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A Sociohistorical Critique of Naturalistic Theories of Color Perception

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Naturalistic experiments of color perception are critically evaluated. The review concludes that they fail to confirm a natural determination of color perception. Rather than demonstrating universal sensitivity to focal colors, the experiments actually yielded enormous cultural variation in response. This variation is interpreted as supporting a sociohistorical psychological explanation of color perception.

An awkward truce prevails between naturalistic and sociohistorical theories of color perception, with each position dominating different aspects of the phenomenon. By mutual agreement, the boundaries of color categories are explained as derivng from social experience. This accords with the work of Sapir, Whorf, Vygotsky, and Luria who conceived of psychological processes as socially mediated. In this view, parents literally teach children color boundaries by referring to certain colors with the same linguistic code, while other colors are designated by other codes. When an American parent asks his/her child the name of blue and green objects, and the child answers with the same word "green," the parent rebukes the child and readjusts the child's categorization system by insisting that "no, the object is blue, not green." Color perception will manifest significant cultural variation insofar as different societies emphasize different color categories. Sociohistorical psychology emphasizes the fact that sensory information is selected, interpreted, and organized by a social consciousness. Perception is thus not reducible to, or explainable by, sensory mechanisms, per se. Sapir, Whorf, Vygotsky, and Luria do not deny the existence of sensory processes – they maintain that these are subordinated to and subsumed within "higher" social psychological functions

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(Luria, 1932; Whorf, 1956, pp. 267–268; Vygotsky, 1978. Cf. also Brown and Lenneberg, 1954, p. 425; Schaff, 1973, p. 191).[1]

While psychologists generally accept a social account of color boundaries, they invoke entirely opposite concepts to explain the perception of the midpoints of color categories, known as focal colors. Perception of focal colors is construed as determined by a natural, species-wide, physiological, sensitivity to these colors independent of social experinece. Socially mediated consciousness does not override natural processes in this domain.

Although this resolution of naturalism and sociohistorical psychology commands mutual respect, it cannot produce lasting peace – for the two theories invoke different premises and processes which cannot both be true. It is illogical to expect that the perception of color boundaries depends upon social learning and manifests cultural variation, while perception of category midpoints is governed by natural, universal mechanisms independent of social experience. How could the single act of color perception be composed of two disjointed, incompatible processes? How could they operate together? What would the switching mechanism be that invoked one process for boundary perception and another process for focal color perception? How could conscious mediation be called up in one case but not the other? Or, alternatively, suppressed in one case but not the other? What functional advantage would be gained by such an awkward juxtaposition of dichotomous operations?

In view of this problematic it is necessary to re-open the debate between naturalistic and sociohistorical theories in order to discover a more principled resolution. There are several ways to embark upon such a resolution. One way is through reviewing the premises of each position with the aim of finding an advantage of one over the other or a possible new synthesis of them both. Because both positions have been clearly articulated in the literature, I shall resist the temptation of taking this theoretical tack, leaving the reader to pursue it on his or her own. Instead, I shall analyze the empirical research that is offered as support for the naturalistic position. I shall demonstrate that the research on focal colors fails to justify the universalist theory and actually indicates that perception of focal colors follows sociohistorical principles. This empirical critique suggests that all aspects of color perception—including the perception of color boundaries and focal colors—can be parsimoniously explained by a unitary set of sociohistorical psychological principles.

The research on focal colors attempts to establish a natural foundation by demonstrating universal sensitivity to focal colors. The assumption is made that universality of responsiveness reflects natural processes. For instance,

[1]Cf. Ratner, 1990, for a full exposition of the distinction between sensory processes and social psychological phenomena. Ratner also presents the evidence demonstrating cultural variation in perception of color boundaries.

