

Language, thought and color: recent developments

Paul Kay¹ and Terry Regier²

¹International Computer Science Institute, University of California, Berkeley, USA

²University of Chicago, Illinois, USA.

Corresponding authors: Kay, P. (paulkay@berkeley.edu); Regier, T. (regier@uchicago.edu).

PK and TR contributed equally to this work.

The classic issue of color naming and color cognition has been re-examined in a recent series of articles. Here, we review these developments, and suggest that they move the field beyond a familiar rhetoric of ‘nature versus nurture’, or ‘universals versus relativity’, to new concepts and new questions.

The ‘Whorfian’ debate over color naming and color cognition has been framed by two questions:

- (1) Is color naming across languages largely a matter of arbitrary linguistic convention?
- (2) Do cross-language differences in color naming cause corresponding differences in color cognition?

In the standard rhetoric of the debate, a ‘relativist’ argues that both answers are *Yes*, and a ‘universalist’ that both are *No*. However, several recent studies, when viewed together, undermine these traditional stances. These studies suggest instead that there are universal tendencies in color naming (i.e. *No* to question 1) but that naming differences across languages *do* cause differences in color cognition (i.e. *Yes* to question 2). These findings promise to move the field beyond a conceptually tired oppositional rhetoric, towards a fresher perspective that suggests several new questions. Here, we review these recent studies, the clarification they bring to the debate, and the further questions they raise.

‘Universalist’ beginnings

Color naming varies across languages; however, it has long been held that this variation is constrained. Berlin and Kay [1] found that color categories in 20 languages were organized around universal ‘focal colors’ – those colors corresponding principally to the best examples of English ‘black’, ‘white’, ‘red’, ‘yellow’, ‘green’ and ‘blue’. Moreover, a classic set of studies by Eleanor Rosch found that these focal colors were also remembered more accurately than other colors, across speakers of languages with different color naming systems (e.g. [2]). Focal colors seemed to constitute a universal cognitive basis for both color language and color memory.

The ‘relativist’ challenge

Recently, however, Debi Roberson and colleagues [3,4] failed to replicate Rosch’s results. They compared speakers of three languages: English, Berinmo, a language of Papua New Guinea, and Himba, a Bantu

language – and did not find privileged memory, similarity judgments or paired associates learning in Berinmo and Himba at the proposed universal foci. Instead, they found that these cognitive variables were well predicted by the *boundaries* of each language’s color categories. This is a form of ‘categorical perception’ of color (categorical perception is said to occur when stimuli that straddle a category boundary are perceived as more distinct than equivalently spaced stimuli within a category). Because color term boundaries vary across languages (see Figure 1a,b), speakers of different languages apprehend color differently. Moreover, these linguistic differences actually seem to cause, rather than merely correlate with, cognitive differences [5], confirming and extending earlier findings by Kay and Kempton. These results call into question the cognitively privileged status of the universal focal colors. And they provide a positive answer to question 2 above: language differences *do* cause differences in color cognition.

Roberson and colleagues have gone further, proposing that universal foci play no central role in color naming either (question 1). They argue that color categories are determined at their boundaries by language, and that best examples of categories are mere epiphenomena of this process [3]. The one universal constraint they do acknowledge is ‘grouping by similarity’ – the very general principle that similar colors will tend to receive the same name. They also emphasize that they have studied languages of non-industrial societies, suggesting that the Berlin and Kay results – based mostly on languages of industrialized societies – are parochial. Lucy has also argued against universals of color naming [6]. He suggested that Berlin and Kay’s finding of universality was based on hopelessly subjective methodology: the data had been analyzed largely by human inspection, rather than objective test. If these claims about color naming turn out to be well founded, the overall picture would be a clearly ‘relativist’ one: that is, a *Yes* answer to both of our framing questions.

Current status of the debate

However, when the above-mentioned (‘relativist’) results on color cognition are juxtaposed to some recent (‘universalist’) findings on color naming, the traditional stances break down. For despite the clear evidence that

language affects color cognition, there is also new evidence for color naming universals. Kay and Regier [7] conducted the first comprehensive objective tests of color naming universals – in part in response to the ‘relativist’ claims above – and found strong statistical evidence of universal tendencies in color naming across languages of both industrialized and non-industrialized societies, the latter from the World Color Survey (WCS). Moreover, there is evidence specifically for universal focal colors in naming. Regier, Kay and Cook [8], extending earlier work by MacLaury [9], found that best examples of color terms in the WCS strongly tend to cluster near the proposed focal colors (Figure 1c). This pattern would not be predicted if the only major universal force in color naming was ‘grouping by similarity’. Webster and Kay [10] found that the foci vary somewhat in placement across languages – but much less than the variation across speakers within a language. The overall picture emerging is that color categories appear to be organized around universal foci (No to question 1) – and at the same time, differences in color naming do induce differences in color cognition (Yes to question 2).

