



# **Evaluating common appearance through a colour naming approach**

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# Agenda



- **Introduction**
  - Common-Appearance
  - Gamut-Mapping
  - Color-Naming
- **Psychophysical experiment (intermediate findings)**
- **Results, Discussion & Outlook**

# Introduction

Typical reproduction requirements, established colorimetry:

Double Stimulus:  
(Side-by-side)



Single stimulus:  
(comparing to virtual reference)



relying on the concept of Just Noticeable Differences  $\Delta E$

# Common Appearance

Assessment of a **set** of stimuli and their common appearance.



Morovič J.: *Color references for digital print production*, (2010).

# Common Appearance

Assesment of a **set** of stimuli and their common appearance.

Example; a fair trade stand:

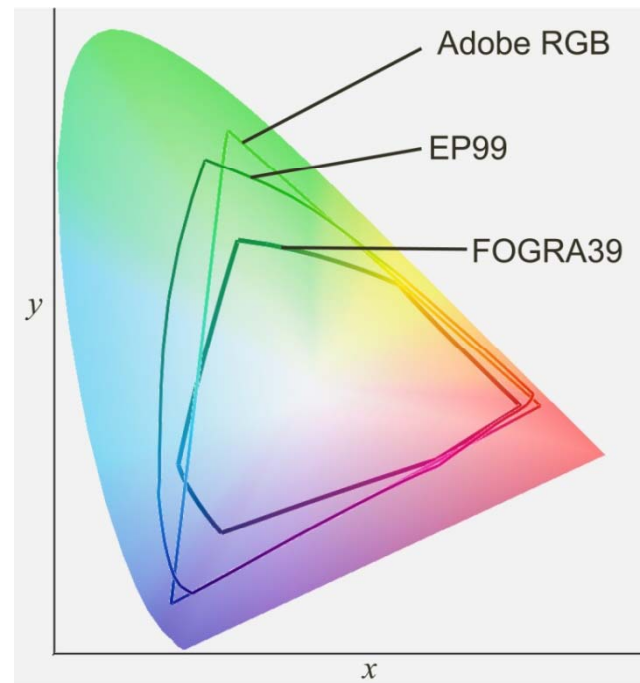


color gamuts of highly varying shape and size  
one wants to use the full potential of each gamut

# Common Appearance

Assesment of a **set** of stimuli and their common appearance.

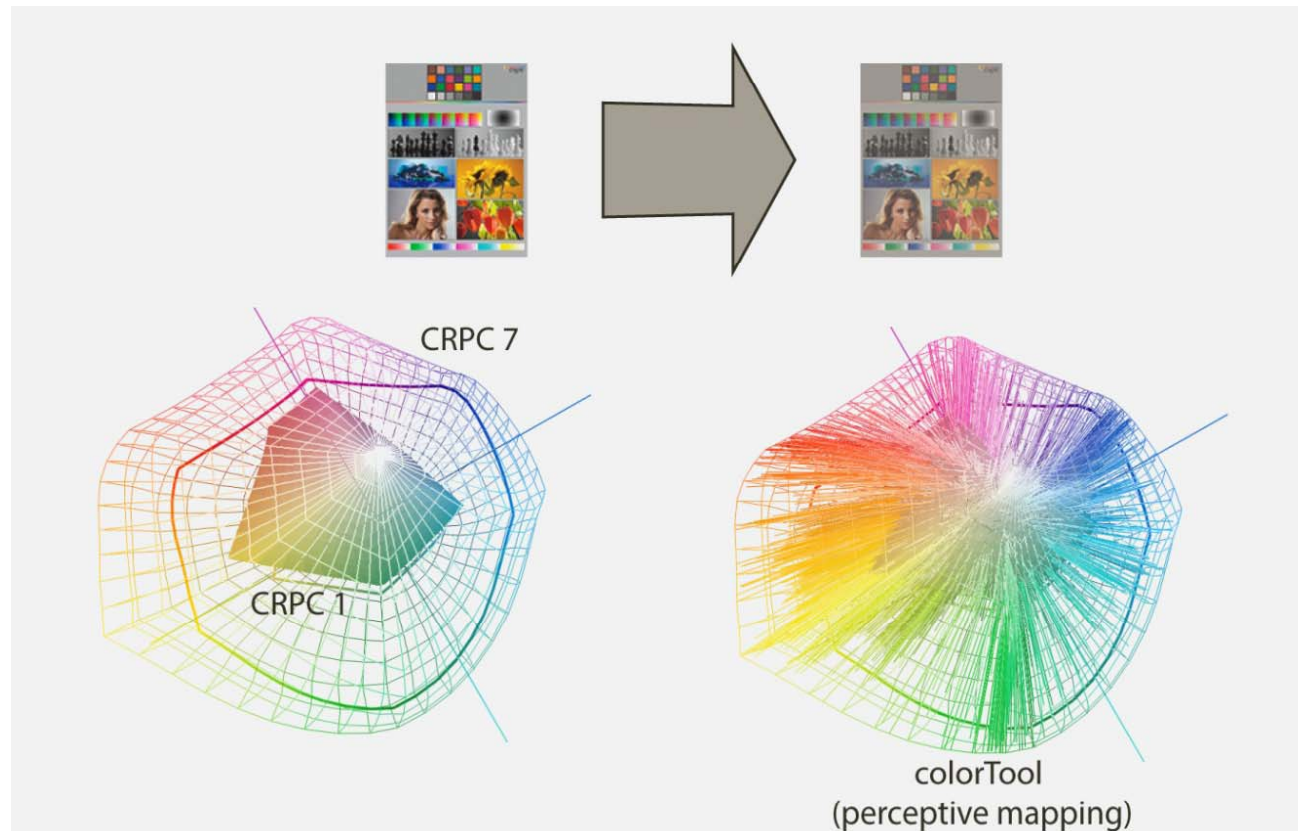
Example; a fair trade stand:



Def.: Common colour appearance is the degree of visual similarity/consistency among a set of stimuli from device gamuts that differ both in shape and size against a given reference

# Gamut-Mapping

The perceptive gamut mapping (50 % art & 50 % science)







# Metric for common appearance

Common appearance is a perception, but can one measure and objectify it?

Is there a metric for common appearance that corresponds to established colorimetry when it comes to small colour differences?

Emerged in Fogra research project 10.057 ([www.fogra.org](http://www.fogra.org))



# Colour Naming



- Intersection of color science and linguistics
- Classic study of Berlin and Kay proposes 11 basic color categories (world color survey)
- Categorization of color-space

Berlin B., Kay, P.: *Basic color terms: Their universality and evolution*.  
University of California Press, Berkeley, 1996

Regier T., Kay P., Khetarpal N.: *Color naming reflects optimal partitions of color space*. *Proc. Natl. Acad. Sci. USA*, pp. 1436-1441, 2007.

# Colour Naming



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For our purpose more color names are needed

Berlin B., Kay, P.: *Basic color terms: Their universality and evolution*.  
University of California Press, Berkeley, 1996

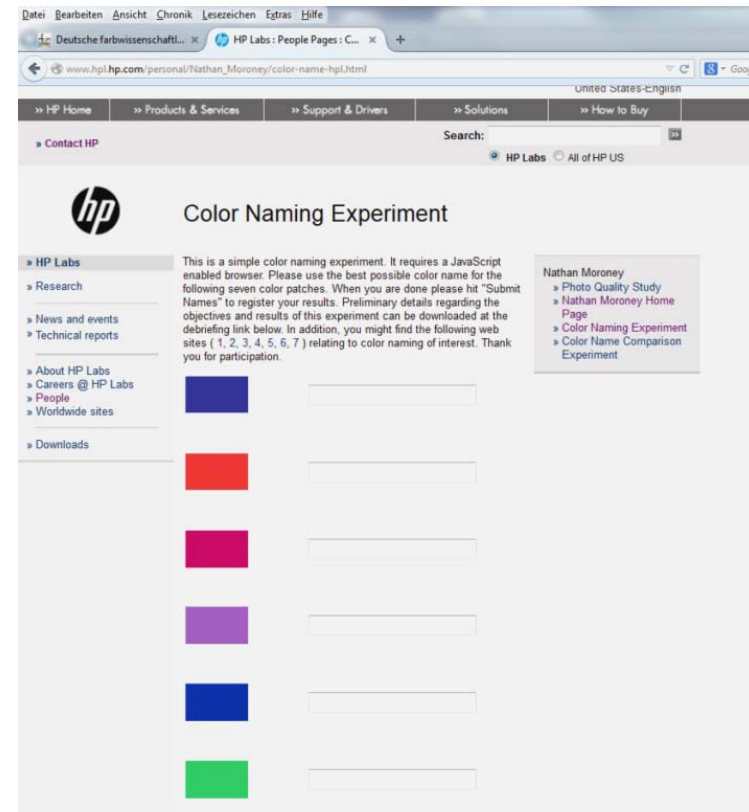
Regier T., Kay P., Khetarpal N.: *Color naming reflects optimal partitions of color space*. *Proc. Natl. Acad. Sci. USA*, pp. 1436-1441, 2007.