Hardin assumes that "The perceptual salience of certain spectral hues suggests the existence of a natural, biologically induced set of hue categories . . ." (1988, p. 156). Hardin premised his "reduction of chromatic expriences to neural processes" (pp. 111–112) on the purported existence of universal color foci—and purported universal color boundaries as well (pp. 169ff). Berlin and Kay (1969, pp. 109–110) similarly use their purported findings of universal focal colors to claim biological constraints on color perception akin to biological constraints on language structure as postulated by Chomsky (cf. also Bornstein, 1975, p. 791; Kay and McDaniel, 1978). We shall have occasion to argue later on that this presumption of universalism being caused by natural mechanisms is fallacious. However, for the moment, we shall let the assumption pass and confine our examination to ascertain whether focal color perception is universal in the first place. A review of the research on focal colors must necessarily begin with the founding work of Berlin and Kay. While their methodology has received severe criticism, these critiques have done little to slow the acceptance of naturalistic conclusions. Consequently, a brief review of these critiques is warranted. Berlin and Kay's data will then be freshly reanalyzed with the intention of reinforcing the earlier methodological critiques. We shall then proceed to analyze other naturalistic research on focal colors.

Berlin and Kay's (1969) pioneering study established focal colors as the universally agreed upon, best prototypical examples of certain colors. The colored sets from which the focal colors were selected were dubbed "basic colors." Now, any claims about the universality of focal colors depend upon the universality of the basic colors from which they were selected. After all, if the basic colors are not universal, then the focal colors certainly cannot be either. Berlin and Kay's procedures for deriving the basic colors make it extremely unlikely that these colors are universally salient. Instead, they seem to be salient primarily to Western enculturated people, which taints the focal colors with the same ethnocentric bias.

Suspicion about the universality of basic colors starts with the subjects who provided the information for generating the basic colors. The subjects were asked to state the names of colors most salient to them, and to identify these on a color chart. Although supposedly representing diverse cultural groups, they, in fact, were bilingual foreign residents of San Francisco. Their obvious social and linguistic enculturation would be expected to make their color perception continuous with native Americans, and any similarity cannot be presumed to be due to universal biological processes. Compounding this cultural restriction in the subject population is Berlin and Kay's homogenizing of the data. From the numerous colors the subject selected as salient, Berlin and Kay decreed that what qualified as a basic color were only those colors whose verbal description was a single, abstract color word. Colors whose names were also object names were excluded. This arbitrary criterion excluded

90% of the colors with which the subjects were familiar. Moreover, the restriction contained a crucial cultural bias: abstract color names (like all abstract stimuli and concepts) are characteristic of modern society, which means that Berlin and Kay's criteria necessarily biased the selection of colors to those that are noticed in our culture. Berlin and Kay's calling these colors "basic" is therefore quite restrictive. It also creates the false impression that the criteria are naturally salient when, in fact, they were simply imposed by the authors. It cannot be emphasized too strongly that the basic colors from which focal colors were later selected, were arbitrarily selected by Berlin and Kay from a larger list of colors provided by the subjects.

The "epistemological chauvinism" (Bousfield, 1979) that haunts Berlin and Kay's methodology has yet another expression. The stimulus colors were further homogenized by arbitrarily giving them certain English names which were not necessarily accurate. For example, the Tiv languange has one color category that includes "warm colors" from red to yellow to brown. When Tiv subjects indicated the boundaries to this category, as well as the best example (focal color), their choices were arbitrarily glossed as "red." This obscures the possibility that they actually perceived the category and the best example as brown, yellow, or even some color that is quite foreign to Americans (Hickerson, 1971, p. 267). Berlin and Kay never investigated the psychological meaning or experience that the color had for the subjects. They unjustifiably assumed that the Tivs and Americans had the same perceptual experience (Bousfield, 1979, p. 106).

Given such sanitized stimulus materials and such homogenized subjects, it would not be surprising had they agreed on the best example, or focal color, of each color category. What is surprising is that the subjects' choices of focal colors varied dramatically. Berlin and Kay's Figure 3 on page 9 of their book shows an enormous distribution of focal choices across subjects of different cultures. For example, focal green varies from our green-yellow through our green to our blue. In other words, certain cultures pick the best example of "green" where we see blue. The distributions of focal orange and yellow also overlap, which means that what some cultures see as the best example of orange corresponds to what other cultures select as the best example of yellow. In view of this data, it is misleading for Berlin and Kay to claim that "the foci of basic color terms are similar in all languages" (p. 10). Just as "basic color terms" are not at all basic, neither are focal colors really focal in the sense of being a consensual converging point of color judgments. Instead, focal colors evidence dramatic cultural variation indicating that their perception is shaped by social experience.

