WHORF AND UNIVERSALS OF COLOR NOMENCLATURE

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Inherent physical-perceptual distinctiveness plays a large role in color salience. In addition, words for color referents vary in lexical salience in a way that is concordant with the physical-perceptual distinctiveness of these referents. Highly distinctive referents typically receive salient labels, while less distinctive referents receive nonsalient ones. Hence the lexical salience of color words reflects underlying physical-perceptual salience. However, in addition to mirroring physical-perceptual distinctiveness lexical salience also magnifies it. Although language does not set the agenda for color categorization, it greatly augments the salience of color categories. Thus lexical salience plays a crucial mediating and amplifying role between the physical-perceptual distinctiveness of color referents and color behavior. These findings are consistent with both a universalist interpretation of color terminology and a Whorfian hypothesis which asserts that color language exerts an active influence on human thought and behavior.

SEVERAL OBSERVERS HAVE NOTED that underlying physical-perceptual factors influence human color categorization (Bornstein 1975; Kay and McDaniel 1978; Cairo 1979; von Wattenwyl and Zollinger 1979).[1] This influence is such that the physically continuous hue spectrum is divided perceptually into four natural categories: "red," "yellow," "green," and "blue" (Bornstein, Kessen, and Weiskopf 1976). These categories in turn have focal referents for which there is widespread cross-language agreement (Berlin and Kay 1969). Focal referents are those color varieties that are judged by speakers to be most typical or representative of a color category, e.g., the best "red" as opposed to other varieties of "red." Berlin and Kay (1969) find that if a language has only one hue term, it is always "red." This is consistent with evidence gathered by Bornstein, Kessen, and Weiskopf (1976) which shows that of the four intrinsic hue categories "red" is especially salient. Furthermore, if a language has four hue terms, they are virtually always "red," "yellow," "green," and "blue" (Berlin and Kay 1969). Thus for the color domain there is widespread lexical uniformity, due in part to underlying physical-perceptual constraints.

Lucy and Shweder (1979) have undertaken several experiments involving color behavior, particularly memory for and communication about color. They relate their findings to a Whorfian framework which claims that language influences color behavior. Unfortunately they treat language as a "black box" variable and do not attempt to determine the means by which it exercises its influences. Our view is that lexical salience both mirrors and magnifies the inherent physical-perceptual salience of color referents and thus affects color behavior. That is, lexical salience reflects underlying physical-perceptual salience, but actively rather than passively; due to lexical salience color categories gain significance for humans beyond the inherent physical-perceptual salience of their referents. The findings reviewed here support a Whorfian hypothesis which proposes that language influences color behavior by differentially augmenting the intrinsic salience of color referents through lexical salience effects.

LEXICAL SALIENCE AND REFERENTIAL SALIENCE

Labels for colors fit into the framework of linguistic marking developed over the years by Jakobson (1941), Greenberg (1966, 1969, 1975), and others. This framework posits a distinction between unmarked and marked linguistic features and extends to all components of language: phonology, morphosyntax, and lexicon. Here unmarked terms are designated lexically salient, while marked ones are described as nonsalient. Several features occur together in typical lexical salience relationships (Greenberg 1966, 1975; Brown and Witkowski 1980). One is greater frequency of use for salient terms than for nonsalient ones. Another feature of lexical salience is phonological and morphological brevity; salient terms are regularly less complex than nonsalient ones. This feature is closely related to frequency of use since, as Zipf (1935, 1949) shows, there is a strong correlation between the orthographic length of words and their frequency of use. Short words have high use frequencies, while long ones have low frequencies. An additional feature is that children learning language regularly acquire salient terms before less salient ones. This is not surprising since short, frequent words are easier for children to learn than long, infrequent ones.

Another feature of lexical salience is developmental priority, i.e., salient lexical items are added to vocabularies before nonsalient ones. Berlin and Kay (1969) show that "red" is the first hue category to be lexically encoded, followed by "yellow," "green," and "blue," with "brown," "purple," "pink," and "orange" added last. This developmental sequence has been confirmed by evidence gathered and compiled subsequent to its formulation (Berlin and Berlin 1975; Broch 1974; Dougherty 1975; Hage and Hawkes 1975; Harkness 1973; Heinrich 1972, 1974; Snow 1971; Witkowski and Brown 1981). In addition, Hays et al. (1972), Durbin (1972), Bolton (1978), and Bolton and Crisp (1979) show that features such as high use frequency and brevity correlate strongly with this developmental sequence. Several other studies (e.g., Cruse 1977; Johnson 1977) show that children learn color names largely in encoding sequence order.

