

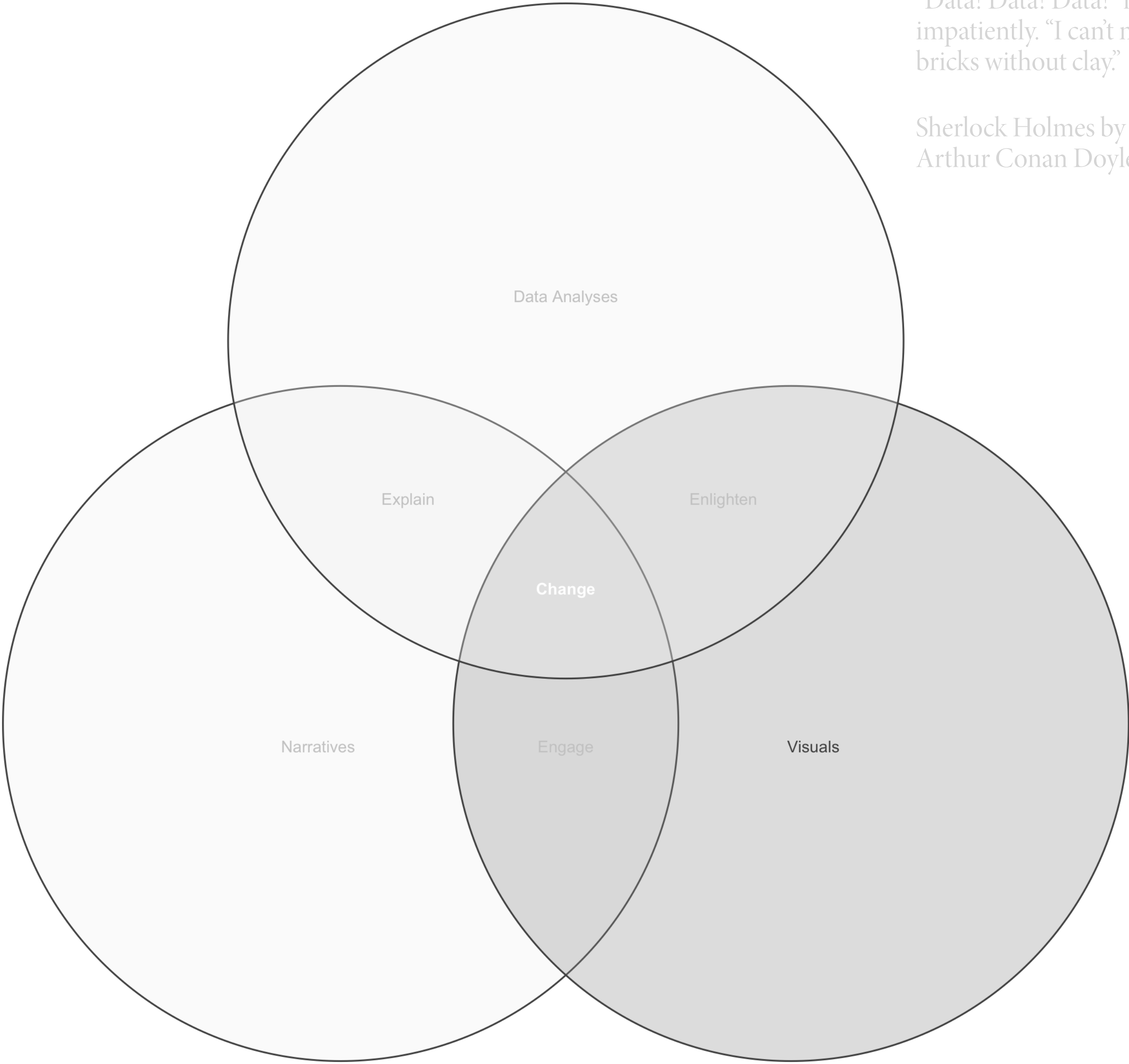
# Storytelling with data

**03 | review; encoding with color; design principles; comparing encoded data**

# course overview, learn to drive change using data visuals and narrative

“Data! Data! Data!” he cried impatiently. “I can’t make bricks without clay.”

Sherlock Holmes by Sir Arthur Conan Doyle, *author*



No one ever made a decision because of a number. They need a story.

Daniel Kahneman, *psychologist, behavioral economist, and author*

The greatest value of a picture is when it forces us to notice what we never expected to see.