Lumsden's (1985) attempt at proving humans' natural, universal sensitivity to focal colors is equally unsatisfactory. Lumsden found that 16-week old infants, presented with a spectrum of colored lights, habituated to the repeated

presentation of the lights and stopped paying attention to them. They only renewed interest when discriminably different lights were presented. Lumsden construed these boundary points as color boundaries. He found a high correspondence between these color boundaries and the distribution of focal colors that Berlin and Kay plotted in their Figure 3. In other words, Berlin and Kay's distribution of red focal colors ranged over the same wavelengths that comprised one of the infants' color boundaries. Altogether, Lumsden identified four color categories separated by three boundaries for children which corresponded to similar ranges and boundaries in adult focal color perception. Lumsden concludes that the congruence is due to the fact that infants' natural sensitivity is the basis of adult perception of focal colors.

This conclusion is invalidated by Lumsden's highly questionable assumptions and procedures. In the first place, it is not obvious that infantile habituation to a group of colored lights is equivalent to adult color perception. We do not know that the range of lights to which an infant habituates is what an adult *sees* as being one color. In fact, Lumsden's own evidence suggests that this is *not* the case. The range of colored lights to which the infants habituated and which Lumsden called yellow is the same range in which Berlin and Kay's adults typically distinguish *three* colors—yellow, orange, and brown. Proclaiming these three adult colors to be identical with the infants' one is unjustified at best.

Secondly, Lumsden confuses the focal colors that adults perceive with color categories that infants purportedly perceive. Focal colors are obtained by asking adults to choose the best example of a range of colors. These best examples are not equivalent to the full color category which includes marginal colors as well. Infants obviously have no concept of a best example and their spontaneous habituation to colored lights indicates, if anything, color categories, not focal colors. Lumsden's data do not support claims regarding focal color perception because focal colors were not investigated.

Eleanor Rosch (also known as Eleanor Heider) further overstated the universality of focal color perception. She further homogenized Berlin and Kay's colors by selecting the most commonly chosen focal color within each of their categories (Heider, 1972).[2] These eight colors were presented to American and bilingual foreign students residing in the U.S.A.—another extremely homogeneous sample. The hues were presented in varying saturations and subjects were asked to pick the *saturation* (purity, richness) that was the best example of the "basic color term." To reiterate, subjects were not asked to

[2]Of course, the most frequently chosen focal color does not necessarily mean that it was chosen by most of the subjects. Long ago, Ervin (1961) found that the most frequently chosen focal color was only judged by 34% of the subjects as being the best representative of the category. Consequently, the criterion of "most frequently selected" contains serious ambiguities and conceals significant psychological differences.

choose the *hue* that best represents the color, they were only given one hue for each color and asked to choose the best saturation. (Although Rosch calls this choice "focal color," the term is a misnomer because subjects were selecting saturation, not hue. A more appropriate term is "focal *saturation*.") Approximately 95% of both foreign and Unites States subjects chose the highest saturation levels as the best representative or focal color.

Rosch's construal of these findings as proof of a physiologically conditioned, universal sensitivity to certain natural prototypical colors is quite gratuitous. In the first place, universality has been *precluded* through a narrow homogenous sample of subjects as well as stimuli. It is quite inappropriate for Rosch to restrict her sample to Americans and foreign students residing in the United States and then proclaim her results as universal. Rosch did attempt to establish universal perception of the highly saturated focal colors in a genuine cross-cultural study. She compared Americans with Dani subjects from Indonesian New Guinea whose language only contains two color terms, light and dark. Although Rosch concludes that the two groups responded similarly to focal colors (saturations) her data do not support the naturalist claim. One indication of perceptual differences was the Dani "unwillingness" to distinguish focal colors from nonfocals. When presented with a set of one focal and two nonfocal colors (saturations), the Dani subjects "were unwilling to designate one of the color chips as the most typical member of the three-chip cateogry" (Rosch, 1973, p. 340). It is not clear whether this unwillingness was due to Dani failure to distinguish the ethocentrically-derived focal colors; whatever the reason, the fact remains that they did not select the supposedly universal focal colors.

