How many colors can you name?

3 Dimensions of Color

<table>
<thead>
<tr>
<th>hue</th>
<th>wavelength</th>
<th>Oscillation frequency of light radiation</th>
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<tbody>
<tr>
<td>brightness</td>
<td>intensity</td>
<td>Amplitude of light radiation</td>
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<tr>
<td>saturation</td>
<td>purity</td>
<td>Intensity of dominant wavelength, relative to entire light signal</td>
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How would you divide these up?
Berlin & Kay (1969)

“The prevailing doctrine of American linguists and anthropologists has, in this century, been one of extreme linguistic relativity. Briefly, the doctrine... holds that each language performs the encoding of experience into sound in a unique manner. Hence, each language is semantically arbitrary relative to every other language. According to this view, the search for semantic universals is fruitless in principle. This doctrine is chiefly associated in America with the names of Edward Sapir and B. L. Whorf. Proponents of this view frequently offer as a paradigm example the alleged total semantic arbitrariness of the lexical coding of color. We suspect that this allegation of total arbitrariness in the way languages segment color space is a gross overstatement.”

Cross-cultural Studies

<table>
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<tr>
<th>Table 2. Languages studied by BM (1)</th>
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<td>Data reported from one subject per language.</td>
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</table>

Berlin & Kay (1969)

Relativistic Position

“Our partitioning of the spectrum consists of the arbitrary imposition of a category system upon a continuous physical domain... The Shona speaker from a color category from what we call orange, red, and purple, giving them all the same utterly unpronounceable name. But he also makes a distinction within the band we term green. Here we have a clear case of speakers of different languages slicing up perceptual world differently. And, of course, it is also the case that the kinds of slices one makes are related to the names for the slices available in his language.”

Berlin & Kay findings support the universalist hypothesis

“Although different language encode in their vocabularies different numbers of basic color categories, a total universal inventory of exactly 11 basic color categories exists from which the 11 or fewer basic color terms of any given language are always drawn.”
Implicational Hierarchy of Color Terms

white < red < green < blue < brown < purple < pink < orange < grey

2048 possible groups of these colors - but only 22 (<1%) are actually found in languages

(Berlin & Kay, 1969)

Cross-cultural Studies

• Studies dating back to 19th century
  - 1972 - Eleanor Rosch - “Dugub” Dani community, Papua New Guinea
    - 2 color terms (‘dark’, ‘light’)
    - Good color perception, similarities to English speakers
    - Better recognition of 8 ‘focal’ colors
    - Verbal paired-associate learning for focal/non-focal colors

Cross-cultural Studies

• Criticisms of Berlin & Kay conclusions
  - Small samples of speakers
  - Over-reliance on Western, literate societies

Kay & Rieger, 2003

• Data collected in situ from 110 unwritten languages
• Languages spoken in small-scale, non-industrialized societies
• Average of 24 native speakers per language
• 330 color chips named, one at a time
• Asked to tell which is the best example of their basic color terms

Kay & Rieger, 2003

• Questions
  - Do color terms from different languages cluster together in color space to a degree greater than chance?
  - Do color terms from unwritten languages of non-industrialized societies fall near color terms from written languages of industrialized societies?
“Certain privileged points in color space appear to anchor the color naming systems of the world’s systems, viewed as a statistical aggregate.”

(Key & Regier, 2003)

Maunsell color chips

MacLaury (1997), *Elemental Chromatic Colors*

Berinmo tribe
New Guinea

Jules Davidoff
U. of London, UK

Debi Roberson
U. of Essex, UK

Questioning Universality

- Experiments
  - I. RECOGNITION MEMORY
  - II. PAIRED-ASSOCIATE LEARNING
  - III. SIMILARITY
  - IV. CATEGORY LEARNING
  - V. RECOGNITION

(Davidoff, 2001)
Recognition Memory

- First just name all the color chips
- Then look at 1 chip at a time. It's then taken away for 30 seconds, and you must point to the color you say in the whole array.

Paired-Associate Learning

- Speakers learn arbitrary associations between (non-)focal colors and objects (e.g. palm nuts - nol)
- Berinmo did not find it easier to form associations to the English focal set of stimuli than to the non-focal set

Categorical Perception

- If categorical effects are restricted to linguistic boundaries, the 2 populations should show markedly different responses across the 2 category boundaries (green-blue and nol-wor)
- Maunsell color chips
- If categorical effects are determined by the universal properties of the visual system, then both populations should show the same response patterns

Similarity Judgments

- Choose the “odd man out” in a set of 3 color chips
- Maunsell color chips
- Maunsell color chips
-Observers judged colors from the same linguistic category (for their language) to be more similar; they were at chance for decisions relating to other language's color categories

(Original slide credits: Davidoff, 2001)
Category Learning

- Taught to divide the color space at 4 places:
  - blue/green (English-only boundary)
  - yellow/green (English-only boundary)
  - nol/wor (Berinmo-only boundary)
  - green1/green2 (no language boundary)
- Shown 6 chips, and told 3 were from category A and 3 were from category B
- Then asked to sort into category A and B - given feedback until they reached the criterion

Recognition Across/Within Categories

English speakers showed significantly superior recognition for targets from cross-category pairs than for those from within-category pairs for the green-blue boundary, but not for the nol-wor boundary. Berinmo speakers had the opposite pattern.

Their Conclusions

- "At the very least, our results would indicate that cultural and linguistic training can affect low-level perception."
- "Our data show that the possession of color terms affects the way colors are organized into categories. Hence, we argue against an account of color categorization that is based on an innately determined neurophysiology. Instead, we propose that color categories are formed from boundary demarcation based predominantly on language. Thus, in a substantial way we present evidence for linguistic relativity."

But...Kay & Kempton (1984)

- English: distinction between green & blue
- Tarahumara (northern Mexico): no lexical distinction 'grue'
- Subjects were given triads of color chips & had to pick which one was "most different" from the other two

Kay & Kempton (1984)

- A-H were the 8 color chips used
- The numbers represent the perceptual distances between the hues

A Closer Look

- This part seems to support the Whorfian hypothesis
- English speakers seem to judge two colors to be perceptually further apart if they cross a color boundary

One Thought

- Maybe this is a result of people naming the colors in order to make their decision
- So the effect of language is not on perception of color but on strategy for encoding color
- So what happens when the experimenters eliminate the ability to name the color?
- Prediction: English speakers should lose their “Whorfian bias”

Eliminating the Naming Bias

- The English subjects (the one who showed the “Whorfian bias”) were shown triads of color chips again
- This time, they were only able to see 2 of the 3 color chips at any given time
- “Tell me which is bigger: the difference in greenness between the two chips on the left or the difference in blueness between the two chips on the right”
Results

- English speakers seem to choose the pair with the larger perceptual difference as most different, whether or not it crosses the language category boundary

The “Whorfian effect” disappears!

More on Verbal Encoding of Colors (Roberson & Davidoff, 2000)

- Subjects were shown a color and then asked to read color words (verbal interference) or look at a multicolored dot pattern (visual interference)
- Subjects then shown 2 color chips - the original color and one that was 1 or 2 color chips away
- Asked which was the original color

Verbal interference only interferes with across-category identification. This suggests that verbal encoding is what causes judgements of greater perceptual distance

So what do we conclude about linguistic relativity and color...?