John W Tukey, *mathematician*

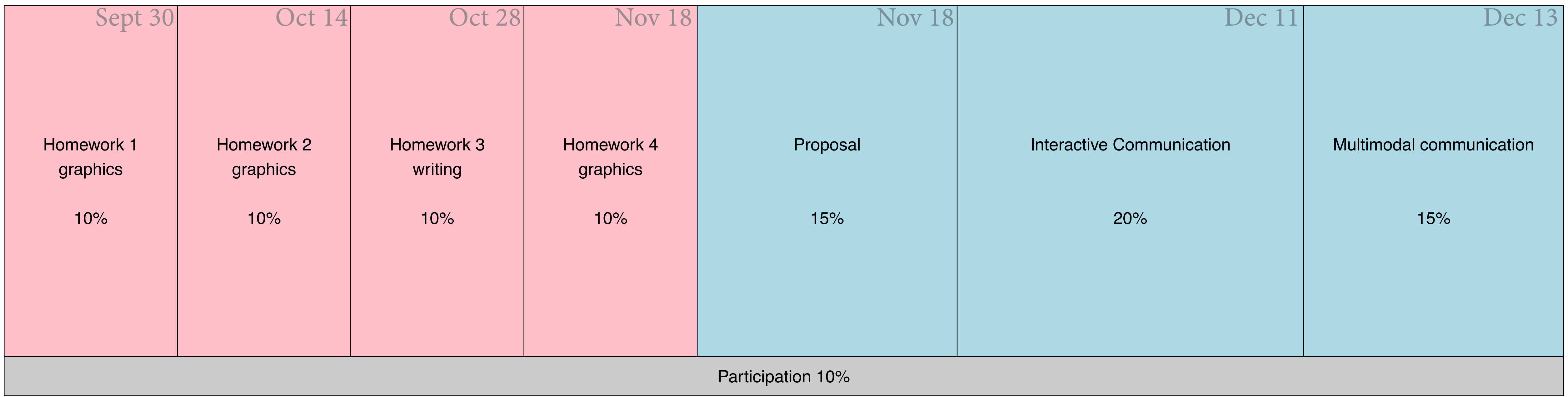
# general course deliverable timeline

## Individual Work

For learning data visualization and written narrative techniques

## Group work

For building graphics and narrative into interactive communications



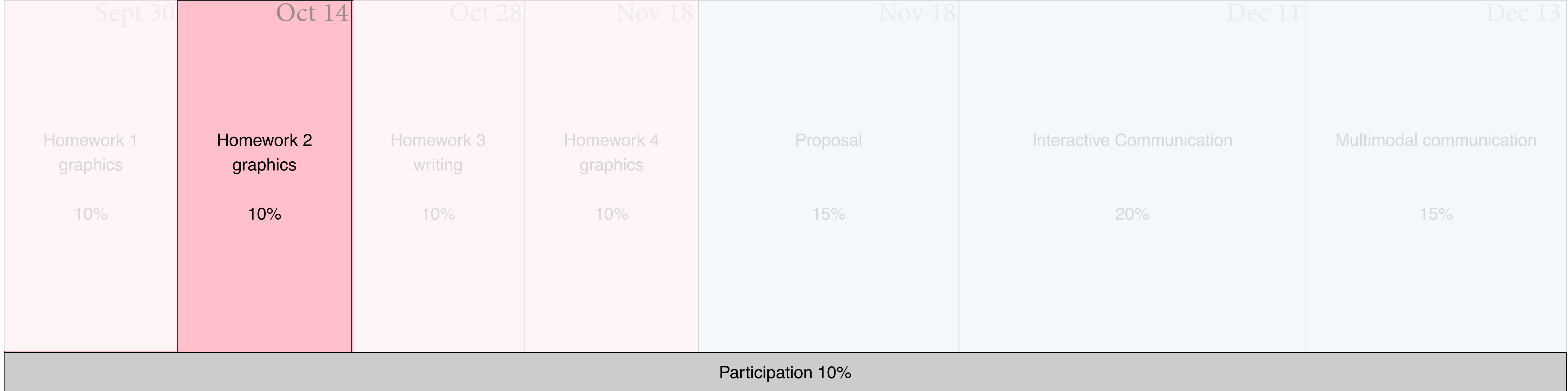
# next deliverable, homework two

## Individual Work

For learning data visualization and written narrative techniques

## Group work

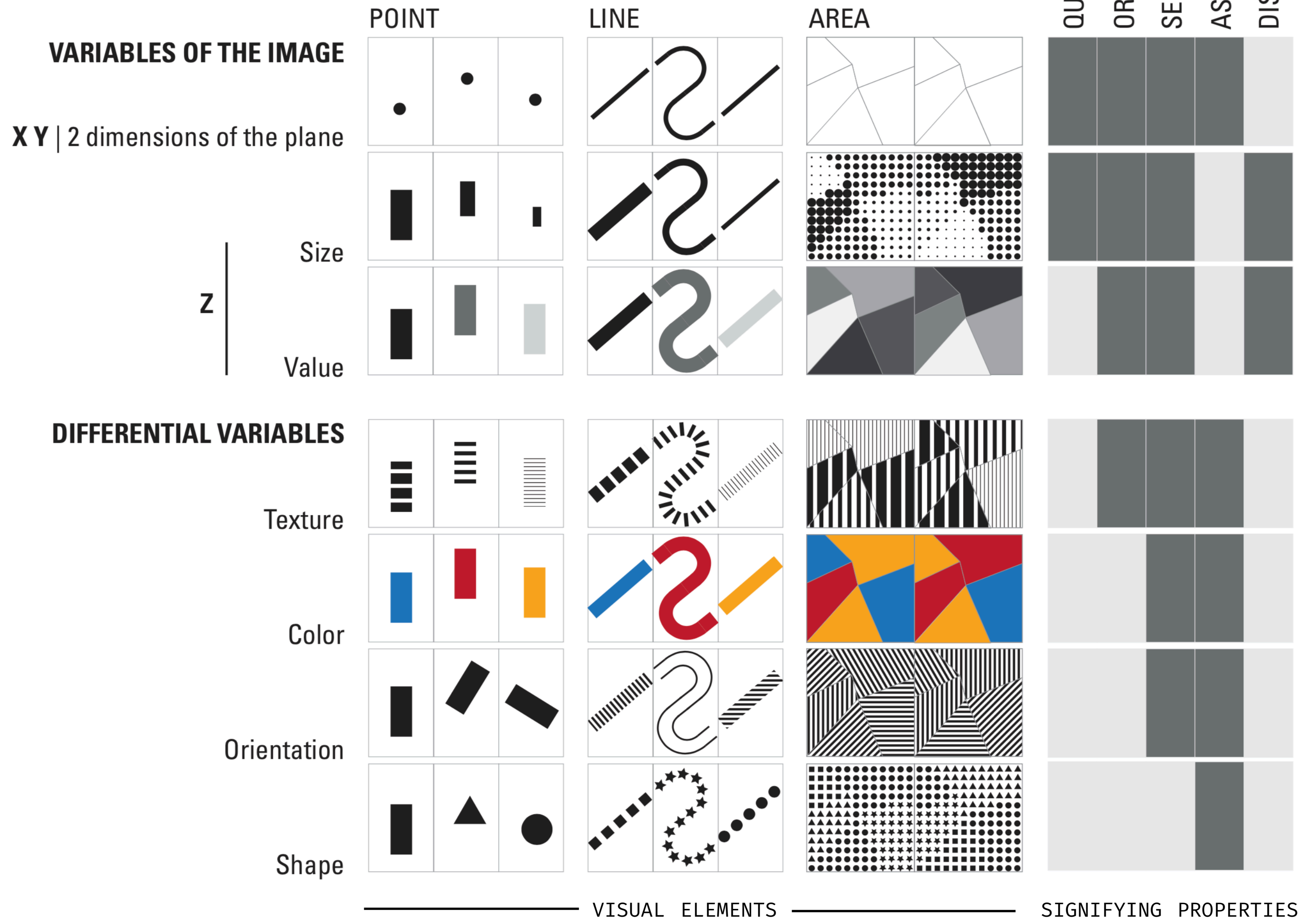
For building graphics and narrative into interactive communications



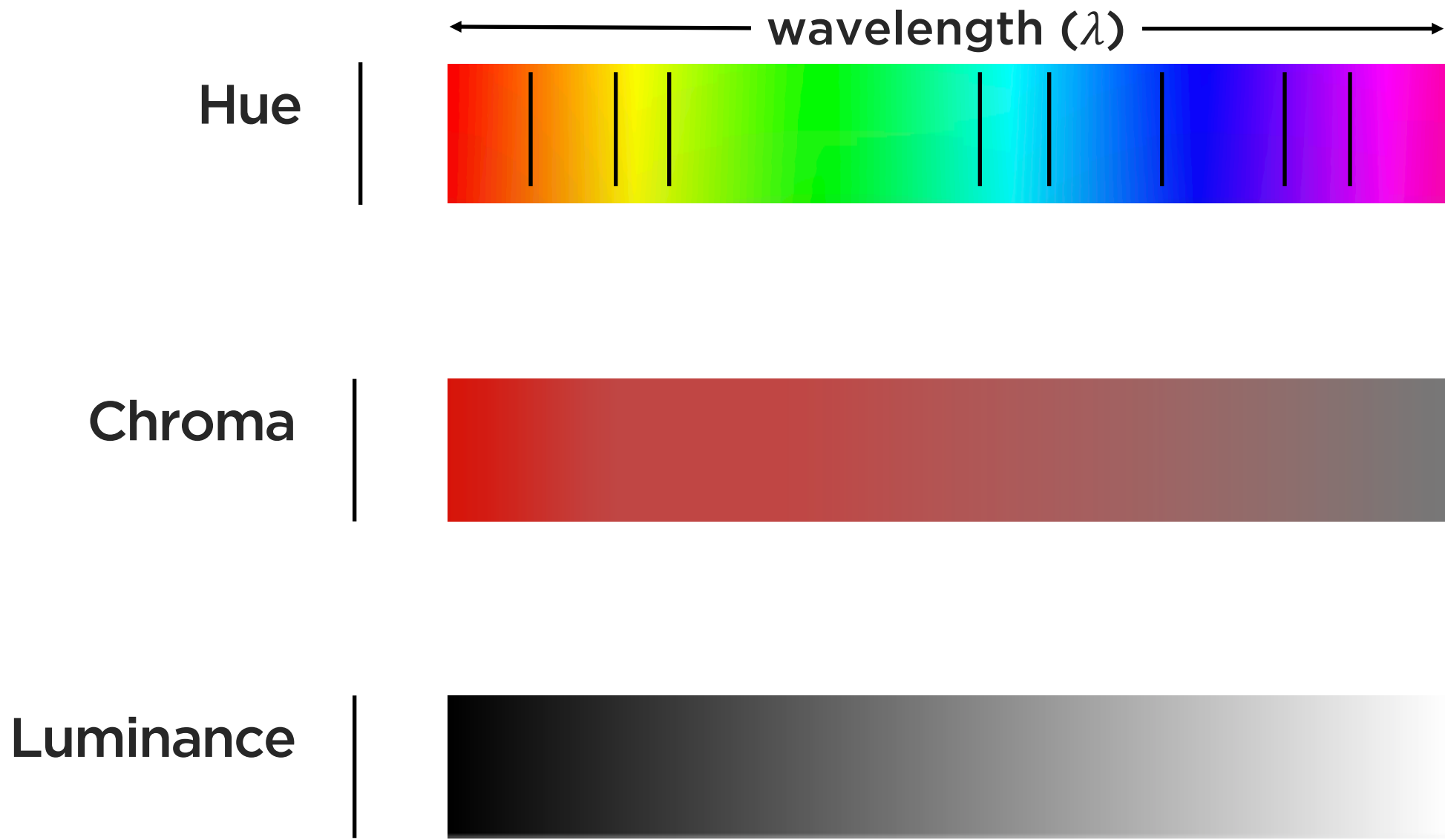
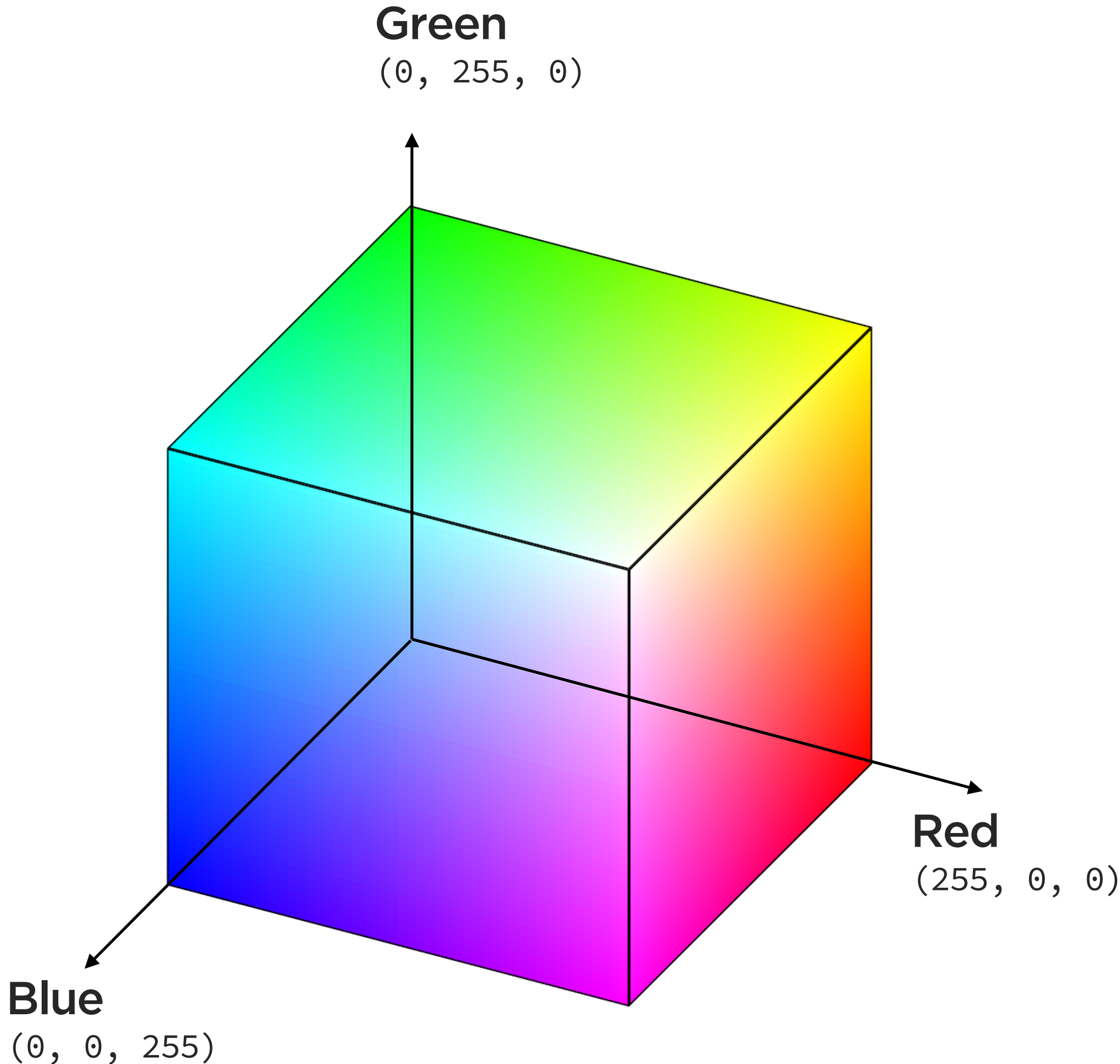
**review homework 1**

