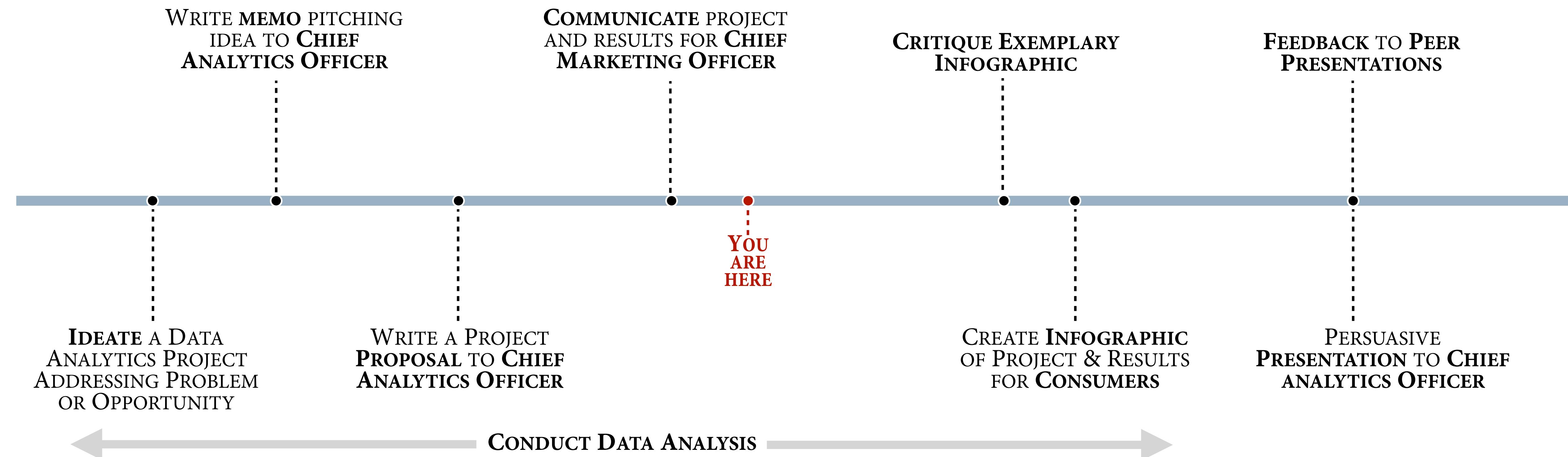


Storytelling With Data

**Effective visuals — encoding data
graphically: grammar, layers, color**

Conceptual project timeline



the grammar of graphics

DATA : a set of data operations that create variables from datasets

TRANSFORMATIONS : variable transformations (*e.g., rank*)

SCALES : scale transformations (*e.g., log*)

COORDINATES : a coordinate system (*e.g., cartesian, polar*)

ELEMENTS : graphs (*e.g., points, lines*) and their aesthetic attributes (*e.g., color, opacity, shape, size, orientation*)

GUIDES : one or more guides (*axes, legends, etc.*)



the grammar of graphics | *ggplot2 is the grammar of graphics implemented in R*

```
# load grammar of graphics
library(ggplot2)

p <-

# functions for data ink

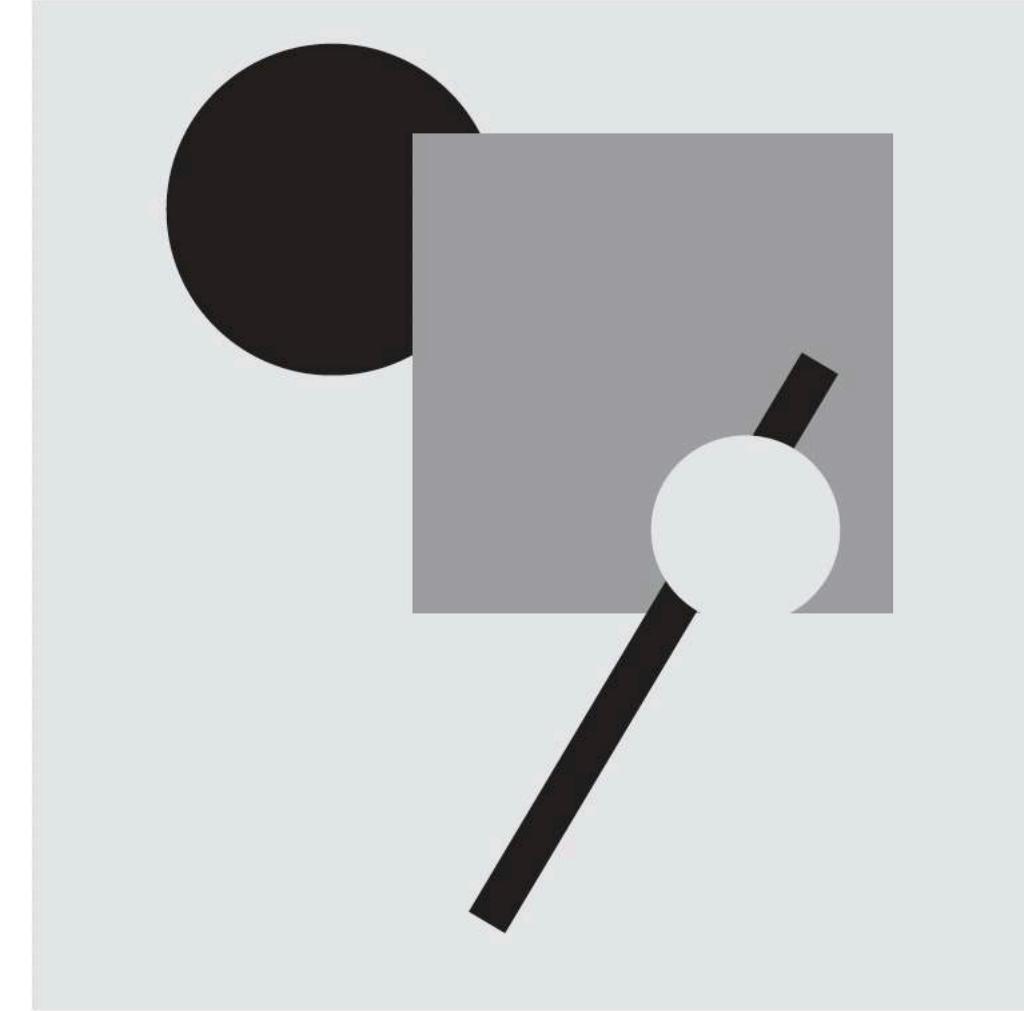
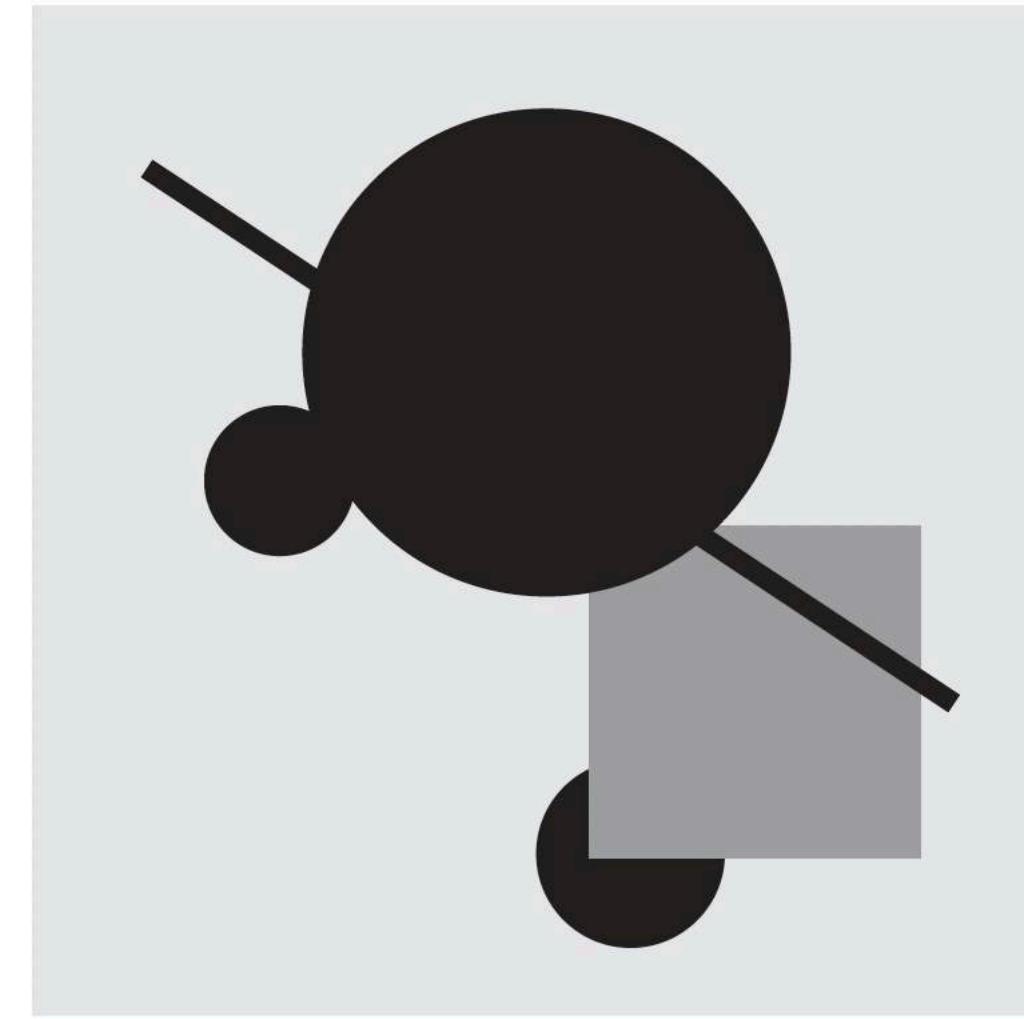
DATA      ggplot(data = <data>,
                mapping = aes(<aesthetic> = <variable>,
                            <aesthetic> = <variable>,
                            <...> = <...>)) +
TRANSFORMATIONS
ELEMENTS    geom_<type>(<...>) +
SCALES & GUIDES   scale_<mapping>_<type>(<...>) +
COORDINATES   coord_<type>(<...>) +
               facet_<type>(<...>) +
               <...> +
GUIDES       # functions for non-data ink
               labs(<...>) +
               theme(<...> = <...>) +
               annotate(<...>) +
               <...>
```

{ element_blank()
element_line(<...> = <...>)
element_rect(<...> = <...>)
element_text(<...> = <...>)



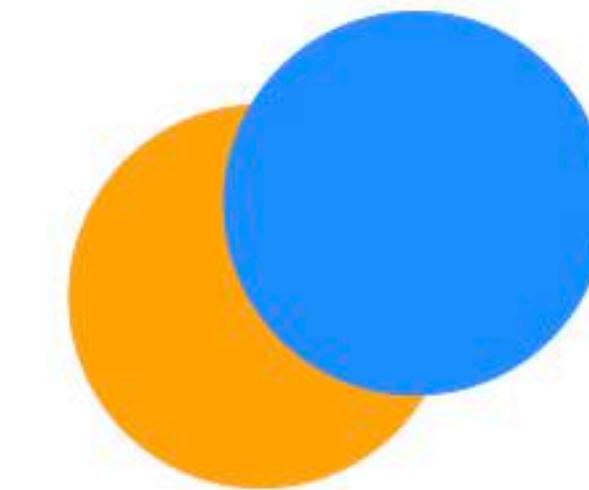
thinking about graphics as layers

graphics as layers | *when one form or shape overlaps another, we see an illusion of near and far.*

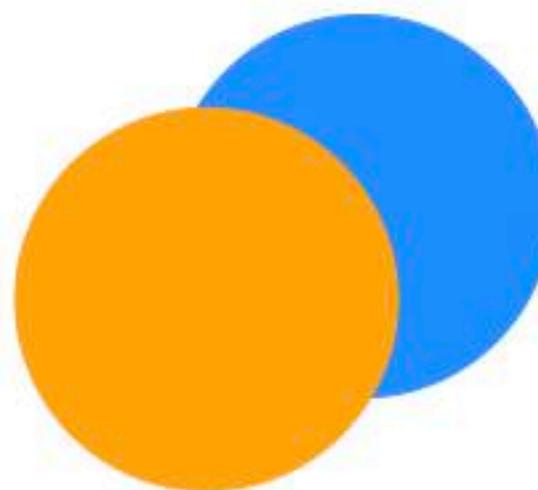


graphics as layers | *order of elements determines position towards reader and when overlapping, occlude.*

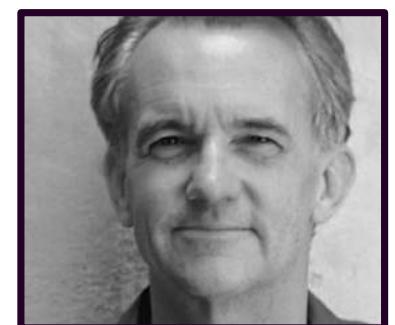
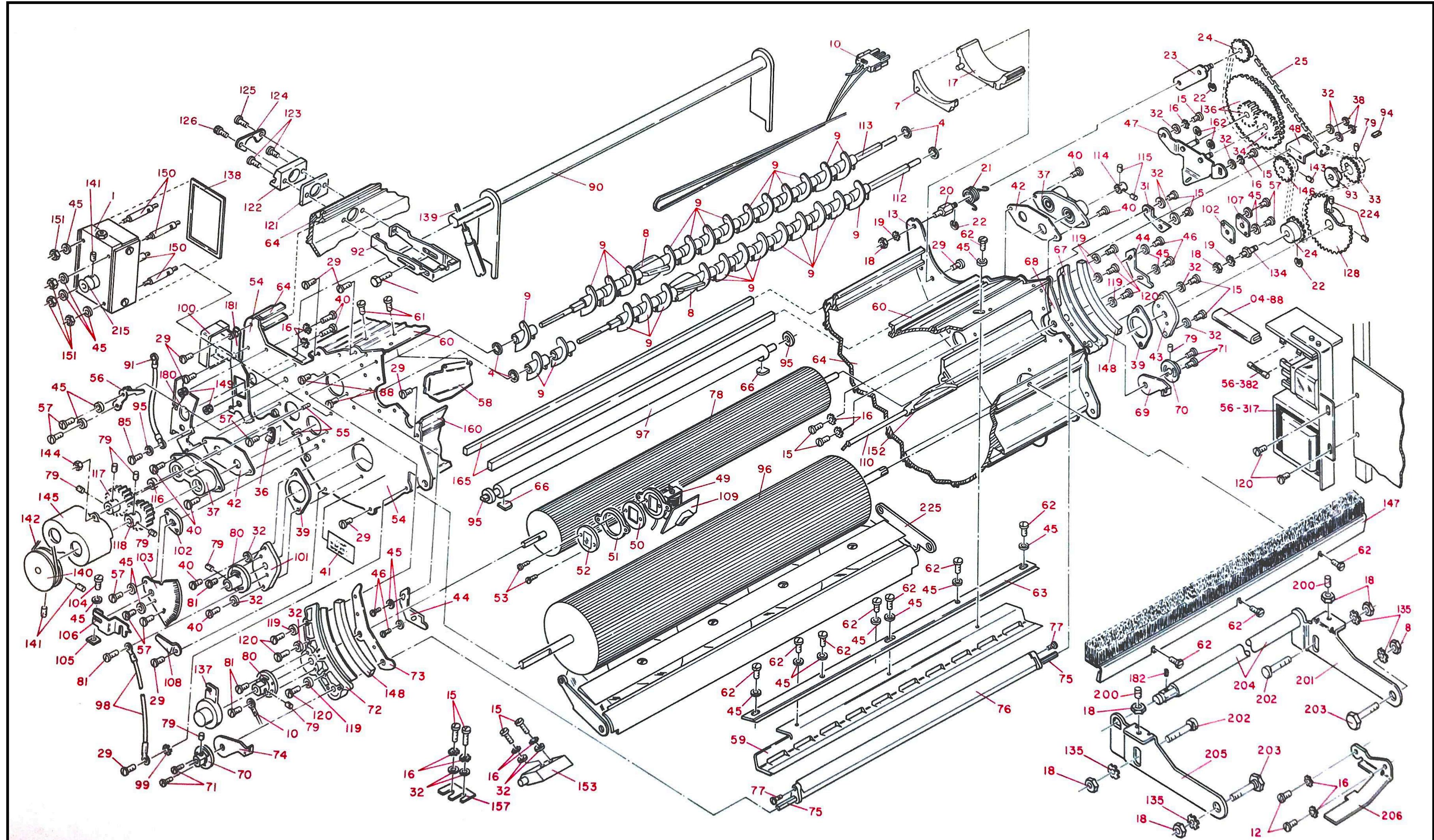
```
ggplot() +  
  theme_void() +  
  scale_x_continuous(limits = c(-5, 5)) +  
  scale_y_continuous(limits = c(-5, 5)) +  
  geom_point(aes(x = 0, y = 0),  
             size = 50, color = "orange") +  
  geom_point(aes(x = 1, y = 1),  
             size = 50, color = "dodgerblue")
```



```
ggplot() +  
  theme_void() +  
  scale_x_continuous(limits = c(-5, 5)) +  
  scale_y_continuous(limits = c(-5, 5)) +  
  geom_point(aes(x = 1, y = 1),  
             size = 50, color = "dodgerblue") +  
  geom_point(aes(x = 0, y = 0),  
             size = 50, color = "orange")
```

