

## Color

Color has been of interest to anthropologists of the twentieth century as the empirical domain par excellence in which to argue for (and against) the linguistic relativity thesis. Nineteenth century scholars were aware that all languages do not reflect identical lexical classifications of color. The classicist (and politician) William Gladstone concluded that differences in color lexicons reflect differences in perceptual abilities: "the organ of color and its impressions were but partially developed among the Greeks of the heroic age." But the ophthalmologist Hugo Magnus recognized that failure to distinguish colors lexically need not indicate inability to distinguish them perceptually, insisting that a naming distinction and a perceptual distinction must be tested for independently. These and other late-nineteenth-century scholars tended strongly to view differences in color lexicons in evolutionary terms.

By the mid-twentieth century cultural evolutionism had largely run its course in the United States. Beginning with Boas and Sapir in the twenties and thirties, the tide of cultural and linguistic relativity was on the rise. In 1940, Whorf wrote that the world presents itself to us "in a kaleidoscopic flux of impressions which have to be organized in our minds." The categories in which this organization takes place, Whorf said, are largely supplied by our language. Thus language dictates perceptual organization.

The idea of semantic universals induced by perceptual universals runs directly counter to the rhetorical thrust of Whorfian relativism, although there is no necessary contradiction between language sometimes influencing perception and perception sometimes influencing language. Phenomena of both types probably exist. Indeed, it is ironic that the early Whorfians chose color as their parade example. Color represents one of the few lexical domains for which humans possess dedicated peripheral receptors. In the retina, the rods and (at least) three different families of cones are devoted to detecting variations in wavelength and luminance information. That the

mid-century relativists chose color as their empirical battleground stands as a tribute to their self-confidence and a rebuke to their common sense.

There have been two major traditions of empirical research on color language stemming from the relativity thesis: a within-language, correlational line of research and a cross-language, descriptive one.

In the 1950s and 1960s, a series of studies was initiated by Eric Lenneberg, Roger Brown, and John M. Roberts that attempted to establish a correlation between a linguistic variable distinguishing colors (codability or communication accuracy) and a non-linguistic cognitive variable over colors: memorability. Since it was *assumed* at the time that any linguistic variable would vary across languages, correlation between a linguistic and the non-linguistic variable within a single language (almost always English) was taken to validate the doctrine that the coding systems of different languages induce differences in the non-linguistic cognition of their speakers.

In 1972, Eleanor Rosch challenged this assumption on the basis of the apparent universal lexical salience of certain "focal" colors. Rosch showed that among the Dani of New Guinea, universal perceptual salience determines both the nonlinguistic and the linguistic variables of the correlational approach, thus undercutting the logic of this line of research. Rosch's view, and her procedures, were criticized by Lucy and Shweder in 1979. Lucy and Shweder's procedures were in turn challenged in 1984 by Kay and Kempton. Also, in a rigorous restudy, Linda Garro was unable to replicate the Lucy and Shweder result. However, Kay and Kempton also showed that differences in lexical classification of color can influence certain non-linguistic color similarity judgments.

In the tradition of cross-language description, the studies of the 1950s and 1960s sought to discover and celebrate the differences among color lexicons. In 1969, using the original stimulus set of Lenneberg and Roberts, Brent Berlin and Paul Kay compared the denotations of basic color terms in twenty languages and, based on these findings, examined descriptions of seventy-eight additional languages from the literature. They reported that there are universals in the semantics of color: the major color terms of all languages being focused on one of eleven landmark colors. Further, they postulated an evolutionary sequence for the development of basic color lexicons according to which black and white precede red, red precedes green and yellow, green and yellow precede blue, blue precedes brown, and brown precedes purple, pink, orange, and gray.

