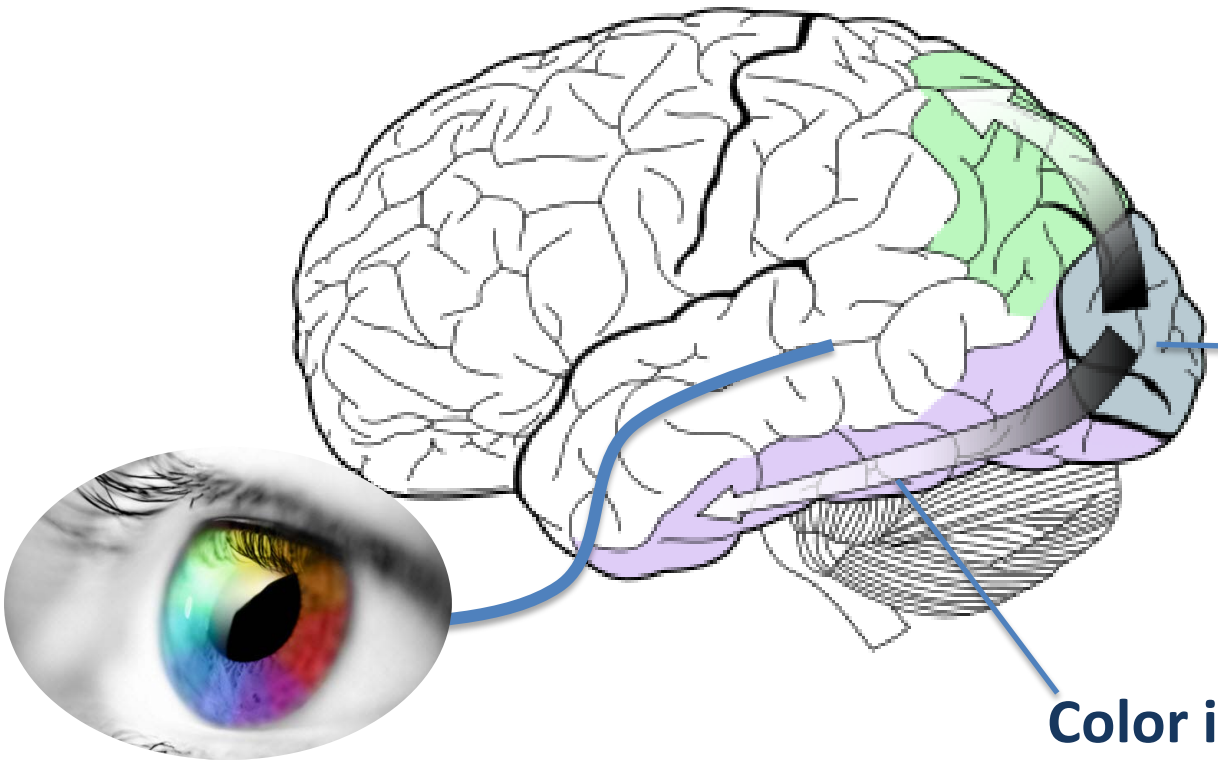
Color – an enormously complex topic.

Kosslyn (2006) ***Graph Design for the Eye and Mind***

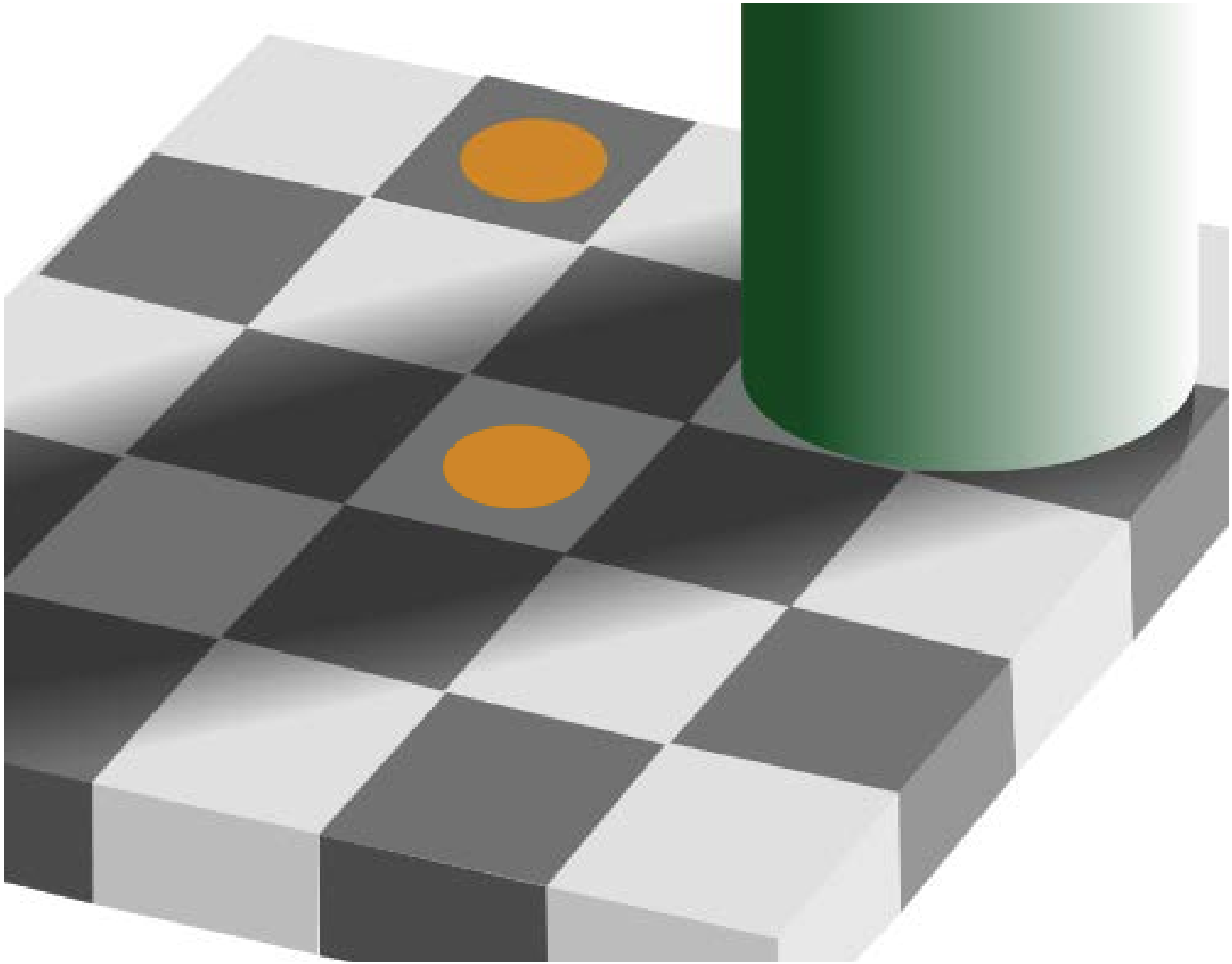
Murrell (2011) ***R Graphics, 2/e***

Few (2012) ***Show Me the Numbers***

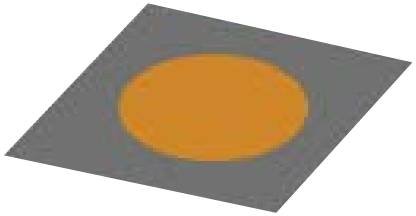
The eye collects, the nerves transmit, and perception occurs in the brain.

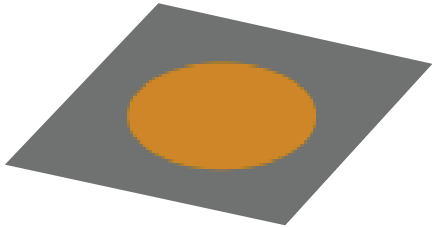


Perception happens in your brain.

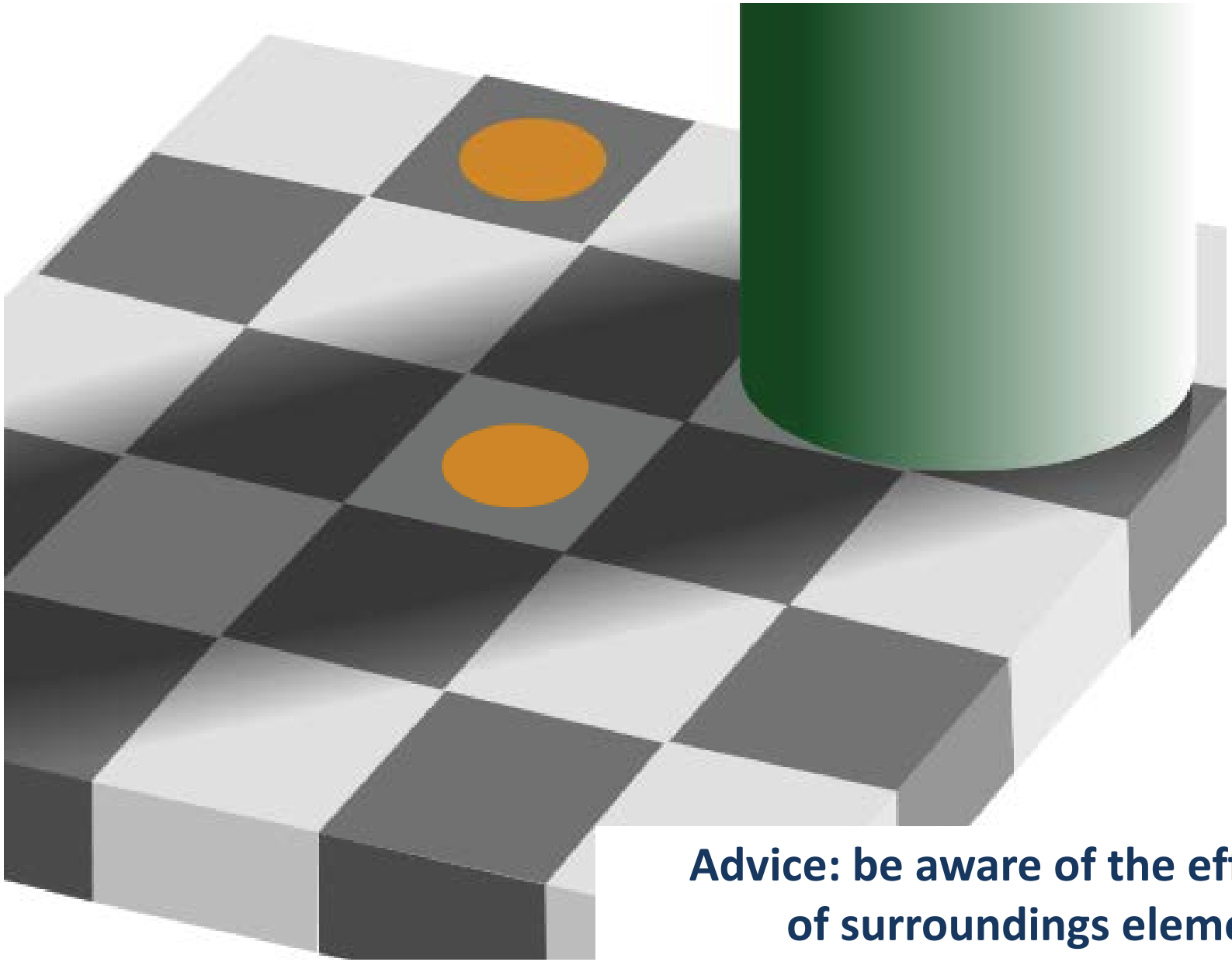


Perception happens in your brain.