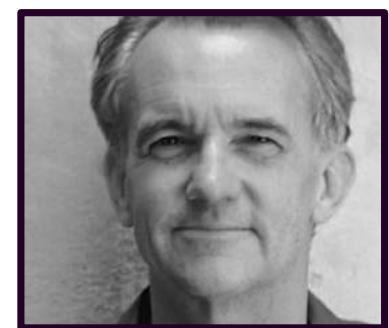
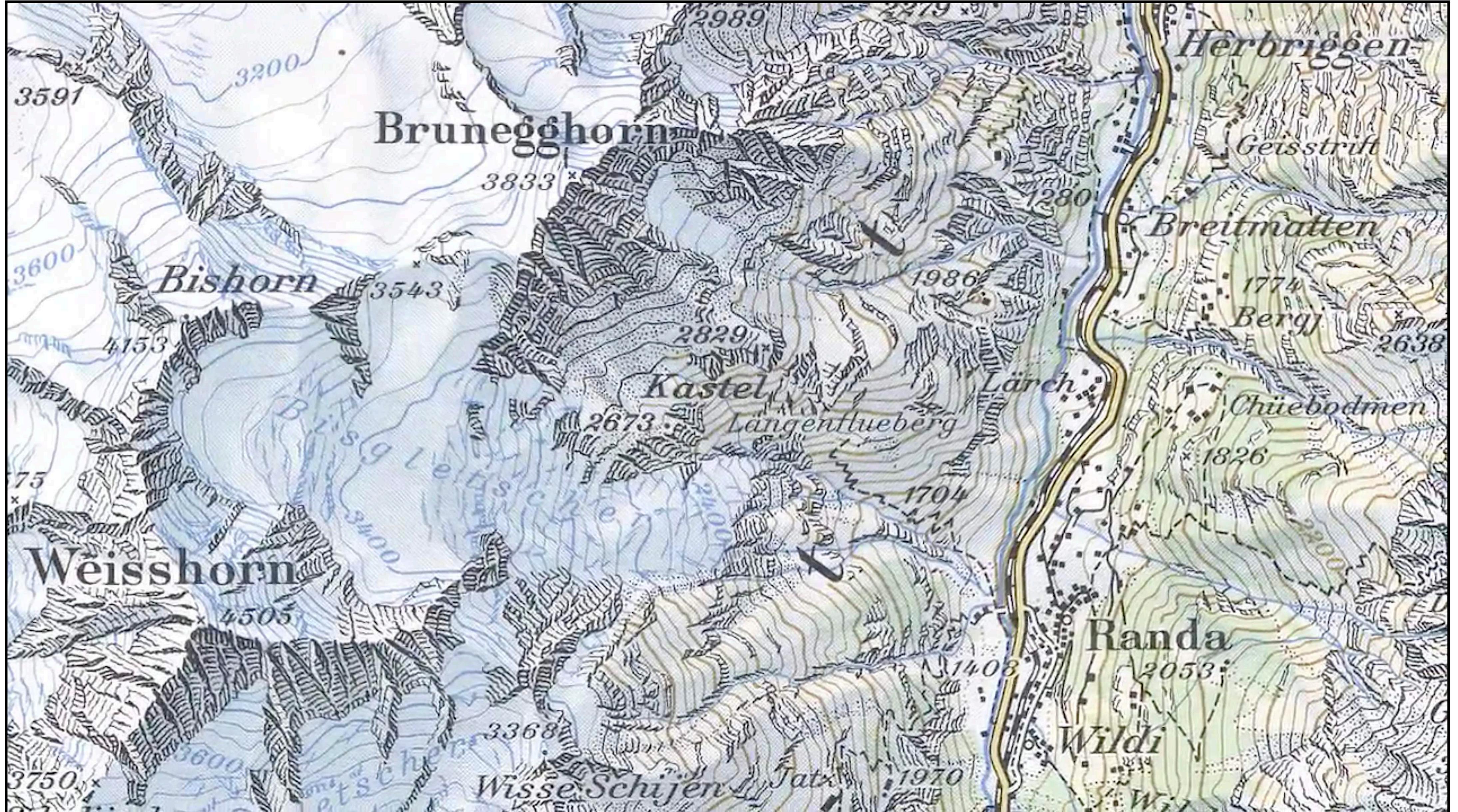


graphics as layers | *layering by type of encoding, color in this case, helps separate information types.*



Tufte, Edward

graphics as layers | *layering by type of encoding helps separate information types. Maps tend to be exemplary.*



graphics as layers | *in this example, observed data are separately layered “behind” scale of residuals.*

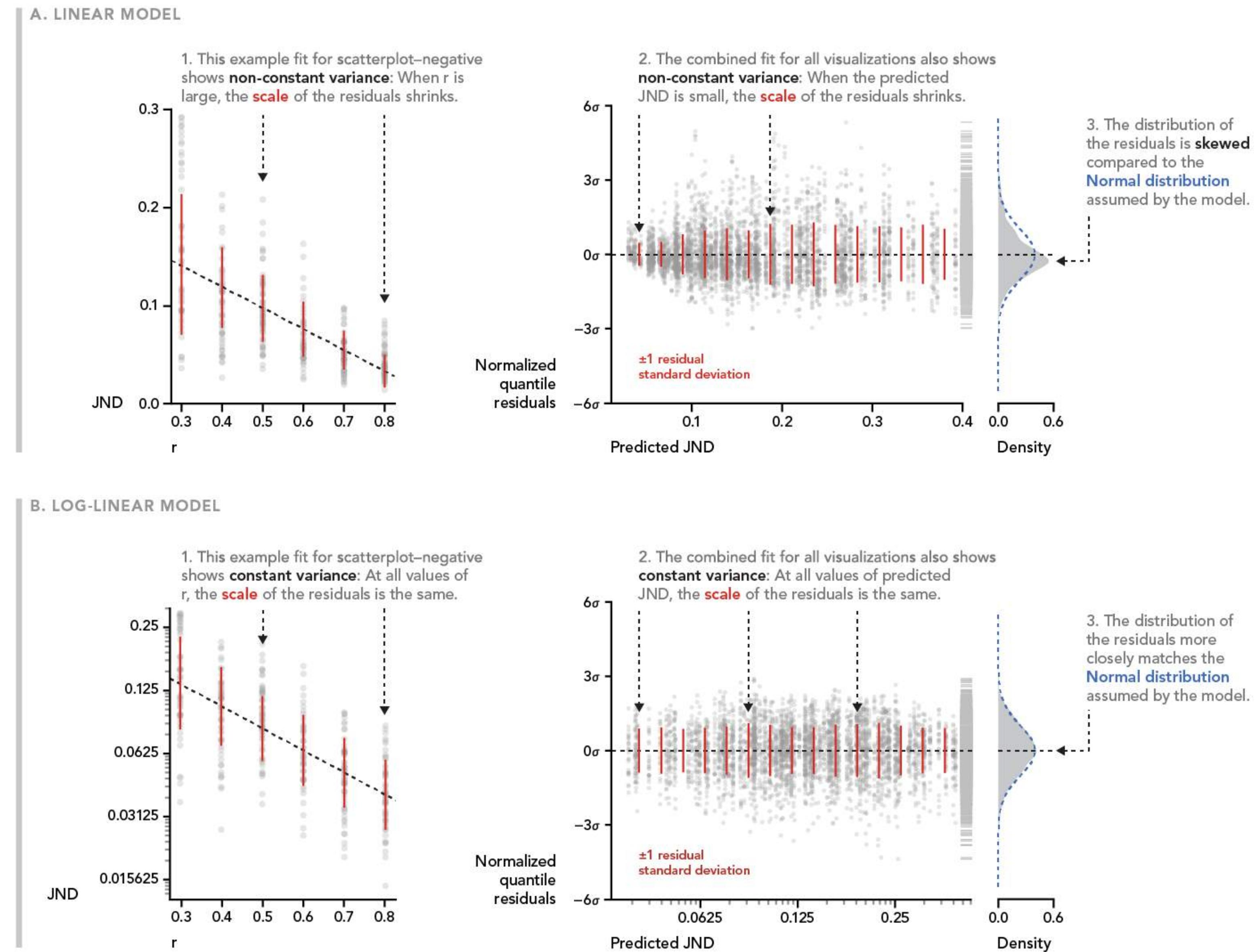
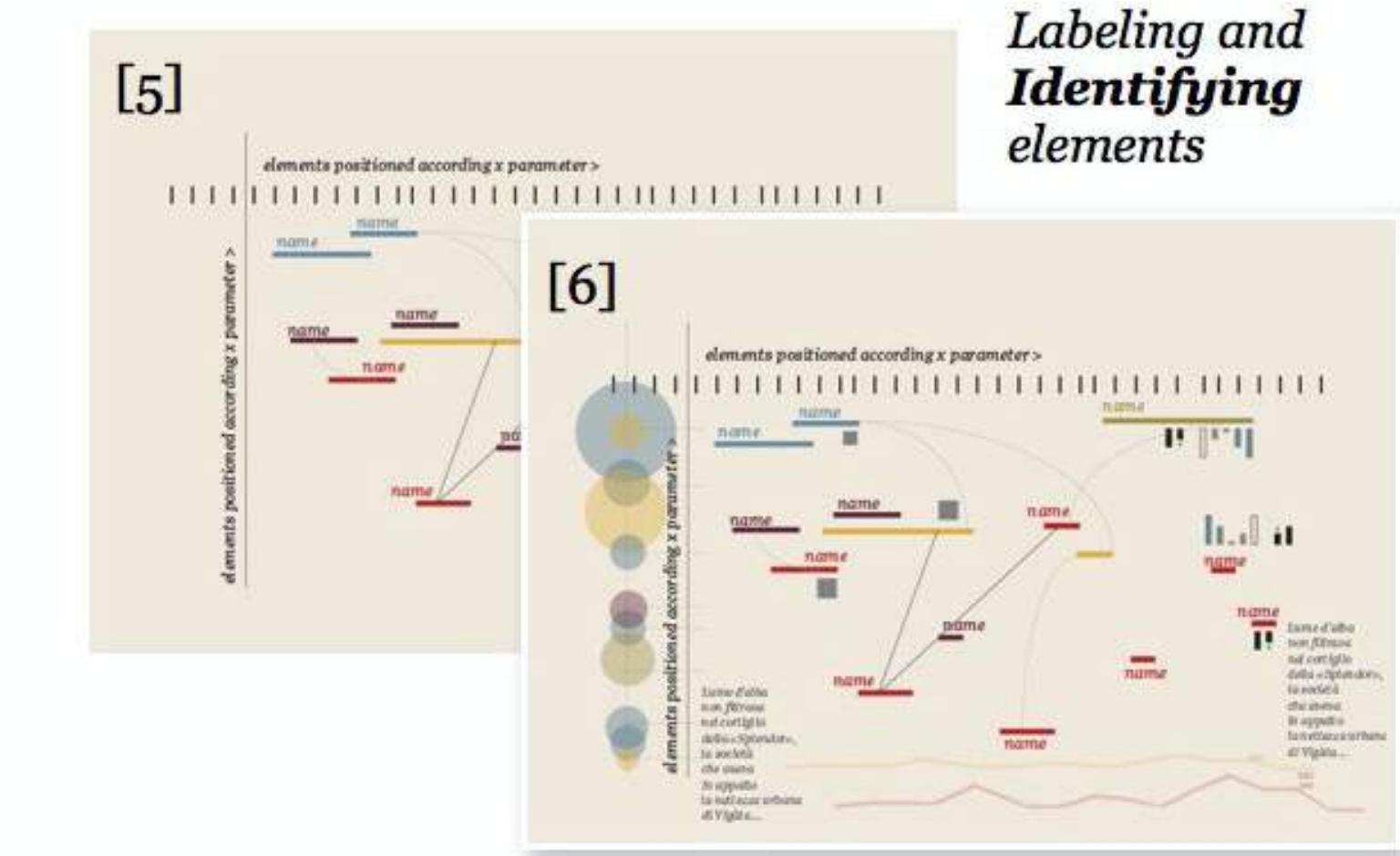
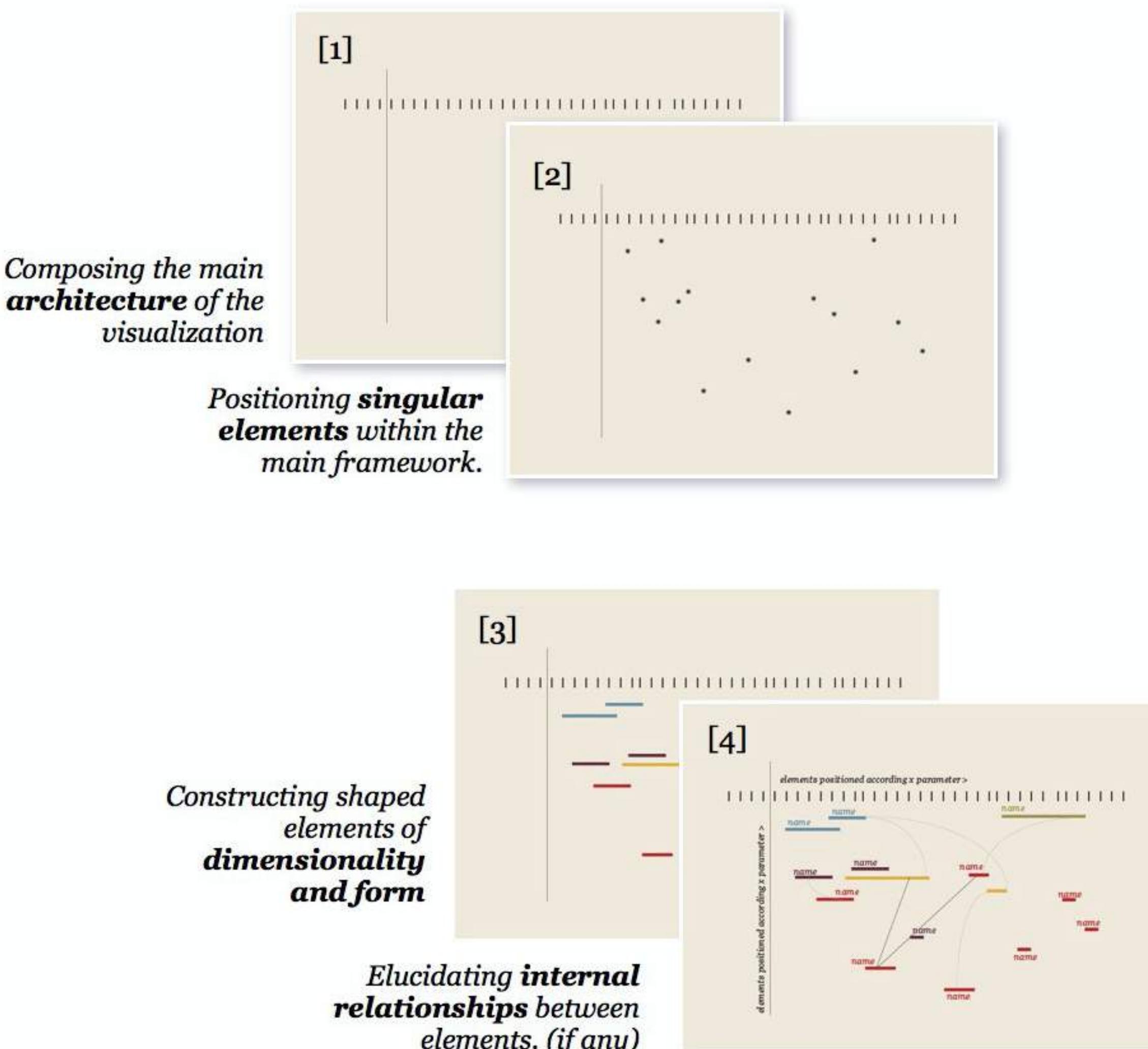


