Colour Classification in Natural Languages †

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Abstract: Names for colours or colour-related properties are ubiquitous among natural languages, and this has made linguistic colour classification a topic of interest: are colour classifications in natural languages language-specific, or is there a more general set of principles by which such classificatory terms are organized? This article focuses on a debate between cultural-linguistic, relativistic approaches, and universalistic approaches in this domain of research. It characterizes the central contemporary debates about colour naming, and the main research strategies currently in use, as well as a novel, hybrid strategy.

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1.0 Introduction

Colour terms in natural languages specify equivalence classes. Excluding classes based strictly on qualitative identity (imagine all the samples in a paint store that are the same shade), they denominate a series of perceptually non-identical shades as a single named classification. As an example, think of all the different shades named *red* in English. The members of this class may vary significantly in perceptual terms and yet be named, correctly, as *red*. Since the members of the class of colour shades named as *red* are not (or need not be) perceptually identical, what is the basis for the equivalence class, the classification? Colour words and colour classifications differ to some extent across languages. Given this is so, it might seem that the principles involved in colour classification are language specific. Whether they are or not is the main focus of this article.

Colour classification has been and continues to be, a contested site for the articulation and critique of the "Sapir-Whorf hypothesis", also called "Whorf's hypothesis" in the colour classification literature. In a broader historical context (Leavitt 2015; Koerner 2000) it has been called the "Vico-Herder-Humboldt-Sapir-Whorf Hypothesis." Whorf's hypothesis, as we shall mainly call it here, is a form of "linguistic cultural relativism," and we shall be discussing the extent to which colour naming practices, and colour classification are relative to language and culture. We note, for the sake of clarity, that the focus of this article is on colour words in natural languages and the shades of colour that they classify.

2.0 Classification of colour in science and in natural language

Many formal systems of colour classification, such as those designed by the CIE (Commission Internationale de l'Eclairage 2019), and the NCS (NCS 2019; Hard and Sivik 1981), are designed to model colour for scientific or industrial, or commercial purposes (Fairchild 2015). Other systems of colour classification, the Munsell System is an example (Munsell 1907; Long 2017), were originally designed to be of use to artists. Formal classifications have a long history (Kuehni and Schwarz 2008) and they aim at differentiating colours precisely. They specify what are essentially definitions for colours, relative to a standard, and they have purposes: what will a colour look like in daylight conditions or some other illuminant, or when viewed on a computer

monitor? There may be an attempt to capture some aspect of human behaviour in such models. The CIE "standard colorimetric observer" is derived from averaged responses for a population of actual subjects (Schanda 2007), but the observer is an abstraction from those responses. It is worth, for a moment, thinking about the difference between the CIE standard observer and the data from which it is derived, for this difference is instructive when it comes to some of the issues that arise for natural language classifications.

The CIE use data generated from controlled psychophysical experiments. The experimental conditions are not normal conditions under which people typically view colours. The results are ecologically invalid in the sense that the behaviour subjects display in such controlled circumstances only roughly approximates their behaviour in real-world circumstances. Such models thus have limitations. Any model for a population will be an average, which will ameliorate individual differences (Webster 2015), which can be significant. Many human subjects are not the paradigmatic trichromats (Perry 2015) used to form the CIE population. Perceptual conditions in real world circumstances vary significantly, illumination, in particular. These are just some of the aspects of colour experience that are ignored in a model such as CIE (Clark 1993 discusses other discounted aspects). The CIE model is designed to capture some regularities in human colour discrimination at the population level in such a way that one can make inductive generalizations that hold at that level, and to some reliable degree for members of the population, for a uniform set of colour stimuli and viewing conditions.

Formal theories of colour classification provide *normative* definitions of colours, establishing carefully insulated, ideal classifications, using technical descriptors for colours that allow those using the systems to precisely identify distinct shades and classes of coloured stimuli. Examination of natural language classifications are, on the other hand, *descriptive* rather than normative. One is interested in the actual colour naming practices of individuals and groups not some ideal, purpose-built system. It is also the case, as has been mentioned, that there are differences in colour vocabulary cross-culturally and even intra-culturally (Kay et al. 2009).

There are many formal systems of colour classification, and the one that you choose will depend on your purpose and that system's adequacy relative to your purpose. Investigations of colour classification in natural language cannot pick and choose and must accept that, descriptively, there is a range of colour classificatory systems, assuming we feel comfortable in describing on-the-ground naming practices as "systematic." These are *synchronic* facts about colour terms in natural language: at any given point in time, the languages of the world exhibit variation in their colour terminology. To make things more complicated we may or may not wish to consider *diachronic* factors. Colour words in a language emerge and recede in historical time (Biggam 2012; Warburton 2007), are borrowed from other cultures (Stanlaw 1997), and derived from new technologies (Gage 1999; Kane 2014). Dealing with colour classification in natural languages involves dealing with *difference* (across and within languages) and it may involve dealing with *change* (that occurs within languages) if the origins and development of colour classifications are of interest to us.

3.0 Relativist theories of colour naming

Suppose that we take linguistic-cultural difference to be an essential feature for the study of colour nomenclature. From an anthropological perspective, specifically a functionalist perspective (Winthrop 1991), colour vocabulary may be viewed as distinct to a group in terms of function. Colour words are used to name and relate to features of the environment that are significant for a group. Perhaps the significance is natural, but it need not be exclusively so. A cognate term for *red* might be derived from a group's word for blood or for fire. While these are naturally occurring, they may also be culturally significant: fire is used to cook and is dangerous, blood, or blood relations, may be thought of as essential to kinship. One cannot, it should also be said, assume that the meaning of colour words in one's first (or only) language, map neatly or perhaps at all onto that of colour words in a foreign tongue. As the linguist Carole Biggam, who has a particular interest in historical colour semantics, says (2012, 1):

> When the colour vocabularies of various languages are considered and compared, the researcher finds that there are many different ways in which humans categorize and "label" colours, resulting in an amazing array of misunderstandings. Monoglot individuals invariably believe that their own colour system is clear and obvious, and they are often mystified when confronted with an alternative system. So the first step which the reader has to take when entering the world of colour semantics is probably the most difficult of all; s/he must restrict his or her own colour system to normal, everyday speech and learn to set it aside when considering foreign or historical colour descriptions. The aim is to dispose of any preconceptions about how colour "should" be classified and described, so as to gain insights into the workings of other languages and cultures, and into the nature of colour itself.