**encoding data as color**

# data encodings, visual channels for encoding data



# encoding data as color, encode data using color spaces, which are mathematical models





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

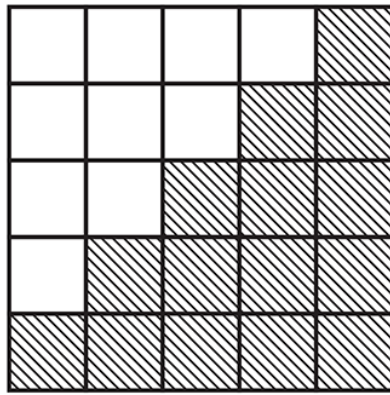


## encoding data as color, **perceived brightness is nonlinear function of luminance**

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

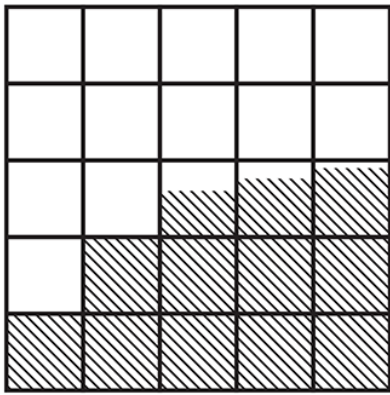
**BRIGHTNESS** : the *perceived* amount of light coming from that region of space.

# encoding data as color, visual perception of arithmetical progression depends on physical geometric progression

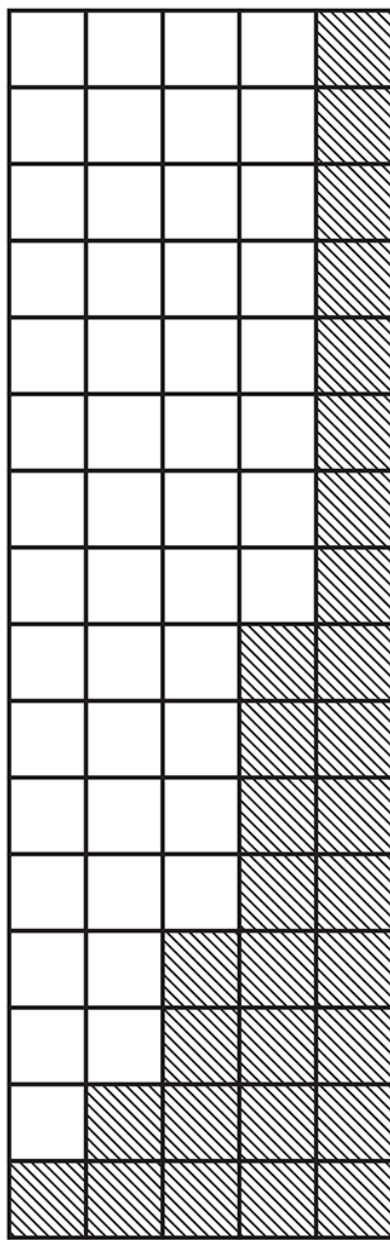


THIS PHYSICAL FACT

REDUCES TO

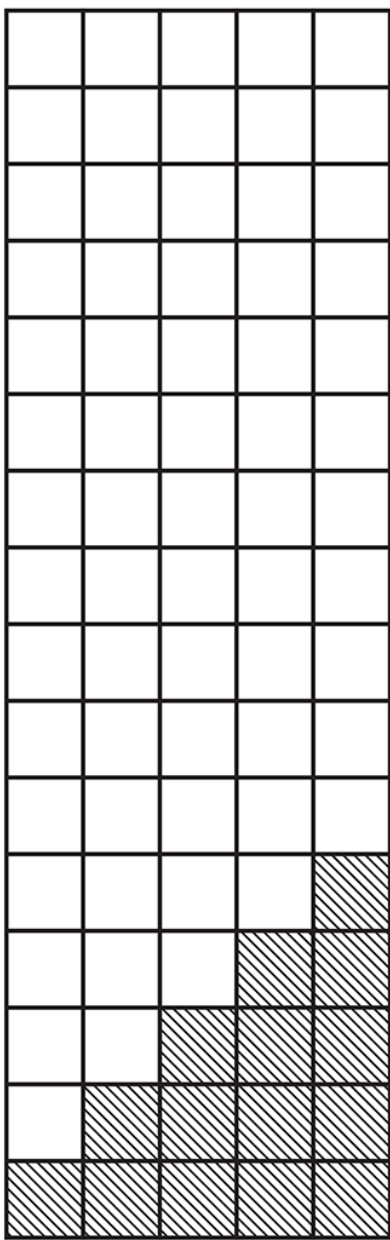


THIS PSYCHOLOGICAL EFFECT



THIS PHYSICAL FACT

PRODUCES



THIS PSYCHOLOGICAL EFFECT

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

**Same luminance or lightness?**

HSL(250, 100, 100)

HSL(250, 100, 100)

HSL( 60, 100, 100)

HSL( 60, 100, 100)

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

**Same saturation?**

HSL(0, 30, 40)

HSL(0, 30, 40)

HSL(0, 30, 90)

HSL(0, 30, 90)