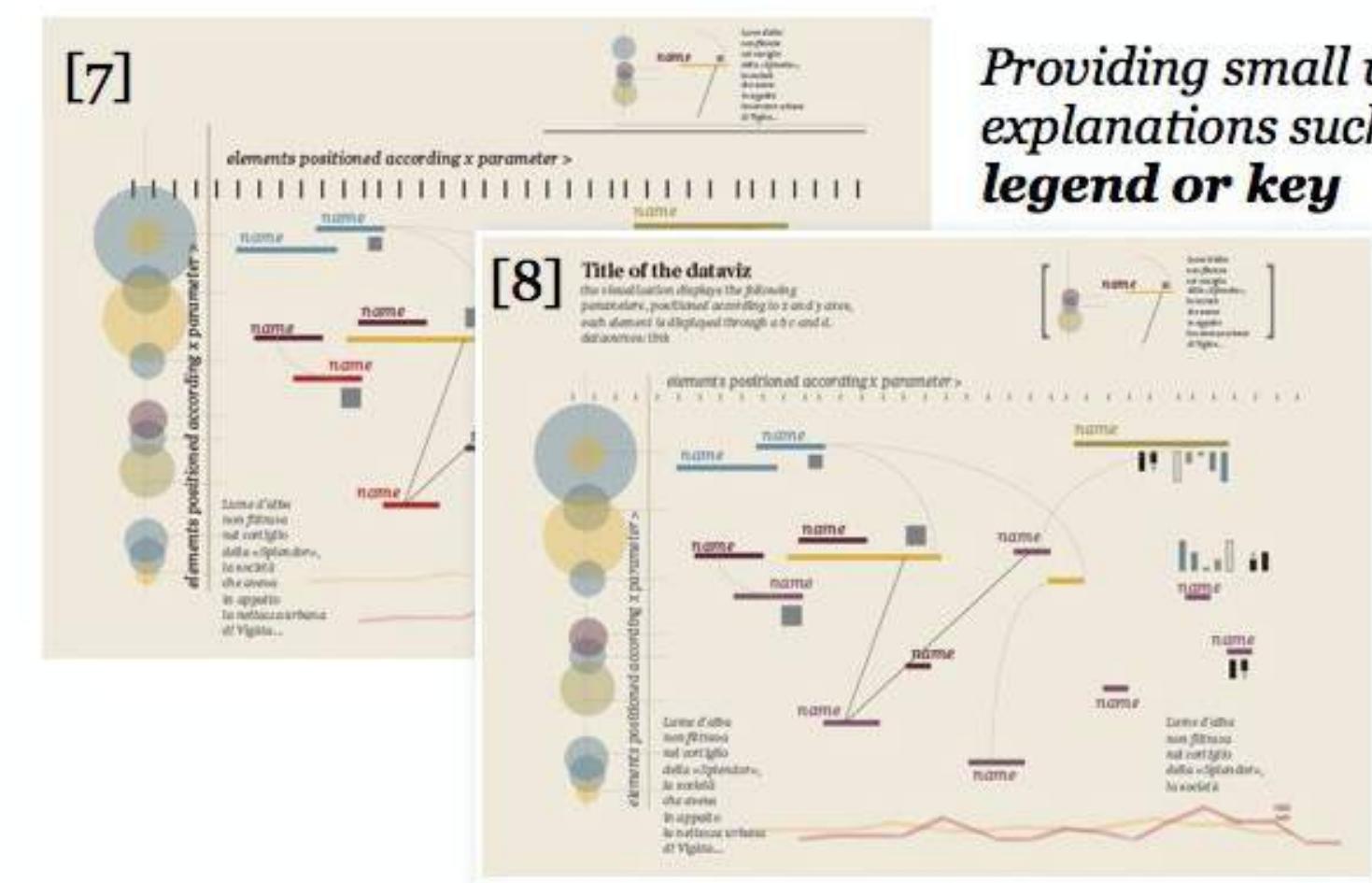
Fig. 3 Comparison of fits of the linear model (Section 3) and the log-linear model (Section 4). Example fits of each model to scatterplot-negative are shown in A.1 and B.1. Plots of normalized residuals for all visualization × direction pairs are shown in A.2 and B.2. Density plots of normalized residuals with comparison to the standard normal distribution are shown in A.3 and B.3.

graphics as layers | *layering can create hierarchy and clarity in graphics narratives*



Labeling and Identifying elements

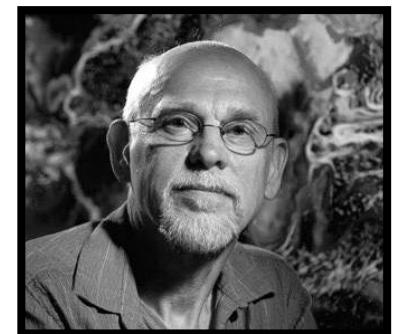
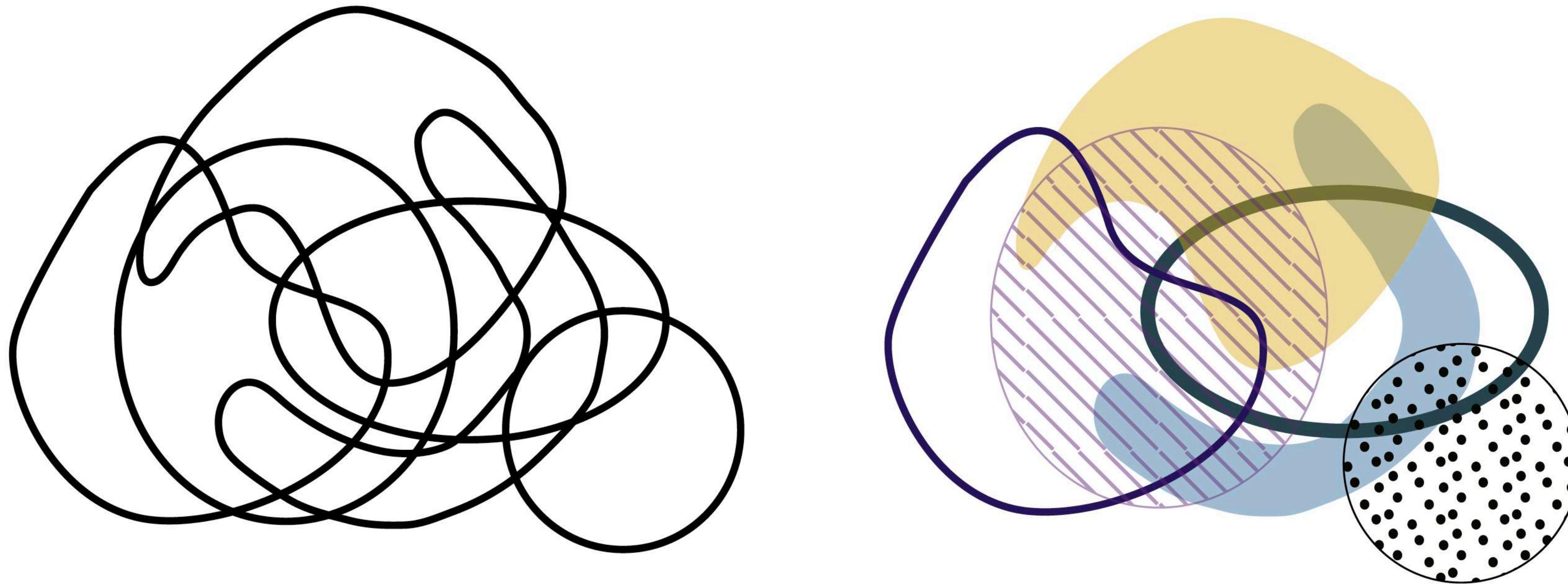
Supplementing the greater story through the addition of “minor or tangential tales” elements



Providing small visual explanations such as a legend or key

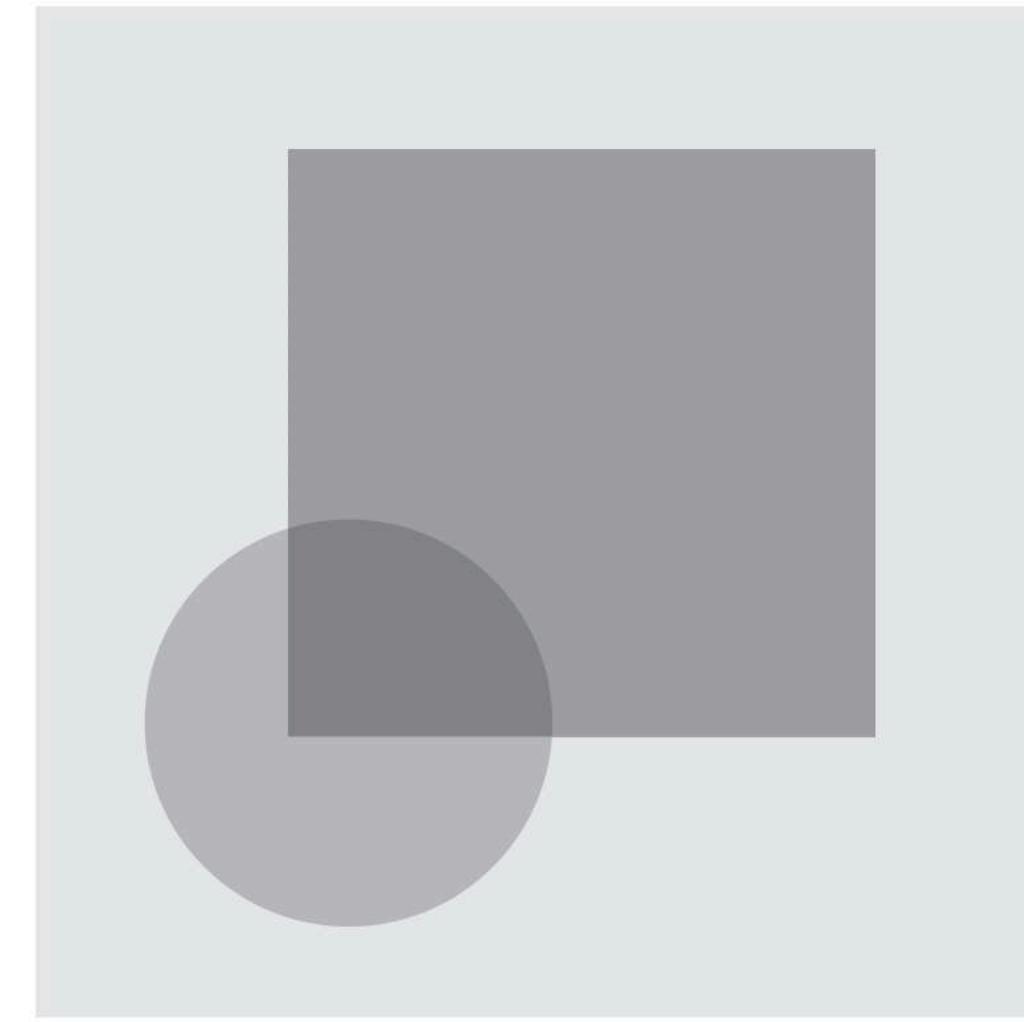
Fine-tuning and stylizing of elements shapes, colors, and weights to make hierarchies pop out.

graphics as layers | *in this Euler diagram, color and texture help to distinguish layers of information*



Ware, Colin

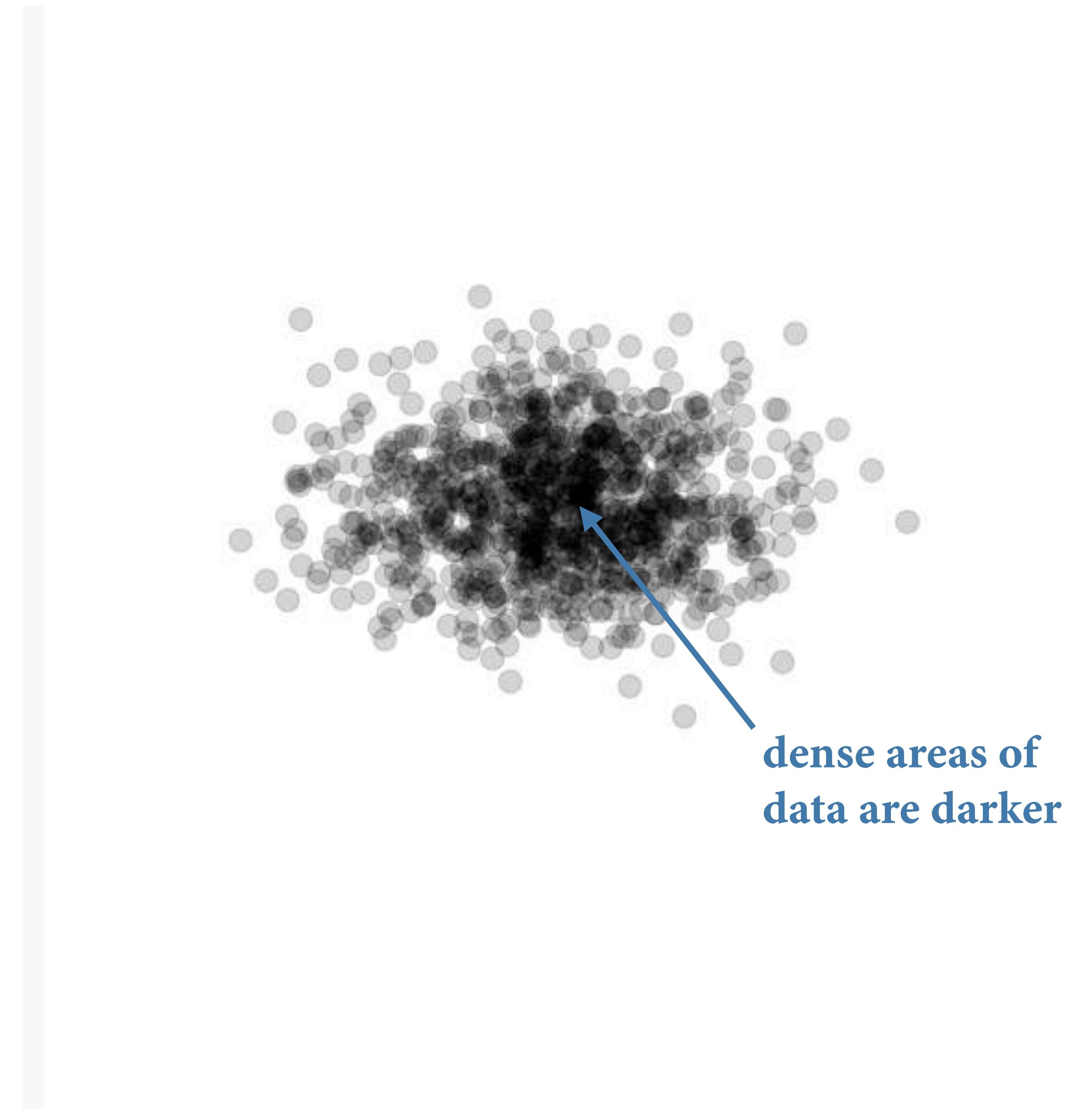
graphics as layers | *transparency can enhance, or create conflicts with, the illusion of spatial arrangement.*



graphics as layers | *for layered data encoded in monochrome, transparency reveals density.*

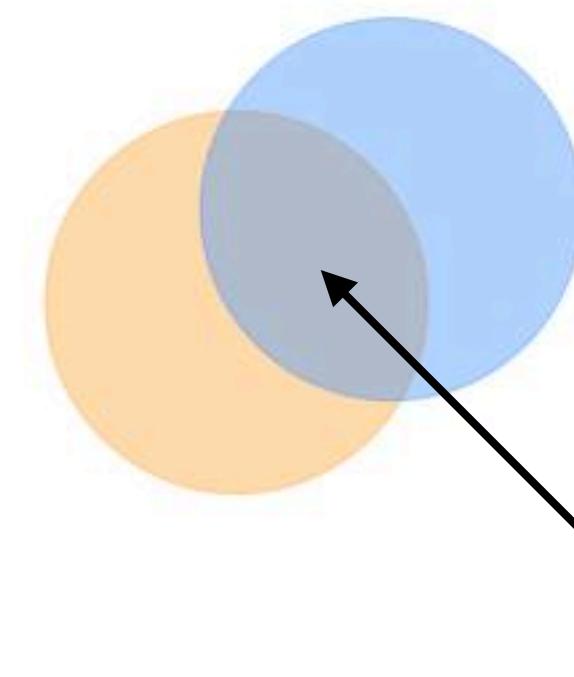
```
x <- rnorm(1000)
y <- rnorm(1000)

ggplot() +
  theme_void() +
  scale_x_continuous(limits = c(-5, 5)) +
  scale_y_continuous(limits = c(-5, 5)) +
  geom_point(aes(x = x, y = y),
             size = 4, color = "black",
             alpha = 0.2)
```



graphics as layers | *layered data encoded in color, if overlapping, is affected by transparency!*