# Experiments in colour naming



Unconstrained (multilingual) web-based color naming experiment by Beretta and Moroney:

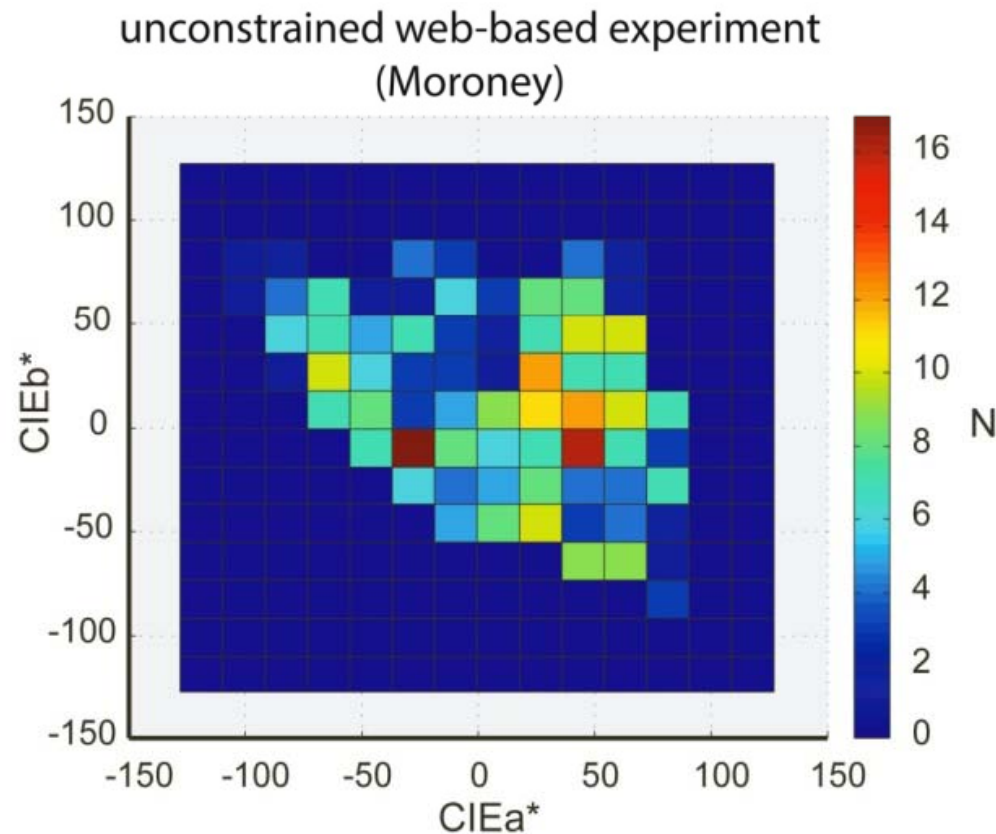
- shows each participant 7 color patches, that they should name
- no restrictions in the names
- statistical analysis results in 400 color names



Beretta G. B., Moroney B. M.: *Color naming: color scientists use Munsell Sheets of Color. Hewlett-Packard Laboratories, pp. 1-27, 2010.*