In a well-known article on the Hanunóo, an island people in the Philippines, the anthropologist Harold Conklin (1955) argued for classifications quite different from those used by Western languages. The Hanunóo language employs classifi-

ers that are not hue based, operating in the following dimensions: light/dark, fast (not faded)/not-fast (faded), dryness/wetness. Another anthropologist, Robert MacLaury (1997) has made a case for the existence, in many languages (often Mesoamerican), of a light/dark classification that may ignore hue classifications, so that faintly coloured samples of almost any hue belong to the classification. While many of MacLaury's examples are perceptual in nature, in that they classify the *lightness of a colour*, the Hanunóo have different fish to fry: "fastness" as one might expect, is often used to describe fabrics, and to judge their dying, while the wetness/freshness dimension may be used to classify different hues in terms of their succulence—a classification that seems independent of significant differences in hue. Whether the Hanunóo colour related words may be dealt with as if they were Western colour terms, that has been a subject of discussion (e.g., Biggam 2012; Lyons 1999; Kay 2006).

An anthropological perspective whose investigation is internal to a human group has the capacity to articulate the local features and functions and perhaps the genesis of some class of words (colour nouns, say) and, in doing so, to make the case for their cultural significance and, with one short inference, the *cultural relativity* of colour language and the colour related properties such words denominate. The essential document of modern anthropology is the ethnographic report, and such reports can be compared. Difference of function and, thus, significance can be noted. Suppose, as is true, that many groups seem to have an equivalent term for English *red*. It may still be the case that the origin story for such a term, in a specific group, has connotations specific to that group (e.g., Warburton 2007). The fact that many groups have a similar term will be of less interest to the anthropologist than the local explanation for its presence and function within that group. Jules Davidoff, a psychologist who has done field research on colour naming among the Berinmo, a people that live in northeast Papua New Guinea (2015, 272-3), wrote:

> Take, for example, the color terms of the Berinmo ...: all five terms in that language have names that refer to objects in the world ... The distinction, in Berinmo, between leaves that are edible (green) and those that are inedible (yellow) makes up two of their terms. Their red term is the name of a berry which, like most berries, is a dark, saturated red when at its best to eat. The red term in other cultures is the word for blood (Rivers 1901), which is a similar hue to the color of ripe berries.

Davidoff's comments exemplify the kind of results ethnography has turned up, especially for non-Western languages: colour terms often have their origin in the names of things, where the colour dimension of a term is indicated by the reduplication of a common noun. Biggam (2012, 23) describes such a case: "In Samoan, for example, *mū* means 'red hot; to burn' and *mūmū* means 'red'". Such words often have functions that suggest they are not well understood as simply the name of an abstract property, the property of being red, say. This is a way speakers of Western languages can understand colour words, but it may not be so for the speakers of other languages, as a number of writers have claimed (Wierzbicka 2018; Lucy 1997; Warburton 2007; Bousfield 1979; Simpson 1991; Conklin 1955). Ethnographers have, generally speaking, paid attention to the connotations (more precisely, the "senses") of colour words, as opposed to just their chromatic referents. They are interested in the meanings and meaningfulness of such words as they develop and change within the lived experience of the people that use them.

4.0 Universalist theories of colour naming

We can, then, deal with the synchronic difference in colour language in relativistic terms: the significance of a colour term, its connotation and perhaps its denotation as well, may vary from group to group. Significance is revealed through ethnographic and semantic examination, and that significance is articulated in terms of the function of colour vocabulary in a language. There is, however, an alternative view, a research tradition that may, with some misgivings, be called "universalist." If the cultural linguistic view is a by-product of modern anthropology, this second approach is grounded in the work of the anthropologist Brent Berlin and the linguist Paul Kay. Their book, *Basic Color Terms: their universality and evolution* (Berlin and Kay 1969) has, for better or worse, set the agenda for colour language research over the last half-century and it is a challenge to the relativist view.

From a meta-theoretical perspective, Berlin and Kay asked two questions: (1) What is the *range* (the denotation) of a colour term: what is the set of colour shades that it classifies as an equivalence class for a language or a speaker? (2) Given the large set of words that name or describe colour in some way (within a language), which ones *count the most* in a language? The focus on these two meta-theoretical questions has had important results. The consequence of (1) is that colour classification in natural language can be investigated by a universally applicable experimental method: ask subjects to indicate all the colour samples in an array or other stimulus set that they would name with a colour term in their language. This approach leaves term connotation out of the picture. As for (2), it led Berlin and Kay to the most influential development in thought about natural language colour classification: the idea of a "basic colour term" (BCT).

BCTs are theoretical constructs. Though there is some dispute and discussion as to the exact nature of the construct and its application (Biggam 2012), and though the idea was not original to Berlin and Kay (Saunders 1993), the

essential goal is to capture the set of terms most important to speakers. Berlin and Kay characterized basicness as follows (1969, 6): A term is likely to be a BCT when it is *monolexemic* (a single word whose meaning is not predictable from the meaning of its parts), *non-hyponymous* (its meaning is not included in the meaning of any other colour term), *non-contextually restricted* (its application is not restricted to a narrow set of things), *psychologically salient* (tends to occur at the beginning of elicited lists; has stability of reference across informants and occasions of use; occurs in the idiolects of all speakers). As noted, there has been discussion and dispute as to the nature and applicability of these criteria, which are best viewed as a cluster of conditions that predict likely BCT status, rather than a definition giving necessary and sufficient conditions. That said, we shall take them as providing a measure of importance to speakers, however imperfect and difficult to apply. A detailed account of the construct and some issues with it can be found in Biggam (2012, ch. 3), who points out that there is no one set of criteria but something more like a menu of choices for the semantic researcher.

With this construct in place, one may apply it to any language to determine if it has BCTs and what the BCTs are. While it is not surprising that an investigation of a language's basic colour terms would delimit the number of colour words thought to be most significant for a group, that is the point of the construct, Berlin and Kay made claims that were quite surprising in relation to cultural relativism. Their broad conclusion was that colour language is far more uniform and "universal" than contemporary views imagined, and that there were non-linguistic constraints on the kind and number of BCTs. We shall discuss these claims in the next section.

The Berlin-Kay theory implied a critique of the cultural relativist view. By ignoring term connotation, they essentially devalued the ethnographic approach and its focus on meaning for speakers in the lived world (Saunders 2007). And in defining BCTs prior to, or independently of, internal ethnographic investigation, they prompted the charge of Eurocentrism (e.g., Saunders and van Brakel 1997; Wierzbicka 1996; Simpson 1991; Kuschel and Monberg 1974; see also Kay and Berlin 1997), by imposing a notion of colour that is said to be derived from abstract, Western thought. The Berlin-Kay theory and its development has been controversial, and we shall examine it in more detail.