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

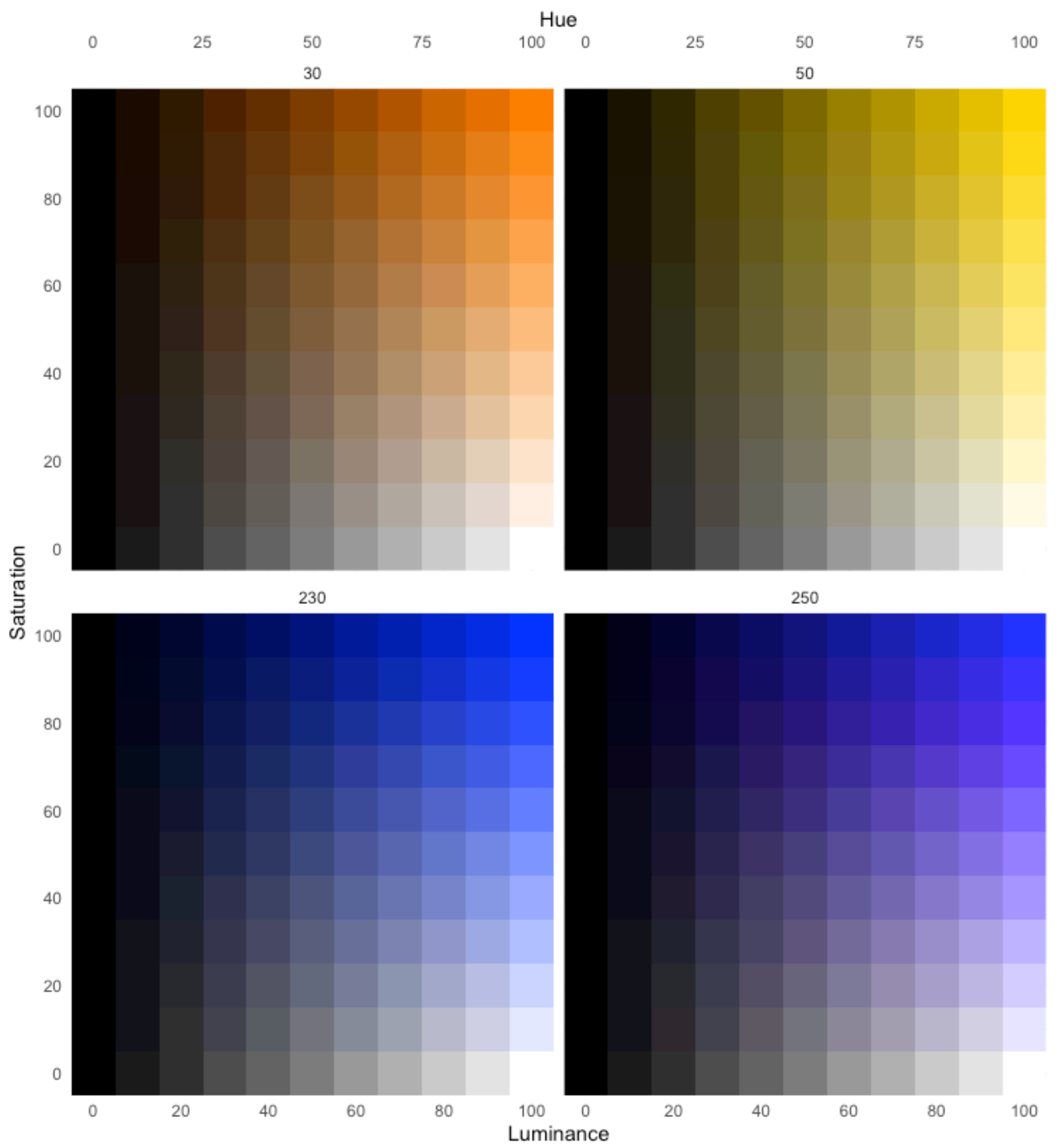
**Equal difference between hues?**

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

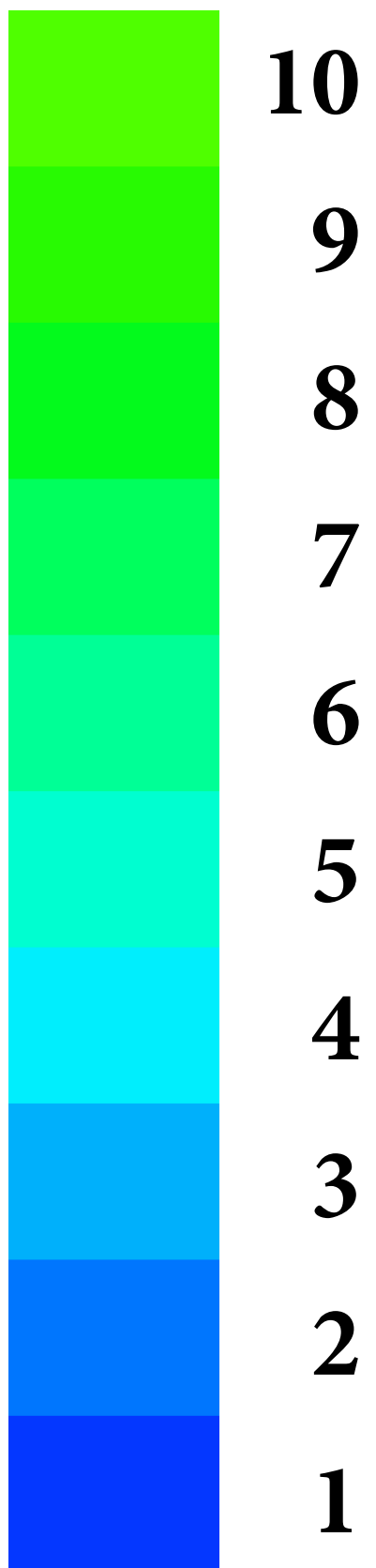
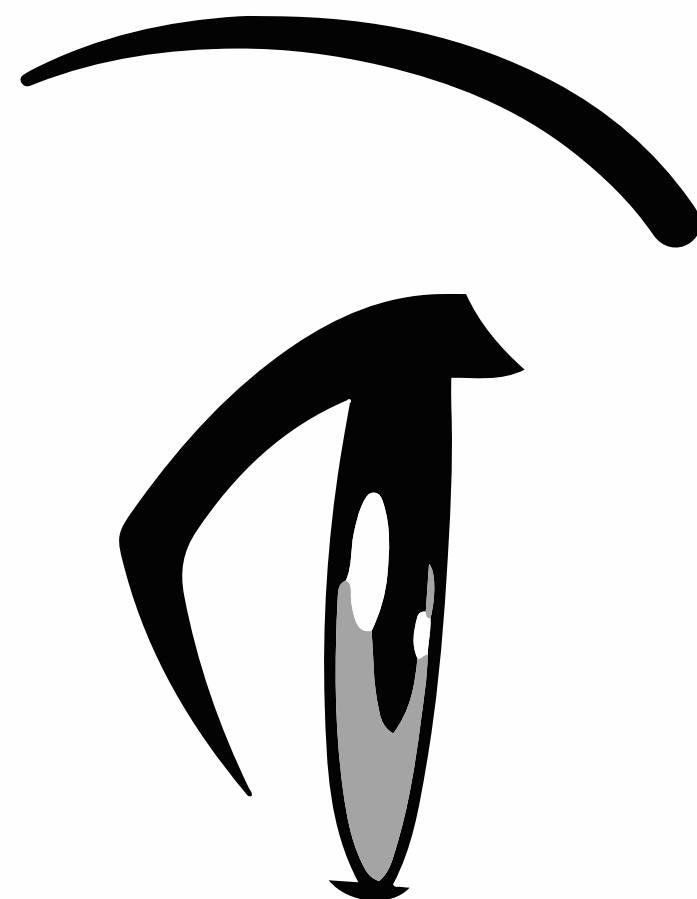
HSL(230, 100, 100)  
HSL(230, 100, 100)  
HSL(250, 100, 100)  
HSL(250, 100, 100)

# color, example encoding data into hue, saturation, and luminance

*default* conversion HSL colorspace to RGB

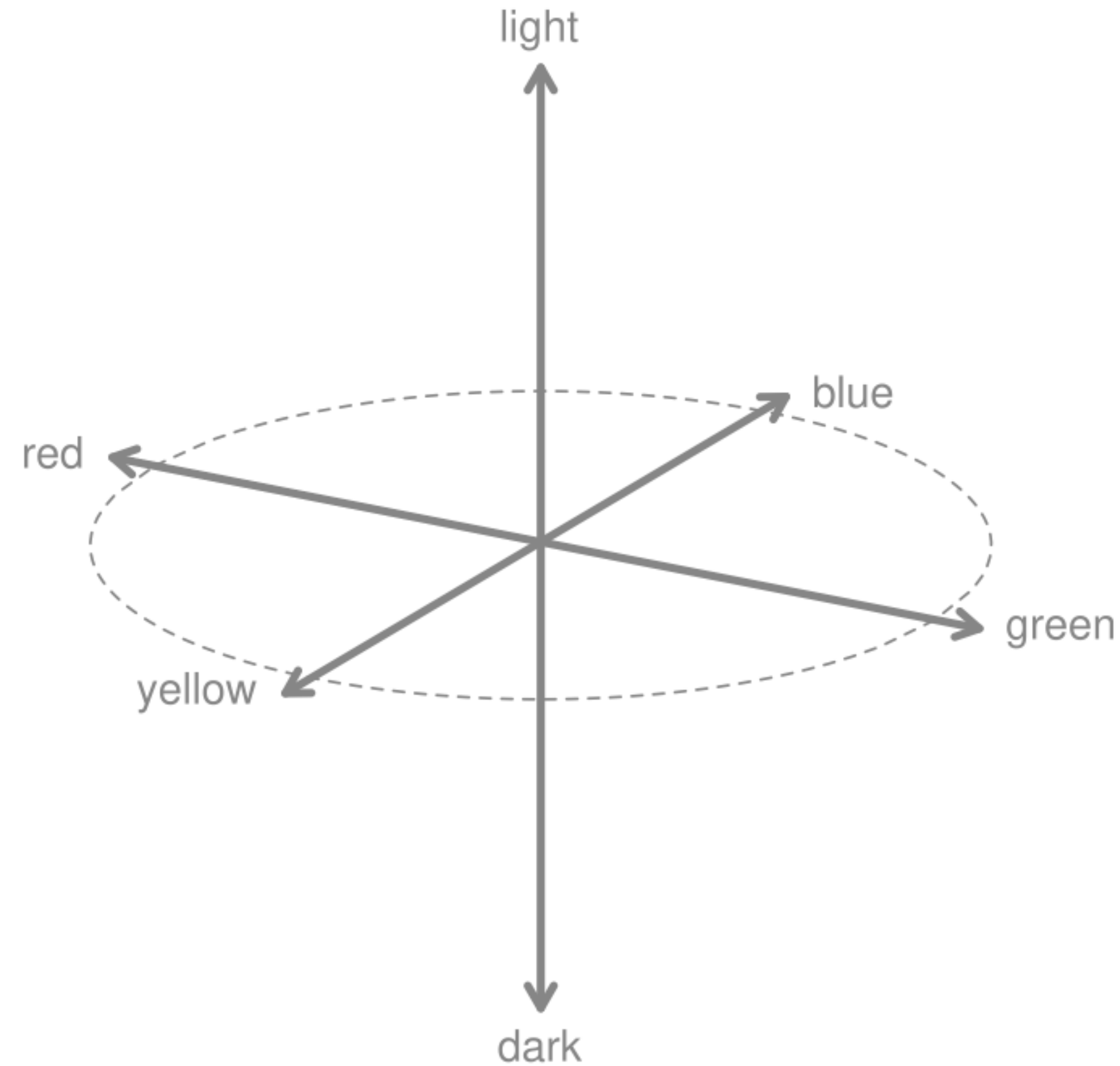


color, as with luminance, *hue* values in the RGB color space fail to uniformly compare across values





# color, perceptually uniform color spaces have been created — CIELuv — but it isn't intuitive like HSL



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

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

```
library(HSLuv)
```

Create sample data encoded as hue, saturation, luminance

```
df <- expand.grid(H = c(30, 50, 230, 250),  
                S = seq(0, 100, by = 10),  
                L = seq(0, 100, by = 10))
```

Map or rescale your data values to valid range for the given the visual channel. This example data are already scaled to HSL ranges, so we don't need to rescale:

```
library(scales)
```

```
df <- df %>%  
  mutate(H = rescale(H, from = c(0, 360), to = c(0, 360) ),  
         S = rescale(S, from = c(0, 100), to = c(0, 100) ),  
         L = rescale(L, from = c(0, 100), to = c(0, 100) ))
```