# Colour names in CIELab\* space

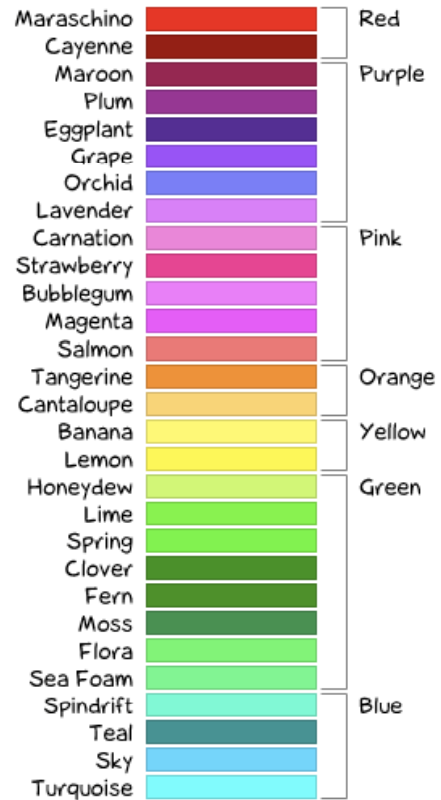
Histogram of the CIELab\* values of the 400 colour names, mapped onto CIEab\* plane



Beretta G. B., Moroney B. M.: *Color naming: color scientists use Munsell Sheets of Color. Hewlett-Packard Laboratories, pp. 1-27, 2010.*

# Similar experiments (webcomic xkcd)

Color names if you're a girl...



Color names if you're a guy...

Doghouse Diaries  
"We take no as an answer."

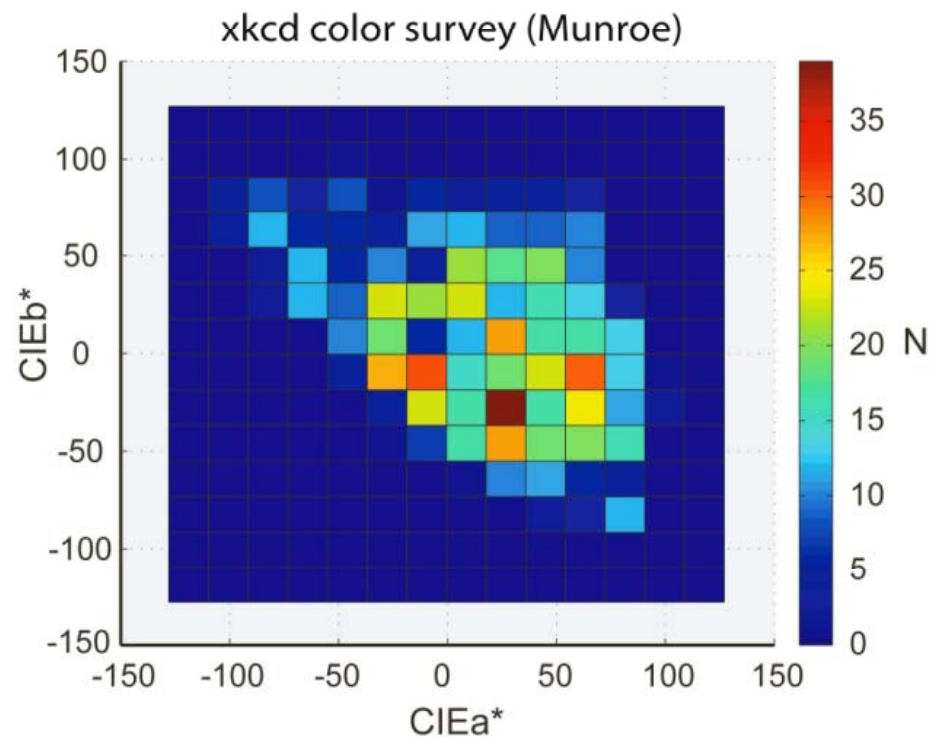
[www.xkcd.com](http://www.xkcd.com) (Munroe R. P.)

# Xkcd color survey

954 most common RGB monitor colors shown to participants.