Perception happens in your brain.



Advice: be aware of the effects of surroundings elements.

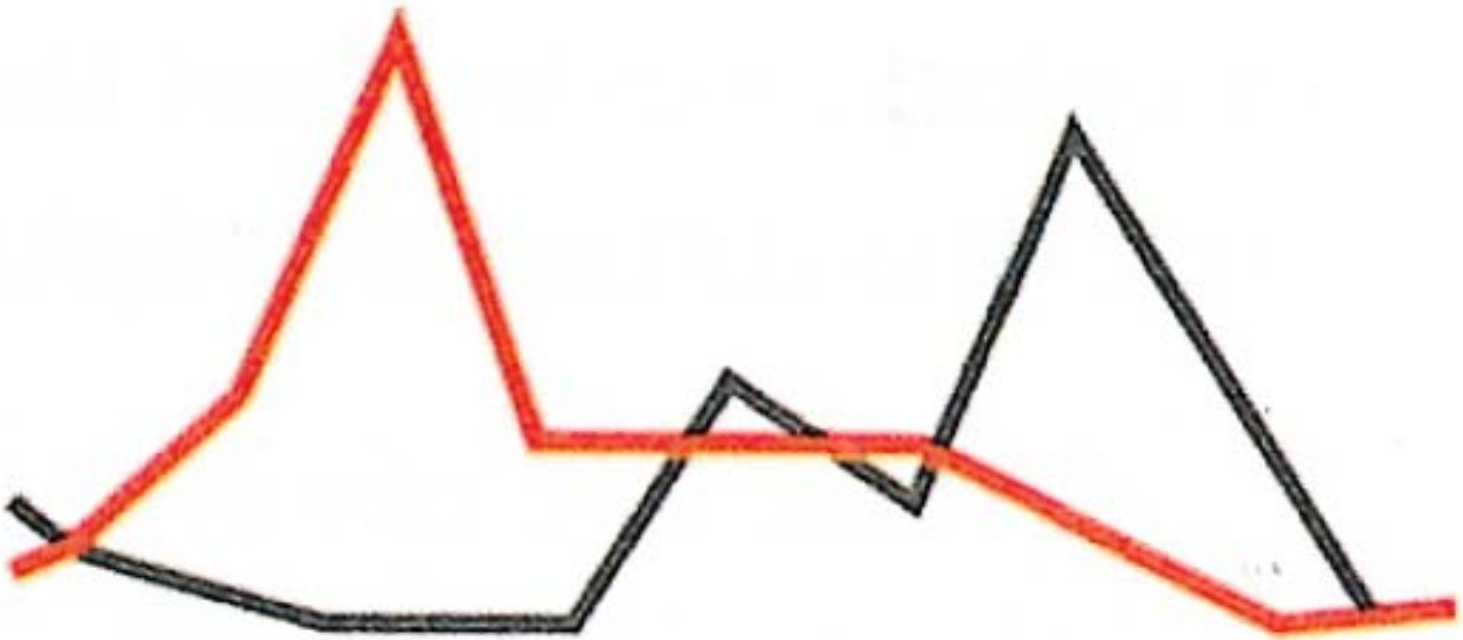
Warm colors "struggle" to be in the foreground–
a psychological stereo effect.

The red line "wants" to move to the foreground.

Kosslyn, p.160

Advice: place warm colors in the foreground.

The effect disappears when the red line is in front.

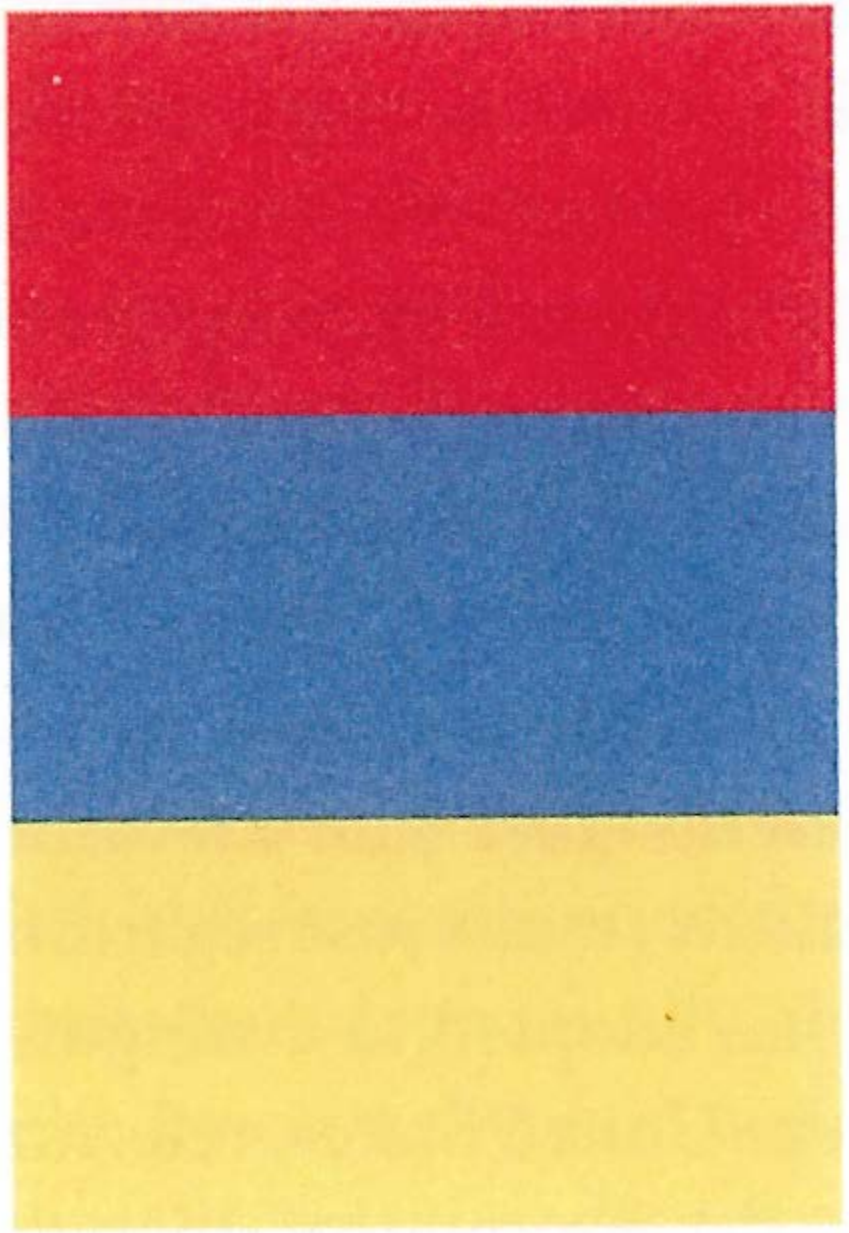


Kosslyn, p.162

Avoid using red and blue in adjacent regions.

The lens of the eye cannot properly focus on two very different hues (wavelengths).

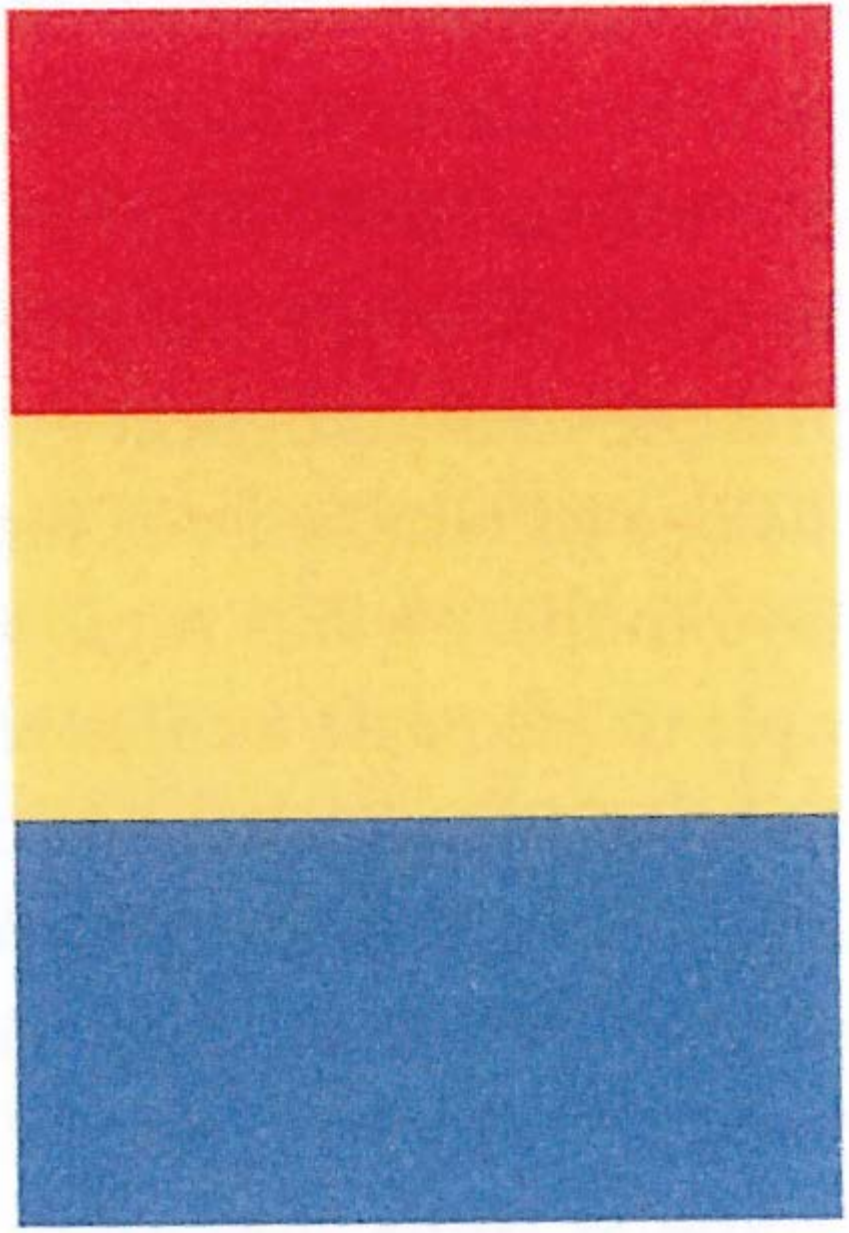
The red and blue regions will appear to shimmer.