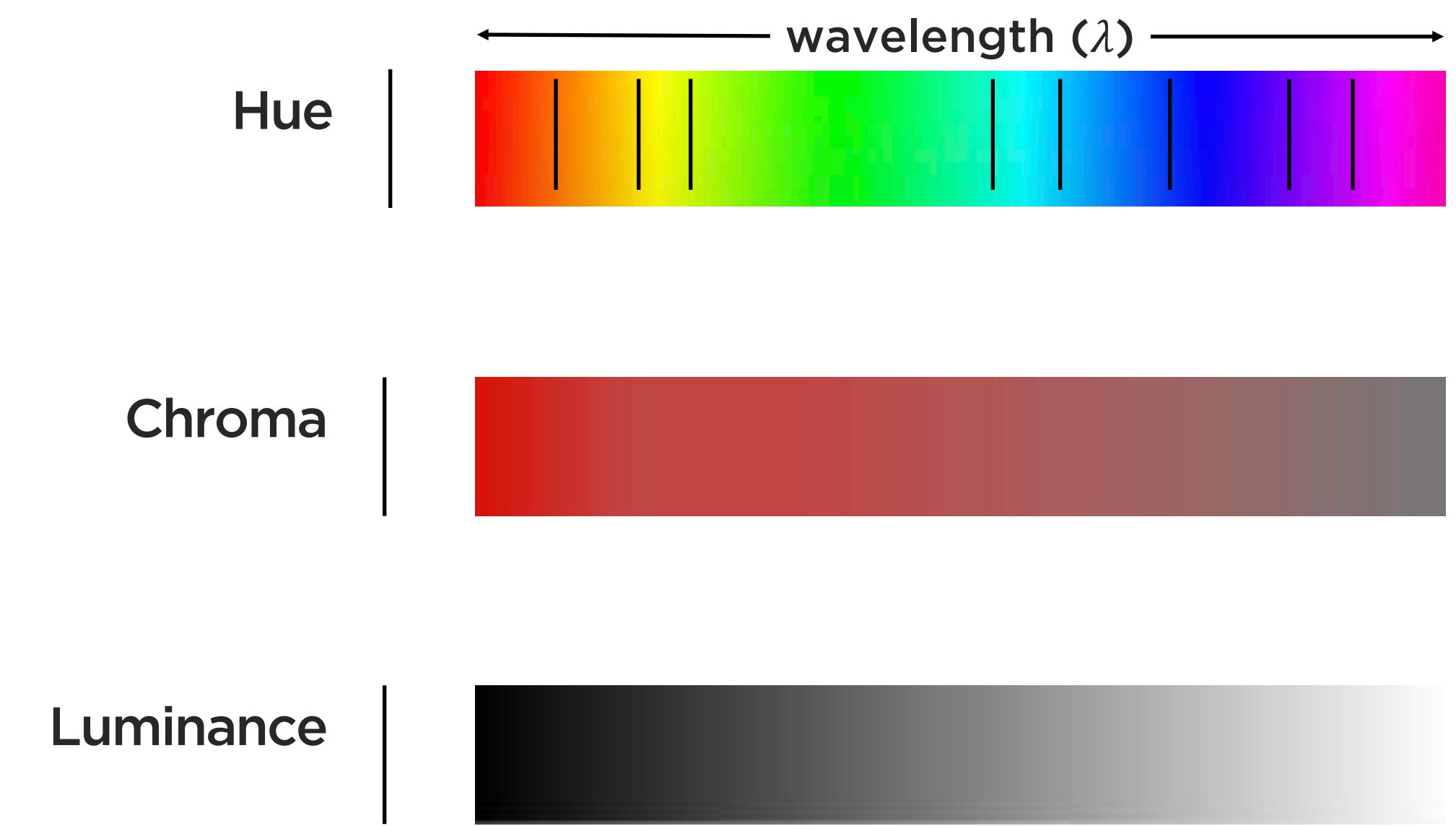
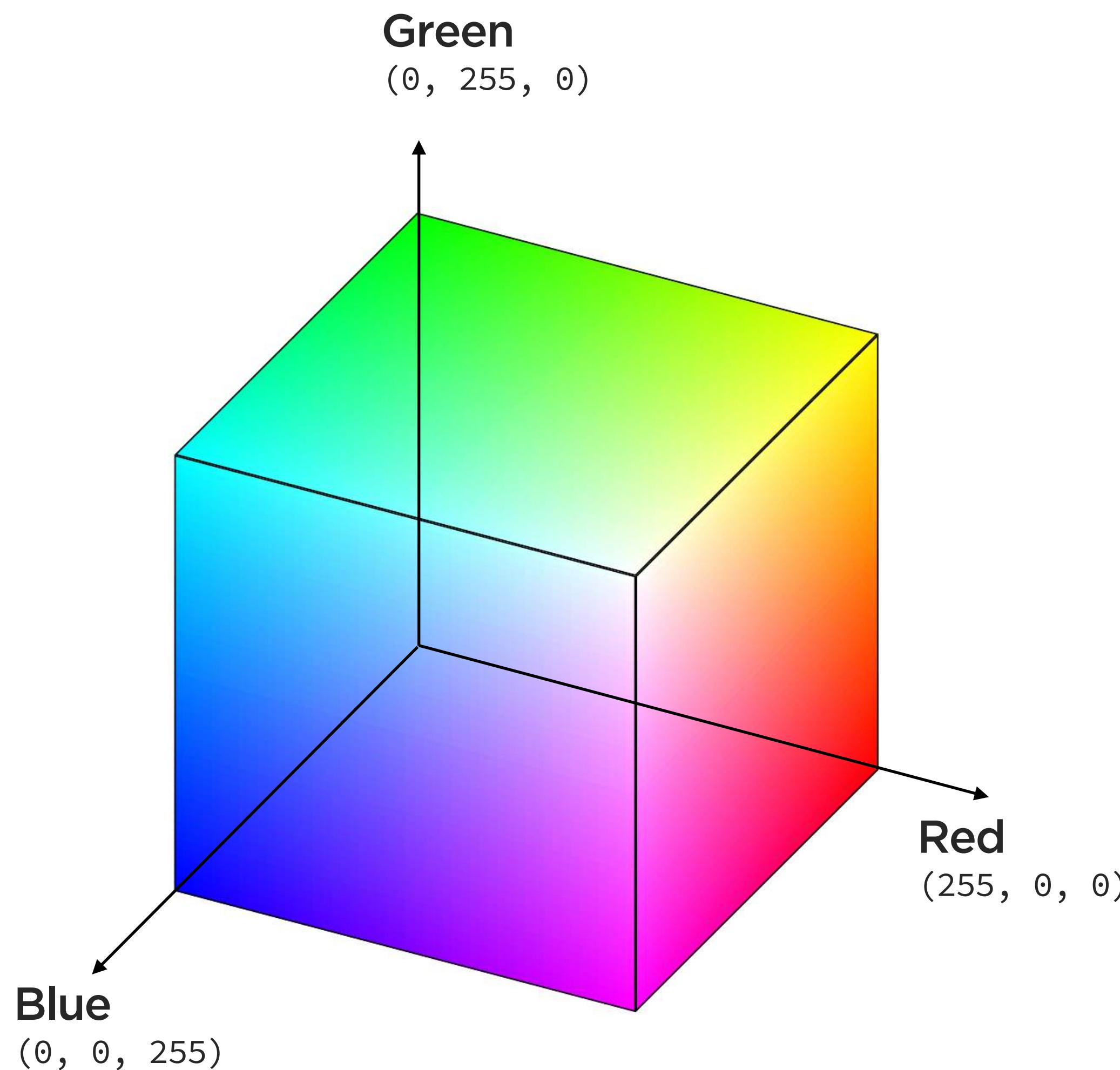
```
ggplot() +  
  theme_void() +  
  scale_x_continuous(limits = c(-5, 5)) +  
  scale_y_continuous(limits = c(-5, 5)) +  
  geom_point(aes(x = 0, y = 0),  
             size = 50, color = "orange",  
             alpha = 0.4) +  
  geom_point(aes(x = 1, y = 1),  
             size = 50, color = "dodgerblue",  
             alpha = 0.4)
```



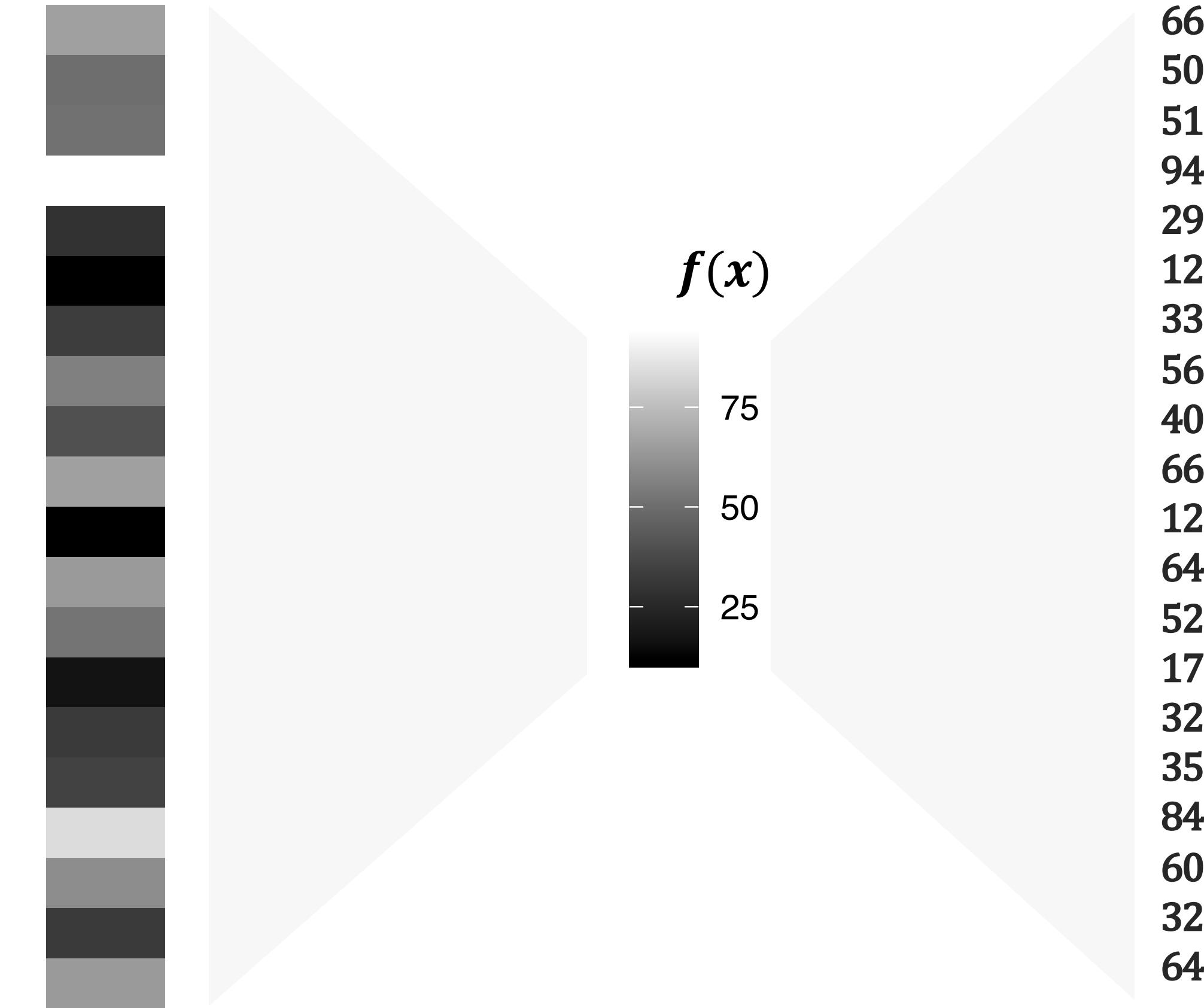
**I didn't encode
data with *this* color!?**

encoding data as color

color | encode data using color spaces, which are mathematical models



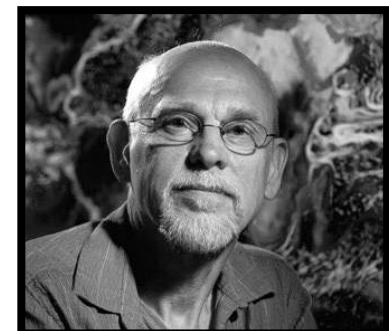
color | how can we map data to light, whether using its hue, chroma, or luminance?



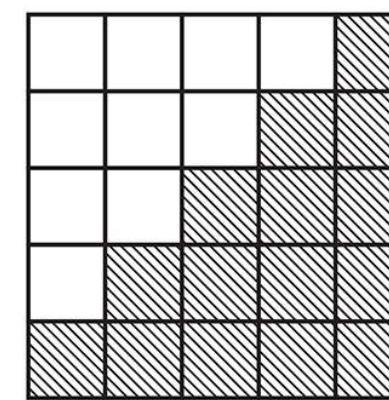
color | *perceived brightness is nonlinear function of luminance*

LUMINANCE : the *measured* amount of light coming from some region of space.

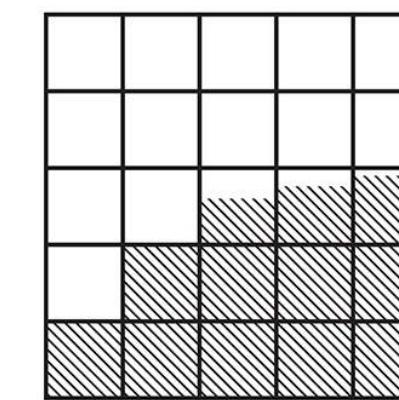
BRIGHTNESS : the *perceived* amount of light coming from that region of space.



color | visual perception of an arithmetical progression depends on a physical geometric progression