5.0 The Berlin-Kay theory and tradition

Until 1969, the contemporary anthropological literature on color was relatively uniform in the view that colour words and the colours that they named were culturally specific. The anthropologist V. Ray (1953, 102) wrote that "each culture has taken the spectral continuum and divided it upon a basis which is quite arbitrary except for pragmatic considerations". This view, based mainly on the observations of ethnographers, and on a relativist methodology (that colour nomenclature differed significantly and unpredictably across cultures) met a serious challenge from Berlin and Kay (1969). It is fair to say that Ray's claim about the cultural relativity of colour language was targeted by Berlin and Kay and much of the research tradition their work has generated.

With the meta-theoretical assumptions described in Section 4 in place, Berlin and Kay (1969) claimed two surprising discoveries in their original work: (1) There is a limited number of BCTs as defined by the stipulated criteria, in any language. These terms name basic color classifications or "categories" (as psychologists and linguists call them). In English, which possesses all eleven of Berlin and Kay's original set of BCTs, the words are *red, yellow, green, blue, orange, purple, pink, grey, brown, black, and white.* (2) Informants who share a basic category (within and across languages) are in agreement as to which shades of colour are the best examples of the basic color categories named by their basic color terms. Berlin and Kay called these exemplars "focal colors." (A third claim, about the diachronic development of BCTs will not be discussed here.) [1]

Berlin and Kay did not deny there was variation in language related to colour, but they held that much of that variation was superficial. If one looked to the criteria for BCTs, then one found not only that many colour related words failed to satisfy such criteria, but that some (especially *red, yellow, green, blue, black* and *white* in their English gloss) stood out as satisfying them, and not only within a given language, but across the set of languages studied. Not every language has all eleven of the original BCTs, but all languages, so Berlin and Kay claimed, possess some subset of the eleven. This is the basis for Berlin and Kay's claim to the "universality" of basic colour terms: any language will possess all or some subset of the limited set of eleven basic terms, identified by criteria for basicness. They did not rule out the possibility there could be more than eleven. One language, Russian, clearly appears to have two BCTs (Paramei 2007) for what is the blue category, in English.

The claim to universality is not exactly transparent. Consider the language of the Berinmo, mentioned by Davidoff (2015), above. Berinmo *nol* denotes the range of shades named in English by *blue* and *green*. In what sense is there a common category between these two languages, a shared universal? To answer this question, we need to understand the authors' second claim, (2), about colour language: that there are shared and agreed upon category foci.

Consider a two-dimensional colour chart (Figure 1). Its dimensions are hue (horizontal) and lightness (vertical). The chart is a subset of the Munsell colour space intended to represent the range of shades that one finds in an equal

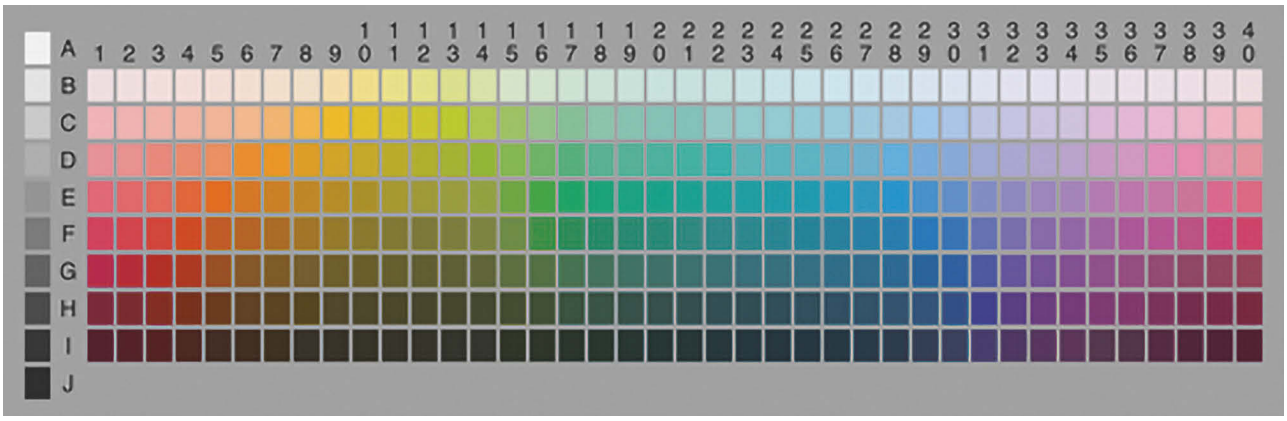

Figure 1. From WCS [The World Color Survey] Data Archives. http://www.icsi.berkeley.edu/wcs/data.html

energy spectrum with non-spectral colours such as brown, pink, and purple added. That means that, at the left side of the chart, there are shades of colour an English speaker would typically call *red* and, moving toward the right, one finds, in order, shades that an English speaker would typically call *orange, brown, yellow, green, blue, violet, pink.*

Not including the achromatic colors (which are represented in a separate column to the left) this chart has 320 individual shades of chromatic colour (shades that possesses some hue). Field ethnographers or experimentalists using such an instrument (or something similar, MacLaury 1997) can determine the BCTs in a language, using the Berlin-Kay or later criteria, and they ask a subject to select, for each of their colour terms, the "best example" of that colour term. This is a request that makes sense to most participants in this kind of experiment, and it produces significant agreement: one is likely to choose a best example of *red* that agrees with the choices of one's fellow English speakers. When the data produced by this sort of task is compared cross-culturally, there is significant cross-cultural agreement as to best examples ("focal colors" or "foci" as Berlin and Kay have it) for individuals speaking different languages. One can also use a modified version of this task to explore boundary placement within basic colour categories: the experimenter (often an ethnographer or a psychologist) can ask the participant to place a token on every shade of colour in the chart that subject would name with a given basic term in their vocabulary (MacLaury 1997, 76-7). In this way, the range (denotation) of a colour term can be specified. And unlike focal colours where there is significant agreement, boundaries were, according to Berlin and Kay, more variable, though much has been written about category boundaries since the original research was published, a subject discussed below.

Returning to Berinmo and the issue with basic term range discussed above: Berlin and Kay would say (as Kay does in Regier, Kay, and Cook 2005) that the Berinmo term is a universal term corresponding to an English universal term not because the range is the same for the two, but because there are two terms, one English and one Berinmo, that have one shared focal colour for both English and Berinmo experimental participants. In the case of *nol*, the focal colour is located in a region of the colour chart that English speakers would call *green* though the range of the term extends across blue shades as well. It is focal colours and their uniformity across languages, not the denotative range of a term that is the basis for universality. More recently, this notion has come to be defined in terms of colour term "centroids", clusters of shades that constitute the statistically significant choices participants make when asked to select basic colour term foci (Abbot, Griffiths and Regier 2016; Regier, Kay and Cook 2005). More recent statistical techniques (e.g., Kay and Regier 2007) have been used to argue that colour category boundaries in different languages/cultures are much less variable than earlier research suggested.