Kosslyn, p.160

Avoid using red and blue in adjacent regions.

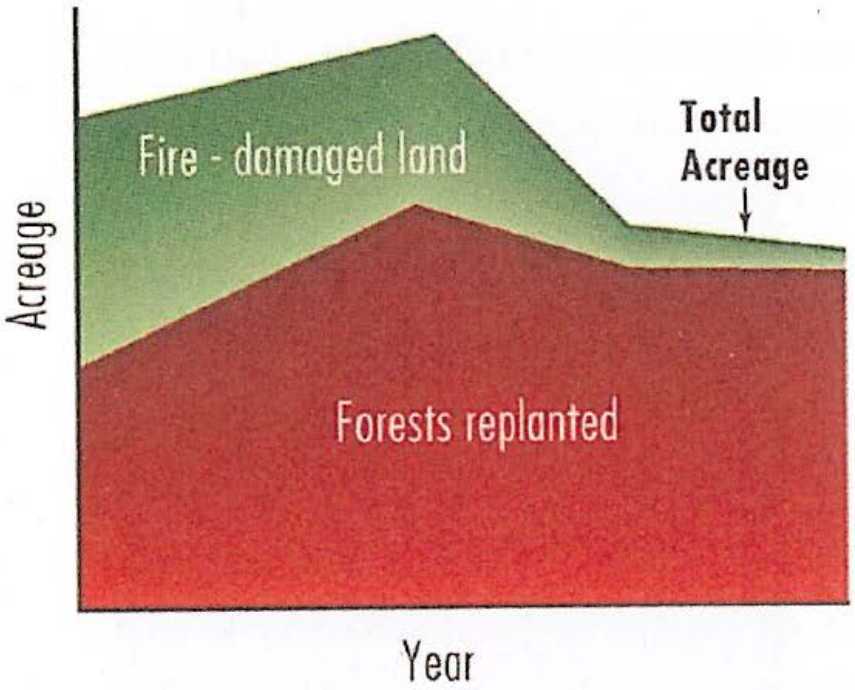
Separating the two hues reduces the perceptual difficulty.



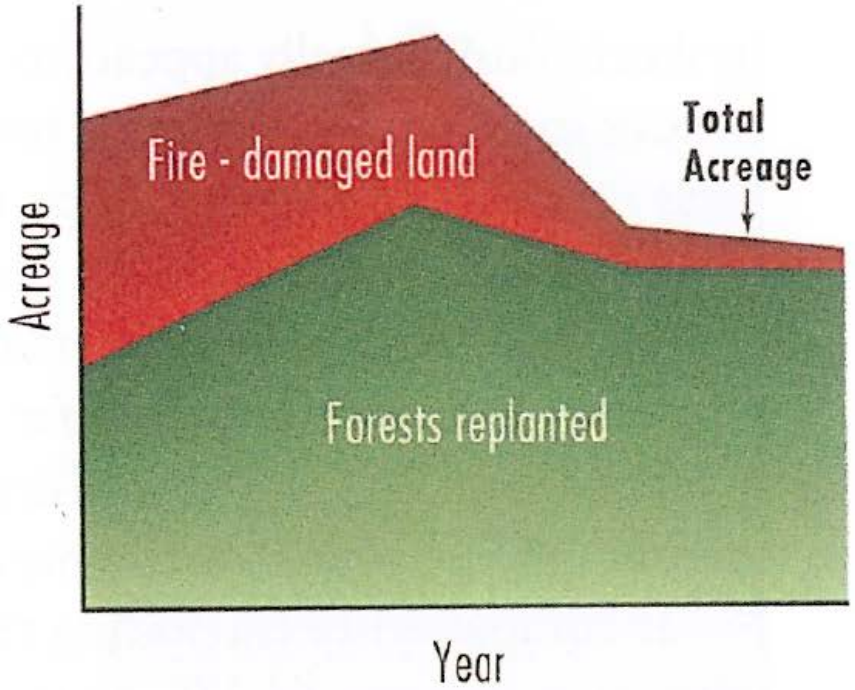
Kosslyn, p.160

Respect compatibility and conventions of color.

[Don't]



[Do]



Kosslyn, p.163

Respect compatibility and conventions of color.

…but be aware of differences between cultures or subcultures.

For example, green means:

- “safe” for process engineers
- “infected” for health workers
- “profitable” for finance managers

Test your color choices with people who represent your audience.

Kosslyn, p.164

In the US, the concepts most often associated with red and blue are…

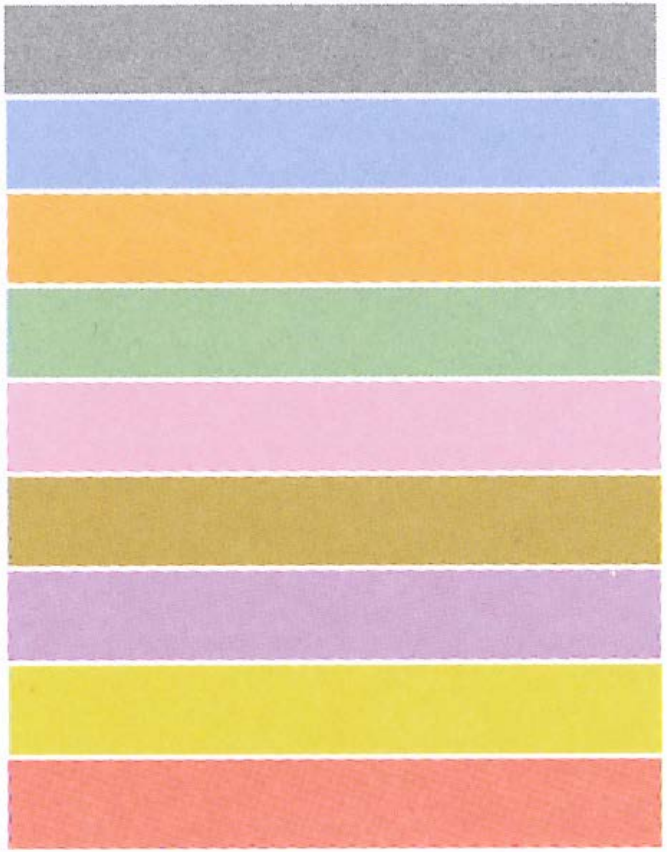
- trust
- security
- high quality
- high technology
- reliability/dependability

- speed
- cheap/inexpensive
- fear/terror
- fun

Kosslyn, p.164

Stephen Few recommends three palettes – and gives us the RGB codes for the colors.