Passing over this disturbing anomaly, Heider employed a more circuitous approach to demonstrate universal sensitivity to focal colors. She hypothesized that the focal colors' salience would make them more easily remembered than nonfocal colors, and this should hold true for even cultures lacking the basic color terms. In other words, contrary to the Sapir-Whorf hypothesis, focal colors are salient independent of language and should be remembered even in the absence of appropriate color terminology. In one experiment (Heider, 1972), Dani and American subjects were presented eight highly saturated focal colors as well as 16 nonfocal colors of different hues and saturations. A color was presented for five seconds, followed by a 30 second unstructured waiting period, after which an array of 160 colors was shown. Subjects had to identify the stimulus color in the array. Results were as follows: both American and Dani subjects recognized more focal colors than nonfocal colors—however the differences are complex as Table 1 indicates.

While the data might be taken as support for Rosch's hypothesis about the superior memorability of focal colors, Lucy and Shweder (1979) argue that Rosch's finding is an artifact of the array of test colors in which focals are

Table 1

American and Dani Recall of Focal and Nonfocal Colors (from Heider, 1972).

	Americans Stimulus Colors		Danis Stimulus Colors	
	8 Focal	16 Nonfocal	8 Focal	16 Nonfocal
Number Correct	5.25	5.73	2.05	1.18

more easily recognized than nonfocals. Using a modified array, but otherwise following Rosch's procedure of a five second presentation followed by a 30 second waiting period, memory for nonfocals improved to where it was equal with memory for focals. Garro (1986) rejects this critique and contends that if the 30 second waiting period is endured silently—instead of allowing conversation as Lucy and Shweder did—focal colors evidence a memory advantage over nonfocal colors. Leaving aside the question of whether memory for focal colors is or is not superior to nonfocal color recall, Rosch's data itself can be interpreted as demonstrating enormous cultural differences in memory for focal colors. After all, Americans remembered 5 of the 8 focal colors in contrast to the Dani who only remembered 2 of 8 focal colors. And this intercultural difference in memory of focal colors (5.25/8 - 2.05/8 = 3.2/8) is far greater than the intra-cultural difference between memory of focal and nonfocal colors (for Americans: 5.25/8 - 5.73/16 = 2.38/8; for Dani: 2.05/8 - 1.18/16 = 1.46/8). Put differently, the cultural difference in memorability of focal colors is greater than the difference between focal and nonfocal colors. In other words, culture and language have a greater impact on memory than focality does!

Rosch does acknowledge the Danis' poor memory for focal colors—however she attributes this to their weak memory in general. Their simple, uneducated life leads the Dani "to have neither need for, practice with, nor any explicit training in the use of memory control processes" (Heider, 1972, p. 19). This explanation is preposterous in its assumption that the failure to remember Heider's ethnocentrically derived focal colors reflects a general memory deficiency. A far more plausible interpretation of the subjects' deficient memory for focal colors is the fact that materials were strangely unfamiliar to subjects. A people who conceive of color as profoundly implicated in specific objects would obviously be bewildered by individual, discrete color chips, divorced from any concrete object. Moreover, the arbitrary task of remembering such meaningless stimuli apart from any real purpose—as an abstract act of free recall—would compound the bizarreness of the experiment for Dani subjects. Interestingly enough, although Rosch's explanation is incorrect, it is a cultural explanation which invokes the Dani life style as the reason for

their poor memory. This explanation contradicts the naturalistic hypothesis it seeks to support. Rosch's hypothesis, after all, is that focal colors are *naturally* perceived and remembered because of an intrinsic sensitivity to them. She frequently insists that this sensitivity is unconditioned by culture and language. Yet her explanation for the Dani's poor memory depends entirely upon the *social* stimulation of memory. Her own conclusion thus contradicts rather than confirms the naturalistic theory. In addition, neither Rosch's social nor her biological explanation can account for the *failure* of *Americans* to remember a sizeable proportion of the focal colors. The complex social life and sophisticated memory control of American subjects should enable them to remember virtually all of the focal colors, especially if combined with a natural sensitivity to them. Yet these subjects inexplicably forgot three of eight focal colors.