These results were challenged on methodological grounds, primarily by anthropologists, and largely embraced by psychologists and linguists. Subsequent field studies have confirmed the main lines of the universal and evolutionary theory but challenged details of Berlin and Kay's specific formulation. Taking into account both the new data on cross-language color naming and what was known about color perception from the vision literature, Kay and Chad K. McDaniel formulated in 1978 a reconceptualization of the model of color lexicon evolution, based in part on earlier, unpublished work of McDaniel that had established the identity of some of the universal semantic foci of Berlin and Kay with the psychophysically determined unique hues. Kay and McDaniel introduced the notion of fuzzy

set into a formal model of the typology and evolution of color lexicons and shifted the emphasis away from the eleven universal color foci of Berlin and Kay to (1) the six primary colors of the Hering opponent process model (black, white, red, yellow, green, and blue), (2) certain categories present in early color terminology systems that consist in fuzzy *unions* of two or more primaries (e.g., [green OR blue]), and (3) categories occurring mostly in later color terminology systems based on fuzzy *intersections* of Hering primaries (e.g., orange = [red AND yellow]).

Kay and McDaniel also related the universal semantics of color to the neurophysiological results of Russell De Valois and his associates. The De Valois findings of the 1960s, based on recordings from LGN (optic nerve) cells of the macaque, were widely considered to provide the neurological locus of the opponent system. It was subsequently recognized that (1) the cells studied by the De Valois group provided no account of the long wavelength red response observed in humans psychophysically, and (2) the specific crossover points between excitation and inhibition for these cells did not correspond well to the psychophysically determined unique hue points. Current vision science continues to maintain the opponent process model on psychophysical grounds while rejecting the specific neurological substrate proposed by De Valois

Since 1978, two important surveys of color lexicons have been conducted, both supporting Berlin and Kay's two broad hypotheses of semantic universals and evolutionary sequence in the lexical encoding of colors: the World Color Survey of Berlin, Kay, and William Merrifield, and the Middle American Color Survey of Robert MacLaury. Kay and Luisa Maffi, in recent work, have proposed, on the basis of the World Color Survey data, a model of the evolution of color terminology systems that attempts to derive the typology and evolutionary trajectories of basic color term systems from facts of color appearance. This model also takes account of the Emergence Hypothesis, according to which not all languages necessarily have a small set of words (or word senses) of pure color meaning whose denotations jointly partition the perceptual color space.

The universalist/evolutionary tradition of research on color categorization has continued to receive methodological criticism from relativists, such as John Lucy and the team of B. Saunders and J. van Brakel, and universalists with competing paradigms, notably Anna Wierzbicka and her associates. The emphasis in these methodological critiques has shifted away from challenging the rigor with which standardized procedures for mapping words to colors are applied to challenging the legitimacy of any such procedures.

(See also *acquisition, brain, category, evolution, relativity, vision*)

## Bibliography

Berlin, Brent, and Paul Kay

1969 Basic Color Terms: Their Universality and Evolution. Berkeley and Los Angeles: University of California Press.

- De Valois, Russell L., I. Abramov, and G. H. Jacobs  
1966 Analysis of Response Patterns of LGN Cells. *Journal of the Optical Society of America* 56:966–977.
- Heider, Eleanor Rosch  
1972 Probabilities, Sampling and the Ethnographic Method: The Case of Dani Colour Names. *Man* 7:448–466.
- Lenneberg, Erik H., and John M. Roberts  
1956 The Language of Experience: A Study in Methodology. *Memoir 13 of International Journal of American Linguistics*.
- Lucy, John A., and Shweder, Richard A.  
1979 The Effect of Incidental Conversation on Memory for Focal Colors. *American Anthropologist* 90:923–931.
- Kay, Paul, and Willett M. Kempton  
1988 What Is the Sapir-Whorf Hypothesis? *American Anthropologist* 86:65–79.
- Kay, Paul, and Luisa Maffi  
In press[CHECK] Color Appearance and the Emergence and Evolution of Basic Color Lexicons. *American Anthropologist*.
- Kay, Paul, and Chad K. McDaniel  
1978 The Linguistic Significance of the Meanings of Basic Color Terms. *Language* 54:610–646.
- MacLaury, Robert E.  
1997 Color and Cognition in Mesoamerica: Constructing Categories as Vantages. Austin: University of Texas Press.
- Saunders, B. A. C., and J. van Brakel  
1997 Are There Non-trivial Constraints on Colour Categorization? *Brain and Behavioral Sciences* 20:167–228. [The paper is accompanied by thirty-one peer commentaries.]

Department of Linguistics  
University of California, Berkeley  
Berkeley, CA 94720  
kay@cogsci.berkeley.edu