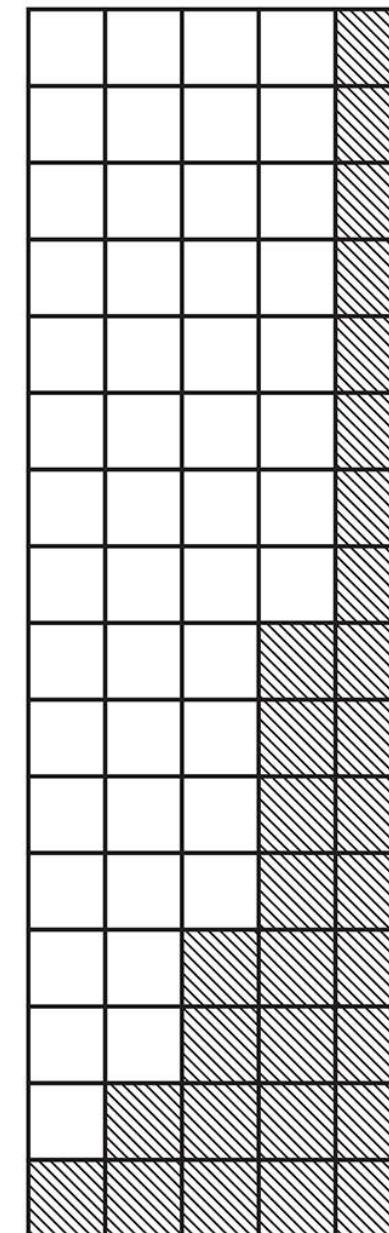


THIS PHYSICAL FACT



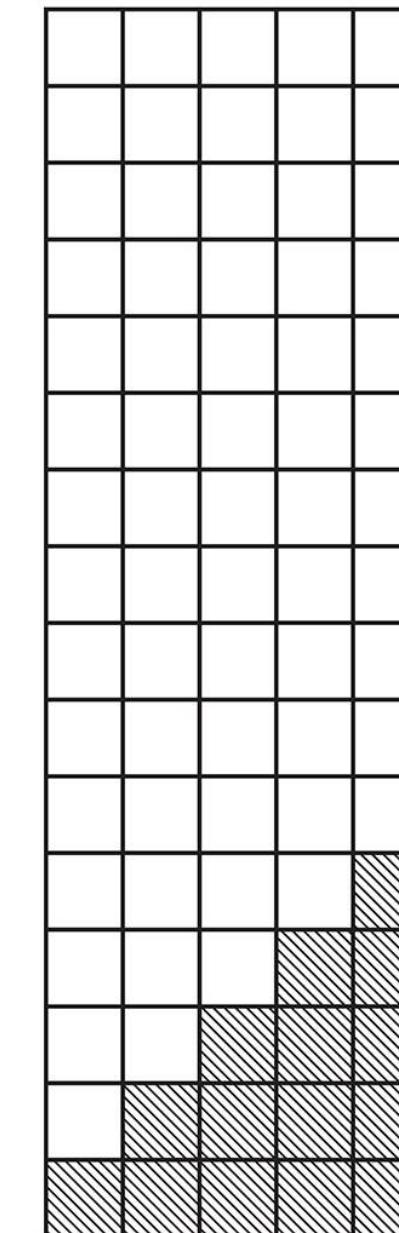
REDUCES TO

THIS PSYCHOLOGICAL EFFECT

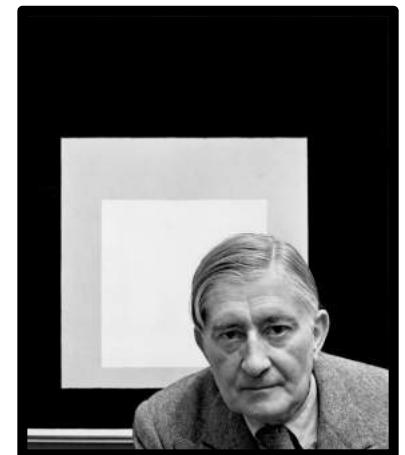


THIS PHYSICAL FACT

PRODUCES

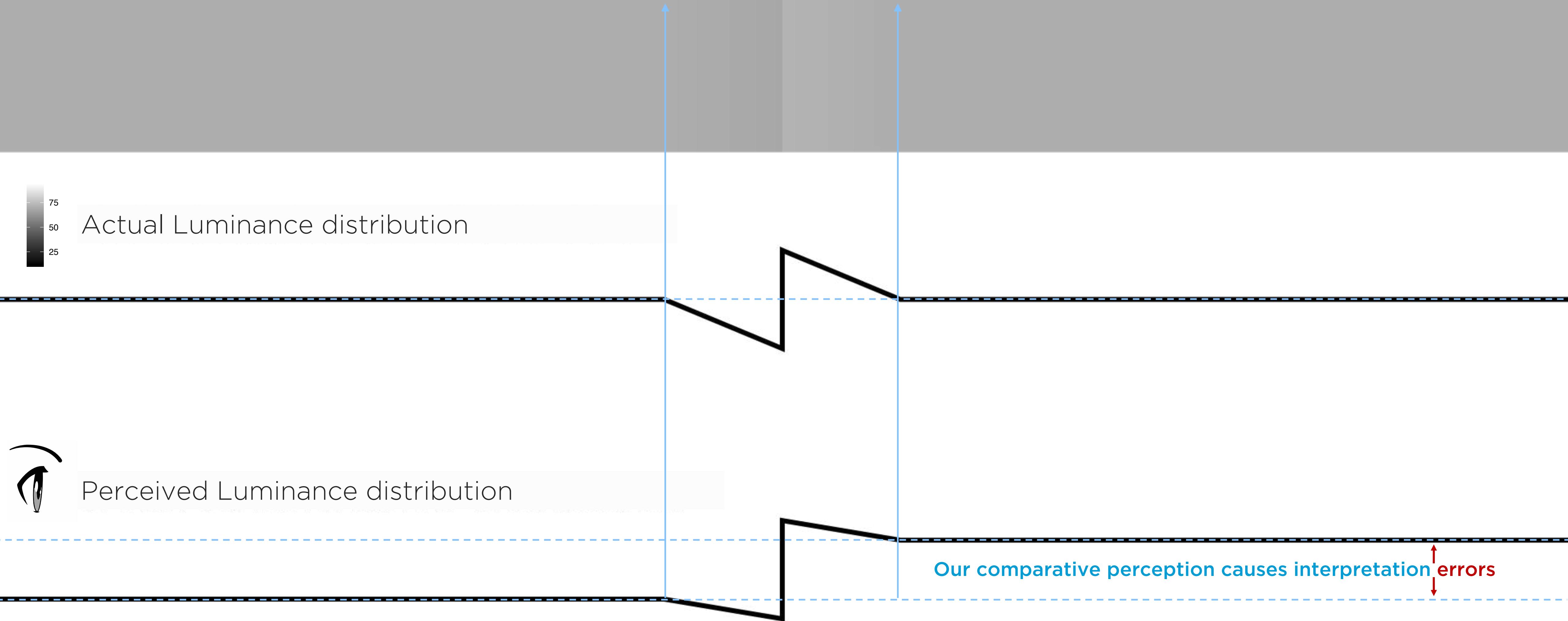


THIS PSYCHOLOGICAL EFFECT

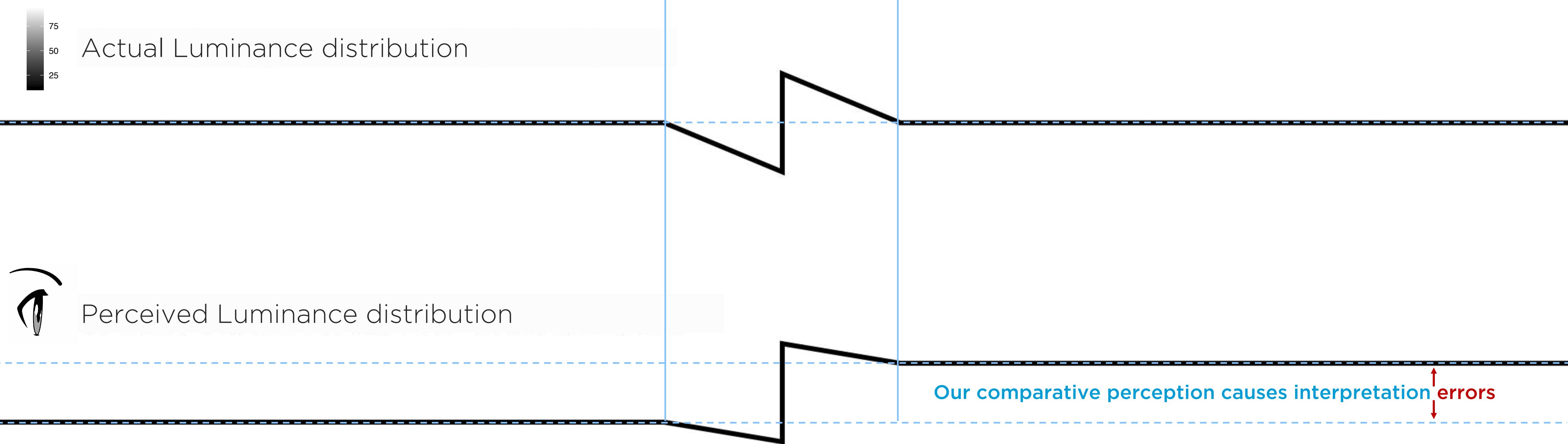


Albers, Josef

color | humans have evolved to see edge contrasts. We see comparative — not absolute — luminance value.



color | humans have evolved to see edge contrasts. We see comparative — not absolute — luminance value.



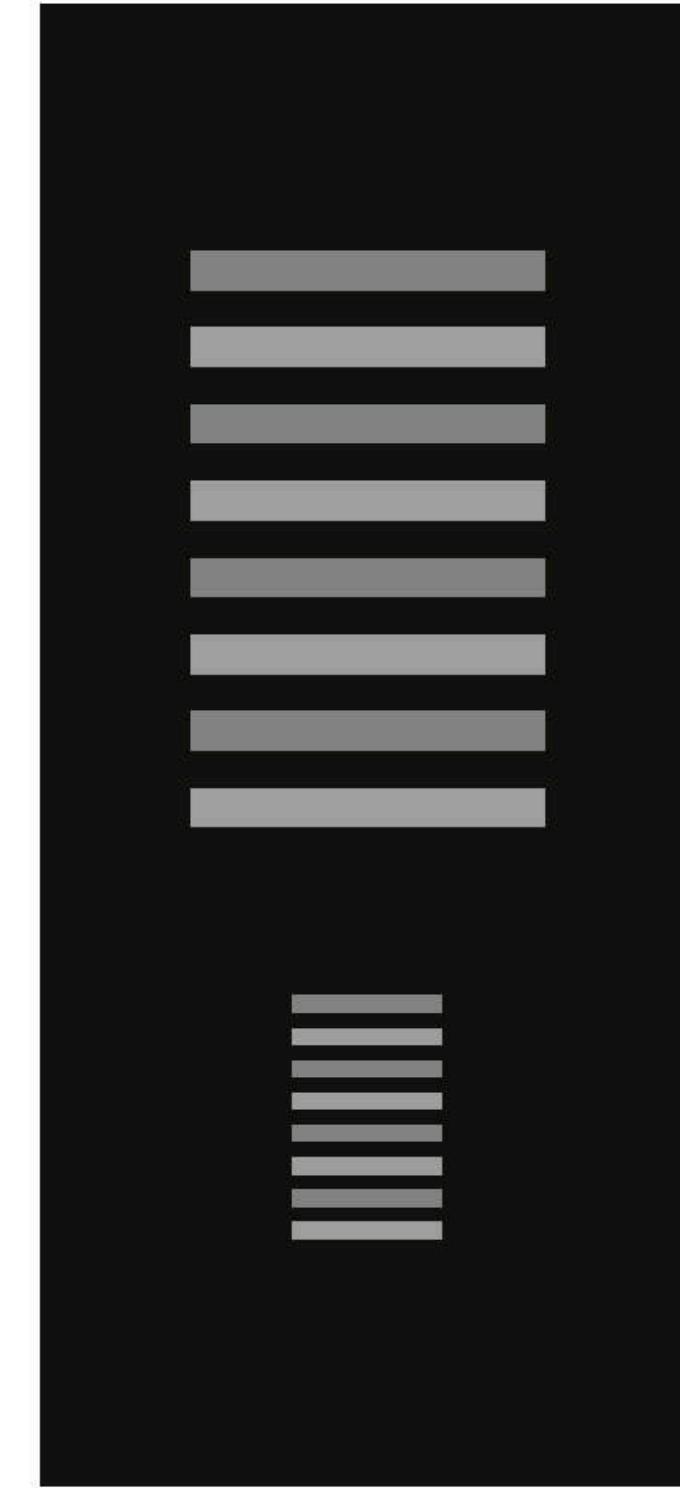
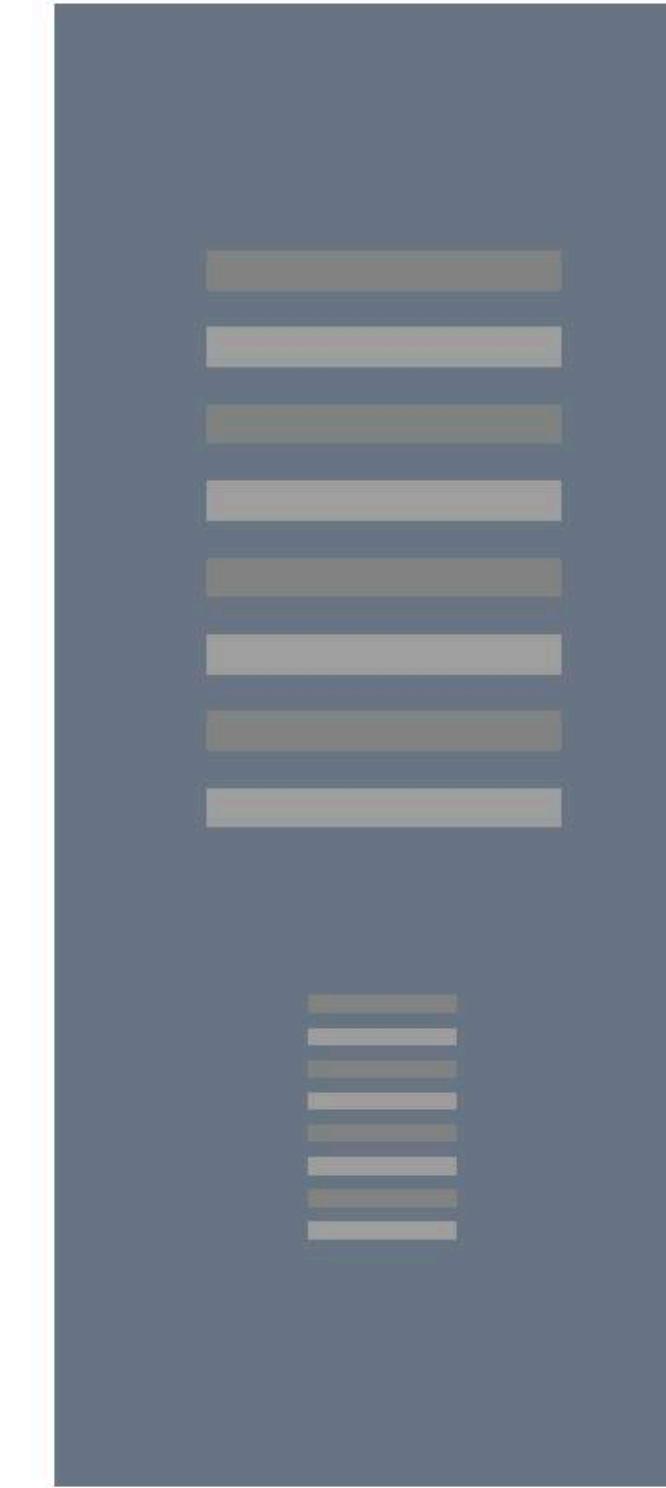
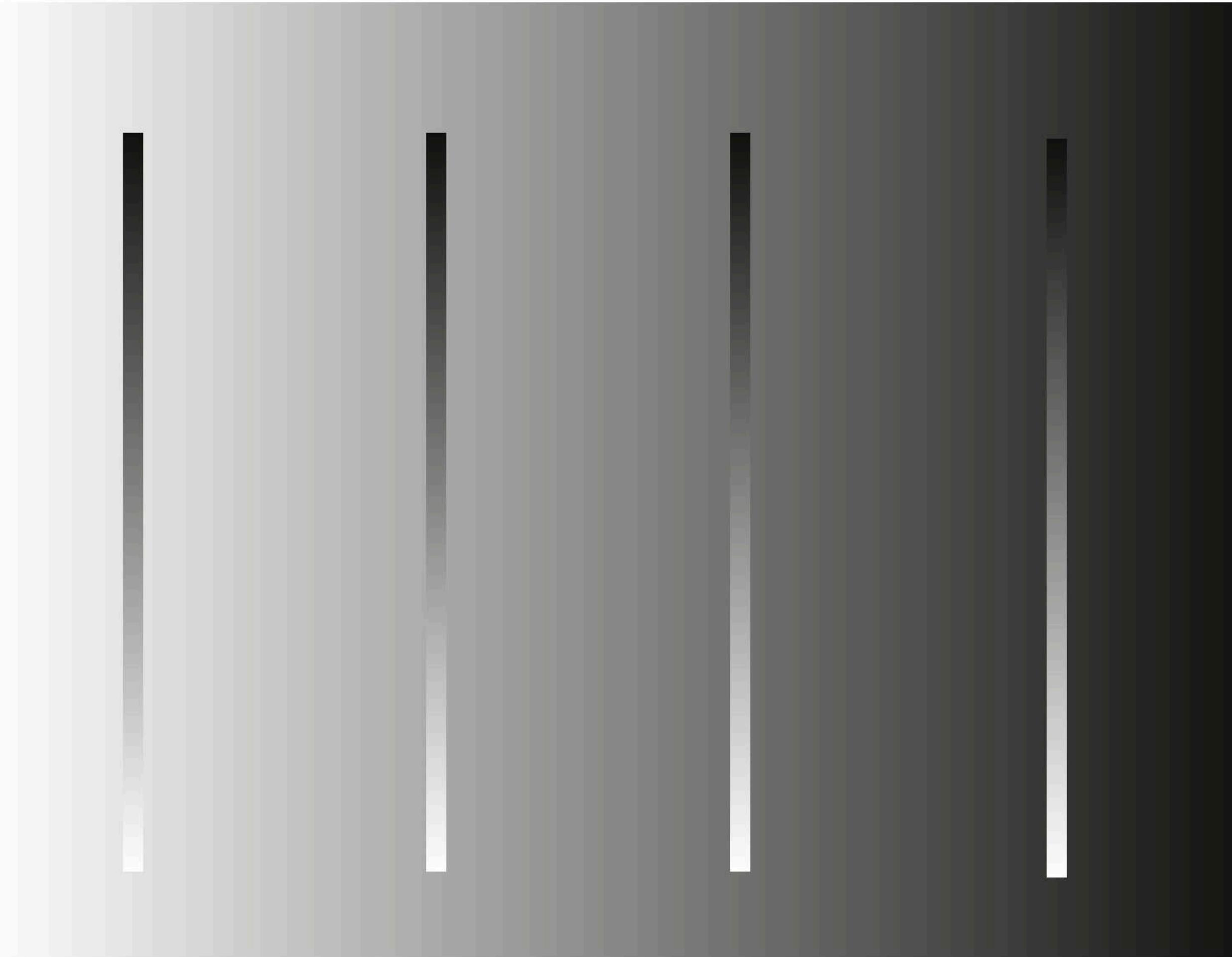
color | *background and adjacent luminance can interfere with our perception*



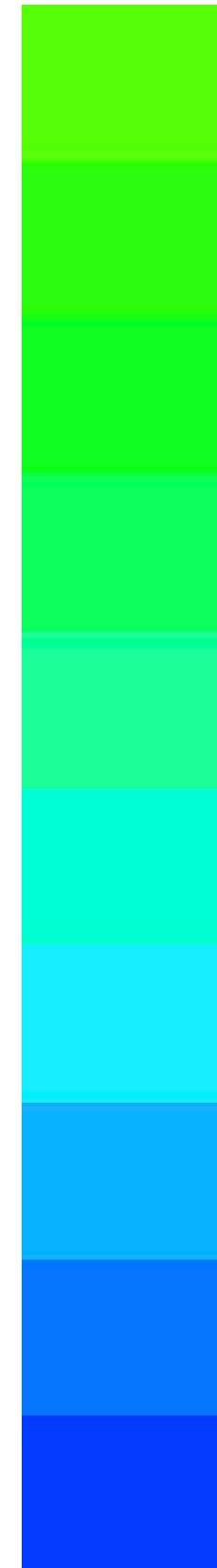
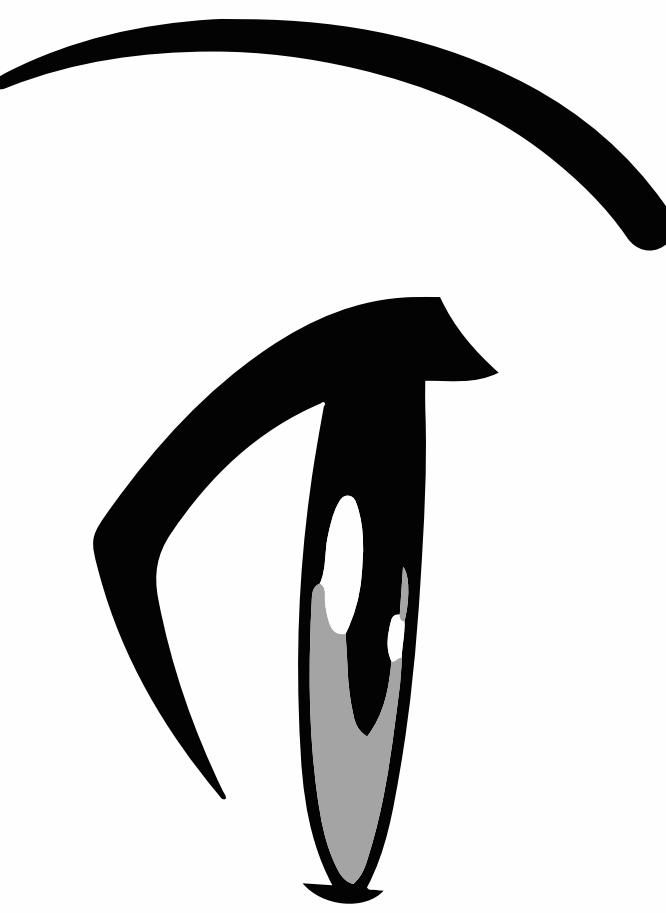
color | background and adjacent luminance can interfere with our perception



color | high foreground to background luminance contrast enhances shape, lower contrast enhances grayscale



color | as with luminance, hue values in the RGB color space fail to uniformly scale across values.



