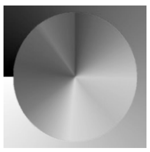
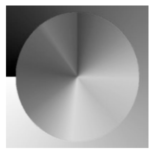
Language & the Mind
LING240
Summer Session II, 2005

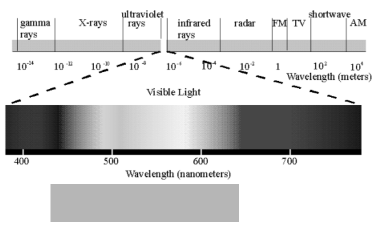
Color Categories & Perception

Lecture7





How many colors can you name?



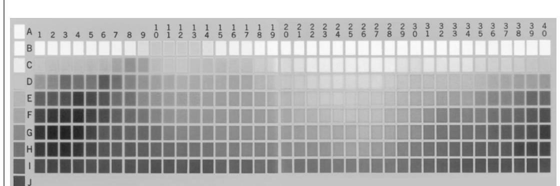
3 Dimensions of Color

hue	*wavelength*	Oscillation frequency of light radiation
brightness	*intensity*	Amplitude of light radiation
saturation	*purity*	Intensity of dominant wavelength, relative to entire light signal

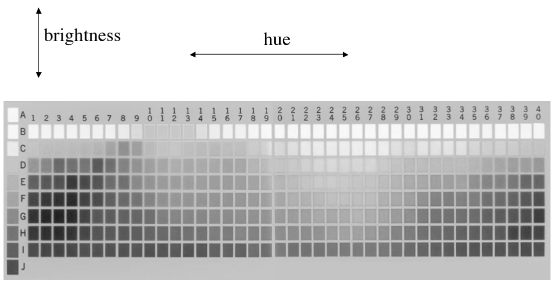
Brightness

Saturation

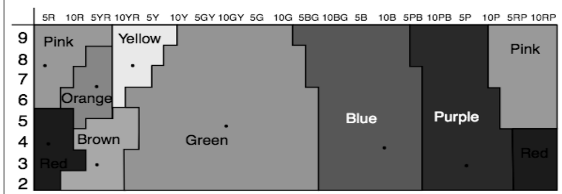
How would you divide these up?



Maunsell color chips



Maunsell color chips



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."

Relativistic Position

"Our partitioning of the spectrum consists of the arbitrary imposition of a category system upon a continuous physical domain… The Shona speaker froms 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."

(Krauss, 1968)

Cross-cultural Studies

Table 2. Languages studied by BK (1)

Index	Language	Where spoken
1	Arabic (Lebanese colloquial)	Lebanon
2	Bahasa Indonesia	Indonesia
3	Bulgarian	Bulgaria
4	Cantonese	China
5	Catalan	Spain
6	(American) English	United States
7	Hebrew	Israel
8	Hungarian	Hungary
9	Ibibio	Nigeria
10	Japanese	Japan
11	Korean	Korea
12	Mandarin	China
13	(Mexican) Spanish	Mexico
14	Pomo	United States
15	Swahili	Tanzania
16	Tagalog	Philippines
17	Thai	Thailand
18	Tzeltal	Mexico
19	Urdu	Pakistan
20	Vietnamese	Vietnam

Data reported from one subject per language.

(Berlin & Kay, 1969)

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 / black < red < green / yellow < blue < brown < purple / pink / orange / grey

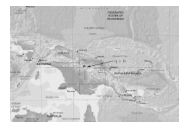
2048 possible groups of these colors - but only 22 (<1%) are actually found in languages