While colour categories do vary from language to language and group to group, that variation is more constrained than scholars prior to 1969 imagined, if we allow the concept of a "basic colour term" to enter into play. One need not accept the BCT construct, and there is a substantial literature (e.g., Gage 1999; Saunders and van Brakel 1997; Lucy 1997; Wierzbicka 1996; van Brakel 1993; Saunders 1995, 1992; Ratner 1987) that is critical of this notion. The psychologist Terry Regier (Regier et al. 2010, 166), in writing about disputes between "universalists" and "relativists" refers to "the battlefield of colour". The philosopher John Sutton (1998, 106) reviewing a philosophical book on colour language research referred to the "colour wars". A detailed and at times heated debate followed the publication of *Basic Color Terms* (Dedrick 1998b).

Despite disagreement, the legitimacy of the BCT construct has been widely, though not universally accepted. It is true that not everything that is important about colour to a group is captured in the study of basicness. Think of the emotional connotations of the colours named by the terms

red, *yellow*, *green* and *blue* in English (Steinvall 2007) for example. Yet the idea that some colour words are more basic than others, in roughly the ways that Berlin and Kay tradition has imagined, has proved robust (Hardin 2014, 1998).

Research into colour classification and colour naming constitute a large research program. Research from different disciplines that is about colour language and engages with the Berlin and Kay theory runs to more than 1000 published items. *Basic color terms: their universality and evolution* has been cited, according to Google Scholar, over 5000 times. We can refer to this large body of work as the "Berlin-Kay tradition" in colour naming research (Dedrick 1998b). For better or worse, there is a before and an after to colour naming research in the twentieth century (and into the present). *Before* Berlin and Kay: an unsystematic cataloguing of colour words from different languages and peoples, dominated by a relativist metatheory. *After* Berlin and Kay: a systematization of colour nomenclature that divides colour words in any language into basic and non-basic, dominated by a universalist theory that looks to find cross-cultural regularities.

6.0 Colour naming, categorical perception, and the Sapir-Whorf hypothesis

"Categorical perception" (Harnad 1987; Goldstone and Hendrickson 2010) occurs when the categories possessed[2] by an individual affect their perception of stimuli at the boundaries between their categories, deforming their perceptual space. For a domain of stimuli that is continuous, such as a colour continuum (as represented, imperfectly, in Figure 1), possession of the categories green and blue would, if there is categorical perception, make it easier to distinguish a pair of colour samples if one were green and the other blue. This is *between-category discrimination*, and it is enhanced by categorical perception. Pairs of colour samples that are both blue or both green are more difficult to discriminate from one another. This *within-category discrimination* is more difficult even if the "perceptual distance" between a stimulus pair (blue/green; blue/blue; green/green) are equal (Bornstein and Korda 1984; Boynton, Fargo, Olson and Smallman 1989). Experimental paradigms demonstrating adult categorical perception in colour often use an "odd man out task", in which subjects choose the colour sample from a group of three that is most unlike like the other two, where perceptual distance between all three samples is equal (e.g., Roberson and Davidoff 2000). Categorical boundaries enhance performance on such tasks, with subjects typically choosing the categorically different shade as the "odd man out".

Categorical perception has been demonstrated in a variety of ways for speech, colour, and for other domains (Goldstone and Hendrickson 2010), and it can be exploited to detect effects of language on thought. The language of the Himba, a people that live in northern Namibia, has five basic colour terms. English has eleven basic colour terms. These languages differ in both the number of terms and the placement of boundaries for the categories named by their terms since, for example, Himba does not have distinct words equivalent to *green* and *blue* in English and there is no blue/green categorical boundary. English and Himba speakers thus have distinct names, categories, and boundaries. Will categorical perception be different for the two languages and in accord with the linguistic differences? If the answer is yes, that is evidence that linguistic colour categories have affected perception or judgement (thought) in a manner dependent on language. And this is what Roberson et al. claimed to have demonstrated with Berinmo (Roberson, Davies and Davidoff 2000) and later with the Himba (Roberson, Davidoff, Davies, and Shapiro 2005). As Roberson and Hanley (2010, 187) summarize this research: "The results indicated that all three groups of participants (English, Berinmo, Himba) showed CP [categorical perception], but only at color boundaries that were explicitly marked in their own language. Crucially, there was no effect of the proposed universal boundary between green and blue for speakers of Himba and Berinmo whose languages do not make this distinction".

In the context of this research into categorical perception we can introduce a larger theoretical concern that was mentioned in Section 1: "the Sapir-Whorf hypothesis". Sapir and Whorf are famous for the hypothesis that bears their name, and which asserts that, as Whorf (1970, 213) has famously put it:

> We dissect nature along lines laid down by our native languages. The categories and types that we isolate from the world of phenomena we do not find there because they stare every observer in the face; on the contrary, the world is presented as a kaleidoscopic flux of impressions which has to be organized by our minds – and this means largely by the linguistic system in our minds.

For Whorf, language was an expression of culture and the lived world of a people. A language encodes culturally specific content that influences the way people who use the language think. Speakers of different languages may think and behave differently depending on the language that they use (Sharifian 2015 discusses linguistic relativity claims, in a variety of domains). If the visible spectrum is conceived of as a continuum (as with Figure 1) distinct types of colours (colour categories) do not, it seems, "stare us in the face" but have to be isolated from the continuum. The process of isolation is accomplished by linguistic categorization, the linguistic-cognitive system in our minds, which is shaped by the particulars

of culture. This view is well summarized in the quotation from Ray (102) we saw earlier: "each culture has taken the spectral continuum and divided it on a basis which is quite arbitrary except for pragmatic considerations".

The results of Roberson and her colleagues bear on the Sapir-Whorf hypothesis in the following way: differences in the set of BCTs available to a speaker correlate with differences in human categorizational behaviour. Cognitive processing guided by language explains these differences in behaviour. Term difference is a consequence of cultural differences. This is what one would expect if Whorf's hypothesis were true in the domain of colour classification. (But see Lucy 1997 for a critique of this denotational interpretation of Whorf's hypothesis for colour; Clifford et al. 2012; Webster and Kay 2012; and Witzel 2019, for a discussion of the nature of the categorical perception in such tasks.)