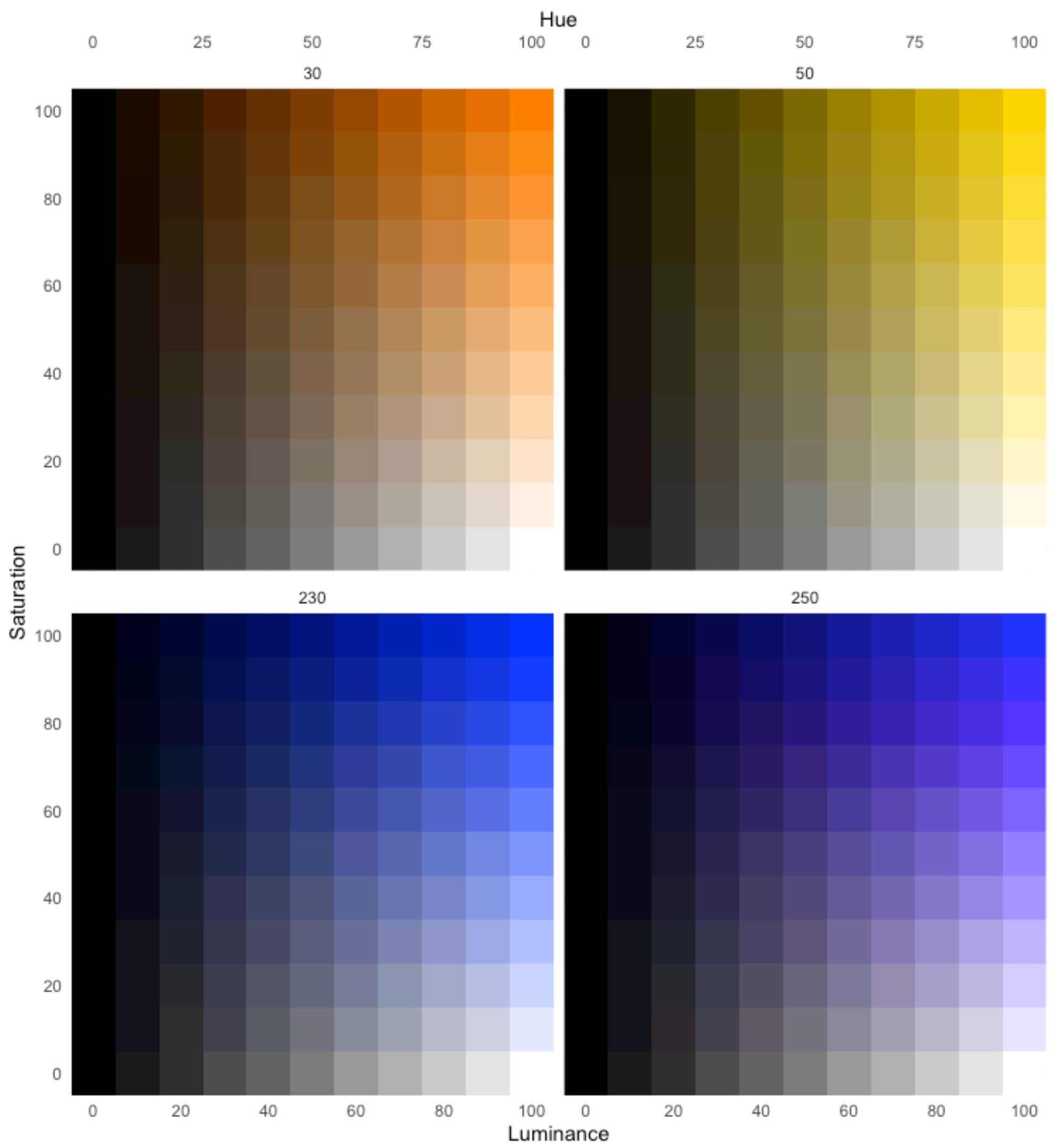
— *data range* — — *visual range* —

Plot data encoded as colors

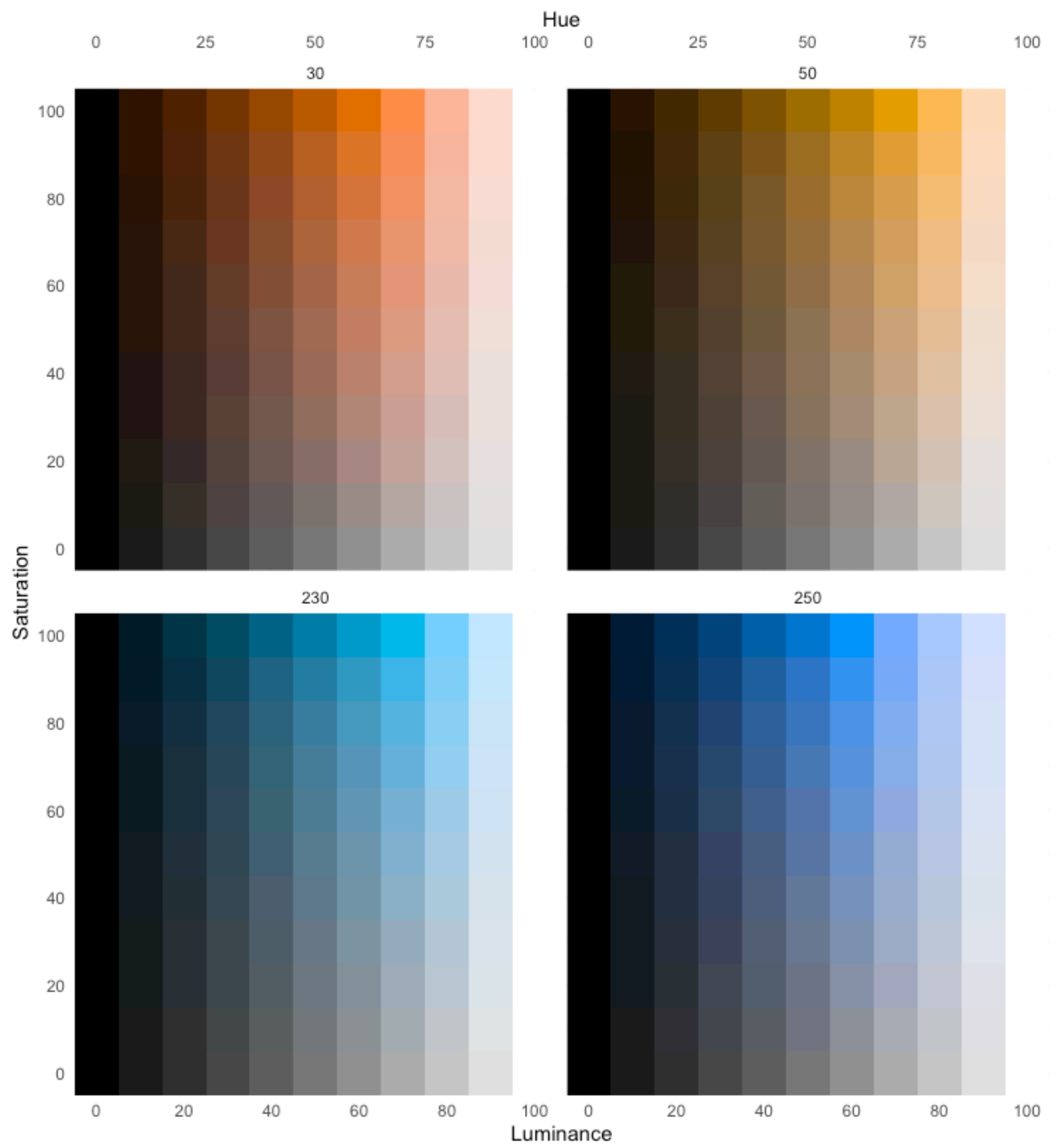
```
ggplot(df) +  
  
  facet_wrap(~ H ) +  
  
  scale_x_continuous(  
    name = 'Luminance',  
    breaks = seq(0, 100, by = 20),  
    expand = c(0,0),  
    sec.axis = sec_axis(~., name = 'Hue')) +  
  
  scale_y_continuous(  
    name = 'Saturation',  
    breaks = seq(0, 100, by = 20),  
    expand = c(0,0)) +  
  
  scale_fill_identity() +  
  
  geom_raster(  
    mapping = aes(  
      x = L,  
      y = S,  
      fill = hsluv_hex(H, S, L)),  
  )
```

# color, example encoding data into hue, saturation, and luminance

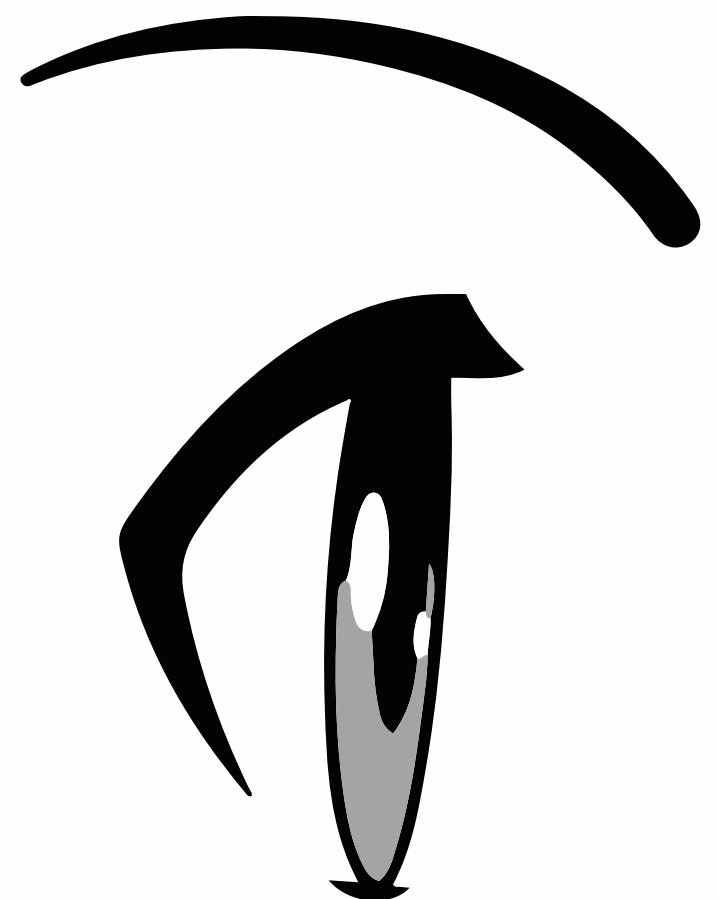
*default* conversion HSL colorspace to RGB