Harkness's (1973) confirmation of Rosch's and Berlin and Kay's universal focal colors is as contradictory as their research. Harkness commits numerous methodological and conceptual errors which are surprising because her other writings express a deep sensitivity to the cultural character of psychology.

In brief, Harkness presented Berlin and Kay's "basic colors" to children and adults in two ethnic groups (Spanish and Mayan speaking) in Guatemala. She asked subjects to name the colors and select the best examples of each. While color areas (boundaries) varied markedly between the two groups, "the best examples of red, green, and yellow adult samples correspond exactly" (p. 182). The results are interpreted as giving "strong support to Berlin and Kay's finding on the universality of best examples of basic color terms" (p. 199). The reason for such universality is that basic color terms represent "natural categories" as Heider asserted (p. 200).

Strangely, the data support none of these contentions. In the first place, the two groups were linguistically quite close which could plausibly account for any perceptual similarity. Assumptions about natural, universal perceptual sensitivity are therefore unwarranted. The entire Mayan community spoke a bastardized dialect that included many Spanish words. The Mayan adults even used some Spanish color terms during the test. In addition, the Mayan-speaking children were students in a bilingual class. In fact, most 11–12 year olds in the Mayan community were so strongly bilingual they were excluded from the analysis (p. 188).

Furthermore, the areas of agreement on color terms and focal colors were limited to red, yellow, green and white. Beyond this commonality, the Spanish speakers named three additional categories—blue, brown, and purple—for which they selected best examples. These categories and best examples were not selected by the Mayan speakers. Even more significant is the fact that the intercultural areas of agreement are more apparent than real. This stems from the unworkable definition of focal color that Harkness employed. Focal colors are simply the chip chosen most frequently as being the best example

of each color term. Harkness's minimal criterion was that 15% of subjects must choose a single chip for it to be designated as focal. Of course, sometimes more than 15% selected the same chip, but the low criterion means that many (if not most) of the focal colors were only selected by a small proportion of subjects; they do not represent widespread agreement at all. Consequently, intercultural commonality of focal colors simply means that as few as 15% of individuals in both cultures chose those chips as the best examples. Given this, it is absurd to conclude that intercultural commonality of focal colors demonstrates a universal agreement that is engendered by a universal perceptual process.

In fact, it is misleading to even suggest universality when only 15% of the subjects are in agreement. Furthermore, Harkness admits that the percentage of subjects choosing the focal colors differed between the two groups which is further evidence for *dis*agreement. She says (p. 193) that the Spanish-speaking subjects demonstrated lower agreement amongst themselves than the Mayan-speakers.

Not only was agreement within each culture low on choosing focal chips. Agreement was also low on naming the chips. Less than 70% of the Spanish-speaking adults named the same chips pink, purple, orange, and grey. This led Harkness to conclude that "for the Spanish sample not all of the 'basic color terms' are equally basic" (p. 184). Actually, Berlin and Kay's abritrary selection of color terms makes none of them basic.

An additional piece of evidence contradicts Harkness's conclusion about universal color perception and demonstrates its cultural character. This evidence concerns developmental changes in color perception. Children chose somewhat different focal colors than did adults. Spanish adults chose two focal browns, neither of which agreed with the one focal brown selected by the 11-year olds. Furthermore, children of both samples manifested lower agreement in naming most of the colors than adults did (pp. 184–185). Whereas 100% of the Mayan adults agreed on which chips were yellow, less than 90% of the children agreed. And whereas 60% of Spanish-speaking adults agreed on purple, only 15% of the children agreed. Since there is no known sensory difference between 8-year olds and adults that would account for these discrepancies, the likely explanation is that the more extensive experience of adults has taught them a common set of color schemas which children have not yet learned.

Social experience, rather than sensory maturation, is evidently also responsible for the fact that Spanish adults indicated significantly more focal colors than did Spanish children (pp. 189, 191). The children selected five focal colors (according to the criterion of at least 15% consensus)—white, black, red, green, yellow—in contrast to the adults' ten. In contrast, Mayan children and adults chose the same number of focal colors—four and five, respectively (pp.