For colour language, issues about categorical perception, colour categorization, and Whorfianism focus on a restricted set of issues that are, to some degree, empirically tractable. As we saw above, the Whorfian hypothesis, construed in terms of colour-categorical perception, makes empirical predictions, predictions that have been born out as correct, at least in some cases. Is it not then surprising to find that universalists are happy with this result? Perhaps not. The relativism that Roberson and her colleagues argue for takes place within the confines of the BCT construct. In the course of their experiments Roberson and colleagues determined the set of colour words for the Berinmo, or for the Himba. They were not explicitly looking for BCTs, but their results were represented in "naming maps" easily comparable to those representing BCTs and they say that (Roberson, Davies et al. 371) "Berinmo has five basic colour terms". The claim that colour category boundaries may differ in relation to linguistic classifications is not a challenge to the claim that there are universal focal colours which organize colour naming schemes, or so it has been argued (Regier and Kay 2009). And even with respect to boundaries, which are at the core of the Berinmo (and Himba) experiments, Kay and colleagues have argued that Berinmo, a language with "non-standard" boundaries, nonetheless conforms well to their universalist scheme (Kay and Regier 2007; Regier and Kay 2009), on a "re-analysis" of the data. As Regier et al. (2010, 180) have written: "at least in the color domain, there are clear universals governing the semantic distinctions that languages make, but there may also be some limited element of arbitrariness in exactly where category boundaries are drawn. This is an ultimately universalist finding, but with a relativist twist".

Research into colour categorical perception (e.g., Skelton 2017) is ongoing. It has taken an interesting turn with the discovery that colour categorical perception appears early in one brain hemisphere, the left, possibly switching to the right hemisphere as language develops (Gilbert, et al. 2006; Drivonikou et al 2007). The implication is that categorical perception may be driven both perceptually and linguistically (at different developmental stages), suggesting that language may potentially overwrite non-linguistically influenced perceptual processes (Franklin 2015). This result would be a form of "Whorfianism" for colour, but the implications for a "lateralized Whorf" are uncertain (Kay, et al. 2009; Franklin 2015), though as Kay and colleagues do make clear, such findings are not viewed by them as a challenge to the core universalist position (Regier and Kay 2009).

7.0 Relativism and universalism revisited

We have, in this article, characterized the issue of colour classification in natural languages as an issue of cultural relativism versus universalism, and we have aimed to capture the central disputes in that debate. In this section we consider 4 different research positions (3 extant, one prospective) that all aim, or claim to aim, at an endpoint somewhere beyond the "simple contrast" (Davidoff et al. 2009) between relativism and universalism.

7.1 The universal constraints position

The clearest interpretation of the universalist position has been called the "perceptual salience theory" (Hardin 1988, 2014), according to which there are universally salient perceptual features that structure human colour space, and which are exploited by us as we develop colour vocabularies (Rosch 1974). On this view, to put it simply, certain shades of colour stand out from others (have perceptual salience) and they can be used by speakers as landmarks for the development of colour categories and colour names. BCTs are thus derived from focal colours, which themselves are derived from psychologically primordial colour "prototypes" (Hardin 1988; Rosch 1974; Rosch Heider and Olivier 1972). These prototypes may, themselves, be generated (Hardin 1988; Kay and McDaniel 1978; Rosch 1974) from more basic biological mechanisms. On this reductive view, language is underwritten by perception, which is underwritten by neurophysiology. The perceptual salience view is a strong form of universalism. As the philosopher C. L. Hardin (1988: 168) describes it: "...far from language carving out categories from a structureless color space, the basic linguistic categories themselves have been induced by perceptual saliencies common to the human race". On this view the colour naming regularities described by the Berlin-Kay tradition may be reduced to (in the sense of *explained by*) lower level properties of the vision system.

The attraction of the perceptual salience theory has waned (e.g., Kay 2015; Hardin 2014; Abramov 1997) but the universalism derived from it persists. We have seen this quotation from Reiger et al. before (2010, 180): "at least in

the color domain, there are clear universals governing the semantic distinctions that languages make, but there may also be some limited element of arbitrariness in exactly where category boundaries are drawn. This is an ultimately universalist finding, but with a relativist twist". In the end, there are "clear universals" governing colour language, but those universals can, to some extent be shaped by language and culture. Given that Regier, Kay and others take it that both colour category boundaries and colour focality are universal "constraints," this concession to the cultural relativist is minimal indeed. This view is distinguished from the perceptual salience theory because it is neutral with respect to the basis for the said universals: what matters is that there are universal constraints on color category formation and naming practices. At this point in time, the explanation for those constraints may be left unaccounted for (Kay 2015). We can call this the *universal constraints position* on the relativist/universalist debate. It permits restricted variation by allowing for some contingencies in basic colour term articulation. It is not committed to any explanation for the constraints, taking that to be a separate question (Kay 2015; Hardin 2014) with multiple possible answers. It sets itself up as specifying a minimal set of constraints that any correct explanation will have to satisfy.

7.2 The postmodern position

The second research position comes from the relativistic end of the spectrum. In its clearest form, one finds it in the work of Barbara Saunders. Saunders (2007, 474) writes that "I suggest that 'to see colour' is not a biological 'given' but a many stranded sociohistorical 'institution.' The complex praxes and generative rules of this institution feed back into, and modify the ontology of the world". One might be inclined to think this is just a return to the cultural, the "sociohistorical" as Saunders says. While there is no question that the account which is proposed lays stress upon the same features as the garden-variety cultural relativist (language, culture, function, meaning), it intends to go beyond those features as well. As Saunders' makes clear in the article we have quoted from, and in other work, (e.g., Saunders 1995; Saunders and van Brakel 1997) one problem with the universalist position, from her point of view, is that its essential concepts, such as "basic colour term" and "focal colour" are sociohistorical phenomena that are not recognized as such. "Colours" as understood in colour science are, on her view, not prior to experience and not a "given" foundation for naming practices, but products of a particular science-driven way of looking at the world (Saunders 1998). What Saunders seems to realize, better than most that are critical of the Berlin-Kay tradition, is that it is very difficult to fight a battle for the values one cherishes (the importance of colour related thought in its cultural and other particularity) once one is inside one of the "machines" (Saunders 2000b) of colour science, and their (illegitimate) extension to colour naming. This is similar to the point made above, about Roberson and her Whorfian view of categorical perception (e.g., Roberson and Hanley 2010): before Roberson and her colleagues conduct their experiments they determine, using a modification of the experimental methodology we have described, the denotation of the colour terms for the Berinmo, or for the Himba. What is striking to these authors is the *difference* between the Berinmo or Himba categories and those of English. What is striking to Kay and his colleagues is their *similarity* to BCT naming data for other languages. Saunders, unlike Roberson, cares little as to whether some reanalysis of WCS data scrubs the Whorfian implications of an experiment. That is because Saunders is aiming to move beyond the categorical schemata both the universalist and Roberson and her colleagues are willing to accept.