(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

Eleanor Rosch
UC Berkeley



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

Table 1. Languages in the WCS

Index	Language	Where spoken	No. of subjects
1	Abidji	Ivory Coast	25
2	Agarabi	Papua New Guinea	24
3	Agta	Philippines	25
4	Aguacatec	Guatemala	25
5	Amarakaeri	Peru	06
6	Ampeeli	Papua New Guinea	27
7	Amuzgo	Mexico	25
8	Angaatiha	Papua New Guinea	25
9	Apinaye	Brazil	30
10	Arabela	Peru	25
11	Bahinemo	Papua New Guinea	25
12	Bauzi	Indonesia	25
13	Berik	Indonesia (Irian Jaya)	25
14	Bete	Ivory Coast	25
15	Bhili	India	25
16	Buglere	Panama	25
17	Cakchiquel	Guatemala	30
18	Campa	Peru	25
19	Camsa	Columbia	25
20	Candoshi	Peru	11
21	Cavineña	Bolivia	25
22	Cayapa	Ecuador	24
23	Chácobo	Bolivia	25
24	Chavacano (Zamboangueño)	Philippines	25
25	Chayahuita	Peru	25
26	Chinantec	Mexico	25
27	Chiquitano	Bolivia	25
28	Chumburu	Ghana	25
29	Cofán	Ecuador	20
30	Colorado	Ecuador	25
31	Cree	Canada	25
32	Culina	Peru, Brazil	25
33	Didinga	Sudan	25
34	Djuka	Surinam	25
35	Dyimini	Ivory Coast	25
36	Ejagam	Nigeria, Cameroon	25
37	Ese Ejja	Bolivia	25
38	Garífuna (Black Carib)	Guatemala	28
39	Guahibo	Colombia	25
40	Guambiano	Columbia	27
41	Guarijío	Mexico	25
42	Guaymí (Ngäbere)	Panama	25
43	Gunu	Cameroon	25
44	Halbi	India	25
45	Huastec	Mexico	25
46	Huave	Mexico	25

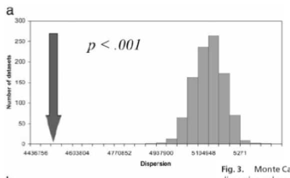
Table 1. (continued)

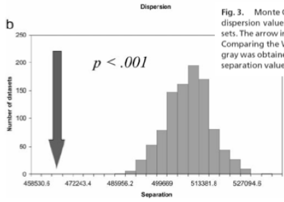
Index	Language	Where spoken	No. of subjects
65	Mawchi	India	25
66	Mayoruna	Peru	25
67	Mazahua	Mexico	25
68	Mazatec	Mexico	25
69	Menye	Papua New Guinea	25
70	Micmac	Canada	25
71	Mikasuki	United States	25
72	Mixtec	Mexico	25
73	Mundu	Sudan	18
74	Múra Pirahá	Brazil	25
75	Murle	Sudan	25
76	Murrinh-Patha	Australia	25
77	Nafaanra	Ghana	29
78	Nahuatl	Mexico	06
79	Ocaina	Peru	25
80	Papago (O'odham)	United States, Mexico	25
81	Patep	Papua New Guinea	24
82	Paya	Honduras	20
83	Podopa	Papua New Guinea	14
84	Saramaccan	Surinam	25
85	Seri	Mexico	25
86	Shipibo	Peru	25
87	Sirionó	Bolivia	25
88	Slave	Canada	24
89	Sursurunga	Papua New Guinea	26
90	Tabla	Indonesia (Irian Jaya)	25
91	Tacana	Bolivia	08
92	Tarahumara (Central dialect)	Mexico	09
93	Tarahumara (Western dialect)	Mexico	06
94	Tboli	Philippines	25
95	Teribe	Panama	26
96	Ticuna	Peru	25
97	Tifal	Papua New Guinea	25
98	Tlapanec	Mexico	25
99	Tucano	Colombia	25
100	Vagla	Ghana	25
101	Vasavi	India	25
102	Waorani (Auca)	Ecuador	25
103	Walpiri	Australia	25
104	Wobé	Ivory Coast	25
105	Yacouba	Ivory Coast	27
106	Yakan	Philippines	25
107	Yaminahua	Peru	25
108	Yucuna	Colombia	25
109	Yupik	United States	25

(Kay & Regier, 2003)

Kay & Rieger, 2003

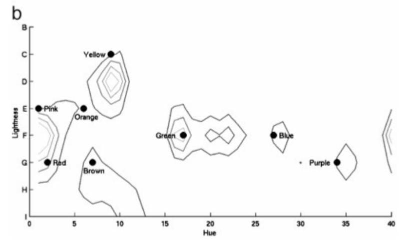
- Questions
  - Do color terms from different languages cluster together in color space to a degree greater than chance?
  - Do color terms from unwritten languages of non-industrialized societies fall near color terms from written languages of industrialized societies?