color | *HSL colorspace is intuitive, but not perceptually uniform in each attribute.*

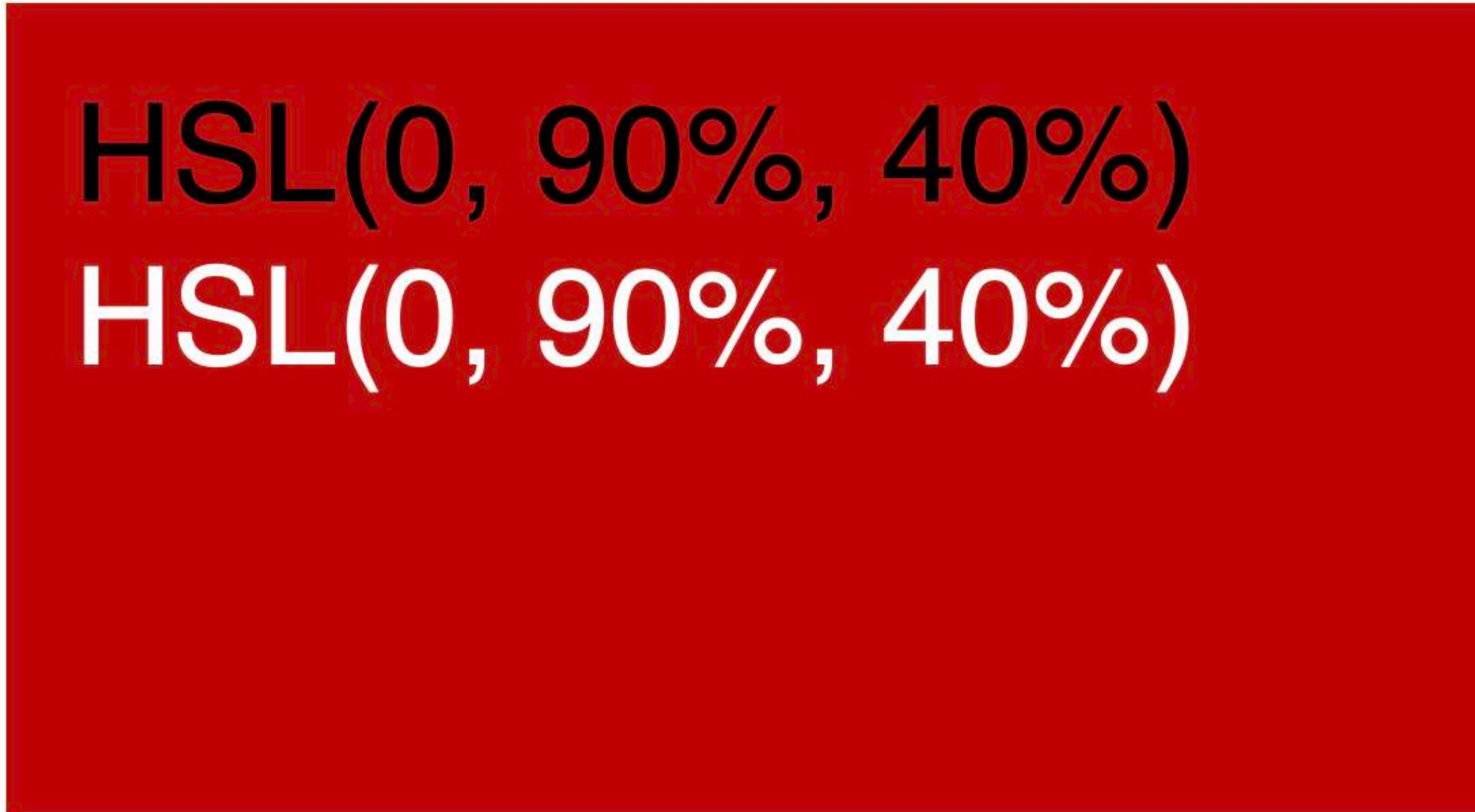
Same luminance or lightness?

HSL(250, 100%, 50%)
HSL(250, 100%, 50%)

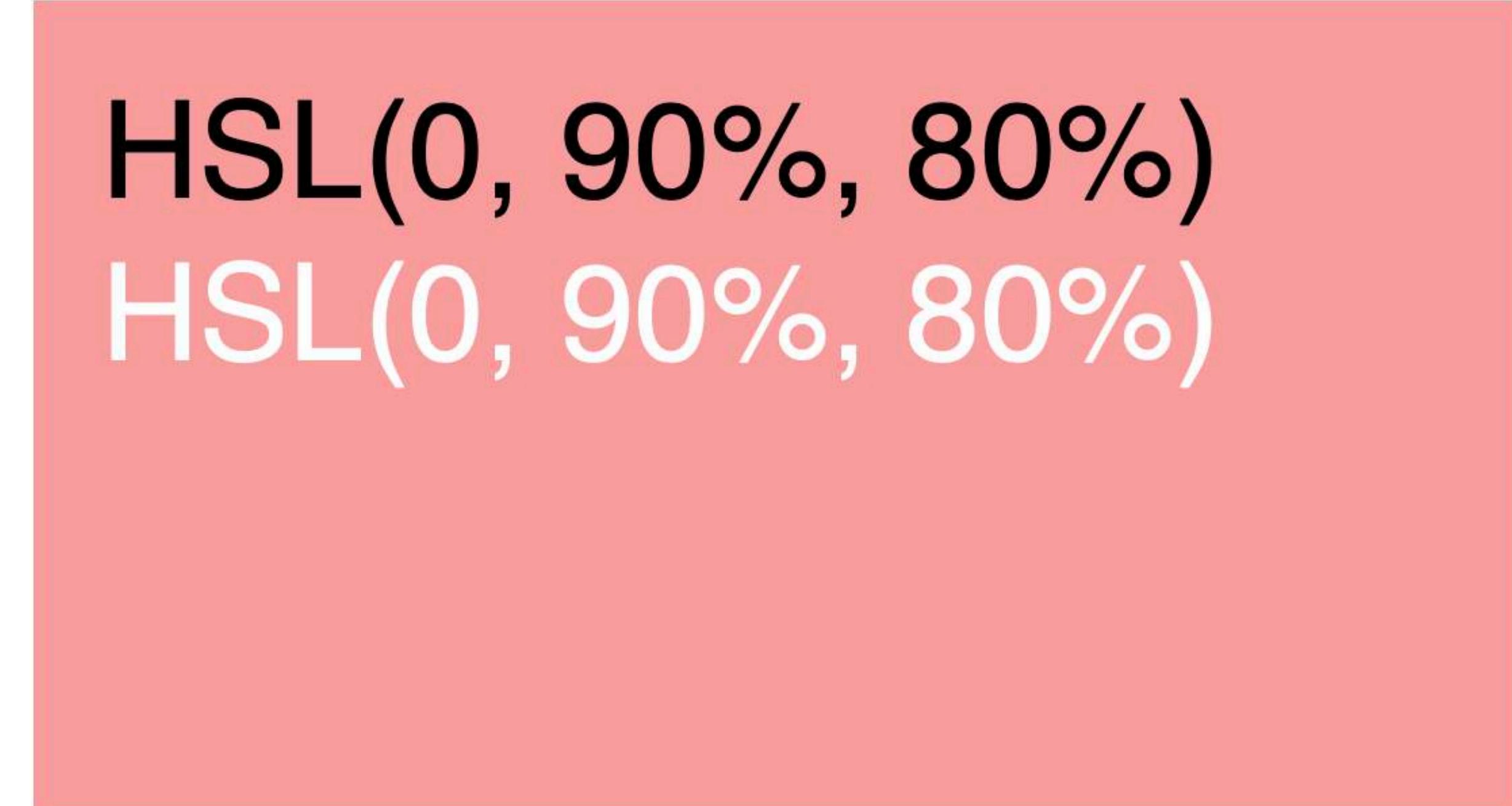
HSL(60, 100%, 50%)
HSL(60, 100%, 50%)

color | *HSL colorspace is intuitive, but not perceptually uniform in each attribute.*

Same saturation?



HSL(0, 90%, 40%)
HSL(0, 90%, 40%)



HSL(0, 90%, 80%)
HSL(0, 90%, 80%)

color | *HSL colorspace is intuitive, but not perceptually uniform in each attribute.*

Equal difference between hues?

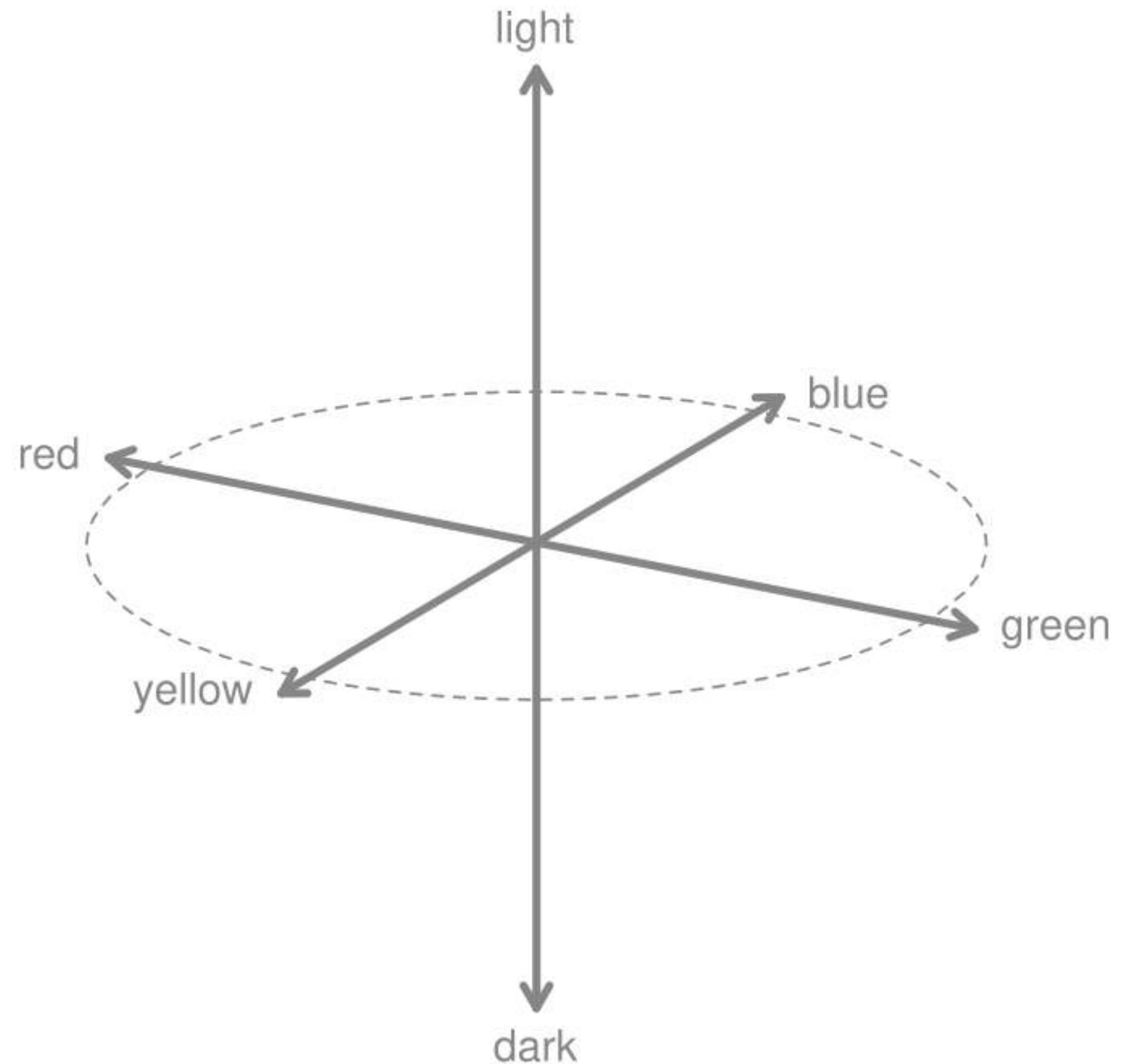
HSL(30, 100%, 50%)
HSL(30, 100%, 50%)

HSL(50, 100%, 50%)
HSL(50, 100%, 50%)

HSL(230, 100%, 50%)
HSL(230, 100%, 50%)

HSL(250, 100%, 50%)
HSL(250, 100%, 50%)

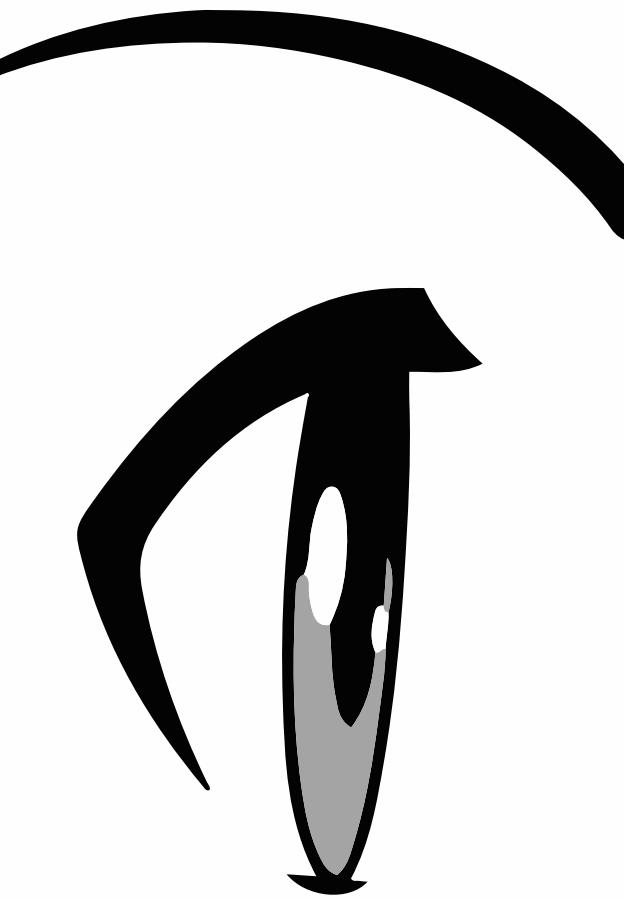
color | other color spaces show changes in color we perceive as uniform.



The International Commission on Illumination (CIE) studied human perception and re-mapped color into a space where we perceive color changes uniformly.

Their **CIELuv** color model has two dimensions — u and v — that represent color scales from red to green and yellow to blue.

color | *perceptually uniform color spaces better represent quantity.*



color | example encoding data as perceptually uniform color attributes: R · ggplot2 · HSLuv

Load functions for mapping data to perceptually-uniform color
<https://github.com/ssp3nc3r/hsluv-rcpp>

```
library(HSLuv)
```

Create sample data encoded as hue, saturation, luminance

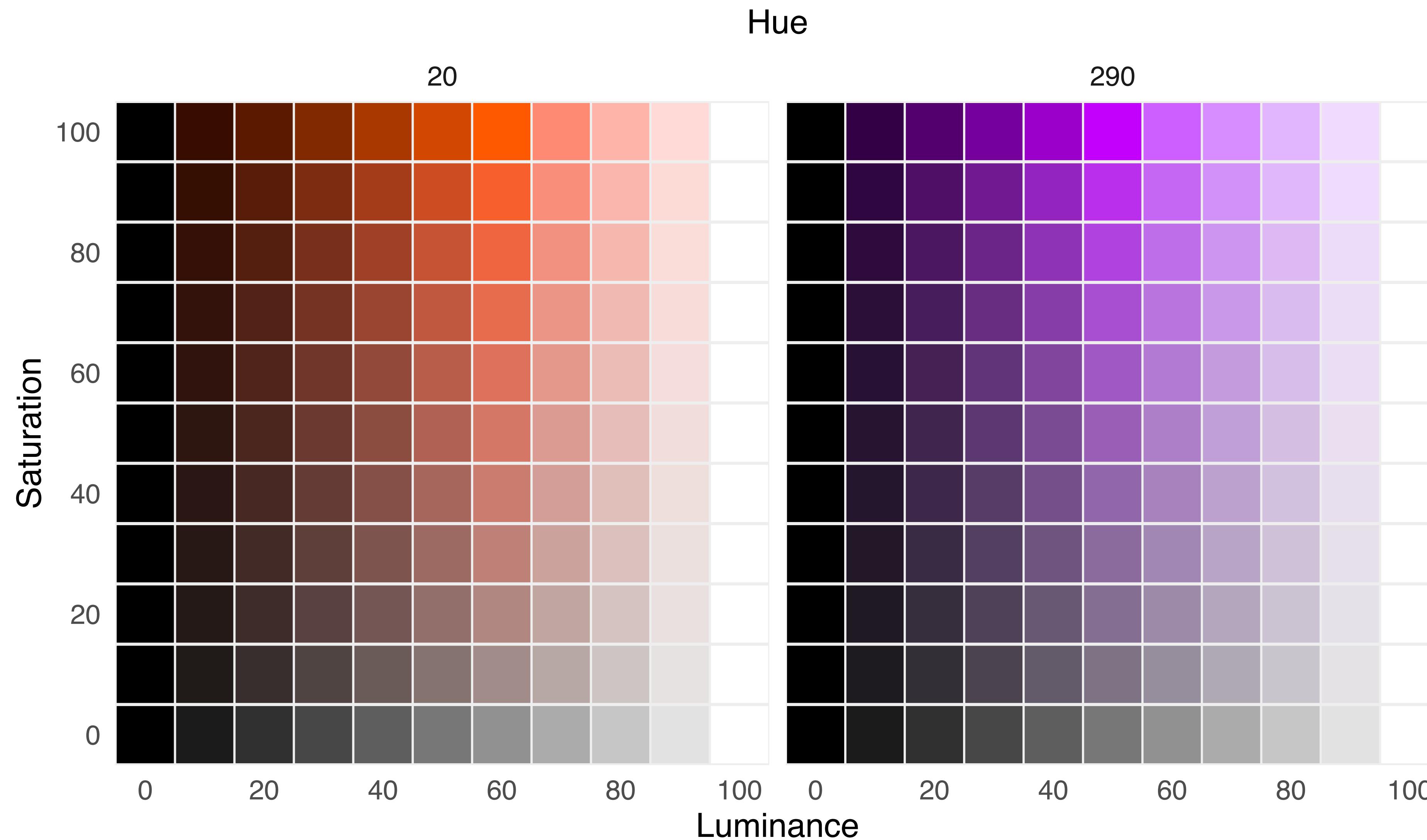
```
df <- expand.grid(H = c(20, 290),  
                   S = seq(0, 100, by = 10),  
                   L = seq(0, 100, by = 10))
```