Words labeling colors of this lexical salience sequence are "basic color terms" (Berlin and Kay 1969). Although basic color words (English examples: *red, green, brown, purple*) differ among themselves in lexical salience largely in accordance with encoding sequence order, as a group they are typically more salient than the numerous nonbasic color expressions of a language (English examples: *pale yellow, olive, royal blue*). Basic color terms, then, are all relatively short and frequent in use and, thus, lexically salient compared to other color expressions in a language.

The intrinsic physical-perceptual salience of hue classes—with "red" more distinctive than "yellow," "green," and "blue," and these more distinctive than "brown," "pink," "purple," and "orange"—corresponds with the lexical salience of their labels. This indicates that the former sequence is translated into the latter. Thus the intrinsic perceptual salience of color referents is converted through lexical encoding to the salience sequence for color labels, manifested through effects such as high use frequency, brevity, and early child acquisition (cf. Witkowski and Brown 1977).

There is also an important cultural influence on color categorization. The number of categories encoded, but not the sequence of encoding, is influenced by societal scale (Berlin and Kay 1969; Naroll 1970; Ember 1978). Large-scale societies typically have larger inventories of basic color words than small-scale societies. This seems attributable to elaborate color manipulation activities such as painting and dyeing in large-scale societies, which augment the usefulness of basic color words (Witkowski and Brown 1978, 1981; Lokaj, Brown, and Witkowski 1982).

The number of basic color words in a language varies from two to eleven (Berlin and Kay 1969). For example, English has eleven terms, while the Dani language in New Guinea has two basic terms (Heider 1972). Of course Dani speakers have additional terms for color and can create a potentially infinite number of expressions by drawing on object names which exemplify colors especially aptly. Such color labels, however, tend to be infrequent in use and complex in form, and are thus nonsalient.

While the number of basic color words varies as a function of their cultural importance, relative physical-perceptual and lexical salience do not change when new categories are encoded. Therefore, the universal aspect of the domain is the salience hierarchy, which is largely constant across languages; the variable component is number of terms encoded. Two factors, then, generate referential salience for color: perceptual regularities common to all humans influence the relative intrinsic salience of color referents and thus their relative lexical salience, while cultural importance affects the entire domain and influences the total number of terms encoded, but not encoding sequence order.

COLOR BEHAVIOR EXPERIMENTS

Lucy and Shweder (1979) have designed experiments to test and expand findings of several earlier studies of color language and behavior, and have related their findings to Whorf's (1956) views of language, thought, and the external world. They argue that color language influences color behavior, but do not explicate the role played by language. Unfortunately, they also assert that physical-perceptual salience seldom influences color behavior (1979:603-4). Our purpose here is to discuss the role of lexical salience as a mediating and amplifying feature relating physical-perceptual salience to color behavior.

Heider (1972) has tested the hypothesis that focal colors (e.g., the best "red") are more easily remembered than nonfocal colors (i.e., color varieties other than typical or representative ones). Heider demonstrates this for English speakers and for Dani speakers in New Guinea. She attributes the success in memory recall tasks of focal versus nonfocal colors to the greater inherent physical-perceptual salience of focal color varieties. The notable perceptual salience of focal colors can also account for the finding that individuals speaking different languages show substantial agreement when asked to locate in a large array the most typical or representative example of a color category (Berlin and Kay 1969).

Lucy and Shweder (1979) have retested for English speakers Heider's finding that focal colors are remembered better than nonfocal ones. They employed the same array of colors and the same focal and nonfocal target colors used by Heider (1972). Their first task involved identification of a target color in the full array while both the color and array are in view. Success in this task for focal and nonfocal color varieties conforms with the physical-perceptual and lexical salience sequence for color (Table 1; see Lucy and Shweder's Appendix 2 for unaggregated data).