*Actual color names if you're a girl ...*

*Actual color names if you're a guy ...*

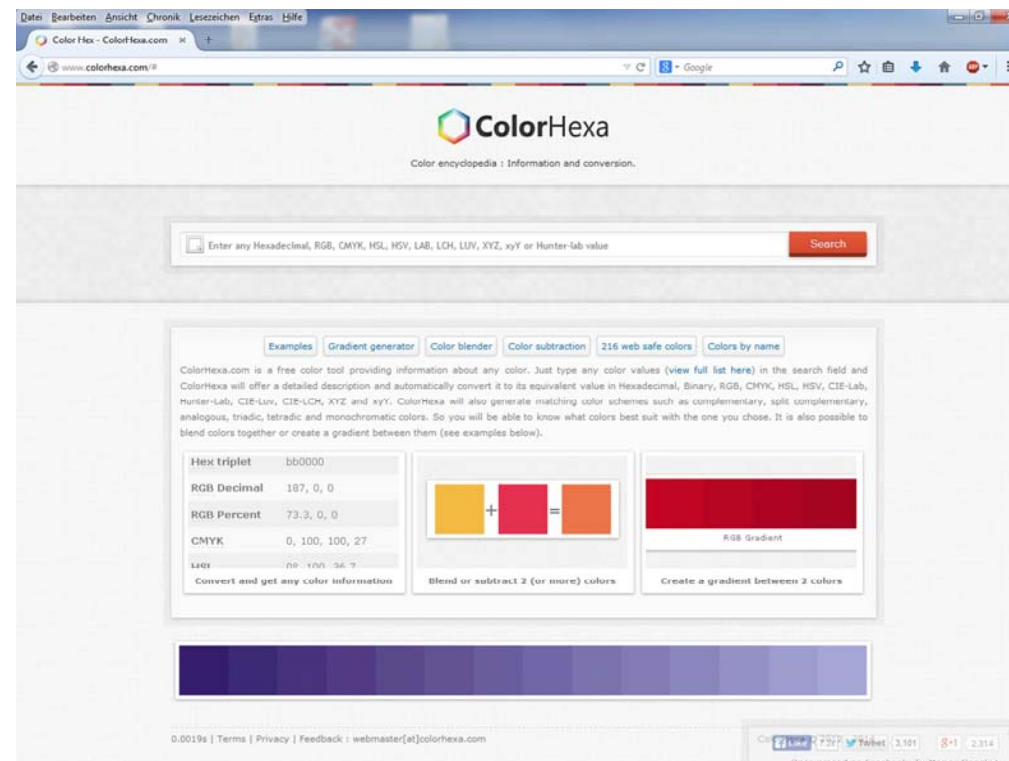


<http://blog.xkcd.com/2010/05/03/color-survey-results/>

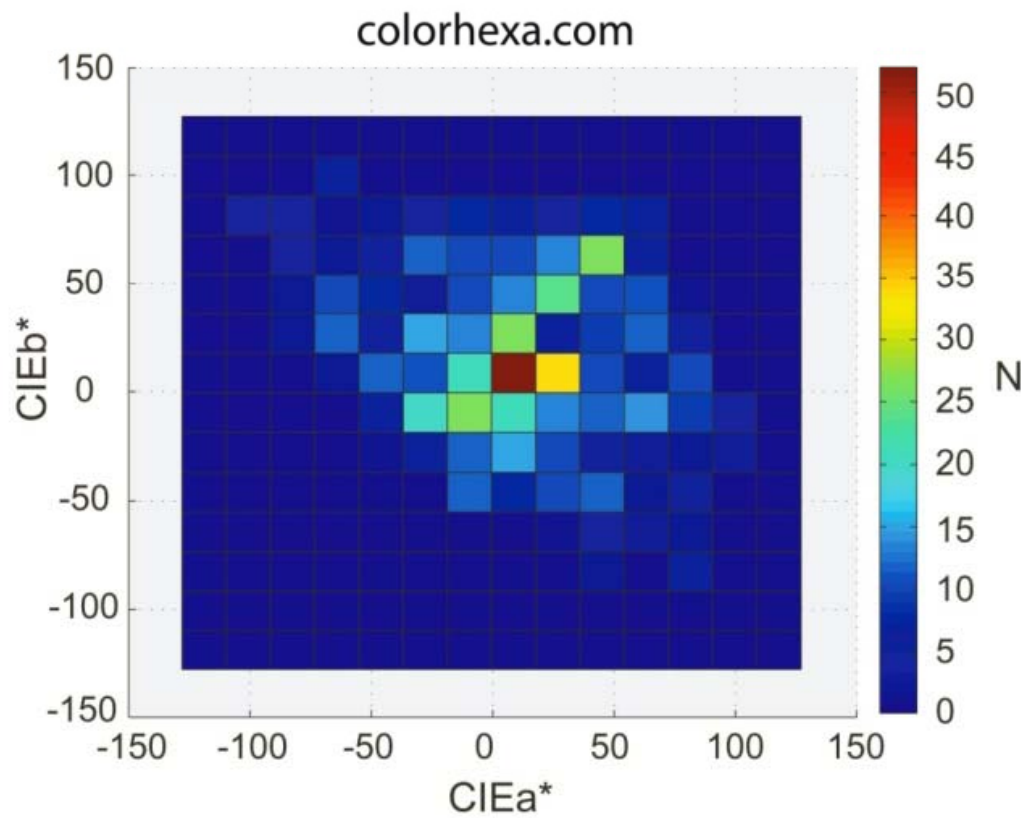
# Colorhexa.com



- Free color tool providing information about any colour
- Lists 746 colour names, and their CIE Lab\* values;  
(no idea how they got them)





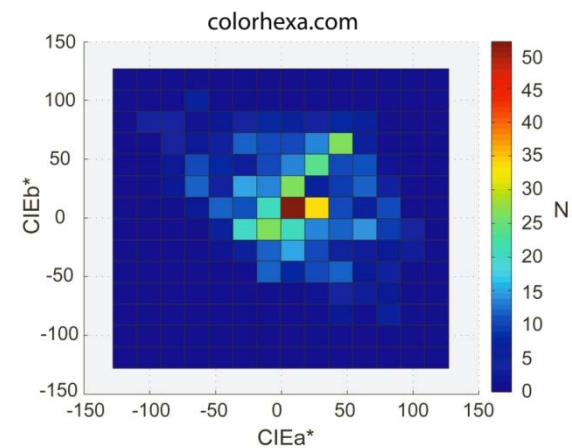