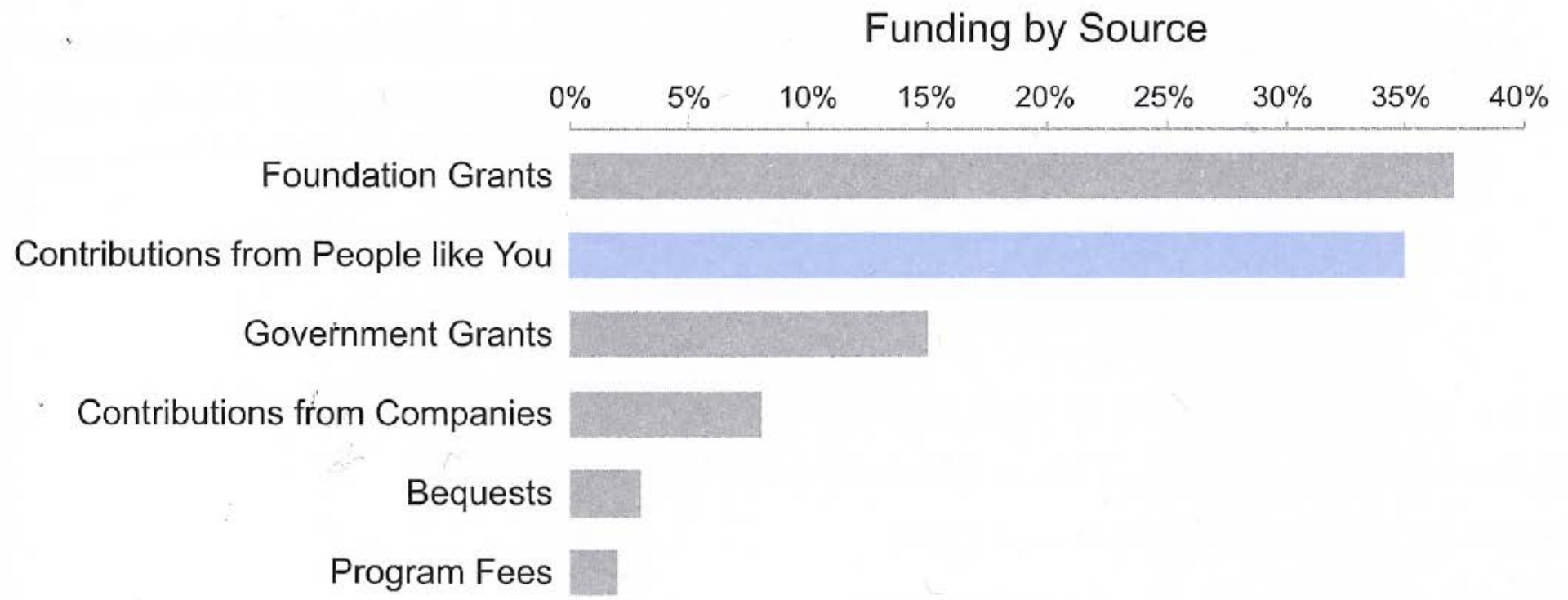
Light



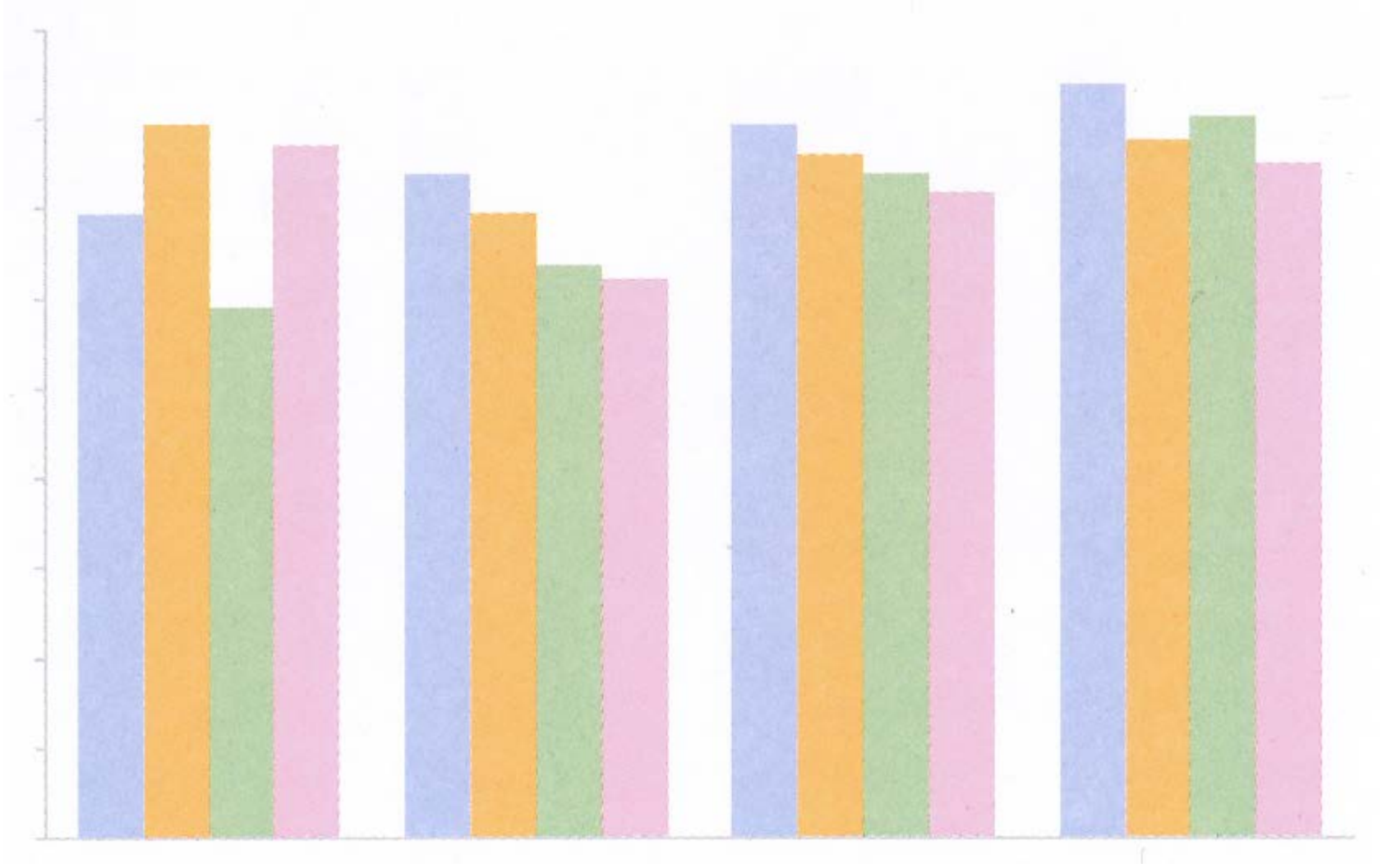
R	G	B
140	140	140
136	189	230
251	178	88
144	205	151
246	170	201
191	165	84
188	153	199
237	221	70
240	126	110

For large data-encoding objects such as bars and boxes.

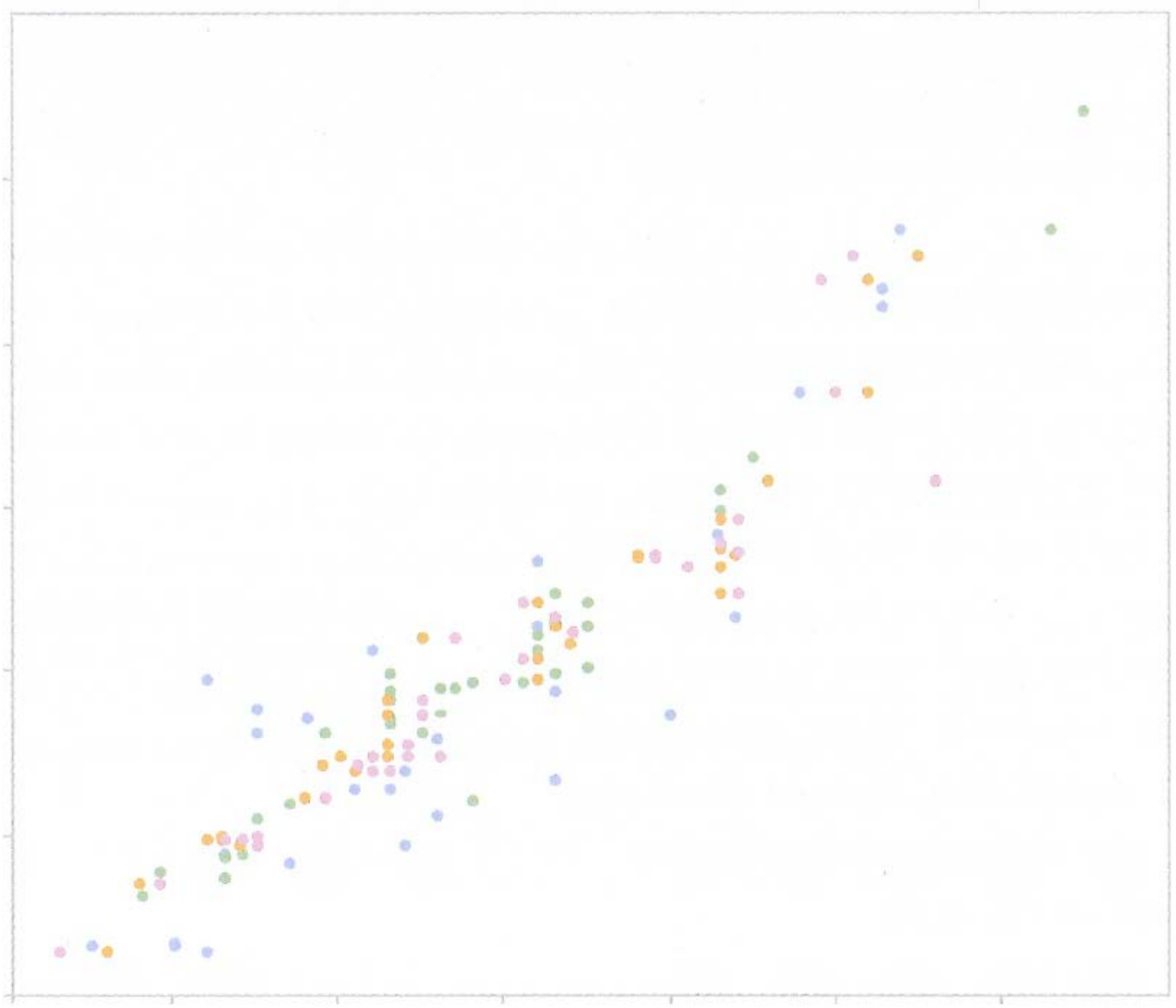
This graph uses contrast effectively to highlight the important information.



A “light” palette allows us to easily distinguish bars…



… but a light palette does not help us distinguish small objects such as data points.

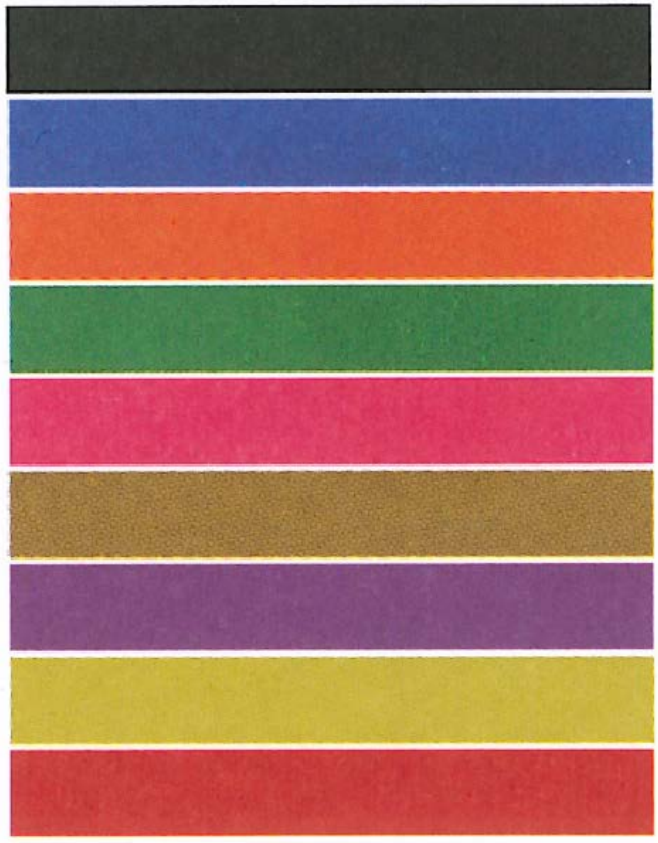


Use a medium palette for small data-encoding objects such as points and lines.

