category WHITE includes white, yellow, red, and all bright colors such as pink, light blue, light green, and light purple, in its extension. The English term "white," however, only includes the color white in its extension. The only thing in common between a stage 1 language's WHITE category and a stage 7 language's WHITE category, such as the English "white," was taken to be their common focal color.

Works Cited

Abramov, I. 'Physiological mechanisms of color vision.' *Color Categories in Thought and Language*. Eds. C. L. Hardin and L. Maffi. Cambridge: Cambridge University Press, 1997. 89–117. Print.

Abramov, I., and J. Gordon. 'Color appearance: on seeing red – or yellow, or green, or blue.' *Annual Review of Psychology* 45 (1994): 451–485. Print.

Berlin, B., and P. Kay. *Basic Color Terms: Their Universality and Evolution*. California: CLSI Publications, 1969. Print.

Boas, F. *The Mind of Primitive Man*. New York: The Macmillan Company, 1938. Print.

Churchland, P. 'On the reality (and diversity) of objective colors: how color-qualia space is a map of reflectance-profile space.' *Philosophy of science* 74 (2007): 119–149. Print.

Cook, R. S., Kay, P., and T. Regier. 'The world color survey database: history and use.' *Handbook of Categorisation in the Cognitive Sciences*. Eds. H. Cohen and C. Lefebvre. Amsterdam: Elsevier, 2005. 224–242. Print

Crawford, T. D. 'Defining 'basic color term'.' *Anthropological Linguistics* 24.3 (1982): 338–343. Print.

Davidoff, J. 'Language and perceptual categorization.' *TICS* 5.9 (2001): 382–387. Print.

Davidoff, J., Davies, I., and D. Roberson. 'Colour categories of a stone-age tribe.' *Nature* 398 (1999): 203–204. Print.

De Valois, R., and K. De Valois. 'A multi-stage color model.' *Vision Research* 36 (1993): 833–836. Print.

De Valois, R., Abramov, I., and G.H. Jacobs. 'Analysis of response patterns of LGN cells.' *Journal of the Optical Society of America* 56 (1966): 966–977. Print.

© 2014 The Author(s)
Philosophy Compass © 2014 John Wiley & Sons Ltd

17479991, 2014, 6, Downloaded from https://compass.onlinelibrary.wiley.com/doi/10.1111/phc3.12131 by HINARI-LEBANON, Wiley Online Library on [20/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