Results

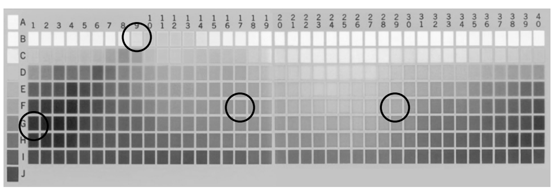
Fig. 3. Monte Carlo tests. (*a*) Clustering within the WCS. The distribution of dispersion values shown in gray was obtained from 1,000 randomized data sets. The arrow indicates the dispersion value obtained from the WCS data. (*b*) Comparing the WCS with BK. The distribution of separation values shown in gray was obtained from 1,000 randomized data sets. The arrow indicates the separation value obtained by comparing the WCS data with BK data (1).



"Certain privileged points in color space appear to anchor the color naming systems of the world's systems, viewed as a statistical aggregate."

Fig. 4. Distribution of color terms from nonindustrialized languages. (*a*) The floor plane corresponds to the chromatic (non-neutral) portion of the color stimulus array. The height of the surface at each point in the plane denotes the number of speaker centroids in the WCS data set that fall at that position in color space. (*b*) The distribution of *a* is viewed from above by a contour plot. The outermost contour represents a height of 100 centroids, and each subsequent contour represents an increment in height of 100 centroids. English color terms fall near the peaks of the WCS distribution.

(Kay & Regier, 2003)



MacLaury (1997), *Elemental Chromatic Colors*

Maunsell color chips

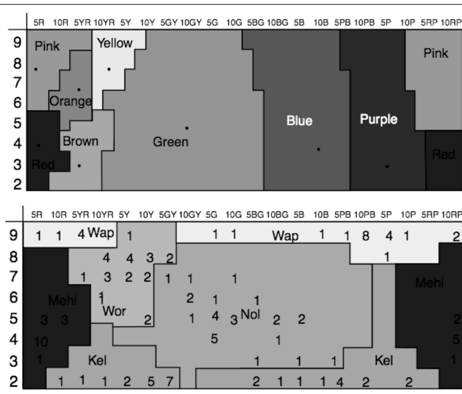
Berinmo tribe
New Guinea

Jules Davidoff
U. of London, UK

Debi Roberson
U. of Essex, UK

English

Berinmo



(Davidoff, 2001)

Questioning Universality

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

Recognition Memory

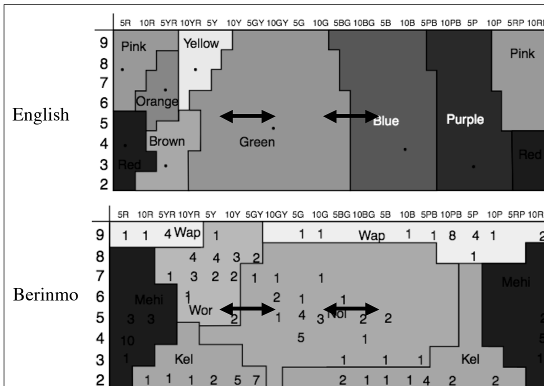
- First just name all the color chips
- Then look at 1 chip at a time. It's then taken away for 30 seconds, and you must point to the color you say in the whole array.

Paired-Associate Learning

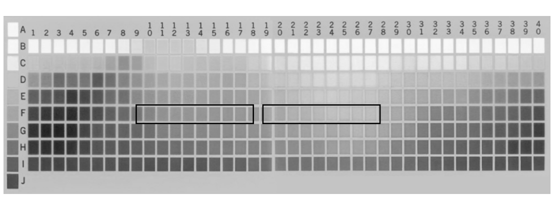
- Speakers learn arbitrary associations between (non-)focal colors and objects (e.g. palm nuts - *nol*)
- *Berinmo did not find it easier to form associations to the English focal set of stimuli than to the non-focal set*

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)
- If categorical effects are determined by the universal properties of the visual system, then both populations should show the same response patterns



(Davidoff, 2001)