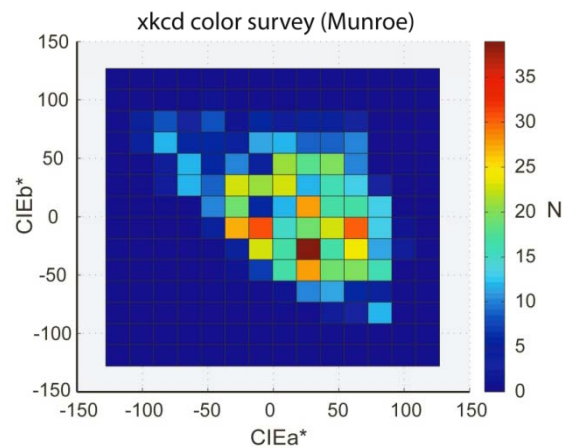
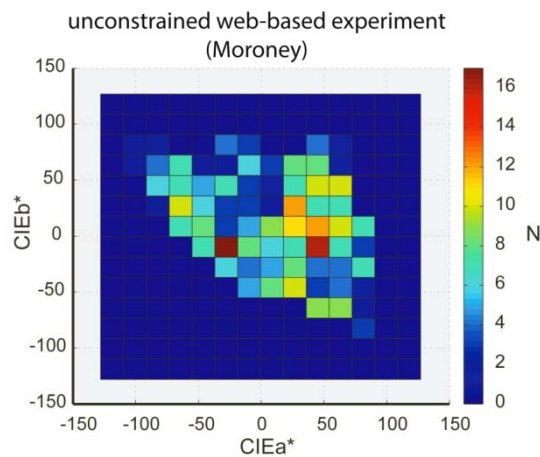


# Density of names in colour space

Web-experiment  
(400 color names)

Xkcd color survey  
(954 color names)

Colorhexa.com  
(746 color names)



# Psychophysical experiment

Idea: Show participants four different groups of prints and let them establish a rank order of the group's common-appearance...