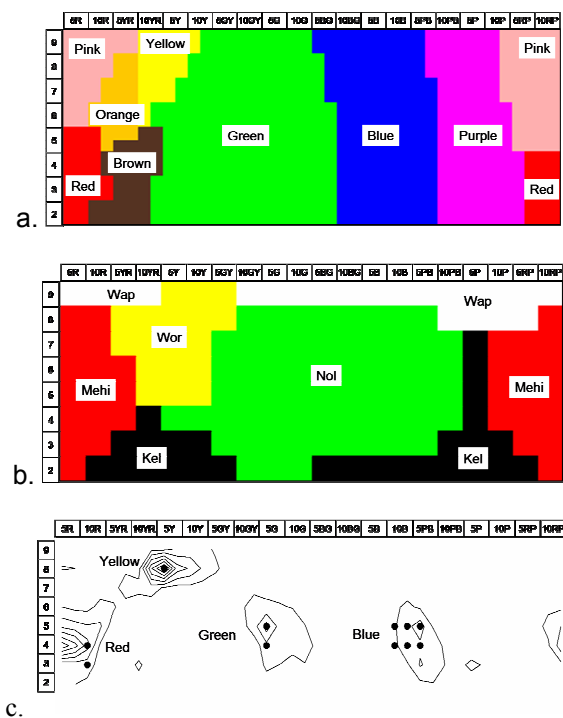


Figure 1. Color categories in (a) English and (b) Berinmo, shown on the same standard array of colors. Color cognition varies across languages in accordance with category boundaries. (Data redrawn from [3]). (c) Nevertheless, variation in color naming is constrained by universal foci [8]. The contour plot shows the number of best-example choices for color terms across 110 languages from non-industrialized societies, which cluster near those of English (black dots).

This non-traditional pair of answers to our two main questions suggests further questions that are currently under investigation. Most broadly: which aspects of color cognition shape language, and which are shaped by it? How do these reciprocal influences work together? Some initial answers are emerging, as we now outline.

What causes universal tendencies in color naming?

Several explanations for universals in color naming have been proposed. Kuehni [11] posits neurophysiological support for the cardinal colors red, yellow, green and blue. Lindsey and Brown [12] proposed that languages spoken near the equator tend to lack separate terms for green and blue because excessive exposure to ultraviolet radiation from sunlight yellows the lenses of people living in this region. However, this theory has been challenged [13,14]. Shepard [15] suggested that the major phenomenal hue axes, especially blue–yellow, derive from evolutionary tuning to the predominant sources of natural illumination. Yendrikhovskij [16] also showed that the sources of color naming universals could reside in evolutionary tuning to the most frequently occurring colors in the environment. Jameson and D’Andrade [17] argued that the universal focal colors are salience maxima in color space and that universals of color naming flow from a process that partitions color space in a way that maximizes information. Steels and Belpaeme [18] emphasize the role of inter-speaker communication, with evidence from simulations of interacting agents. In short, there is no lack of explanations for universals of color naming, some mutually consistent and others not.

What causes categorical perception of color, and is it really perceptual?

It has been widely assumed that language is the cause of color categorical perception. This is suggested because – as we have seen – named category boundaries vary across languages, and categorical perception varies with them. However, Franklin and Davies [19] have found startling evidence of categorical perception at some of these same boundaries in pre-linguistic infants and toddlers in several language groups. Thus, some categorical color distinctions apparently exist before language, and could then be reinforced, modulated or eliminated by learning a particular language.

Much of the evidence for categorical ‘perception’ of color comes from tasks that involve memory; hence it could be that the category effects stem from memory rather than perception. Recently, however, Franklin *et al.* [20] found that both adults and infants respond categorically in a visual search task that minimizes the involvement of memory. They concluded that the effect was probably truly perceptual. This is a tentative conclusion that deserves further investigation. The perceptual status of ‘categorical perception’ of color is currently an object of study, as is its status with respect to innateness, learning and unlearning.

Summary

The debate over color naming and cognition can be clarified by discarding the traditional 'universals versus relativity' framing, which collapses important distinctions. There are universal constraints on color naming, but at the same time, differences in color naming across languages cause differences in color cognition and/or perception. The source of the universal constraints is not firmly established. However, it appears that it can be said that nature proposes and nurture disposes. Finally, 'categorical perception' of color might well be perception *sensu stricto*, but the jury is still out.

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