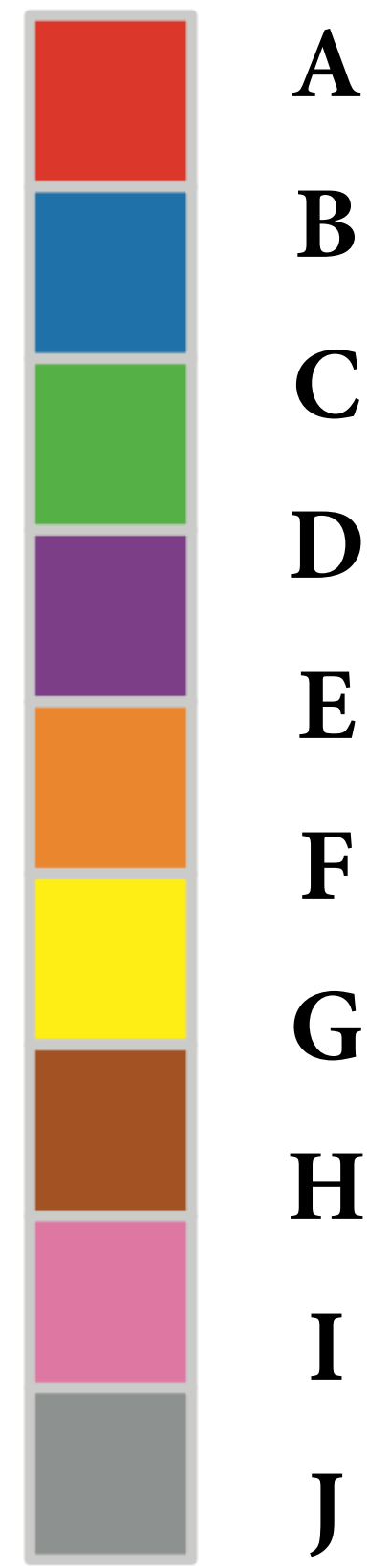
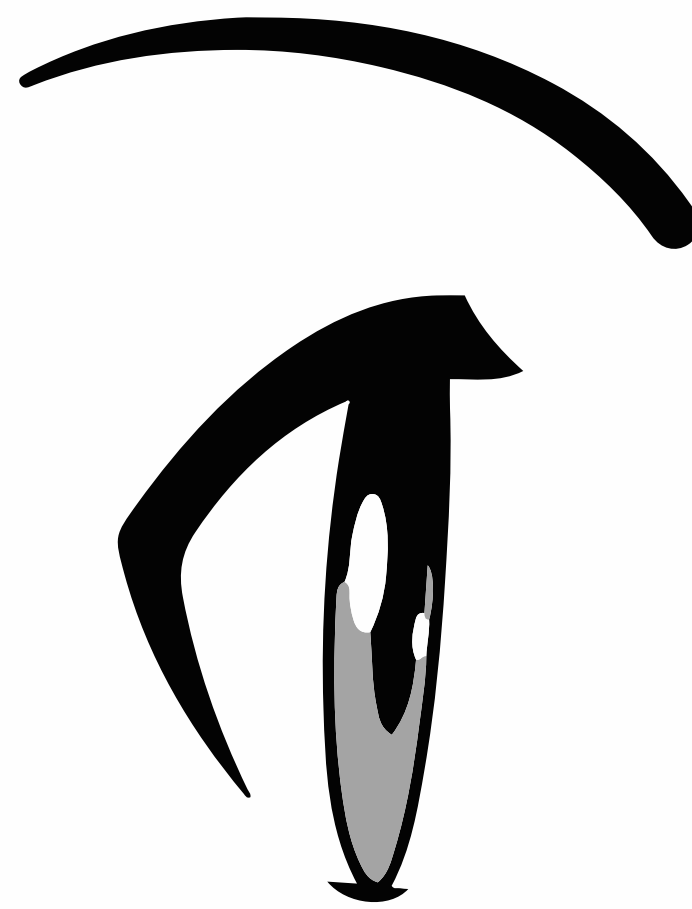
*perceptually uniform* conversion HSLuv colorspace to RGB



# color, perceptually uniform color spaces better represent changes in quantity

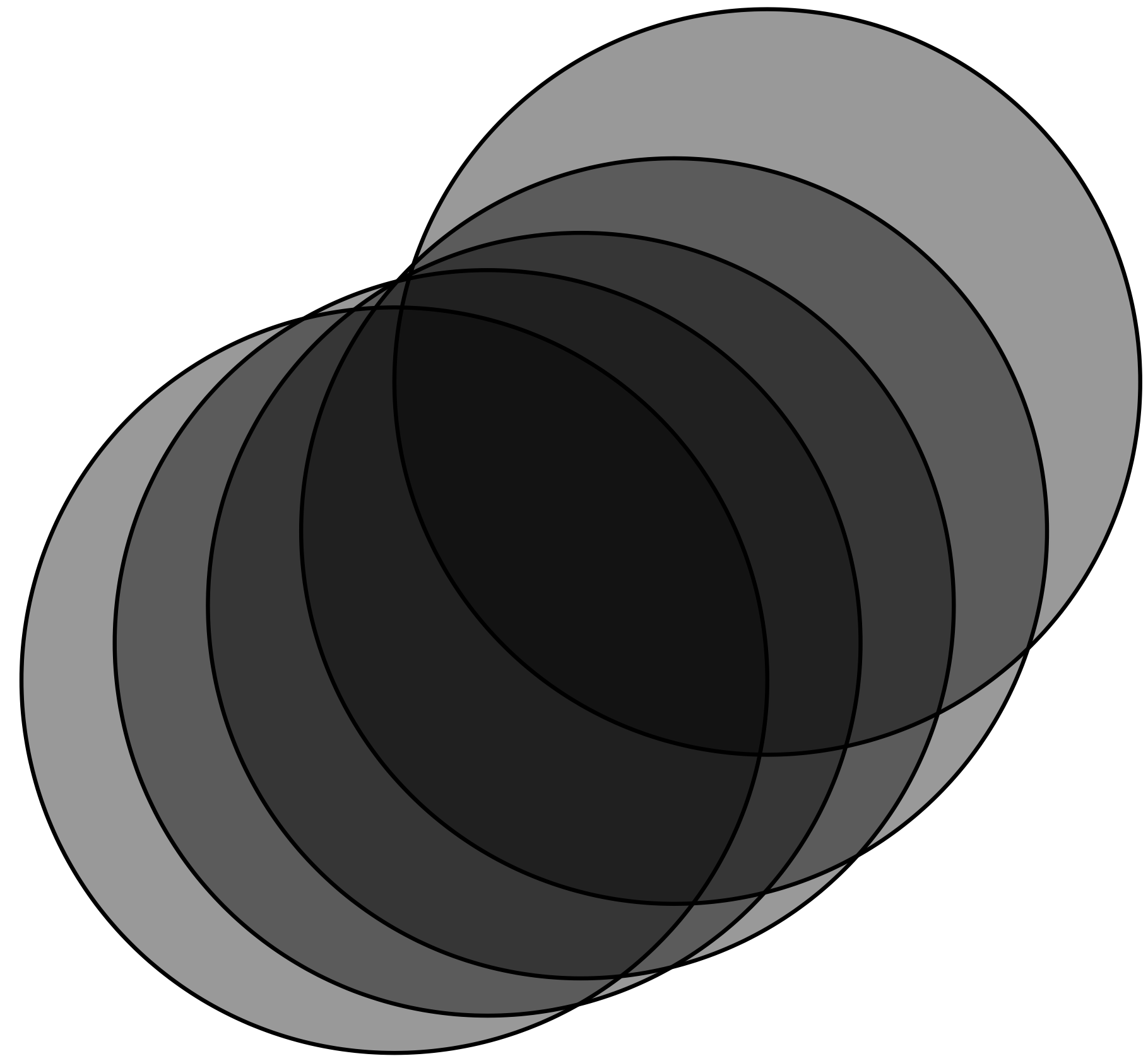


**color, perceptually uniform color spaces also help in distinguishing categorical data**



encoding as color, layering — transparency (alpha) of *monochromes* can help us reason about the density of overlapping shapes