Medium

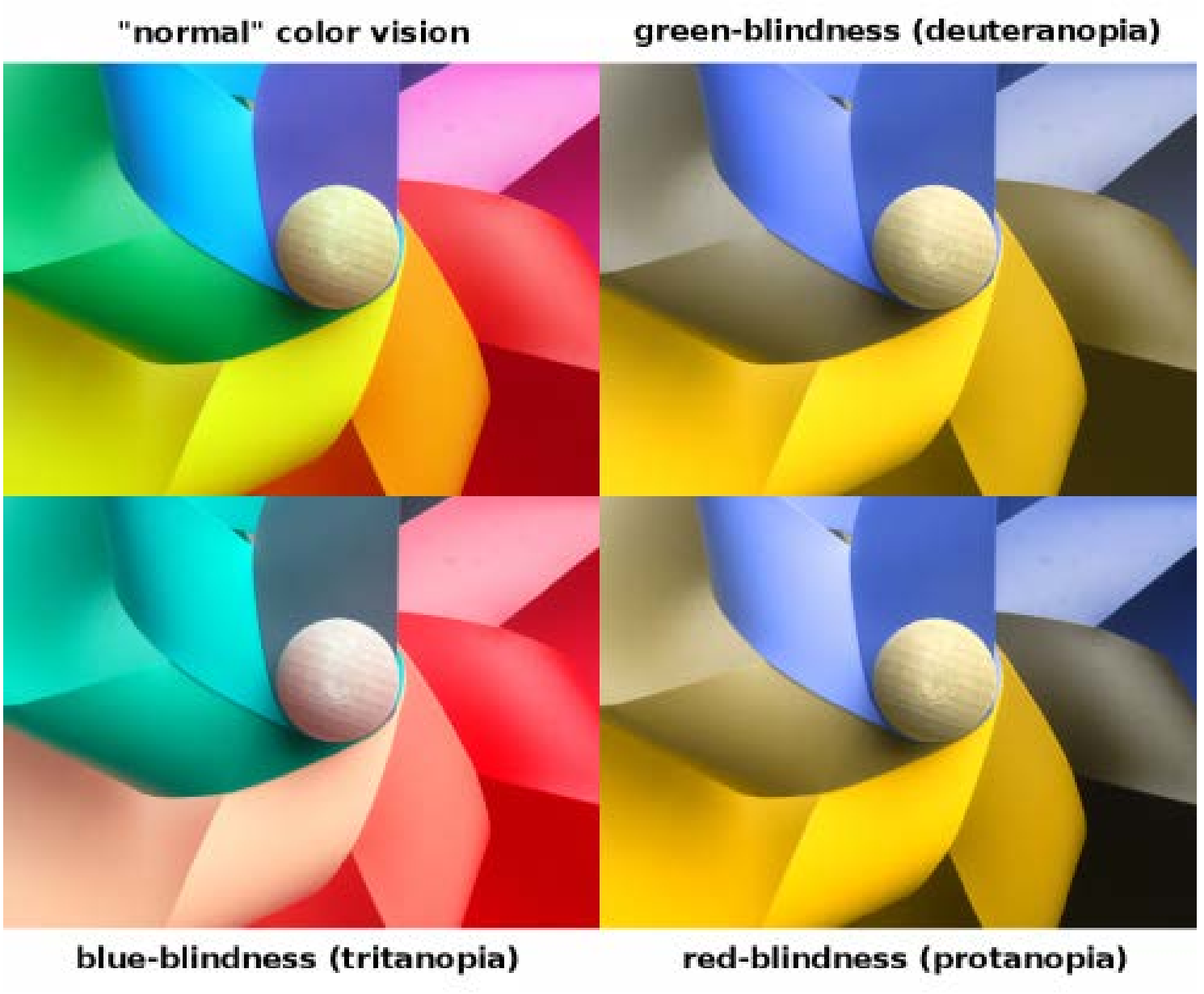
R	G	B
77	77	77
93	165	218
250	164	58
96	189	104
241	124	176
178	145	47
178	118	178
222	207	63
241	88	84

Use a dark palette to highlight a particular item.

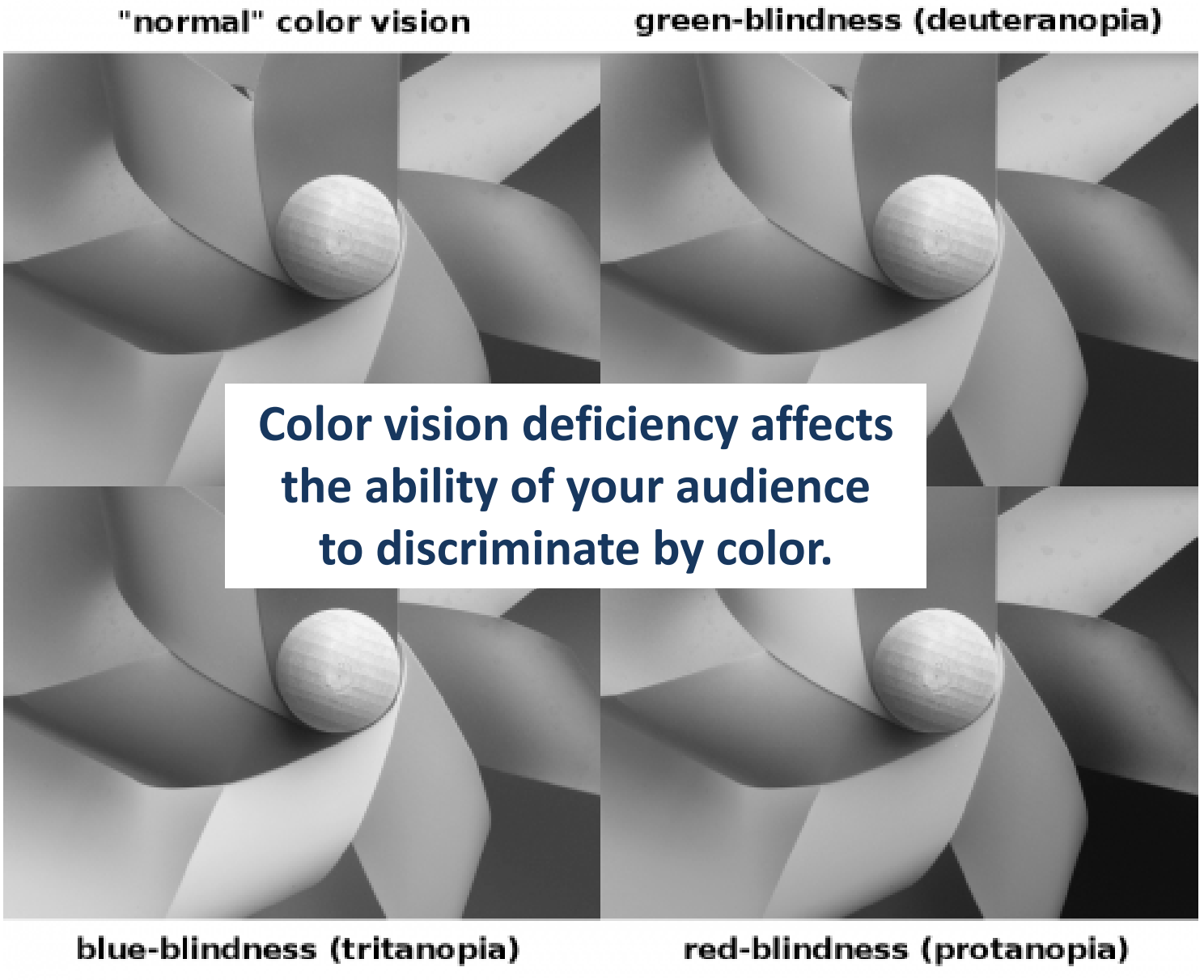


R	G	B
0	0	0
38	93	171
223	92	36
5	151	72
229	18	111
157	114	42
123	58	150
199	180	46
203	32	39

Perception – variation in discriminating color.



Perception – variation in discriminating color.

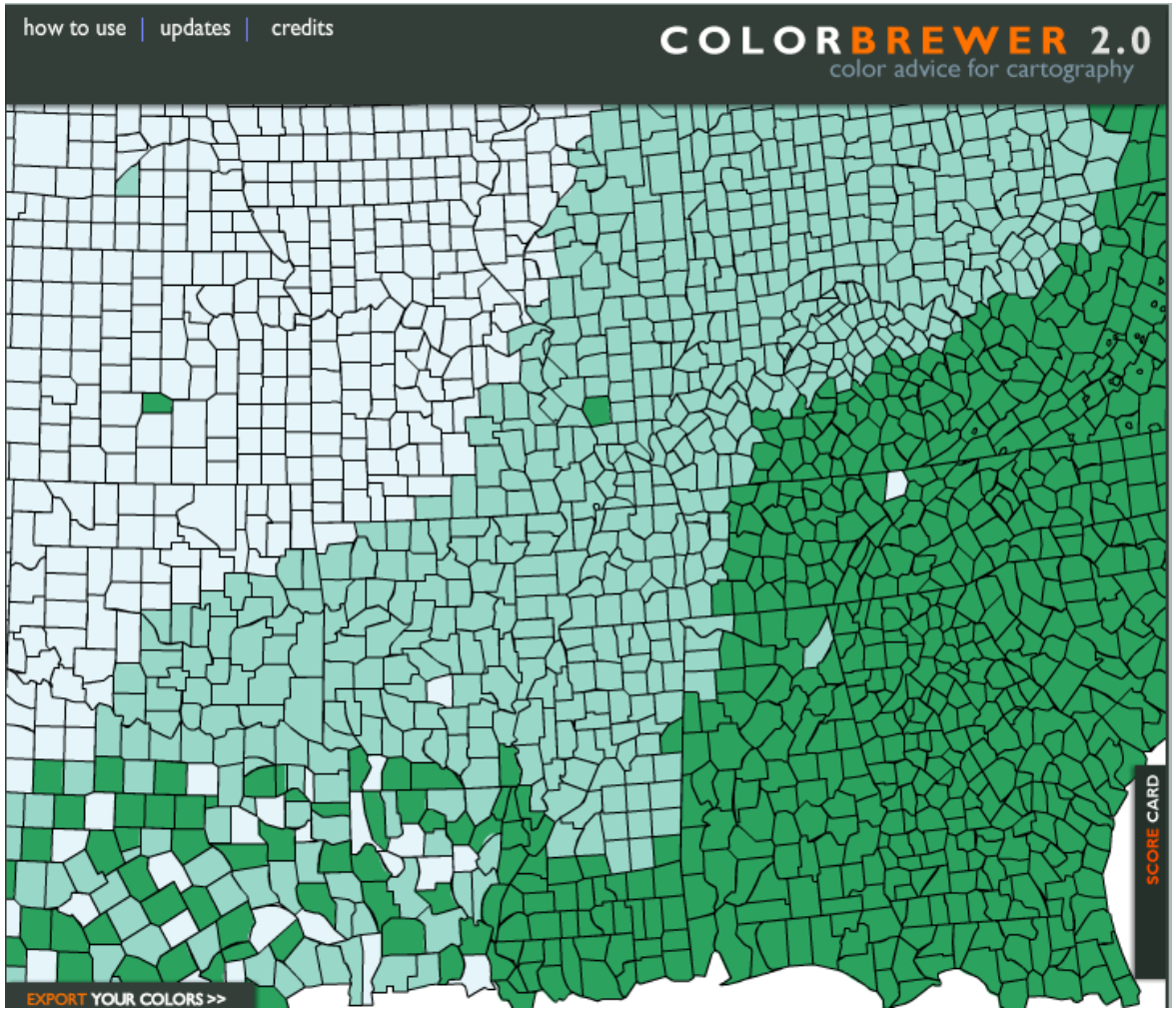


Perception – variation in discriminating color.