Saunders, sometimes writing with colleague Jaap van Brakel (e.g., Saunders and Brakel 1997), has engaged in two sorts of projects: The first involves a critique from a largely scientific perspective, of concepts from colour science that have been utilized in the Berlin-Kay tradition (unique hues, color spaces, hue-saturation-brightness characterizations of colour, etc.). The second is a deeper critique of the claims colour science makes to be objective in its characterization of coloured experience. She writes (2007, 468), describing her "long term aims," that "I wish to contribute: first, to histories and philosophies of science which do not sanctify the past or ratify contemporary scientific epistemology... second, to the vital and growing area of 'science studies' in the human and life sciences; third, to the re-evaluation of vernacular color praxes and 'subjugated knowledges' as distinct from scientific ones". Saunders has attempted a significant amount of the critical work necessitated by such a broad set of concerns. We will call this the *postmodern position*. It treats (and thus explains) the Berlin-Kay tradition and its universalist claims as a sociohistorical consequence of a particular scientific worldview which, on her view, is both problematical in terms of its own factual basis (Saunders and van Brakel 1997) and in terms of its inability to characterize the social and the historical aspects of lived experience (Saunders 2000b, 93):

> B&K presuppose a set of ideological givens: Munsell, psychological reality, the innate colour space. Yet it makes as much sense to treat these givens as ideological, as a body of ruling ideas created by a ruling class. It makes as much sense to treat these givens as a form of misrepresentation containing distorted ideas about, say, colour science on the one hand, and intercultural relations on the other. Doing so would help correct the fundamental erasure of social and histori-

> cal relations, practices and ideas, in B&K's work, which makes invisible historically particular impressions, noticings, reportings.

The interested reader is directed to Saunders and Brakel (1997) which deals with the (supposedly) factual basis for the Berlin and Kay tradition—it includes commentary by a number of colour scientists and other interested parties—and to, for example, Brakel and Saunders (2002) which works to articulate a sociohistorical reconception of colour.

7.3 The communicative position

The core idea of this research position is that the explanation for the universal constraints on colour naming is essentially cognitive and social, rather than a matter of perceptual salience. Such accounts develop a strand implicit in Berlin and Kay's idea of a basic colour term, the idea that BCTs are defined partly by their value in communication. Recall the criteria for basicness discussed in Section 5. The core criteria are: *monolexicality*, *non-hyponomy*, *contextual non-restriction*, and *psychological salience*. Many critics of the BCT construct fasten attention on the third criterion on this list and argue that it abstracts colour away from its contexts and from its meaning for a group. We have touched on that argument and its implications in Sections 3 and 6. Much contemporary work, and there are antecedents (Dedrick 1998a; MacLaury 1997; Harrison 1972) focuses instead on the communicative, cognitive function of basic colour language, which is suggested by the psychological salience criterion which is itself, as Biggam says (2012, Ch.3), a complex set of criteria. Does basic colour terminology develop so as to solve communicative problems for a complex perceptual domain that is continuous and without natural boundaries? An early empirical version of the communicative position is Jameson and Andrade (1997) who argued that the regularities observed by the Berlin-Kay tradition, across the data collected in the WCS could be explained in terms of maximizing communication efficiency for a colour categorical scheme. Similar "optimality" accounts have been developed by Regier and colleagues (Regier, Kemp and Kay 2015; Regier, Kay, and Khetarpal 2007), while Steels and Belpaeme (2005) among others (Puglisi, Baronchelli, and Loreto 2008; Jameson and Komarova 2009) have used interactive artificial-agent models to study the development of colour terms. One commitment that all this research shares, implicitly or explicitly, is to an understanding of colour categorization and colour naming as solutions to information processing problems, located in a social dimension. In this respect, the research described above has tended to focus on diachronic issues: how a colour categorical scheme develops in order to satisfy informational, cognitive constraints: how does colour language and categorization develop in particular extant languages or, more theoretically, how might schemes such as the ones we actually find in the world come about given certain assumptions about optimizing communication. The communicative position may focus on the idea that BCT systems or schema develop over time, the so called "evolutionary hypothesis" of Berlin and Kay and later researchers, which we have not discussed here (but see endnote 1).

In a recent review of the current literature on colour naming and classification, the psychologists Lindsay and Brown (2019, 127) take a focus on communication to be the trend in much contemporary colour language research:

> While some aspects of the mental representation of color in language are undoubtedly related to innate neural processes, other aspects of that representation are better understood with reference to the information-theoretic aspects of color communication. Both of these processes may be influenced by the pragmatic relation between the individual and his/her physical and cultural environment. We note a major shift recently, away from the study of color as a passively experienced human percept, and towards a paradigm that considers the role of color in the many cognitive tasks people perform every day.

Part of the motivation for a transition from "innate neural processes" to an emphasis on "the role of color in the many cognitive tasks people perform everyday" is the failure (up to now) of the reductive perceptual salience theory, discussed above. Part of the motivation is just consilience with the contemporary movement away from innatist theories of mind (Griffiths et al 2008), a general trend in cognitive science. And part of the motivation may just be a recognition that the colour naming and categorization regularities articulated by the Berlin-Kay tradition really are, at the very least, the product of social activity. Colour naming is not just an individual achievement, it is a feat of socio-linguistic coordination as well. Others understand our use of colour words and can act on those words, just as we can understand and act on theirs.

This contemporary focus, which is here named the *communicative position*, might seem to build bridges between the universal constraints position and the postmodern position: focusing on the "everyday" cognitive tasks rather than "innate neural processes" is surely of importance to the postmodernist. Agreement between these positions is, however, unlikely. While compatible with the universal constraints position, in that it aims to give an explanation for the constraints in terms of communicative function, the research trend Lindsay and Brown identify is wholly within the orbit of contemporary cognitive science and psychology, and largely operates within the confines of the BCT theo-

retical construct. The cognitive tasks that people preform "every day" are abstracted away from contextualized human experience and relocated to the laboratory (e.g., Bae 2015) or the computational model (e.g., Belpaeme and Bleys 2009, Zasalavsky 2019). There is nothing wrong with these approaches—unless one thinks that the problem is with the application of a scientific worldview to lived experience.