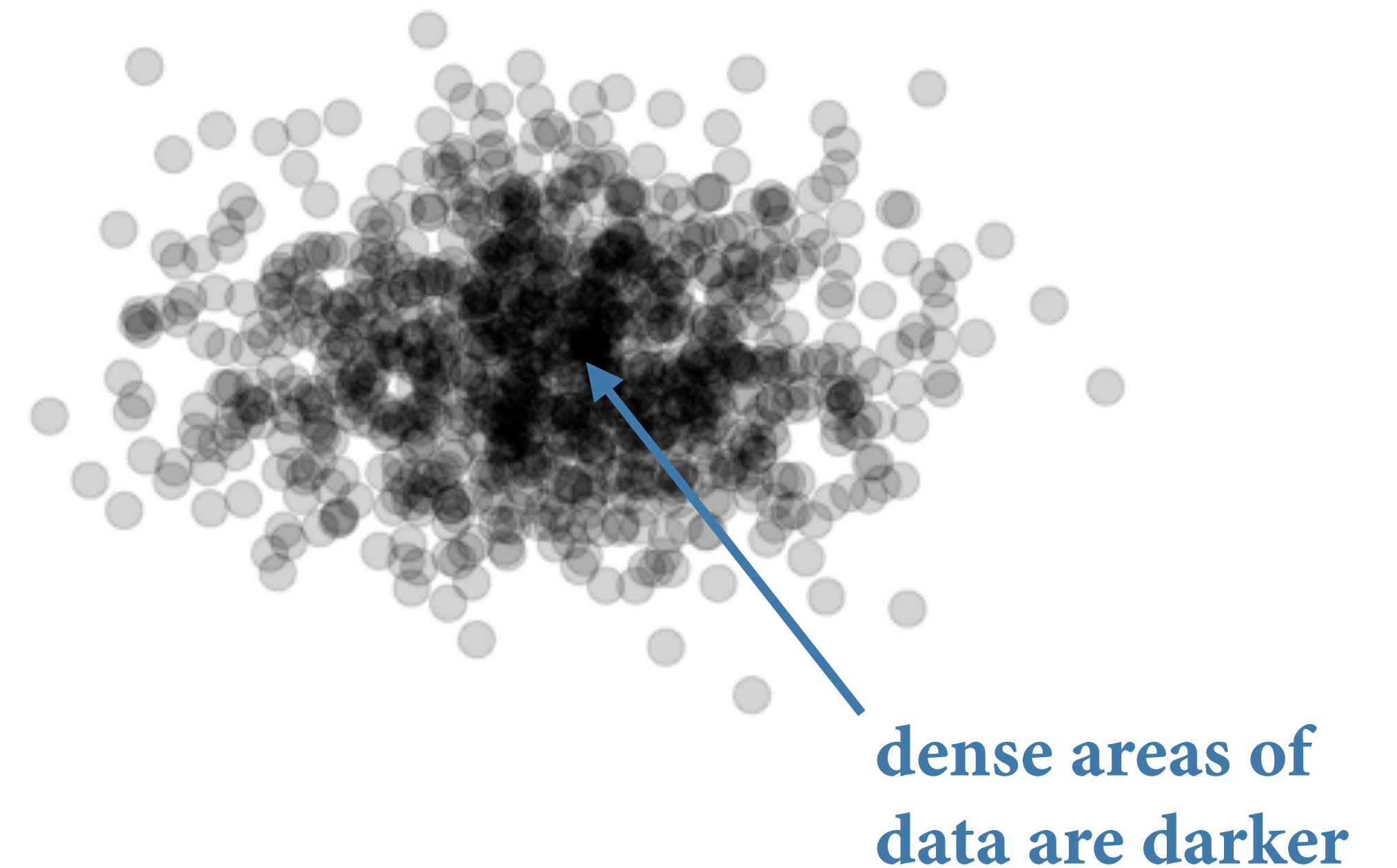
```
ggplot() +  
  theme_void() +  
  coord_equal() +  
  ggforce::geom_circle(  
    mapping = aes(  
      x0 = seq(from = 0, to = 1, length.out = 5),  
      y0 = c(0, .1, .2, .4, .8),  
      r = 1),  
    fill = "#000000",  
    alpha = 0.4)
```



encoding as color, layering — transparency (alpha) of *monochromes* can help us reason about the density of overlapping shapes

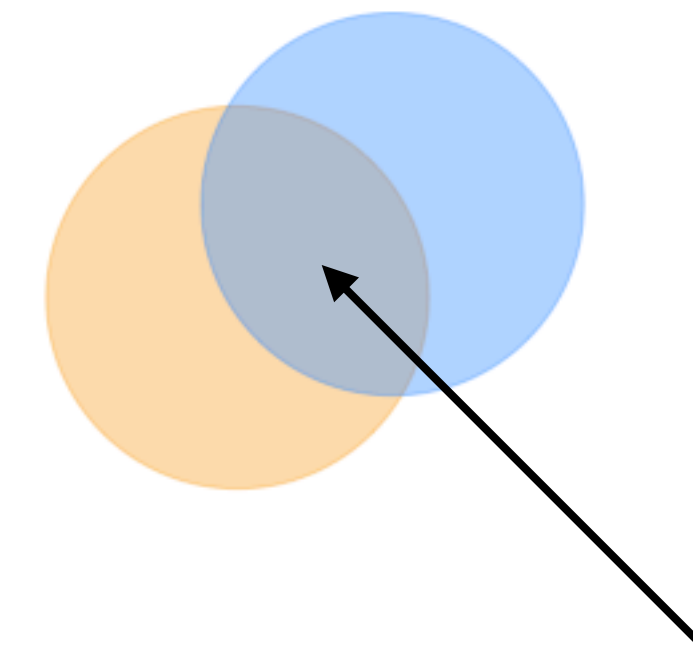
```
x <- rnorm(1000)
y <- rnorm(1000)
```

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



encoding as color, layering — data encoded in *semi-transparent hues*, if overlapping, are affected by transparency!

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



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

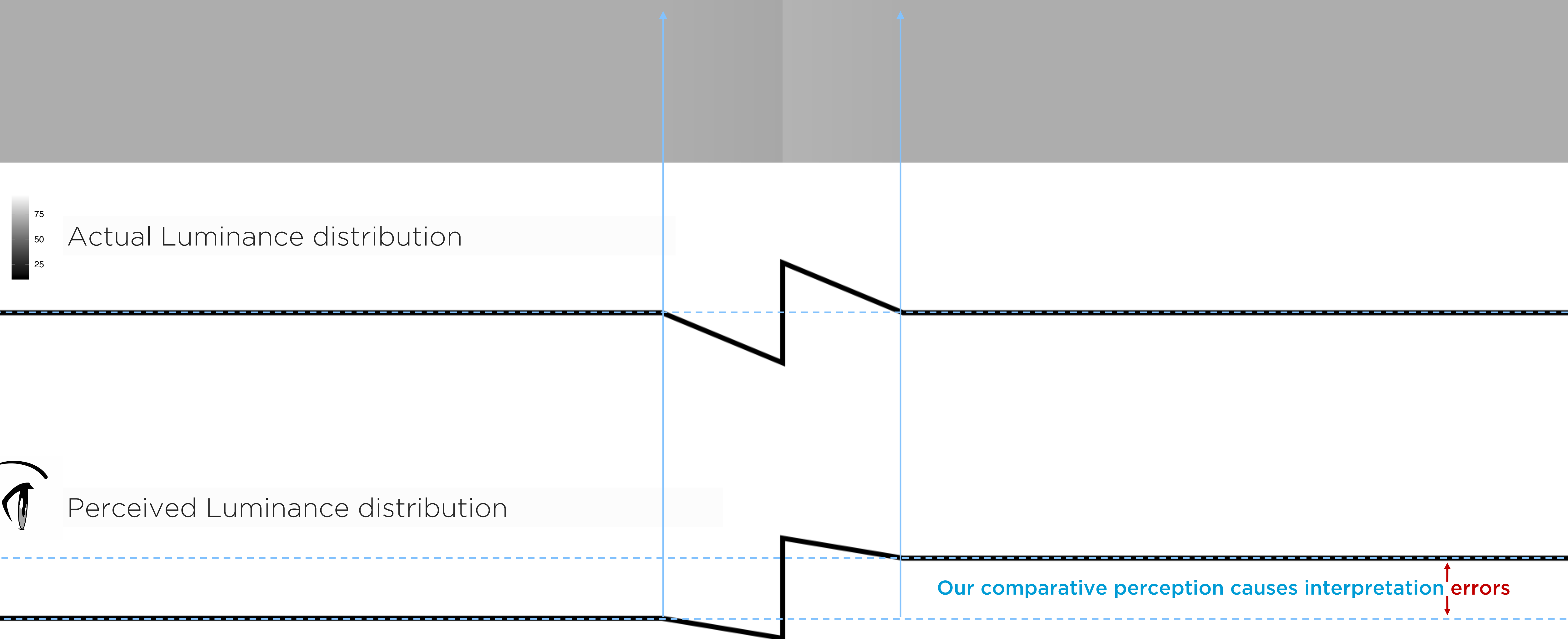


**interaction of color**

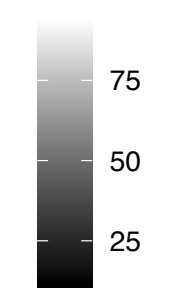
**color, humans have evolved to see edge contrasts. We see comparative — not absolute — luminance value.**



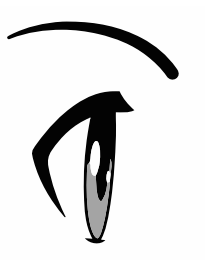
**color, humans have evolved to see edge contrasts. We see comparative — not absolute — luminance value.**