“normal”

red-variant

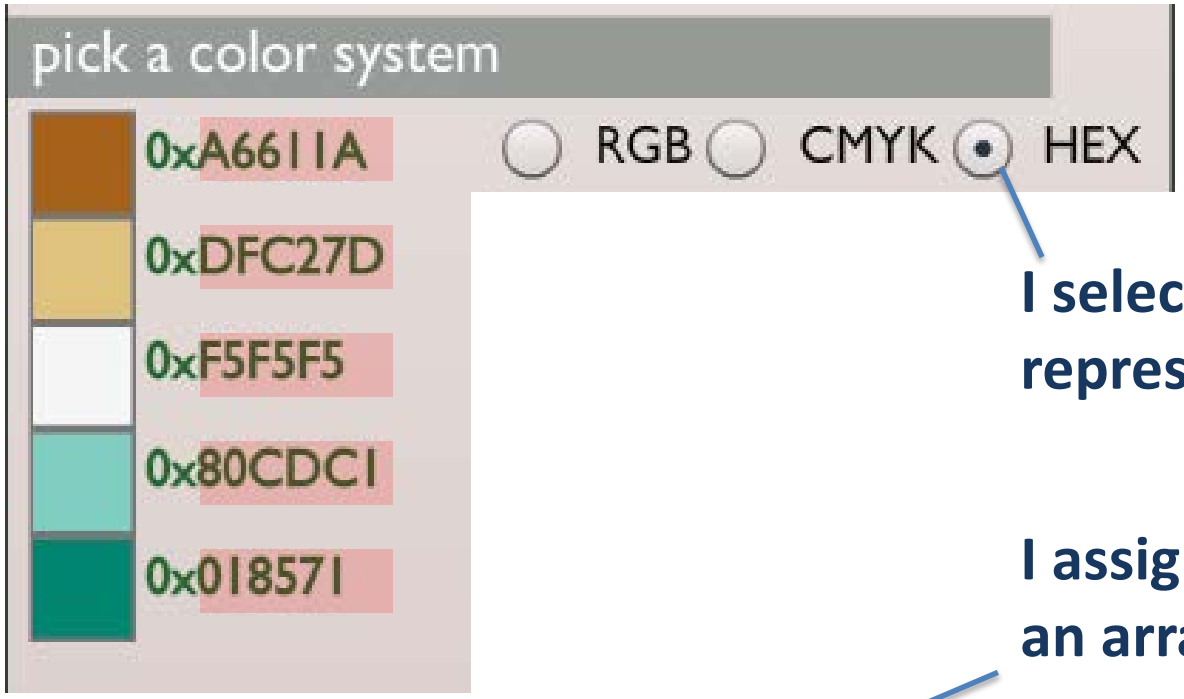
Selecting color palettes – use the Color Brewer website.



[Color Brewer]

diverging palette
sequential palette
color-vision-deficient safe
color IDs

Selecting a divergent color series from the Color Brewer website.



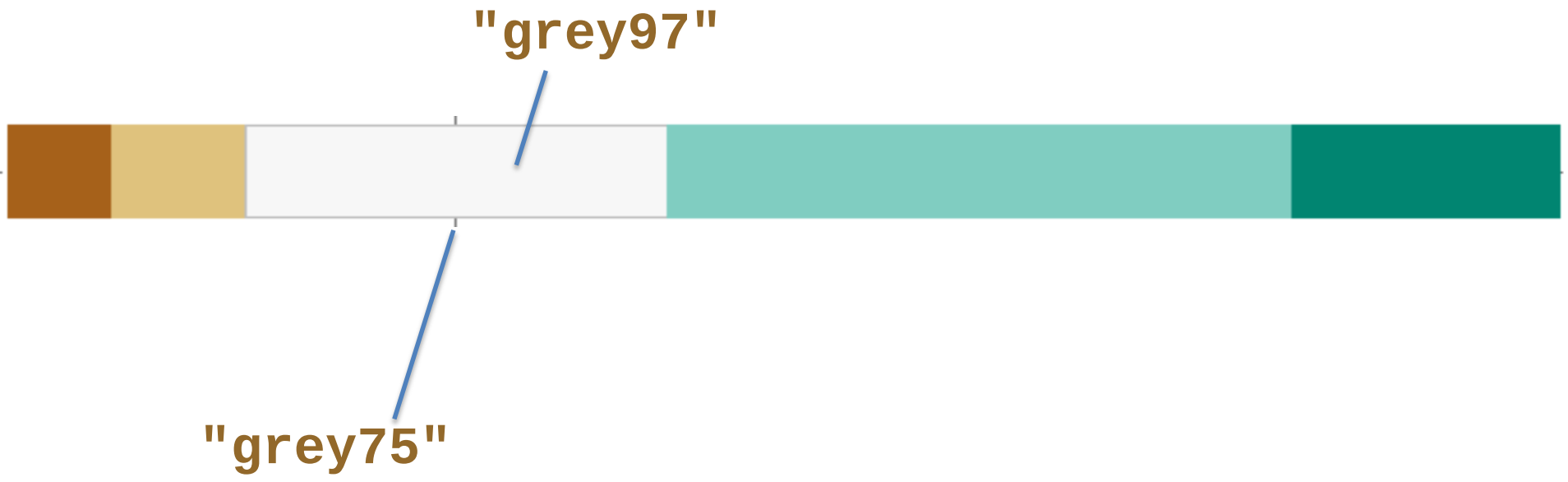
I selected the hexadecimal representation.

I assigned these colors to an array in R.

```
myFill = c("#a6611a", "#dfc27d", "grey97",
           "#80cdc1", "#018571")
```

The border around the bars are the same hues except for the central gray border.

```
myBorder = c("#a6611a", "#dfc27d", "grey75",
             "#80cdc1", "#018571")
```



The RColorBrewer package codes the colors for you.

```
library(RColorBrewer)

palette <- brewer.pal(5, "BrBG")
```

Creates a vector of color codes

Number of colors

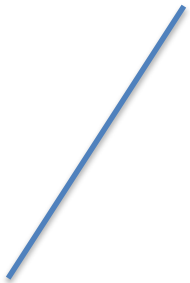
The RColorBrewer palette name

Create your own names for the colors you use regularly

```
library(RColorBrewer)

palette <- brewer.pal(5, "BrBG")

darkBr  <- palette[1]
lightBr <- palette[2]
neutral <- palette[3]
lightBG <- palette[4]
darkBG  <- palette[5]
```



your own color variables

Use your color names for fill or color arguments in ggplot

```
library(RColorBrewer)

palette <- brewer.pal(5, "BrBG")

darkBr  <- palette[1]
lightBr <- palette[2]
neutral <- palette[3]
lightBG <- palette[4]
darkBG  <- palette[5]
```

```
myFill = c(
 darkBr, lightBr, neutral, lightBG, darkBG )
```

```
# purple-green (divergent)
PRGn <- brewer.pal(6, "PRGn")
  darkPR  <- PRGn[1]
  medPR   <- PRGn[2]
  lightPR <- PRGn[3]
  lightGn <- PRGn[4]
  medGn   <- PRGn[5]
  darkGn  <- PRGn[6]

# grays
Grays <- brewer.pal(6, "Greys")
  gray1 <- Grays[1]
  gray2 <- Grays[2]
  gray3 <- Grays[3]
  gray4 <- Grays[4]
  gray5 <- Grays[5]
  gray6 <- Grays[6]
```

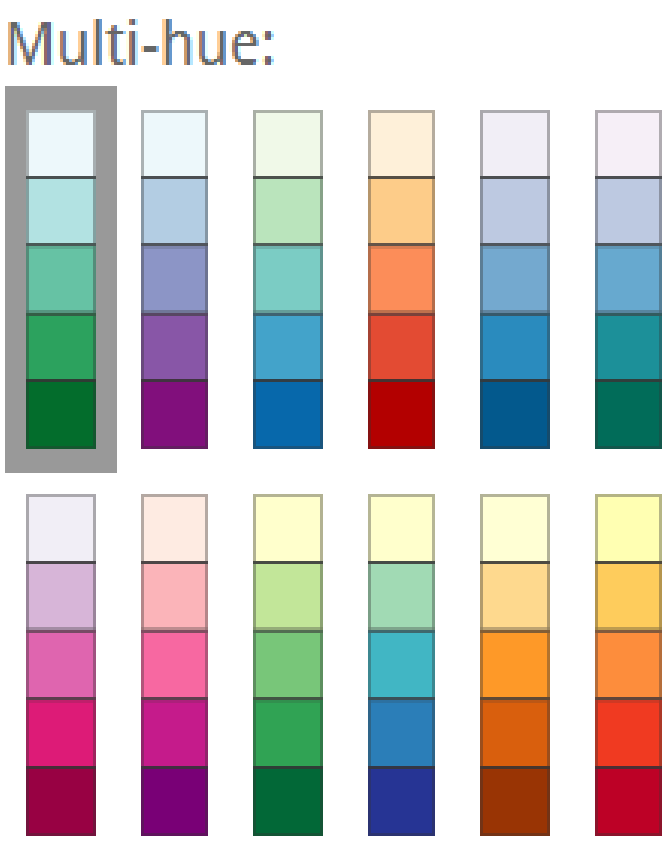
The RColorBrewer palette name

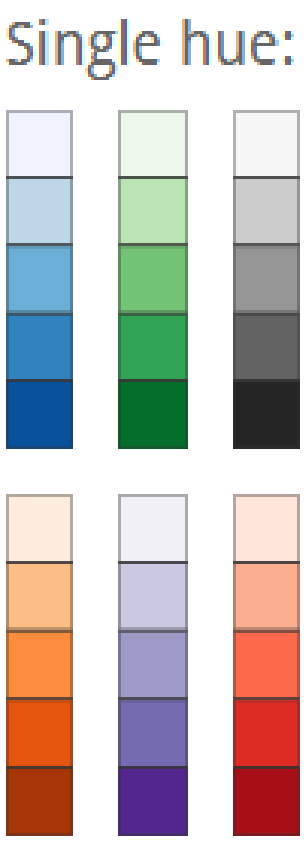
Number of data classes.