Maunsell color chips

Similarity Judgments

- Choose the "odd man out" in a set of 3 color chips
- Perceptual distances were the same for each pair in the set
- *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*

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

Category Learning

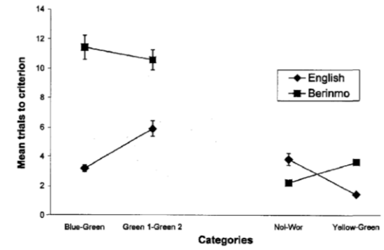


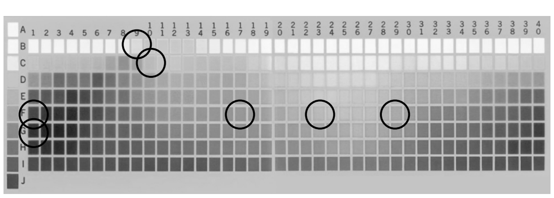
Figure 9. Mean errors to criterion for the two populations learning the blue versus green and Green 1 versus Green 2 category divisions and for those learning the nol versus wor and yellow versus green divisions in Experiment 5.

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

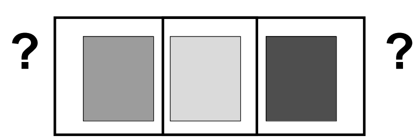
- "At the very least, our results would indicate that cultural and linguistic training can affect low-level perception."
- "Our data show that the possession of color terms affects the way colors are organized into categories. Hence, we argue against an account of color categorization that is based on 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**."



Black: MacLaury (1997), *Elemental Chromatic Colors*
Blue: Kay (2005), Berinmo color centroids

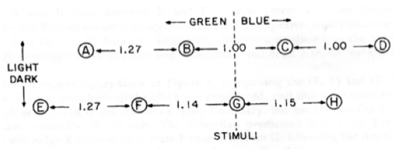
But…Kay & Kempton (1984)

- 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

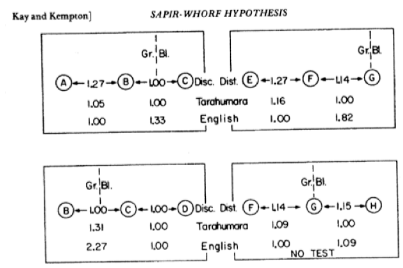


Kay & Kempton (1984)

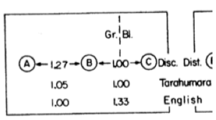
- A-H were the 8 color chips used
- The numbers represent the perceptual distances between the hues



Kay & Kemton (1984)



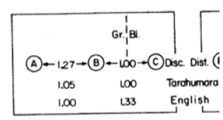
A Closer Look

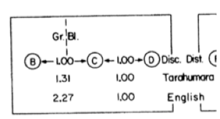


• This part seems to support the Whorfian hypothesis

• English speakers seem to judge two colors to be perceptually further apart if they cross a color boundary

A Closer Look





• This part also seems to support the Whorfian hypothesis

• English speakers seem to judge two colors to be perceptually further apart if they cross a color boundary…but the **Tarahumara speakers *also* have some of this effect**

One Thought

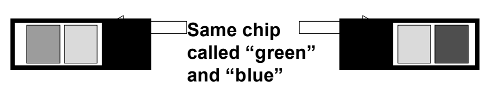
• Maybe this is a result of people ***naming* the colors** in order to make their decision

• 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"**

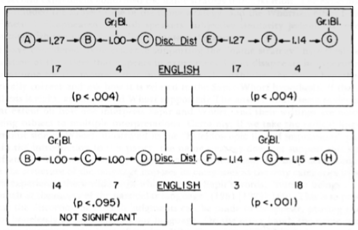
Eliminating the Naming Bias

•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

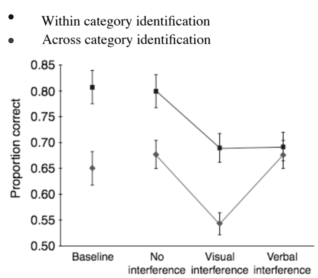


- English speakers seem to choose the pair with the larger perceptual difference as most different, whether or not it crosses the language category boundary

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…?