TABLE 1
Memory for Focal and Nonfocal Colors

Lexical Salience Sequence	Identification Success when Stimulus and Array are in View
1. Focal "red"	94%
2. Average for focal "yellow," "green," and "blue"	82%
3. Average for focal "brown," "pink," "purple," and "orange"	72%
4. Average for nonfocal "red," etc.	65%

The Berlin and Kay color array was reduced by Heider from 320 to 160 color varieties by eliminating alternate columns; memory tasks utilizing the full array proved too difficult. In these arrays, based on the Munsell color system (Newhall, Nickerson, and Judd 1943), color varieties are arranged horizontally by hue and vertically by brightness. In addition, all colors are at maximum saturation, so that different hues have widely varying saturation levels. Collier (1973) noted this feature of the Munsell array and suggested that the cross-language tendency to identify the same focal colors might relate to saturation level. To test this hypothesis, Collier (1976) constructed a modified version of the array which held saturation relatively constant across colors. With this array he replicated Berlin and Kay's findings on color-term focus; speakers of radically different languages located the best, or most representative "red," "yellow," etc., within restricted and nonoverlapping areas of color space.

Heider (1972) notes that her focal and nonfocal target colors are not perceptually equidistant from neighboring colors. Consequently, she applied a control procedure developed by Brown and Lenneberg (1954) to test for any possible systematic bias favoring focal colors, but found none. Lucy and Shweder (1979) question the appropriateness of her control procedure and suggest that the memory success of focal colors may be due to bias rather than inherent physical-perceptual salience. However, they present no evidence demonstrating focal-color bias, and in fact provide evidence against it. In a repetition of their experiment described above, they randomized placement of colors in the array such that "reds" are mixed with "blues," "greens," and so forth. In this array small original differences in perceptual equidistance are irrelevant, due to large differences in equidistance between adjacent colors produced by randomization, yet focal colors continued to show a strong advantage over nonfocal ones (see Part one of Experiment two). In short, Lucy and Shweder present no evidence that perceptual nonequidistance in the array favors focal colors. Furthermore, their randomization procedure provides positive evidence against this hypothesis.

Finally, Lucy and Shweder claim that their first experiment simulates conditions of perfect memory because the stimulus color and array are always in view. Under this interpretation the experiment is not a memory task, since the stimulus color is always in view and need not be remembered. A circumstance that argues against this interpretation, however, is that individuals were directed to perform as accurately and as *quickly* as possible. The four-to-five-second average response latency score indicates that performance was indeed rapid (Lucy and Shweder 1979:589). Evidently individuals glanced at the stimulus color then quickly searched the large array for the matching color (they were not allowed to pick up the stimulus color and match it directly). The short latency times suggest that there was little checking back to review the original stimulus color; hence this task is a memory task. That is, the stimulus color is held in memory for the four to five seconds required to locate the matching color in the large array. Since Lucy and Shweder's findings show a strong advantage for focal as opposed to nonfocal colors in this very short term memory task, they confirm Heider's memory findings.

Nevertheless, Lucy and Shweder conclude that Heider's array favors focal colors. When randomization did not lessen this putative bias, they removed colors from the array that were most similar to the focal and nonfocal target colors. Similarity was determined by how often a nontarget color is falsely picked in place of a target color. Since nonfocals show lower rates of correct matching, more false positives similar to nonfocals exist than those similar to focals. Hence removing false positives improves the performance of nonfocals more than focals. After several sifts in which false positives were removed, they finally managed to equalize substantially the performance of focal and nonfocal target colors (see their Experiment two). In this way Lucy and Shweder artificially improved the performance of nonfocal target colors compared to focal ones.

This artifically balanced array should greatly reduce focus effects if physical-perceptual salience is the only factor involved, i.e., if lexical salience has no independent effect. However, Lucy and Shweder continued to find focus effects in their subsequequent experiments–sometimes even strong ones. Thus Lucy and Shweder inadvertantly produced an important methodological breakthrough: the factors of physical-perceptual and lexical salience, usually welded tightly together because the latter reflects the former, have been to a large degree separated. By controlling for physical-perceptual salience, independent influence of lexical salience can be assessed. Their attempt to eliminate a putative bias creates a true bias with great theoretical significance.

MEMORY AND LEXICAL SALIENCE

Lucy and Shweder conducted additional memory recognition tests using their randomized array, reduced from Heider's 160 colors to 120 by the sifting described above. Individuals were shown one of the focal or nonfocal target colors, then after a lapse of either thirty seconds (short-term memory) or thirty minutes (long-term memory) they were asked to identify the target color in the array. For short-term memory there was no statistically significant focal color advantage, although the primary focals ("red," "yellow," "green," and "blue") showed a modest advantage compared to nonprimary focals and nonfocals (76 percent versus 53 percent correct identification; see their Appendix 4). This result confirms that most of the physical-perceptual advantage of focal colors was indeed removed through sifting.