Different palettes have different upper limits.

?RColorBrewer
in your Console to see the names and the limits (after installing the package and loading it of course)

Sequential palettes in RColorBrewer



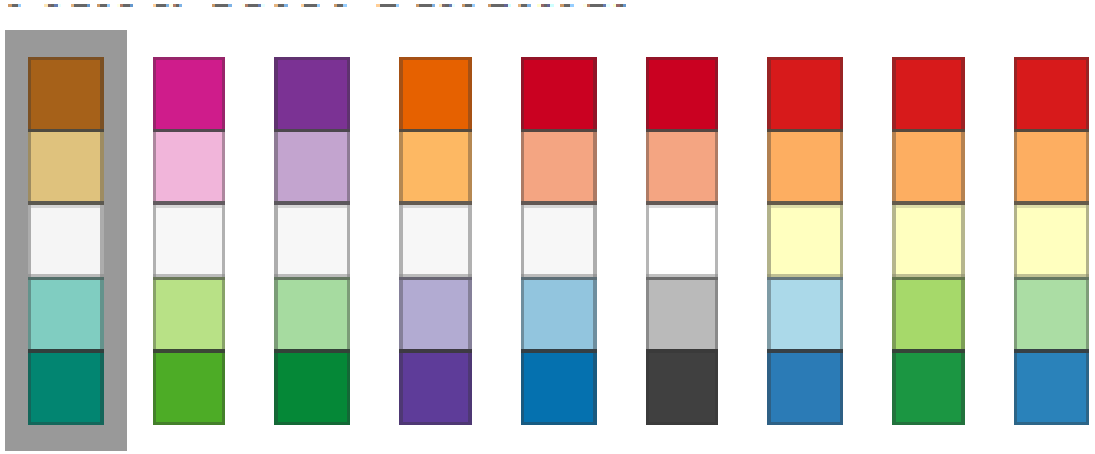


Palette names

Blues	BuGn
BuPu	GnBu
Greens	Greys
Oranges	OrRd
PuBu	PuBuGn
PuRd	Purples
RdPu	Reds
YlGn	YlGnBu
YlOrBr	YlOrRd