7.4 The hybrid position

The hybrid program begins with the assumption that Berlin-Kay ideas have wide though not universal application. Why might one think this, beyond the concerns with language and culture we have discussed? Consider an argument from the anthropologist Anna Wierzbicka (Wierzbicka 1996; 2006) who argues that the BCT construct cannot be universal since it cannot apply to languages that lack a concept of colour. Without a concept of colour, a language cannot have colour terms of the sort the Berlin-Kay tradition requires, since such terms must be construed as referring (denoting) *abstract* colours, which a people such as the Australian Walpiri (whom Wierzbicka discusses in detail) lack. We have pointed out that the Berlin-Kay tradition's approach is to focus on denotation and ignore connotation. Wierzbicka's argument is that once you understand the way connotative meaning is structured for some groups, you see that talk about their colour related words having the sort of denotation Berlin and Kay take for granted is a mistake. And so the Berlin-Kay paradigm comes crashing down. (Wierzbicka 2018; but see Kay 2015; 2006; 2004 for responses).

Wierzbicka's argument establishes less than she thinks but it may have significant implications for universalist claims. It establishes less: the argument really is a rejection of one (very important) criterion for basicness, *contextual non-restriction* (that BCTs refer to colour as a property, abstracted from context), and it is not entirely clear that connotation cannot be decoupled from denotation, in the way Wizerbicka supposes it cannot. Is it not possible (Kay 2004) for words with complex semantics to have more than one sense? It is also the case that Wizerbicka's argument does not undermine the application of the Berlin-Kay criteria to languages that have, unproblematically, an abstract conception of colour. One way to understand her argument is as follows. The communicative position models cognitive constraints on languages where the speakers are trying to solve, as Lindsay and Brown say, a particular kind of information processing problem (maximize communicative competence among speakers of a shared language). In other words, once a group finds its way to an abstract conception of colour (whether organically, or through loan words, or through linguistic imperialism), there will be more or less optimal solutions to colour classification problems, just the sort of solutions that the communicative position seeks to identify. For any group that *does* have an abstract conception of colour, constraints of the sort the universalist tradition identifies will emerge. The mistake of the Berlin-Kay tradition, on this interpretation, is to imagine all languages fit this bill.

No one actually advocates for the hybrid position, making it prospective in nature. Even so, it has much to recommend it. In the first place, once one gives up the notion of universal perceptual salience as the basis for BCTs and basic colour categories, one may give up their inevitability. Suppose that there *is* a universal perceptual salience, attaching to colour prototypes of the sort Rosch proposed. Then it becomes a problem (Bornstein 1985; Dedrick 2002) when a language does not structure its colour language accordingly, or so some have thought. This problem, if it is such, can be solved by giving up universalism: not all languages correspond to the universal scheme, so universalism is false. It can also be solved by arguing all the languages of the world do, really, conform to the universal scheme. The debate we have followed to this point pretty much imagines a zero-sum game here: universalism/relativism, or the somewhat modified version of universalism, the universal constraints position, that finds space for a very restricted Whorfianism. One should note, however, that the communicative position does not require universality. Without some form of perceptual universalism (universal perceptual salience), there is no need to think that all the peoples of the world are posed with and solve exactly the same information processing problem. Indeed, as cognitive science moves away from innatist models of the mind and toward inductive, probabilistic accounts, learning relative to one's environment (including one's social environment) will play a more significant role.

There are other advantages to the hybrid program. It is compatible with the universal constraints position in the sense that the constraints will be applicable to a large class of languages. Indeed, the universal constraints program and the communicative program complement each other: the "universal" constraints are explained as an optimal solution to a socially significant information processing problem. Further, perhaps surprisingly, the hybrid view is not incompatible with the postmodern program. One can take it that a specific sort of learning about colour (that colour can be understood as disembodied, abstract) has to emerge in a culture for its classifications to get on the universalist track. And one may, if one wishes, take the learning that is involved to be grounded in the sociohistorical rather than the purely perceptual since one has, on the hybrid view, already given up perceptual salience as the basis for linguistic colour classification, in line with the communicative program. In her discussion of the Walpiri's thoughts about colour Wizerbicka (2018) notes that these people appear to use two classificatory systems in their language, one that is indige-

nous to their culture (and lacks abstraction) another that is borrowed from the West and that conforms to the Berlin-Kay tradition. In this language, perhaps, we find evidence of both universal and culturally particular *schemas*. Other researchers (e.g., Kushel and Monberg 1974; Lucy 1987; Stanlaw 1997) have made claims similar to Wizerbicka for other languages.

8.0 Concluding remarks

This article scratches the surface of the massive literature on colour naming and classification. New work, often bringing to bear the resources of computational modelling and statistics is published on a regular basis (e.g., Haynie et al. 2016; McCarthy et al. 2019). It is arguable that once the computationally inclined sciences realized there was a relatively large data set to analyze (the data found in the WCS) a new generation of researchers entered the field. It is likely that however colour naming and categorization research develops, a fundamental feature of the research landscape will remain. It will seem to some (those we have called "universalists") that there are too many constraints upon linguistic colour classification for it to be understood strictly in cultural terms. It will seem to others (those we have called "relativists") that those constraints are, at worst, artifacts of research strategies or, at best, eliminate significant experiential features of a coloured lived world. We have suggested that a hybrid approach to research might do much to bridge the gap between these two metatheoretical approaches, but that approach has not been taken up.

The debate about "Whorfianism" and colour classification remains significant. Attempts to show Whorfian effects of language on thought through the study of colour classification go back to the earliest days of cognitive psychology (Brown and Lenneberg 1954), and Berlin and Kay's direct critique of relativist thought on the topic has generated an interest in Whorfianism that persists. Sometimes, that is because it seems to offer a straightforward and easily explicable refutation of the larger Whorfian idea that language and culture influence thought. Steven Pinker (1994), for instance, dismissed Whorfianism as he understands it, and illustrated his refutation in part with an account of colour naming drawn from Berlin and Kay (1969) and Rosch (1972). That account shows, Pinker thinks (63), "The way we see colors determines how we learn words for them, not vice-versa". This view is far too crude, as the research on categorical perception we have discussed indicates. It is also crude from the communicative position we have discussed. On that view, we seek an understanding of how colour terms and categories come to function as stable, reliable tools for communication within a group of people and, as Lindsay and Brown noted (2019, 127), this has involved movement away from the innatism Pinker prefers towards "the role of color in the many cognitive tasks people perform every day".