# Four mapping strategies

3 x perceptive gamut mapping (with default settings) of commercial softwares (A, B, D) and 1 x native color approach (C)

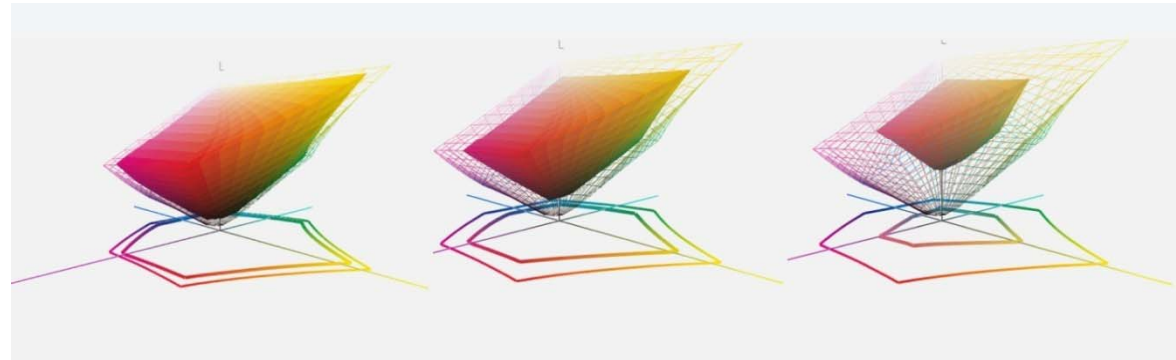
Let participants rank the common appearance; get a mean opinion score





# The used colour gamuts

- CRPC1 (gamut 3)
- CRPC4 (gamut 2)
- Fogra39 (gamut 1)
- EP99 (reference)



# Correlation of common appearance and color names

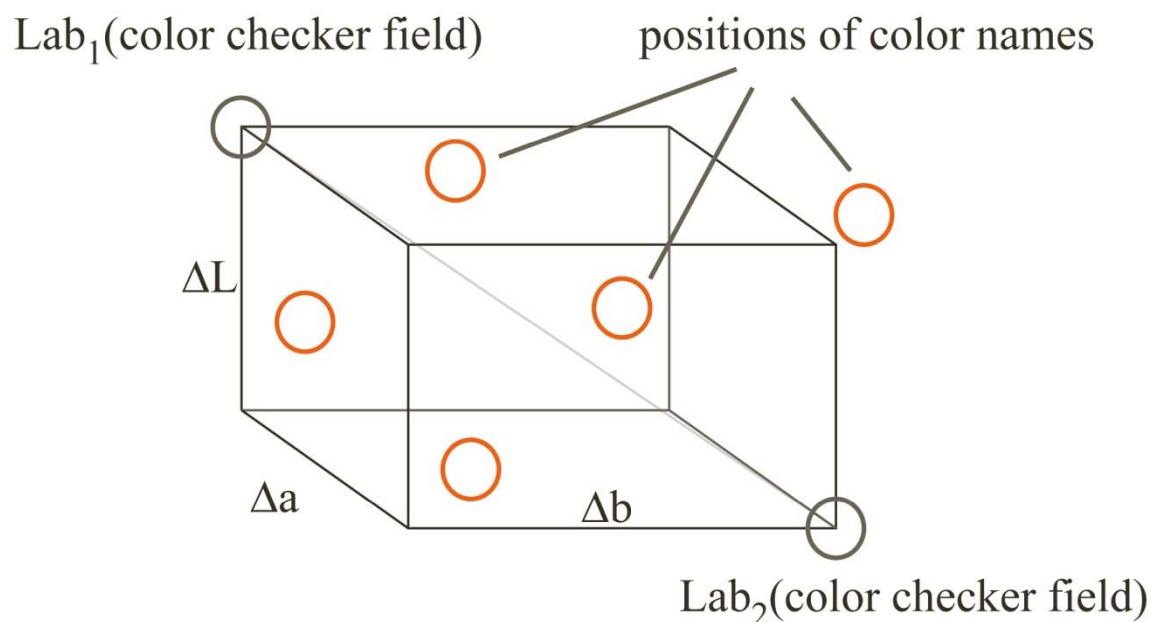
Each printout includes the colorchecker (Xrite).

This allows a comparison of the CIALab values of the color checkers fields (orange circle) in the different gamuts.