The long-term memory findings, however, follow the lexical salience sequence for color quite closely (Table 2; see their Appendix 4).

TABLE 2
Lexical Salience and Long-Term Color Memory

Lexical Salience Sequence	Long-Term Memory Success
1. Average for focal "red," "yellow," "green," and "blue"	67%
2. Average for focal "brown," "pink," "purple," and "orange"	50%
3. Average for nonfocal "red," etc.	42%

Lucy and Shweder's memory findings are weaker than Heider's (1972), because through sifting they largely neutralized the inherent physical-perceptual advantage of focal colors. What is surprising in this context is the appearance of focus effects for long-term memory, almost certainly due to the influence of lexical salience. The weak findings for short-term memory support this interpretation, since immediate memory is probably less dependent on language. Memory, whether short term or long term, can involve at least two cognitive strategies: colors can be stored directly as images or as labeled categories, or, conceivably, as both simultaneously. It is usually assumed that detailed images play a greater role in short-term than in long-term memory; labeled categories would therefore be more important in long-term memory.

These findings demonstrate that even when physical-perceptual salience is largely neutralized, the salience inherent in labeled categories has a notable influence. Lexical salience not only reflects physical-perceptual salience, but also differentially augments it. That is, categories with salient labels exert a greater influence than categories with nonsalient ones. The function of lexical encoding in the color domain is not to alter physical-perceptual salience, but instead to capture and amplify it. Highly salient color referents are translated through lexical encoding into highly salient labeled categories—more effective long-term memory vehicles than less-salient labeled categories associated with less-salient referents.

COMMUNICATION ACCURACY AND LEXICAL SALIENCE

Communication accuracy is the degree of success speakers have in directing the attention of others to specific referents through verbal description. In the case of colors, communication involves a high level of accuracy when a verbal description, such as a color term, or expression, consistently leads to correct identification by others of the color intended.

Lantz and Stefflre (1964) show that color varieties correctly selected from an array by one individual, after they have been described by another using only color terms and expressions, tend strongly to be those colors best remembered in recall tasks. Thus color varieties that are remembered readily are those readily identified through communication. In addition, brevity of name, a lexical salience feature, is indicative of memory success (Lantz and Stefflre 1964). Colors with short names are remembered better than those with long names, especially in long-term and difficult memory tasks. Communication success and memory success, then, are greater for colors with salient labels than for those with less salient ones. Furthermore, long-term memory is more strongly related to communication success than is short-term memory, suggesting that communication (and therefore language) is more influential in long-term than short-term memory (Lantz and Stefflre 1964).

Lucy and Shweder (1979) also investigated color communication between individuals, and found lexical salience for color to be strongly related to successful color communication (Table 3; see their Appendix 6).

TABLE 3
Lexical Salience and Two-Person Communication

Lexical Salience Sequence	Two-Person Communication Success
1. Focal "red"	77%
2. Average for focal "yellow," "green," and "blue"	52%
3. Average for focal "brown," "pink," "purple," and "orange"	44%
4. Average for nonfocal "red," etc.	35%

Lucy and Shweder's final experiment was a group communication task. Descriptions for the focal and nonfocal target colors were gathered from twenty-nine individuals. By sifting and averaging, common names and phrases were extracted (see their Appendix 5). These descriptions ranged from highly salient terms, such as *red* for focal "red" (Chip 21: Appendix 5) to nonsalient expressions such as *olive green, yellowish green,* and *avocado green* for a nonfocal "green" (Chip 1: Appendix 5). New individuals then chose colors from the array that best fit these descriptions. Again lexical salience for color strongly predicted success in this task (Table 4; see their Appendix 6).

TABLE 4
Lexical Salience and Group Communication

Lexical Salience Sequence	Group Communication Success
1. Focal "red"	70%
2. Average for focal "yellow," "green," and "blue"	50%
3. Average for focal "brown," "pink," "purple," and "orange"	43%
4. Average for nonfocal "red," etc.	27%

Lucy and Shweder also confirm Lantz and Stefflre's (1964) finding that communicative success for a color variety is strongly related to memory success for that color variety. In addition, they show that lexical salience (the "focality" variable in their Figure 2) exerts a much stronger influence on communication than on memory. This is to be expected, since communication is a more strongly language based activity than is remembering. From the results presented above it is apparent that lexical salience contributes strongly to communication success.