[link to Color Brewer](#) website

Diverging palettes

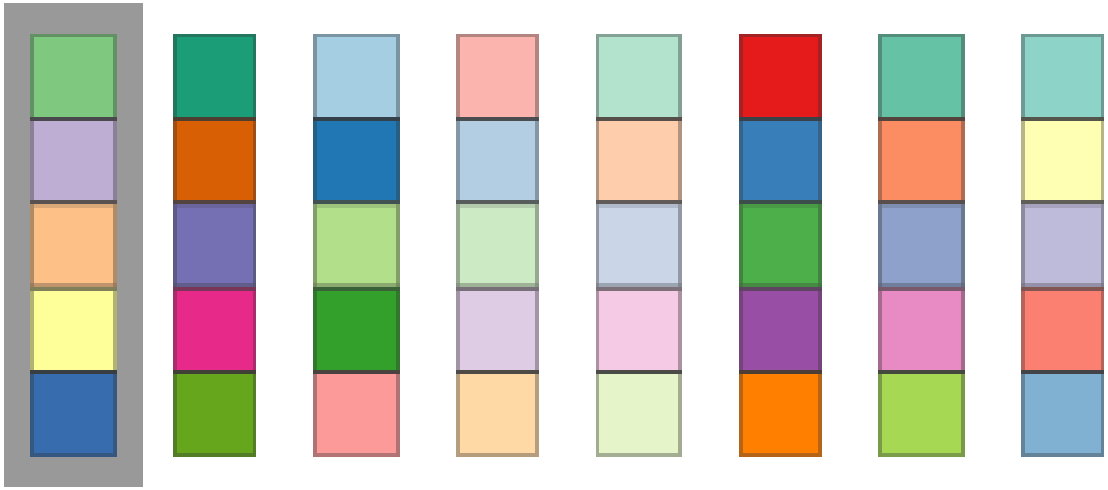


Palette names

BrBG	PiYG
PRGn	PuOr
RdBu	RdGy
RdYlBu	RdYlGn
Spectral	

link to Color Brewer website

Qualitative palettes

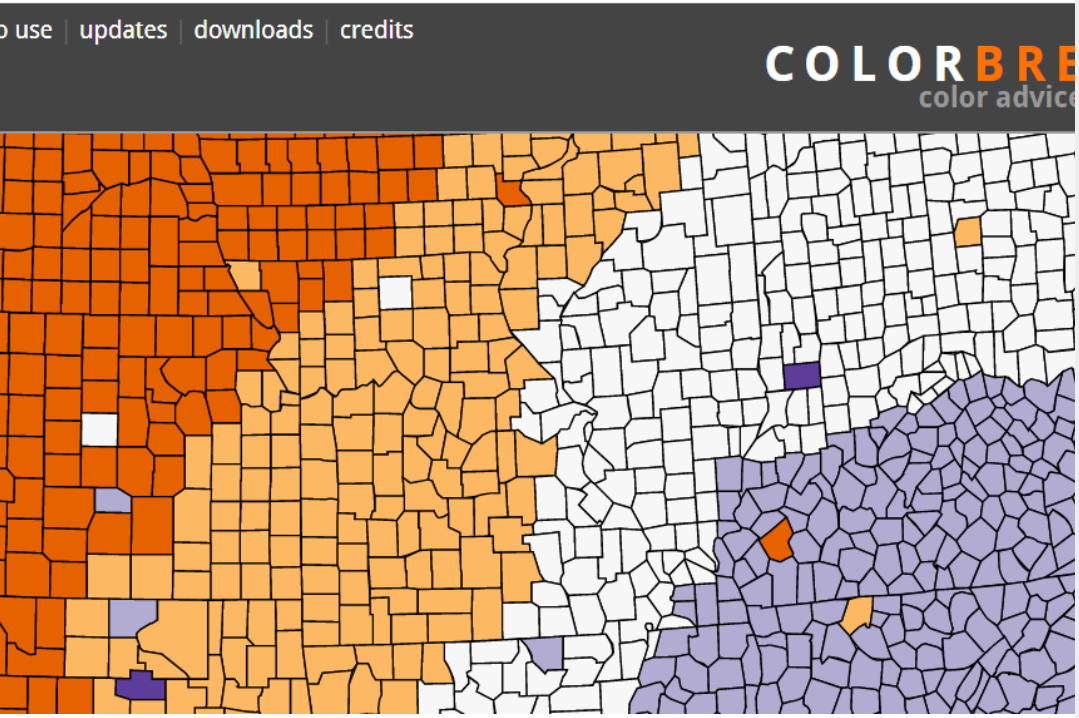


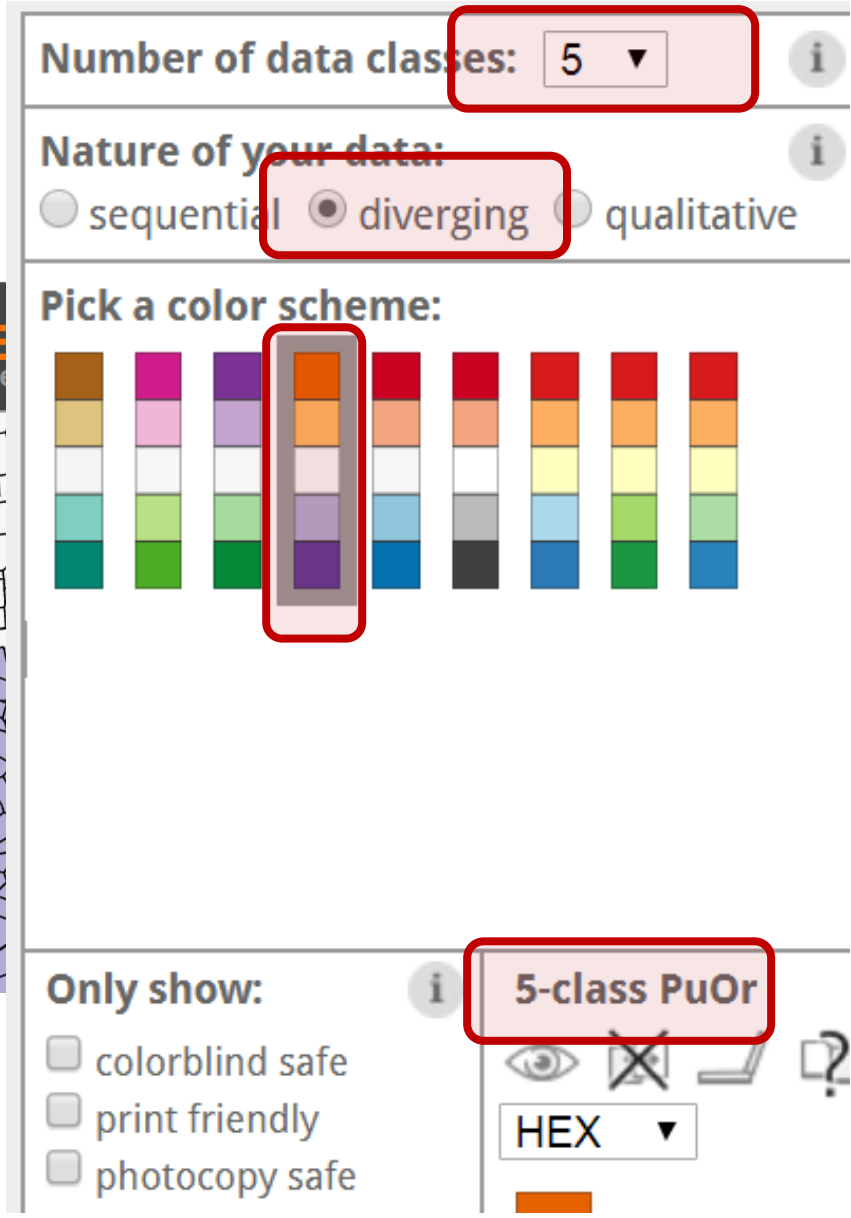
Palette names

Accent	Dark2
Paired	Pastel1
Pastel2	Set1
Set2	Set3

[link to Color Brewer](#) website

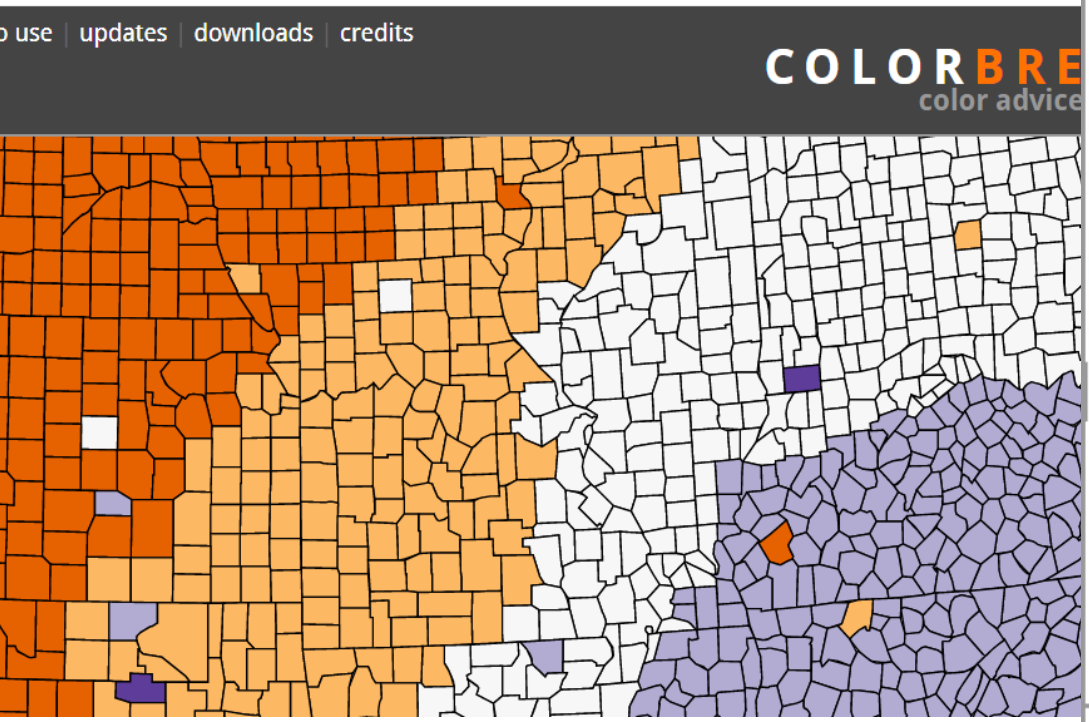
Fine tuning your palettes





[link to Color Brewer](#) website

Fine tuning your palettes

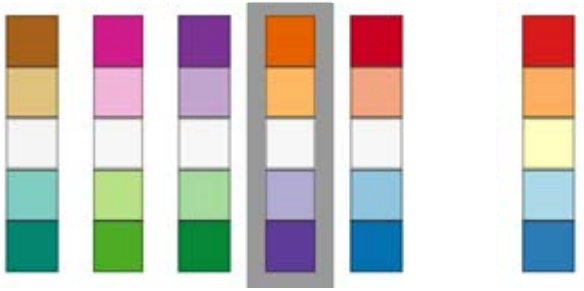


Number of data classes: 5

Nature of your data:

sequential | diverging | qualitative

Pick a color scheme:



Only show:

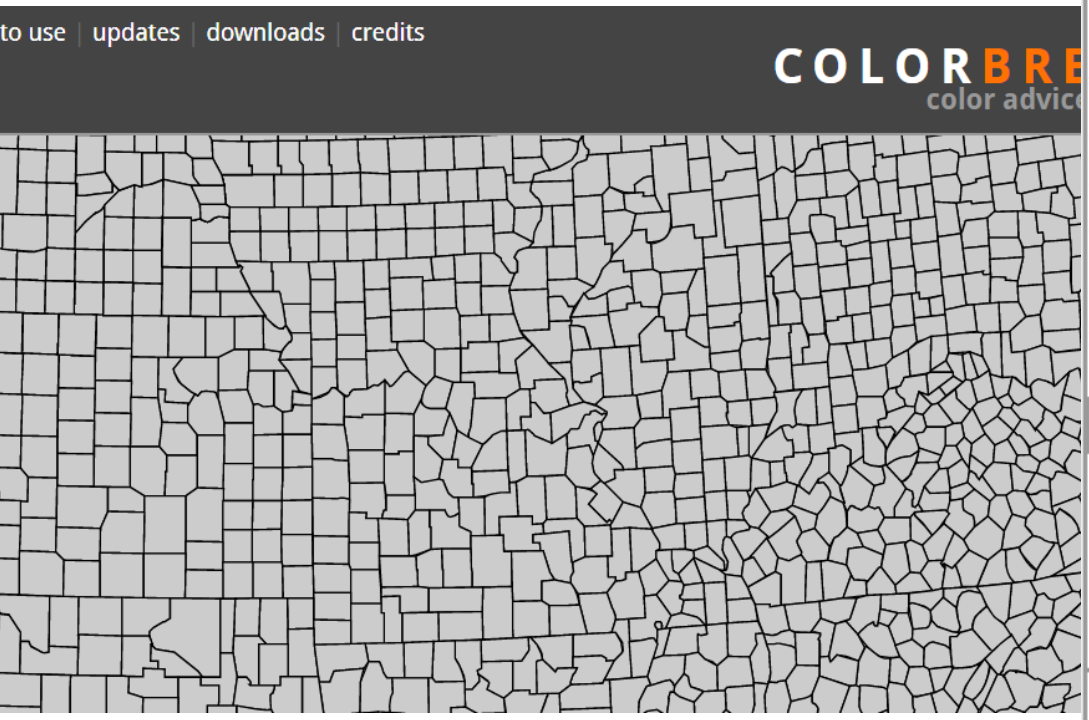
- colorblind safe
- print friendly
- photocopy safe

5-class PuOr

HEX

[link to Color Brewer](#) website

Fine tuning your palettes



Number of data classes: 5

Nature of your data:

sequential diverging qualitative

Pick a color scheme:

Only show:

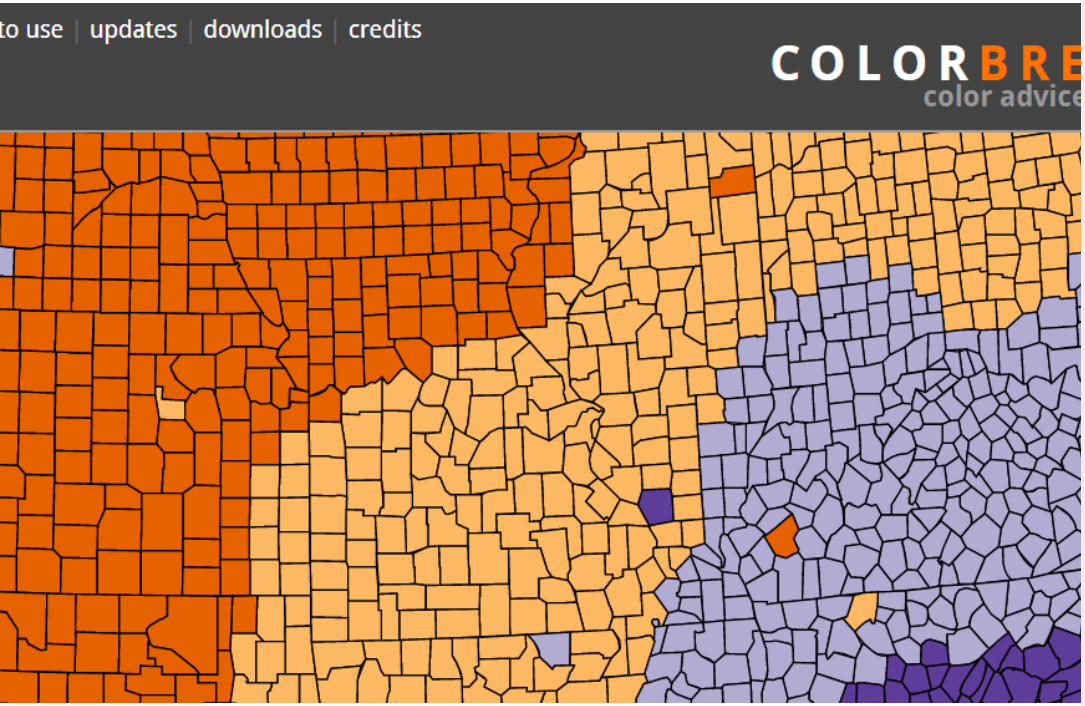
colorblind safe

print friendly

photocopy safe

[link to Color Brewer](#) website

Fine tuning your palettes



Number of data classes: 4

Nature of your data:
sequential diverging qualitative

Pick a color scheme:

Only show:
4-class PuOr
colorblind safe
print friendly
photocopy safe
HEX

[link to Color Brewer](#) website

Other R functions and packages for managing color.

convertcolor()	for conversions between different color spaces RGB, CMYK, HSL, hexadecimal, 0-255
colorspace	package for creating colors in a variety of color spaces
munsell	package for HCV (hue/chroma/value) specification
dichromat	palettes accounting for color vision deficiencies
built-in palettes	rainbow(), heat.colors(), terrain.colors(), topo.colors(), cm.colors(), gray.colors()