Convert HSLuv scaled values to RGB
color space as hex code #RRGGBB

```
df$colors <- with(df, hsluv_hex(H, S, L) )
```

Plot data encoded as colors

```
library(ggplot2)  
  
ggplot(df) +  
  theme_minimal() +  
  theme(panel.grid = element_blank(),  
        axis.text.x.top = element_blank()) +  
  geom_point(aes(L, S),  
             color = '#eeeeee',  
             fill = df$colors,  
             size = 10,  
             shape = 22) +  
  scale_x_continuous(breaks = seq(0, 100, by = 20),  
                     sec.axis = sec_axis(~., name = 'Hue')) +  
  scale_y_continuous(breaks = seq(0, 100, by = 20)) +  
  facet_wrap(~H) +  
  labs(x = 'Luminance',  
       y = 'Saturation')
```

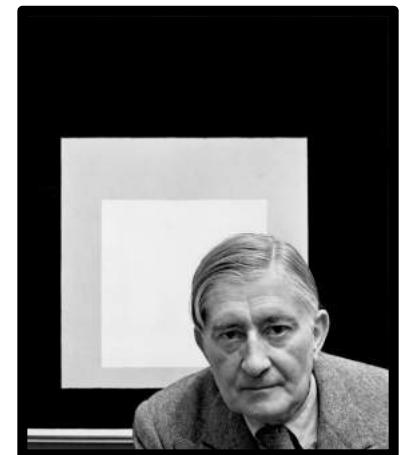
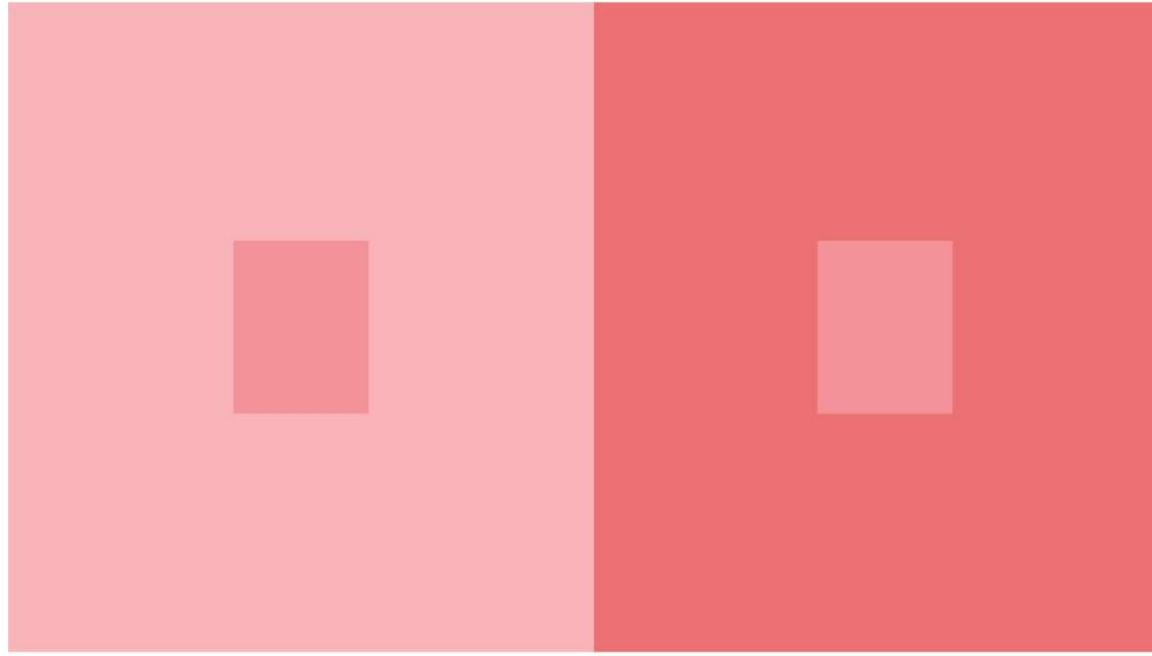


color | perceptually uniform color spaces also help in distinguishing categorical data.



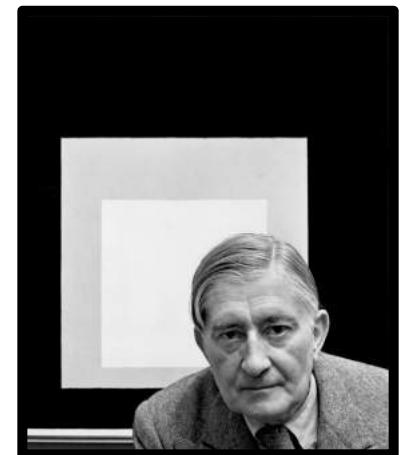
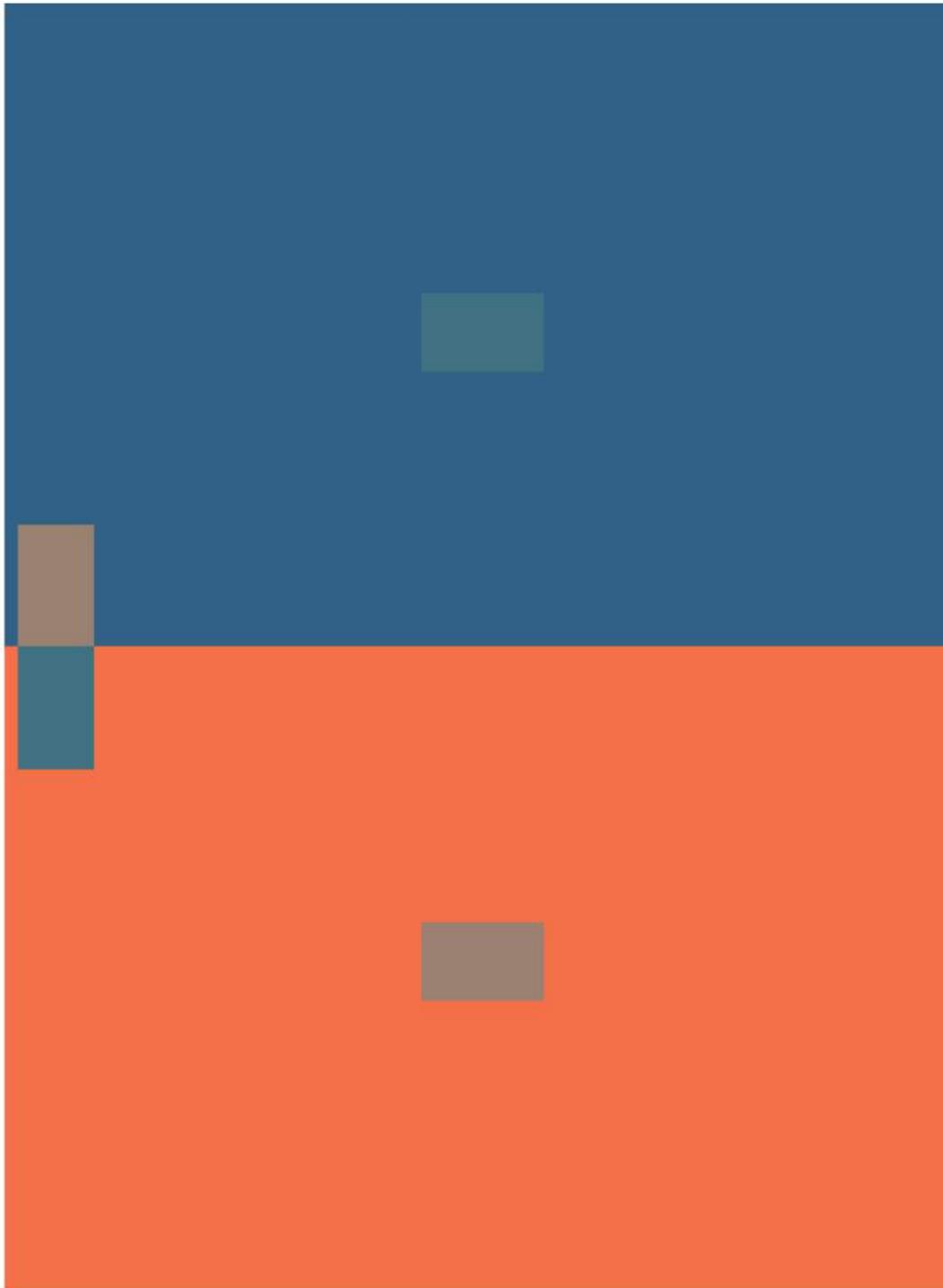
interaction of color

interaction of color | *one color appearing as two*



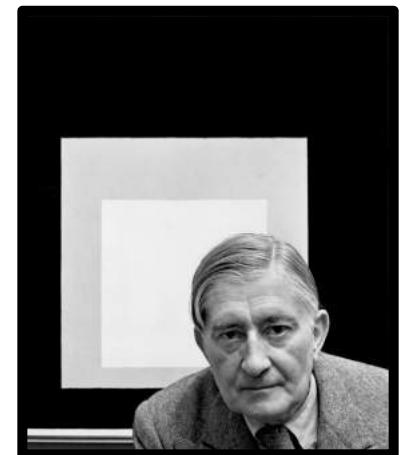
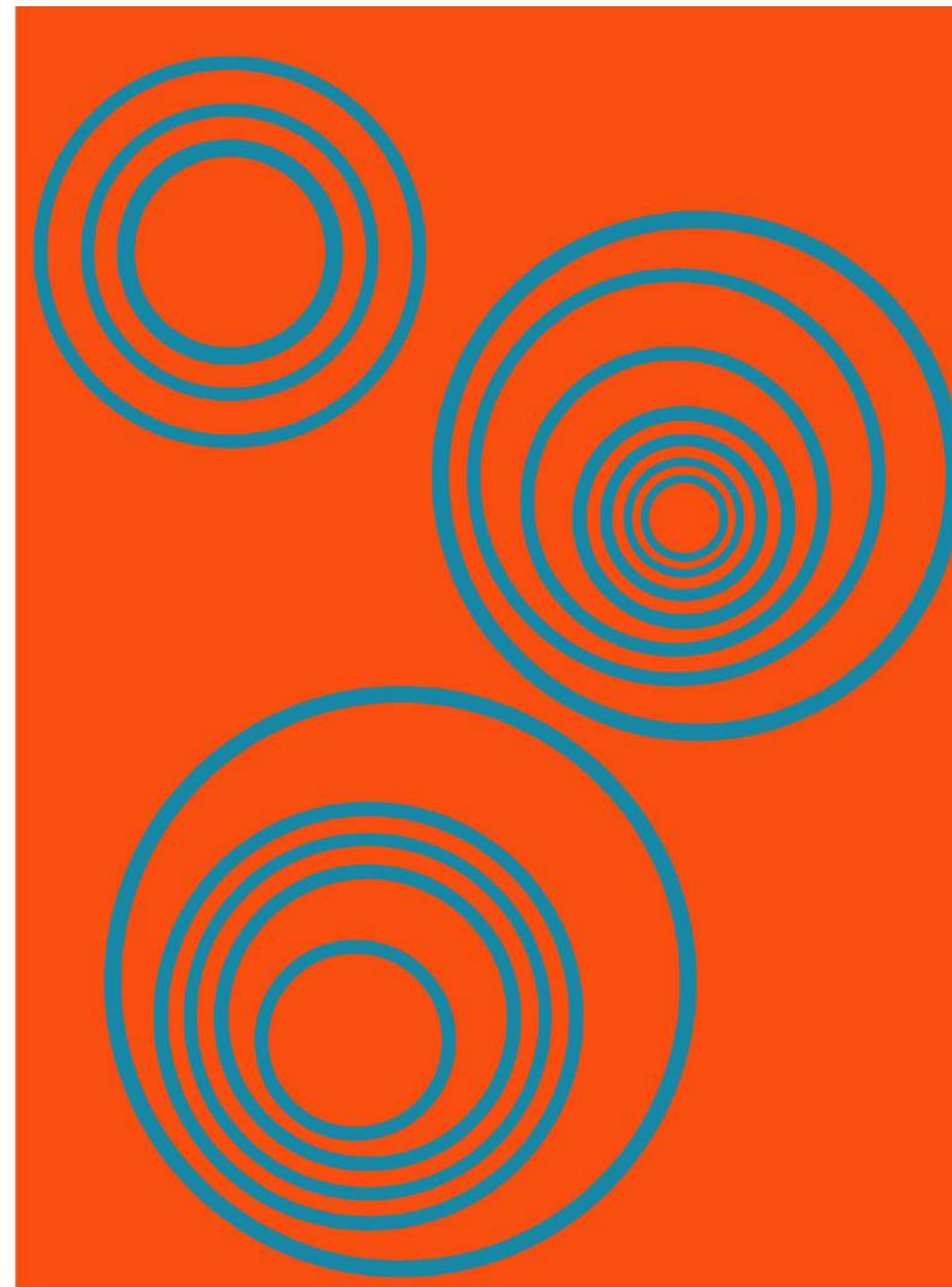
Albers, Josef