Future investigation will undoubtedly determine in greater detail the contribution made to successful communication by individual features of lexical salience. One possibility involves the frequency-of-use feature. Highly salient or frequently used color terms are, of course, associated with high degrees of communication success as compared to less frequently used terms and expressions. If a term is used often, there is abundant opportunity for speakers to reach consensus with respect to its referential range and focus. High referential agreement would, in turn, facilitate communication success. This advantage disappears when frequency of use is reduced; words or expressions which are only occasionally used provide less opportunity for referential consensus to emerge.[2]

LEXICALIZATION AND COLOR BEHAVIOR

The role of lexical salience in augmenting the significance of color referents suggests that variation in the number of salient basic-color words encoded in languages should strongly influence color communication and memory. A greater number of salient basic-color words should enhance these behaviors by providing an expanded number of lexical benchmarks for communicating about color phenomena and, consequently, for remembering them successfully. As noted above, variation in the number of basic color terms encoded in languages appears attributable to the variable cultural importance of the color domain across societies (Berlin and Kay 1969; Naroll 1970; Ember 1978; Witkowski and Brown 1978, 1981; Lokaj, Brown, and Witkowski 1982).

Stefflre, Castillo Vales, and Morley (1966) retested the hypothesis that communication accuracy is related to successful memory performance with speakers of Spanish and of Yucatec Mayan. Although the hypothesis proved true for both groups, the relationship was much stronger for Spanish speakers than for Yucatec speakers. Differences between Spanish speakers and English speakers, controlling for memory difficulty conditions, however, are minor (Lantz and Stefflre 1964; Lucy and Shweder 1979). Both Spanish and English have eleven basic color words (Berlin and Kay 1969) while Yucatec has five (Witkowski and Brown 1981). Hence, in languages with smaller color word inventories there is less agreement between color varieties remembered successfully and those identified successfully through communication. Consequently, one function of lexicalization in the color domain may be the creation of all-purpose categories through labeling, suitable to a wide range of color-related behaviors.

Heider's (1972) study of color memory among English speakers and Dani speakers (in New Guinea) also demonstrates a lexicalization effect. The Dani have two basic color terms—one focused in black, which also labels blues, greens, and other dark colors, and a second term focused variably in white and red by different informants, which also includes yellows, oranges, and other light colors. As noted above, Heider found that Dani and English speakers remembered focal colors more successfully than nonfocal color varieties. This provides strong evidence supporting the intrinsic physical-perceptual salience of focal over nonfocal color varieties, since this constant effect cannot be due to lexical encoding, which varies widely between the two languages.

English speakers, when compared to Dani speakers, on the other hand, are three times as successful in remembering target colors, both focal and nonfocal. This suggests that an augmented system of basic color words provides a framework that greatly enhances overall memory performance for color. Heider (1972) notes many differences between American and Dani culture which may affect memory performance, but it seems unlikely that they account for the entirety of the threefold difference.

In addition, cultural differences between Dani and Americans should influence memory success equally for focal and nonfocal colors. That is, both color varieties should show a constant cultural effect, and thus an equivalent change in memory success—this is not the case, however. Focals show a greater change than nonfocals (Heider 1972). There is a 40 percent memory difference for focals (25.6 percent success in Dani versus 65.6 percent success in English), while nonfocals show a 28.4 percent difference (7.4 percent success in Dani versus 35.8 percent success in English). Thus focals benefit more from lexical encoding and salience and show a greater lexicalization effect. This finding provides an independent confirmation of the important role played by lexical salience in color behavior.

The lexicalization findings above suggest that augmentation of the number of salient basic color words encoded in languages provides an important lexical anchoring system that enhances memory performance and plays a substantial role in memory success. Thus the degree of lexicalization in the color domain, which is strongly influenced by cultural importance, plays a significant role in color behavior across societies. These findings are consistent with both a universalist interpretation of color terminology and a Whorfian hypothesis which asserts that language exerts an active influence on thought and behavior.

NOTES

1. We are grateful for comments on an earlier draft provided by Brent Berlin, Roy Ellen, Carol Ember, Melvin Ember, and Eugene A. Nida. Albert C. Heinrich is to be singled out for special thanks for an especially detailed and helpful critical reading.

2. For further exploration of the possible influence of lexical salience, see Brown and Lenneberg's (1954) discussion of "codability."

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