What remains on the table for colour language and categorization research? Data based approaches which seek to extract new statistical regularities from a rich data set have already been mentioned at the start of this Section. It is also fair to say, as indicated by the universal constraints position, that the explanation for BCT and categorical regularities remain uncertain (e.g., Kay 2015). That being the case, one can argue that the door is still open to more full-throated versions of relativism, such as that promoted by Roberson, Davidoff and their colleagues. Both have claimed, as we have seen (e.g., Roberson and Hanley 2010), that colour names and colour categories are largely culturally relative. The issue that these researchers must confront: is there not too much agreement in colour naming and categorizational schemes, cross-culturally, for this to be a viable position? One can read the postmodern position as a challenge to the entire edifice of the Berlin-Kay tradition, and Saunders certainly intends this. As such, it might be thought to provide comfort to relativists such as Roberson and Davidoff: there is no such agreement in the first place, it is a mirage that self-certifies its own claims to be objective. But this will not help a relativist such as Roberson, whose research operates with the confines of colour spaces, Munsell colours, and an experimental protocol that requires individuals to see colour in a contextually restricted way. These are the targets of the postmodernist position, as described here.

We will, in closing, raise one concern that has already been marked and which deserves some form of answer which has not yet been provided. We have seen most of the following quotation from Davidoff (2015, 272-273) [italics added] before:

> Take, for example, the color terms of the Berinmo ...: all five terms in that language have names that refer to objects in the world ... The distinction, in Berinmo, between leaves that are edible (green) and those that are inedible (yellow) makes up two of their terms. Their red term is the name of a berry which, like most berries, is a dark, saturated red when at its best to eat. The red term in other cultures is the word for blood (Rivers, 1905), which is a similar hue to the color of ripe berries. *So a physiological explanation for the origin of color terms is not needed for any language, nor is it needed for the similarity of its terms to those in other languages for which there would be similar natural constraints.*

The part we have not seen is the last sentence in italics. Davidoff is clearly making a point about the perceptual salience explanation for BCTs, but the point generalizes. The point is not just, why do we need a non-local explanation for

this language's set of BCTs but, further, are local explanations to be discounted given the fact that they are local and cannot account for the cross-cultural similarities? If they are to be discounted, why exactly? The answer to such a question should go beyond a recapitulation of the cross-cultural regularities if it is not to beg the question, especially in the absence of an adequate explanation for the cross-cultural regularities in colour naming.

Notes

1. The two claims discussed are synchronic claims: they apply to BCTs that could be uncovered in extant languages by an experimental method. The third claim is a diachronic claim, according to which BCTs develop (or "evolve," as Berlin and Kay would have it) over historical time. This diachronic claim is derived from mainly synchronic information. Suppose you made lists of all the languages studied experimentally with three BCTs, four BCTs, five BCTs, etc. Then you looked at the lists, and you found that for a language with *n* terms, you could predict *n* + 1 terms, on the basis of the data you had collected, such that, for example, a three-BCT language will have *black*, *white*, and *red* BCTs, and a four-BCT language will have, to a very high degree of probability, *black*, *white*, *red*, and *yellow* or *green* BCTs. The difference between three and four-term languages will be more than just a difference in the number of terms, as the denotative range of the BCTs will differ: *red* in a three-term language names yellow shades, but in a four-term language, they are denominated by *yellow*. A term that is not present in a three-term language will not, by definition, have a best example, a focal colour. If best examples are "landmark" colours (facilitating learning, communication, etc.), then languages with more BCTs have more landmarks, as well as more restricted denotative ranges for their BCTs. The supposition described here is essentially what Berlin and Kay claimed to be true. Further, they formulated an "evolutionary sequence," according to which BCTs developed through a historical process from two BCTs to the original maximum of eleven—a postulated history that could be and in some quarters has been interpreted phylogenetically: it is the stages that any BCT schema will pass through as it adds more BCTs to its stock (there is very little evidence for subtraction). The evolutionary sequence should be treated as a hypothesis—as it is mainly an inference from synchronic data. In this sense, the evolutionary claim is another basis for universalist arguments—BCTs develop according to a sequence universal to all languages—though it is typically set to the side when proponents of universalism make claims about the BCTs in a language and their foci. On the evolutionary view, a given scheme of BCTs occupies a "stage" or "partition" in this universal process. We should say that the preceding account is a sketch of the evolutionary hypothesis, which has itself gone through significant modifications over time. The reader interested in the evolutionary claim(s) should pay attention to Berlin and Kay (1969), Kay and McDaniel (1975, 1978), Kay and Maffi (1999). Biggam (2012 Ch. 6.) provides a detailed narrative that tracks the developments. It is worth mentioning that six of the eleven original BCTs—*red, yellow, green, blue, black,* and *white*—the so called "Hering primaries" have become the focus of the evolutionary hypothesis. These six are fundamental to the psychological opponent colours theory, first formulated by Ewald Hering (1920/1964).
2. The reader will note that this formulation of colour categorical perception makes no mention of where the categories "possessed" come from. This is an interesting question, where there is disagreement. Roberson (Roberson et al. 2005) argues that the basic colour categories of the Himba or the Berinmo, and the contrast class for each, English speakers, differ. As such, so the argument goes, colour categories are not prior to language, but formed through language acquisition and enculturation which is culturally relative. The alternative to this account has a tradition, beginning in the work of the psychologist Mark Bornstein (Bornstein et al. 1976), who claimed that colour categories, red, yellow, green and blue in particular, are hardwired into infants at birth. Using a habituation technique, which focuses on attention differences in infants exposed to coloured stimuli, Bornstein claimed that such infants are sensitive to categorical differences similar to those that turn up in mature (English) speakers. One way to map this onto the Berlin-Kay tradition: the most important basic (chromatic) categories (red, yellow, green, and blue) are prior to language and project into the language that children learn. This means that at least some basic colour categories are viewed as themselves perceptual universals, facilitating the development of BCTs. More recent research by Franklin and Davies (2006) in the tradition of Bornstein, has refined and extended these claims. So are categories themselves candidates for psychologically grounded universals? One reason for thinking they are not: as Roberson and colleagues argue, the colour categories of mature speakers, for many languages, do not map onto the categories of English speakers (and languages with similar sets of BCTs/basic colour categories). If some set of basic colour categories are "innate" in the sense of prior to language, why is it that a language need not respect the innate categorical divisions? This is a problem that both Bornstein (1985) and Franklin and Davies (2006) recognize. Franklin and Davies (115) write that "The finding that perceptual colour categorization is shown before the

acquisition of colour terms, in some ways, raises more questions than it answers. For example, if there is an innate set of perceptual colour categories, why do different languages segment the colour space differently from each other?"

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