De Valois, R., De Valois, K., and L. Mahon. 'Contribution of S opponent cells to color appearance.' *PNAS* 97.1 (2000): 512–517. Print.
Geiger, L. *Contributions to the History of the Development of the Human Race*. London: Tubner and Company, 1880. Print.
Gladstone, W. E. *Studies on Homer and the Homeric Age*. Oxford: Oxford University Press, 1858. Print.
Hering, E. *Outlines of a Theory of the Light Sense*. Cambridge, Massachusetts: Harvard University Press, 1964. Print.
Hickerson, N. 'Review of basic color terms: their universality and evolution.' *International Journal of American Linguistics* 37.4 (1971): 257–270. Print.
Hurvich, L. M., and D. Jameson. 'An opponent-process theory of color vision.' *Psychological Review* 64.6 (1957): 384–404. Print.
Jameson, K., and R.G. D'Andrade. 'It's not really red, green, yellow, blue: an inquiry into perceptual color space.' *Color Categories in Thought and Language*. Eds. C. L. Hardin and L. Maffi. Cambridge, Massachusetts: Cambridge University Press, 1997. 295–320. Print.
Jraissati, Y. 'Proving universalism wrong does not prove relativism right: considerations on the ongoing color categorization debate.' *Philosophical Psychology* (2012). Electronic. DOI:10.1080/09515089.2012.733815
Kay, P. 'Synchronic variability and diachronic change in basic color terms.' *Language in Society* 4 (1975): 257–270. Print.
Kay, P., and C. K. McDaniel. 'The linguistic significance of the meanings of basic color terms.' *Language* 54.3 (1978): 610–646. Print.
Kay, P., Berlin, B., Maffi, L., and W. Merrifield. 'Color naming across languages.' *Color Categories in Thought and Language*. Eds. C. L. Hardin and L. Maffi. Cambridge, Massachusetts: Cambridge University Press, 1997. 21–56. Print.
Kay, P., Berlin, B., and W. Merrifield. 'Biocultural implications of systems of color naming.' *Journal of Linguistic Anthropology* 1.1 (1991): 12–25. Print.
Lucy, J., and R. Schweder. 'Whorf and his critics: linguistic and nonlinguistic influences on color memory.' *American Anthropologist* 81 (1979): 581–615. Print.
Lyons, J. 'The vocabulary of color with particular reference to Ancient Greek and classical Latin.' *The Language of Color in the Mediterranean*. Ed. A. Borg. Wiesbaden: Otto Harrasowitz, 1999. Print.
MacAdam, D. L. 'Visual sensitivities to color differences in daylight.' *Journal of the Optical Society of America* 32 (1942): 247. Print.
Mervis, C. B., and E. M. Roth. 'The internal structure of basic and non-basic color categories.' *Language* 57.2 (1981): 384–404. Print.
Munsell, A. H. *A Color Notation: An Illustrated System Defining All Colors and Their Relations*. Boston: The Hoffman Brothers Co., 1941. Print.
Regier, T., and P. Kay. 'Language, thought, and color: Whorf was half right.' *TICS* 13.10 (2009): 439–446. Print.
Regier, T., Kay, P., and R. Cook. 'Universal foci and varying boundaries in linguistic color categories.' *The 27th reunion of the Cognitive Science Society, Stressa, Italy* 2005. 1827–1832. Print.
Regier, T., Kay, P., Gilbert, A. L., and R. B. Ivry. 'Language and thought: which side are you on, anyway.' *Words and the Mind: How Words Capture Human Experience*. Eds. B. Malt and P. Wolff. Oxford: Oxford University Press, 2010. 165–182. Print.
Regier, T., Kay, P., and N. Khetarpal. 'Color naming reflects optimal partitions of color space.' *PNAS* 104.4 (2007): 1436–1441. Print.
Rivers, W. H. R. 'Vision.' *Reports on the Cambridge Anthropological Expedition to the Torres Straits*. Ed. A. C. Haddon. London: Cambridge University Press, 1901. Print.
Roberson, D., and J. Davidoff. 'The categorical perception of colours and facial expressions: the effect of verbal interference.' *Memory & Cognition* 28 (2000): 977–986. Print.
Roberson, D., Davies, I., and J. Davidoff. 'Color categories are not universal: replications and new evidence from a Stone-Age culture.' *Journal of Experimental Psychology: General* 129.3 (2000): 369–398. Print.
Rosch, E. 'Probabilities, sampling, and ethnographic method: the case of Dani colour names.' *Man* 7.3 (1972): 448–466. Print.
——. 'Natural categories.' *Cognitive Psychology* 4.3 (1973): 328–350. Print.
——. 'Principles of categorization.' *Concepts Core Readings*. Eds. E. Margolis and S. Laurence. Cambridge, Massachusetts: MIT Press, 1999. Print.
Saunders, B., and J. Van Brakel. 'Are there non-trivial constraints on colour categorization?' *Behavioral and Brain Sciences* 20 (1997): 167–228. Print.
Whorf, B.-L. 'Science and linguistics.' *Technological review* 42.6 (1940): 229–231, 247–248.

© 2014 The Author(s)
Philosophy Compass © 2014 John Wiley & Sons Ltd

17479991, 2014, 6, Downloaded from https://compass.onlinelibrary.wiley.com/doi/10.1111/phc3.12131 by HINARI-LEBANON, Wiley Online Library on [20/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License