186–187). This is an additional cultural difference that Harkness overlooks in her advocacy of universal focal color perception.

In conclusion, Harkness's data, like that of other naturalistically oriented psychologists, demonstrate cultural variation—not universality—in focal color perception. Evidently, humans are not equally sensitive to the same focal colors. Since no differences have been discovered in the visual apparatus of the subjects in the foregoing studies, the substantial variation in focal perception suggests a cultural rather than a natural underpinning.

All the preceding cross cultural research is premised on the idea that common responsiveness to focal colors reflects and demonstrates a natural, sensory-neural determination of perception. However, attributing universal psychological activity to physiological mechanisms is unjustified because similarities in focal color perception could be due to environmental factors. Focal colors might be more prevalent in the environment than nonfocal colors, in which case preference for and sensitivity to saturated colors would hinge on familiarity with them. Until this possibility is ruled out, physiological sensitivity to saturated colors cannot be presumed.[3] It is a logical non-sequitur to conclude natural determination from universal response tendencies. Of course, the striking absence of universal responsiveness to focal colors makes this issue quite moot and challenges any notion of naturalism. Naturalistic explanations of color perception can only be maintained by ignoring social variations, and this is precisely what proponents of naturalism do. Hardin barely mentions the relativist position (Hardin, 1988, p. 155) and affords no detailed discussion of its argument or the evidence that has been marshalled in its behalf. He also uncritically accepts Berlin and Kay's universal findings without mentioning any of the numerous critiques that have been levelled against it. Hardin then completes the conspiracy of silence by concluding that "the publication of *Basic Color Terms* has by and large successfully passed the critical scrutiny of linguists and anthropologists" (Hardin, 1988, p. 156).

While cultural variation in color perception undermines the naturalistic theory, a more direct challenge to naturalism is Lucy and Shweder's (1979) demonstration that color perception and memory are not natural but involve higher social-psychological functions. Taking the nonconventional step of talking to their subjects to ascertain the psychological activity of color perception and recall, Lucy and Shweder found that subjects coded colors in prepara-

[3]Of course, even a genuine sensitivity to saturated colors presented as bare, isolated stimuli on Munsell color chips provides precious little information about the perception and memory of colors in psychologically meaningful contexts. All of the foregoing research on color perception only concerns what Whorf termed lower sensory processes. The research unfortunately ignores the social psychology of color perception which, as Whorf emphasized, typically overrides the lower processes. (Cf. Kay and Kempton's 1984 experiment which found that linguistically encoded color concepts override physiological mechanisms to determine color perception.)

tion for recall by associating them with names of colors as well as with names of familiar objects. Some examples are "pea soup green but a little lighter" or "the color of my bedroom." The test colors in the array were then compared against this verbal code in order to match the stimulus color. Subjects generally mediated their color perception by culturally provided cognitive and verbal codes. Very few subjects reported using pure visualization without the verbal element (Lucy and Shweder, 1979, p. 593). Emotions also mediate color perception since subjects had strong emotional reactions such as "ugly," "pretty," and "dull" to specific colors. Color perception of focals and nonfocals alike is therefore definitely not a natural sensitivity predetermined by physiological processes. It is a psychological process intimately involving social thinking and language. Focal color perception is not an automatic response to sensory information. It is intentionally constructed by a social consciousness that selects, compares, and interprets sensory information in order to yield a resultant perceptual response. The interdependence of focal color recognition with their social familiarity is reflected in Lucy and Shweder's finding that interpersonal codability of stimuli and array colors correlate more than 0.5 with recognition memory (cf. also, Brown and Lenneberg, 1954; Lantz and Steffire, 1964; Steffire, Vales, and Morley, 1966).

Lucy and Shweder's findings strip away the veil of reification that impersonal, "objective" experimental procedures impose. Traditional positivistic procedures obscure the social psychological activity that constitutes a response, and this lends credence to the illusion of naturalness. But illuminating the activity that actually generates responses reveals the intentional, socially mediated effort that underlies color perception—and psychological functions in general.

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