interaction of color | *two different colors look alike*



Albers, Josef

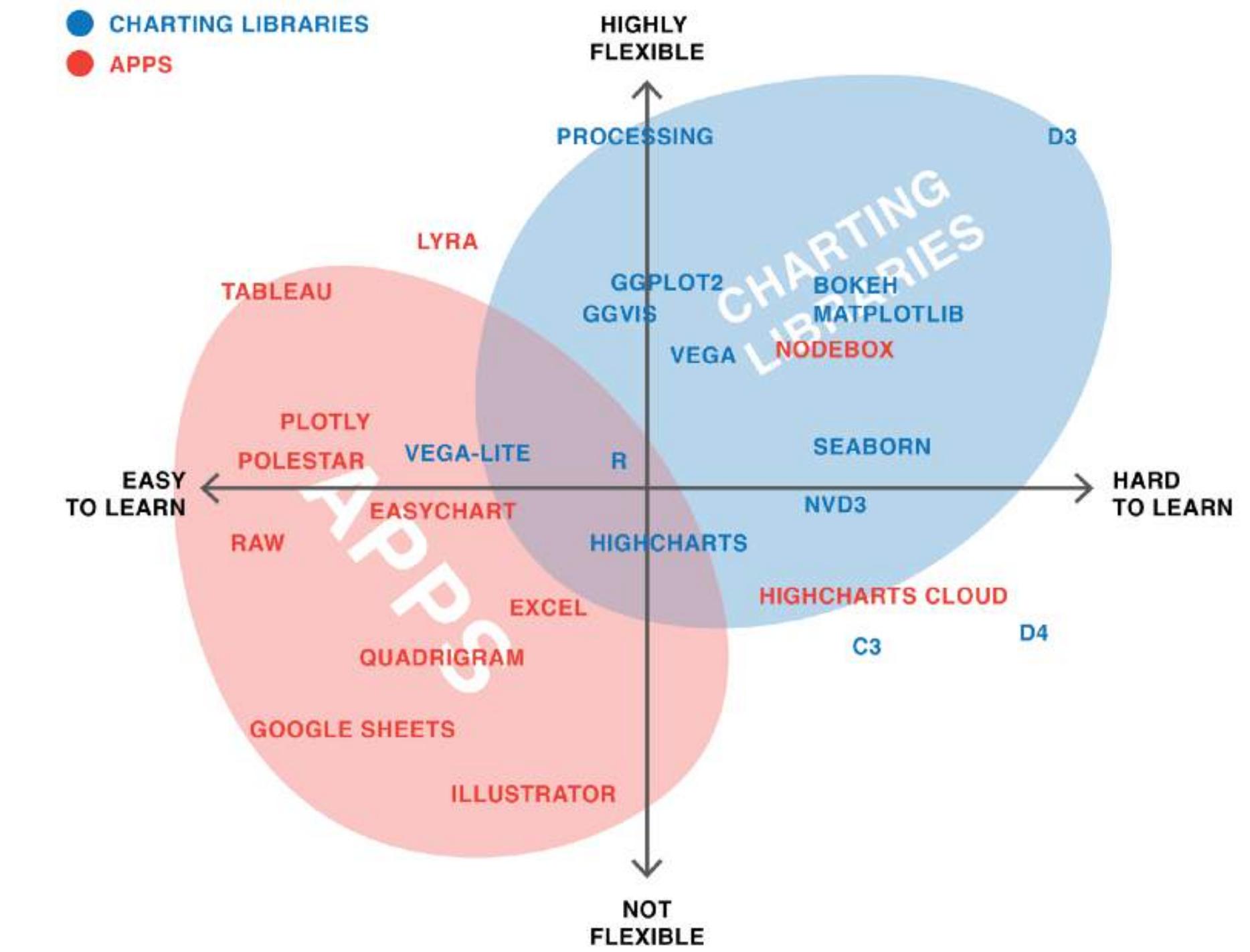
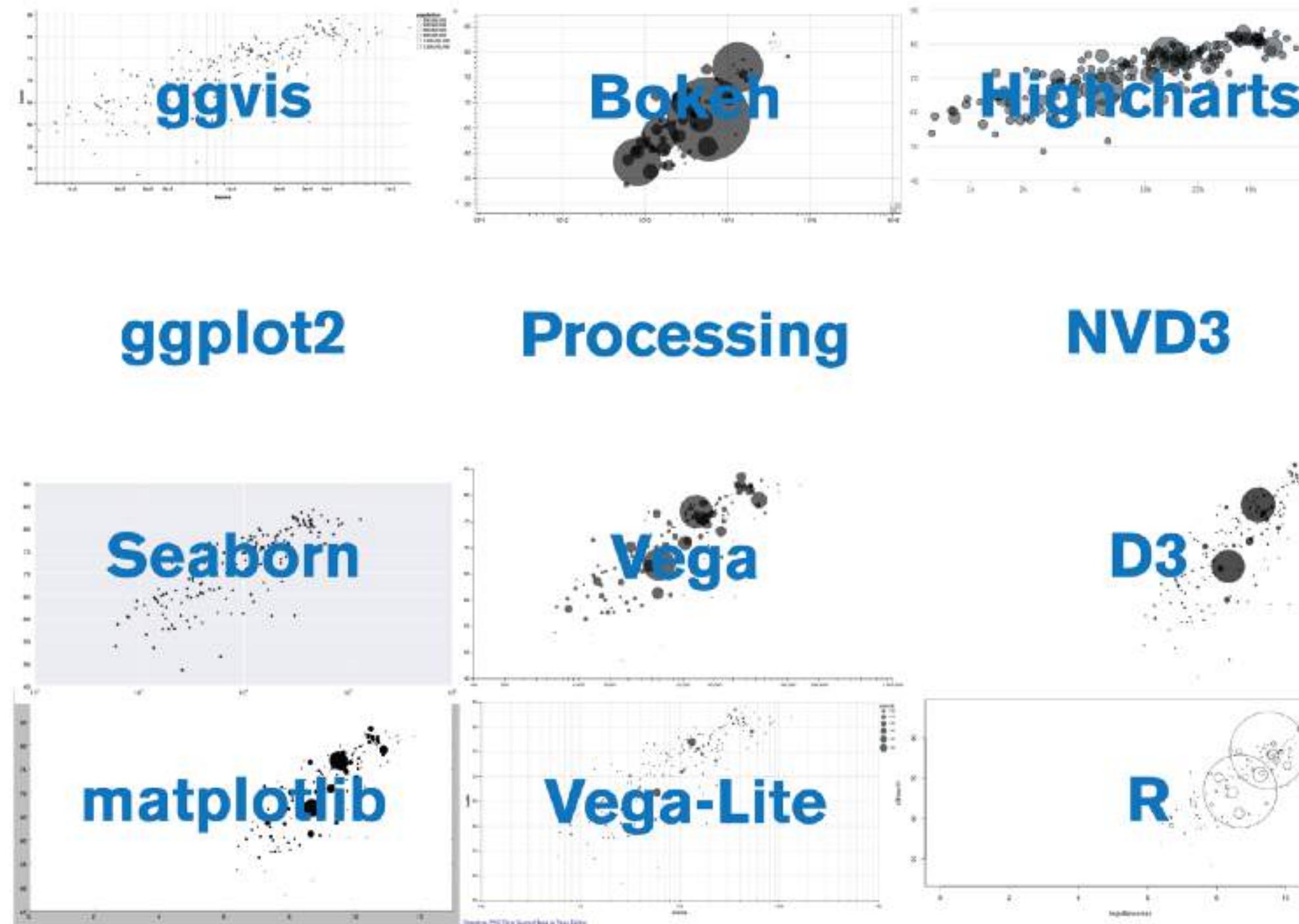
interaction of color | *vibrating boundaries, occurs with contrasting hues of similar luminance*



Albers, Josef

perspectives on tools

thoughts about tools | *a designer's experiments. One chart created with numerous tools (though more exist)*



“There are no perfect tools, just good tools for people with certain goals.”



Rost, Lisa Charlotte

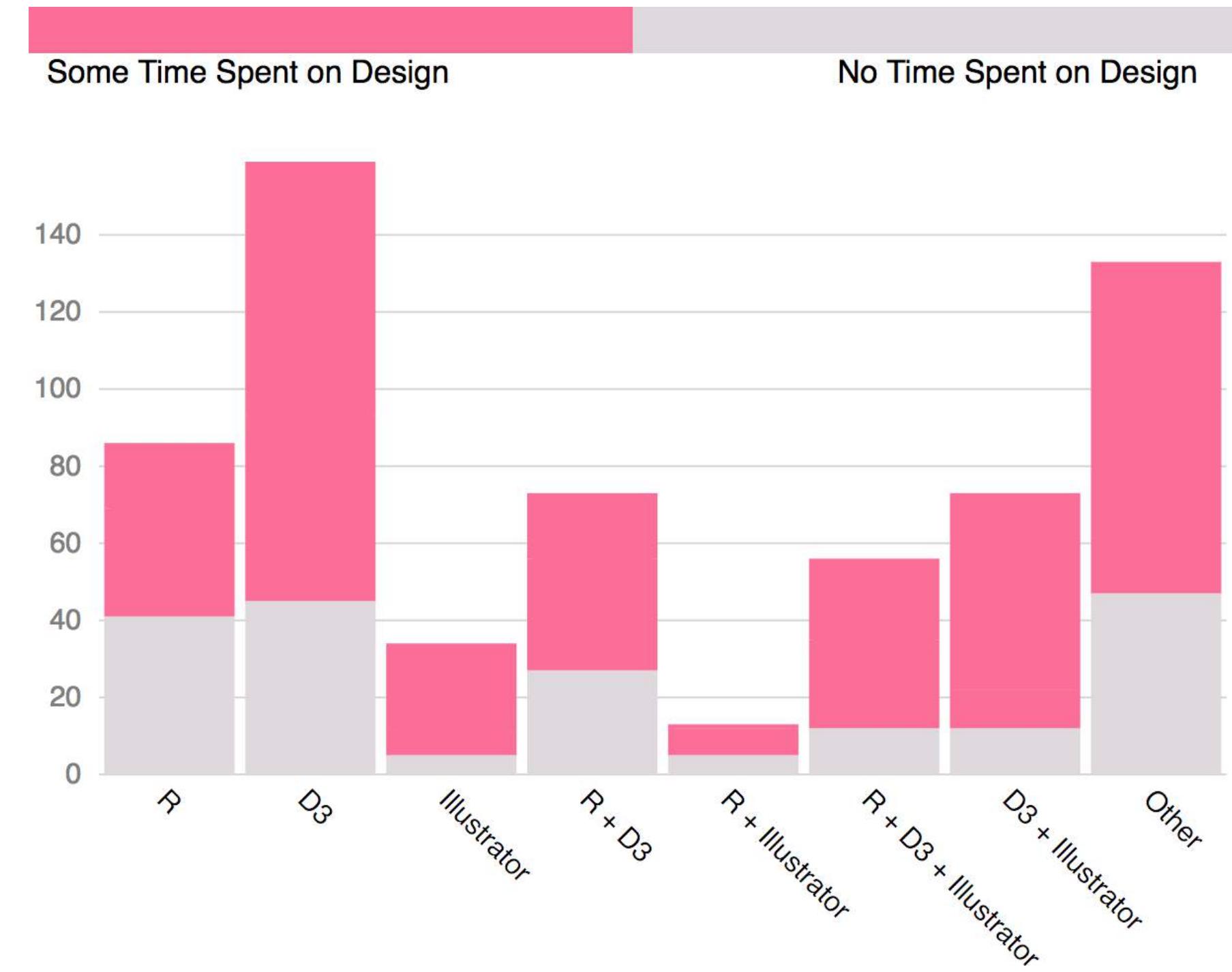
thoughts about tools | *whatever your tools, invest time learning—and applying—design. Do it for your audience.*

 **Edward Tufte**
@EdwardTufte

#Rstats coders and users just can't do words on graphics and typography. Proof: 40 years of clunky, even recent Stanford Statistics textbooks. Publication-quality work requires: R + Adobe Illustrator + reasoning about words on graphics + respect for audience/readers/viewers

1 4:04 PM - Jun 26, 2018

[See ./philip.sh's other Tweets](#)



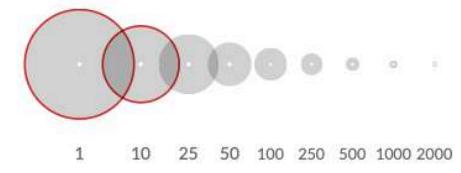
practice in the studio

practice in the studio

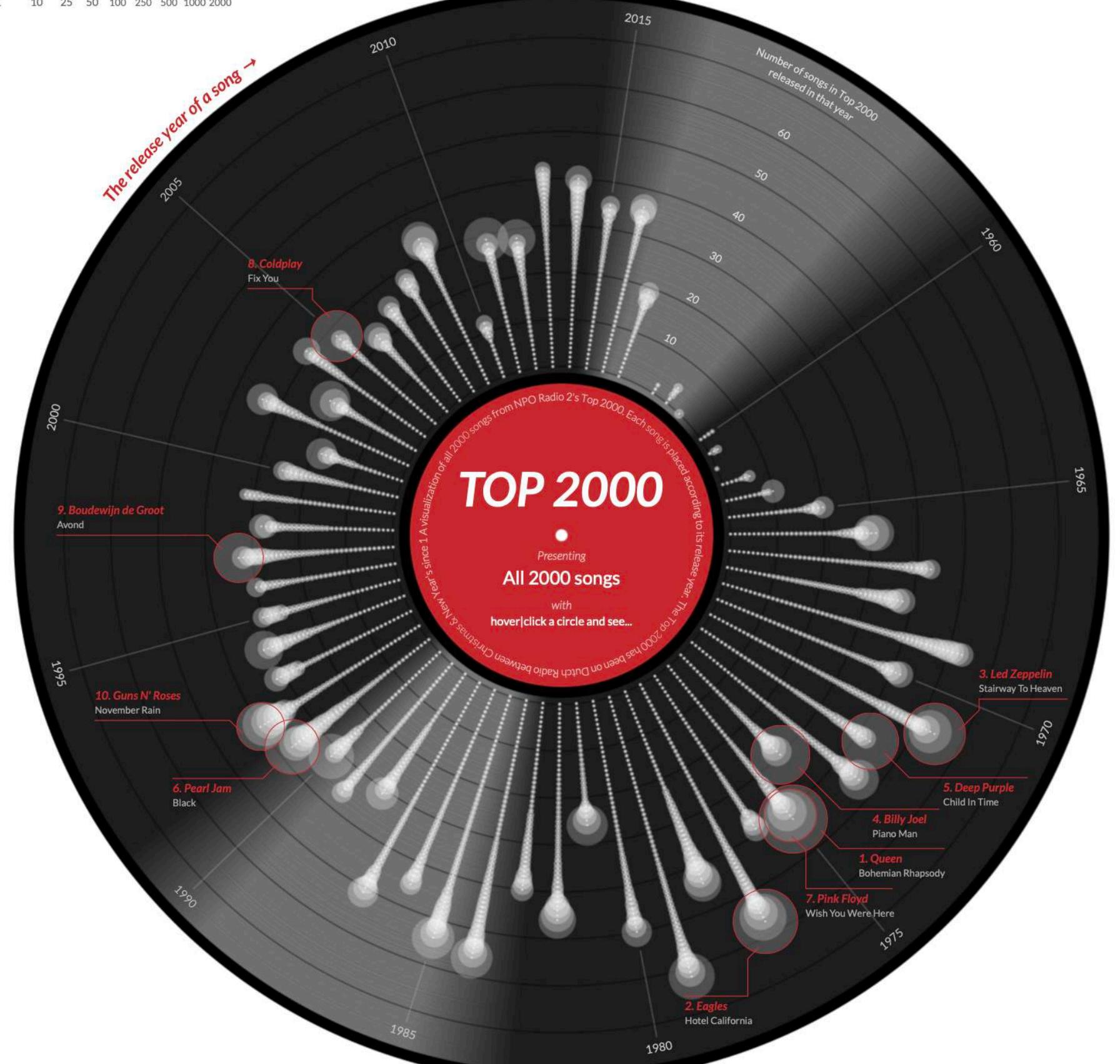
Let The Music Play

All songs from the **TOP 2000** of 2017 according to their release years

Position in the Top 2000



1 10 25 50 100 250 500 1000 2000



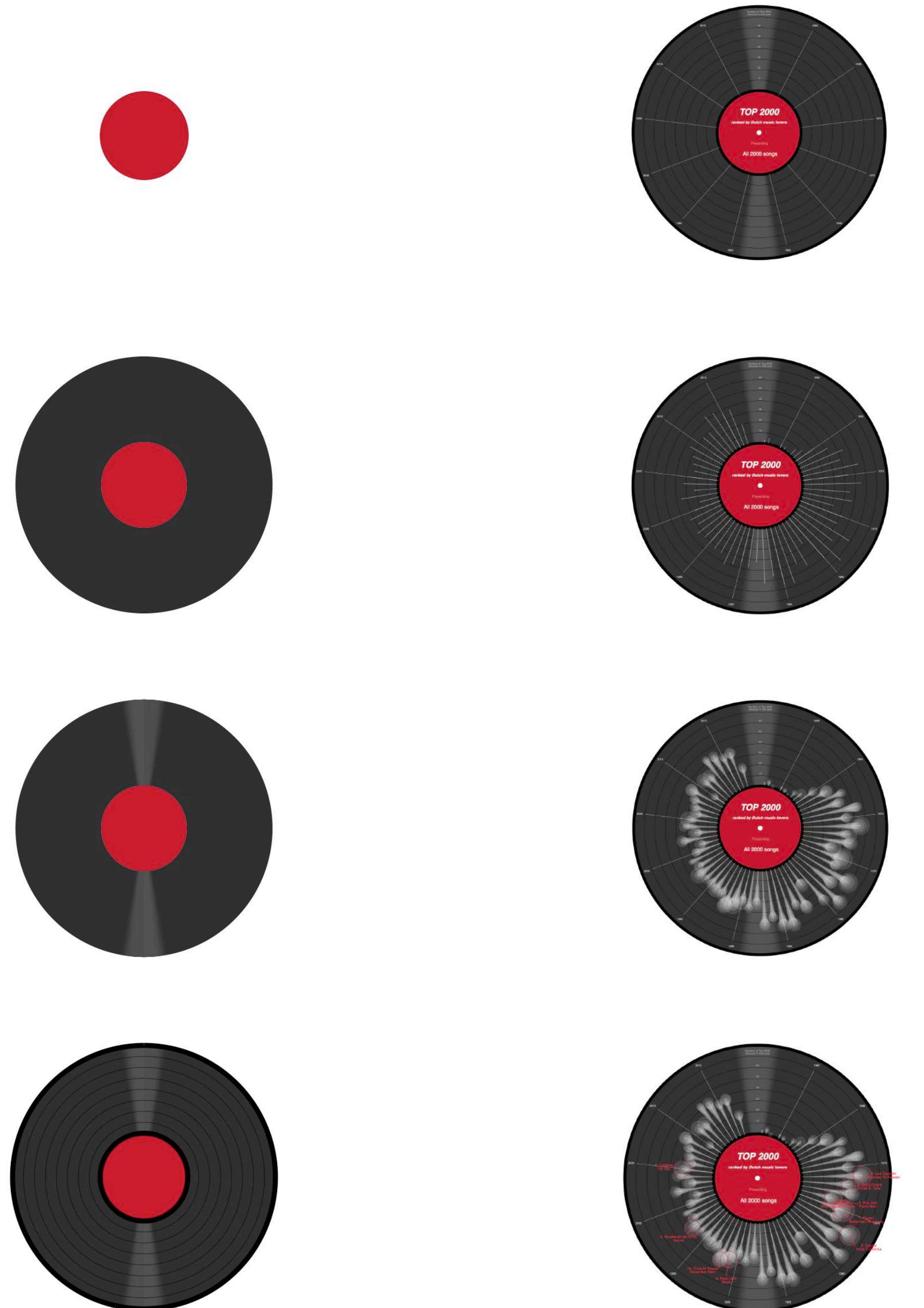
When hovering (or clicking on mobile) a circle all the songs of that artist are **highlighted** and connected by a **line**. When the song happens to be a collaboration between two artists, you'll see multiple lines, one for each artist.

Created by Nadieh Bremer | Visual
Cinnamon

Data from NPO Radio 2

Ga naar de Nederlandse versie

Check out my Top 2000 visuals from 2015 &
2016



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