# Correlation of common appearance and color names

Compare two CIELab values of one particular field in two different gamuts:





# Observable for correlation



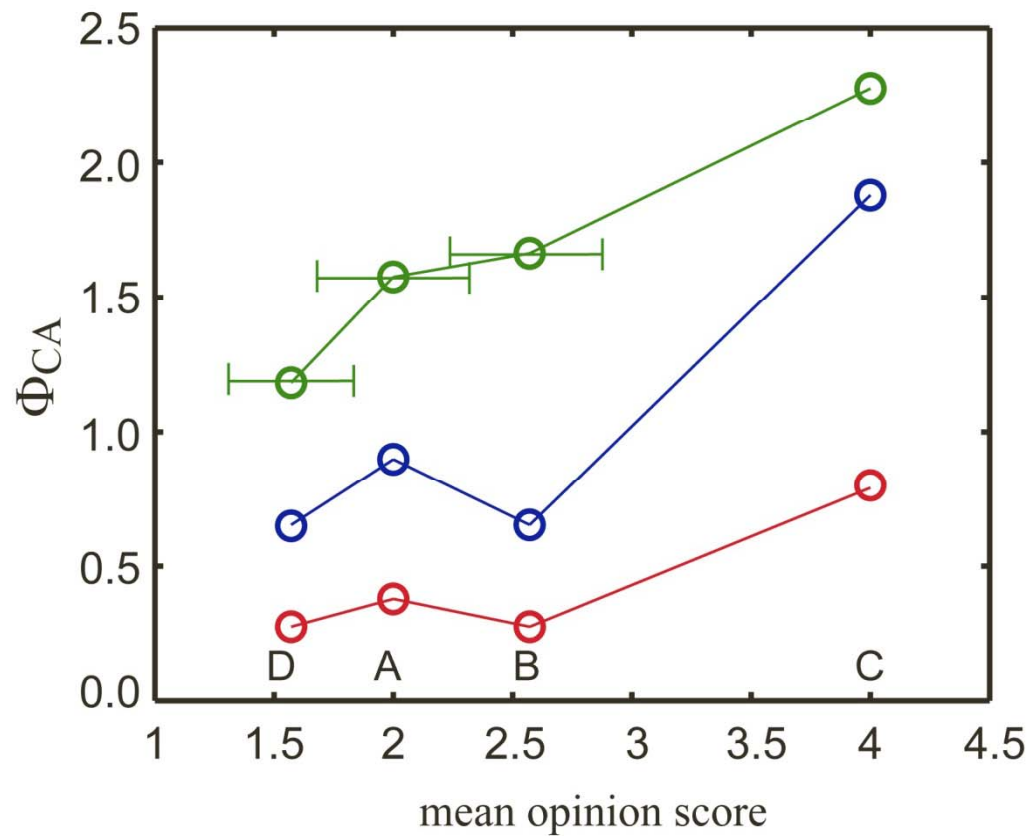
Define  $\Phi_{CA}$  as an observable for common-appearance :

$$\phi_{CA} = \frac{n_{CN}}{N_{ij}} \sum_{\substack{i, j \in G \\ j \neq i}} \left[ \sum_{k \in CB} N_k^{i, j} \right]$$

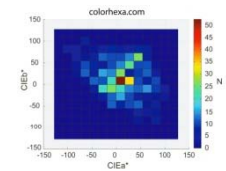
$\Phi_{CA}$  simply counts the number of CB crossings  
(with arbitrary scaling)



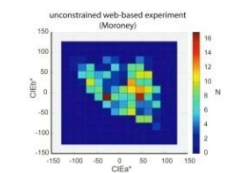
# Results (7 participants)



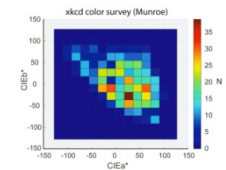
green:  
colorhexa.com



blue: web-based  
color experiment



red: xkcd color  
survey



# Results & Discussion



- There is a visible trend but ...
- More statistics is needed
  
- The colour name densities and their distribution in colour space play a crucial role
  
- Experiment design may have to be rethought ...
- Finding an improved observable to measure CB



Thank you for your attention