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



Actual Luminance distribution



Perceived Luminance distribution



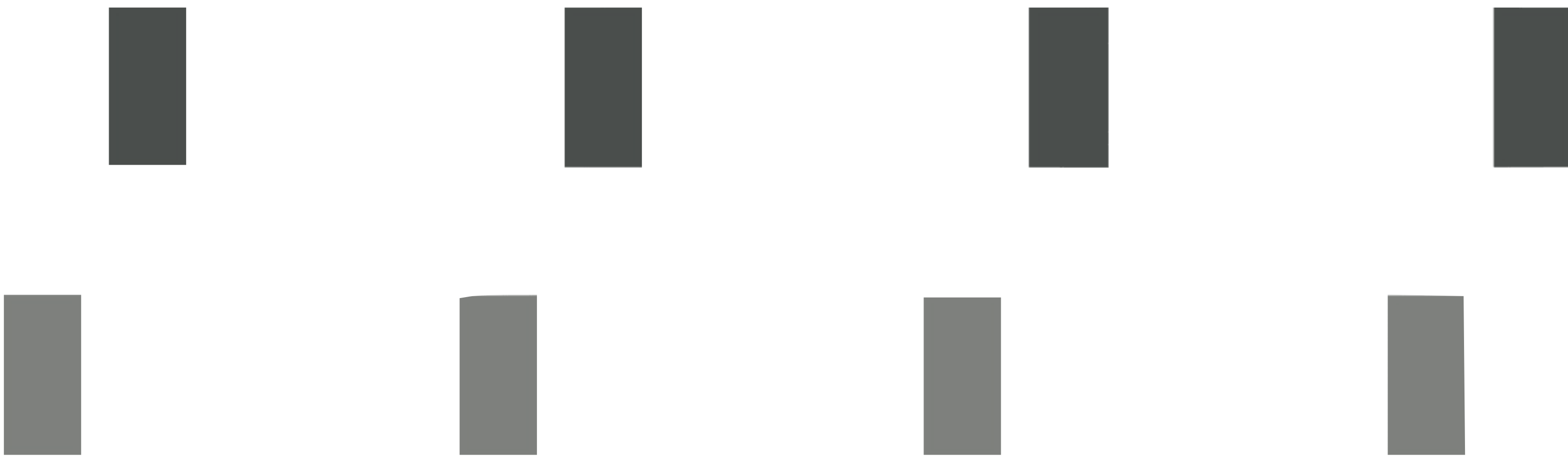
Our comparative perception causes interpretation errors



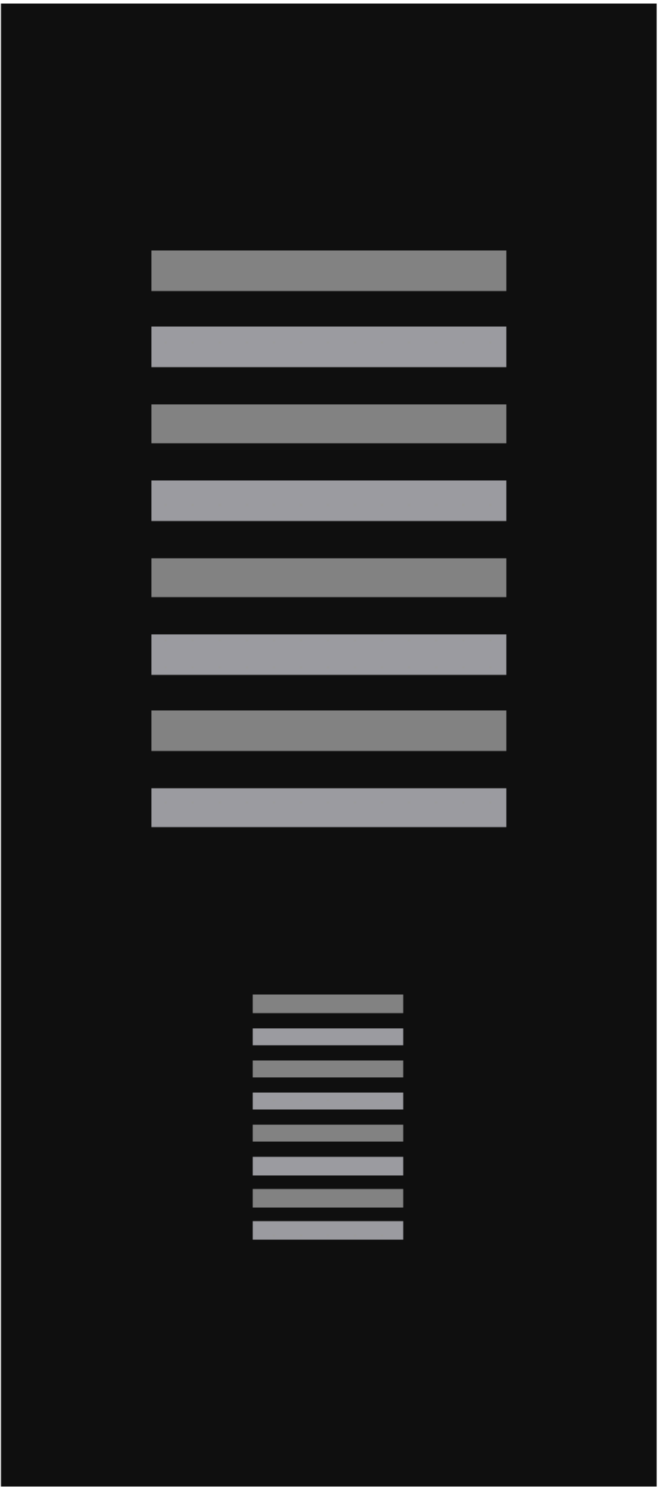
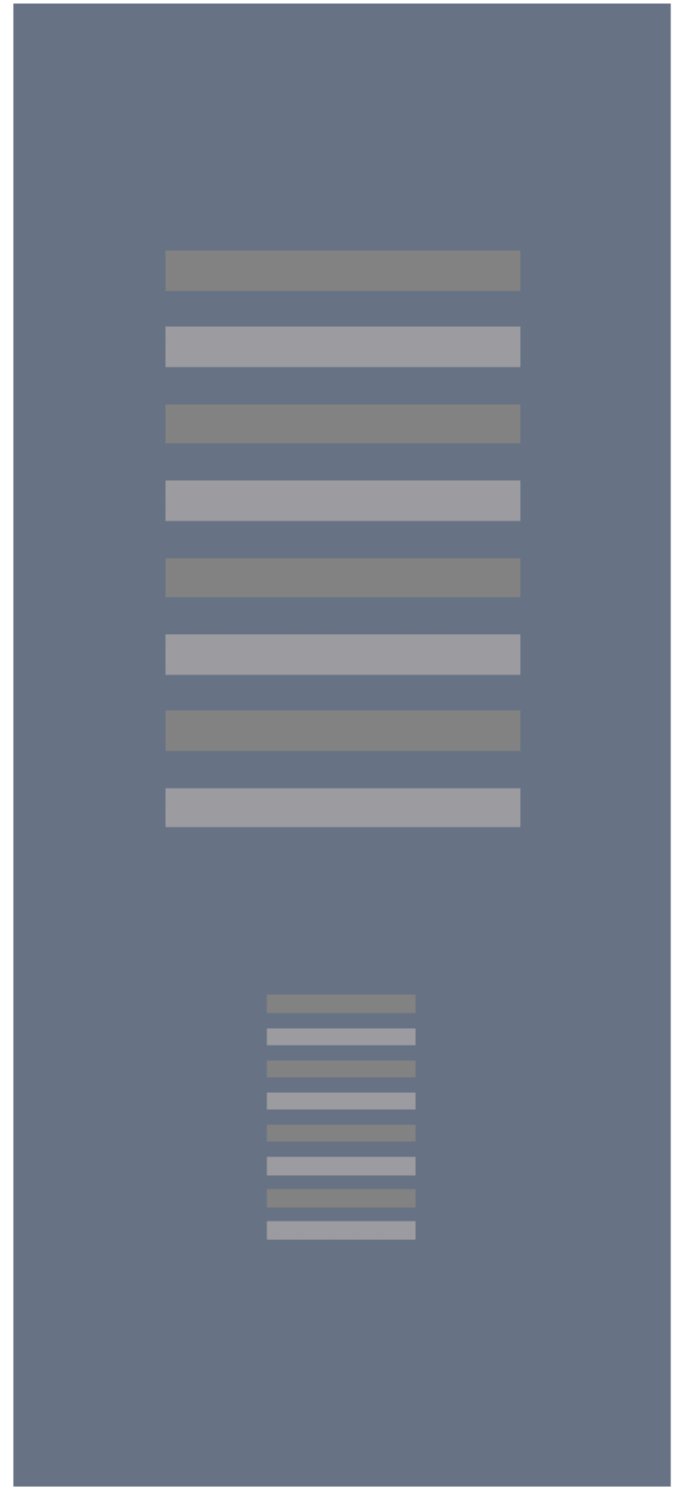
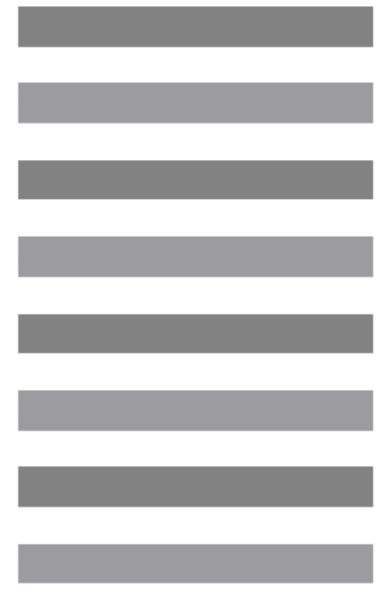
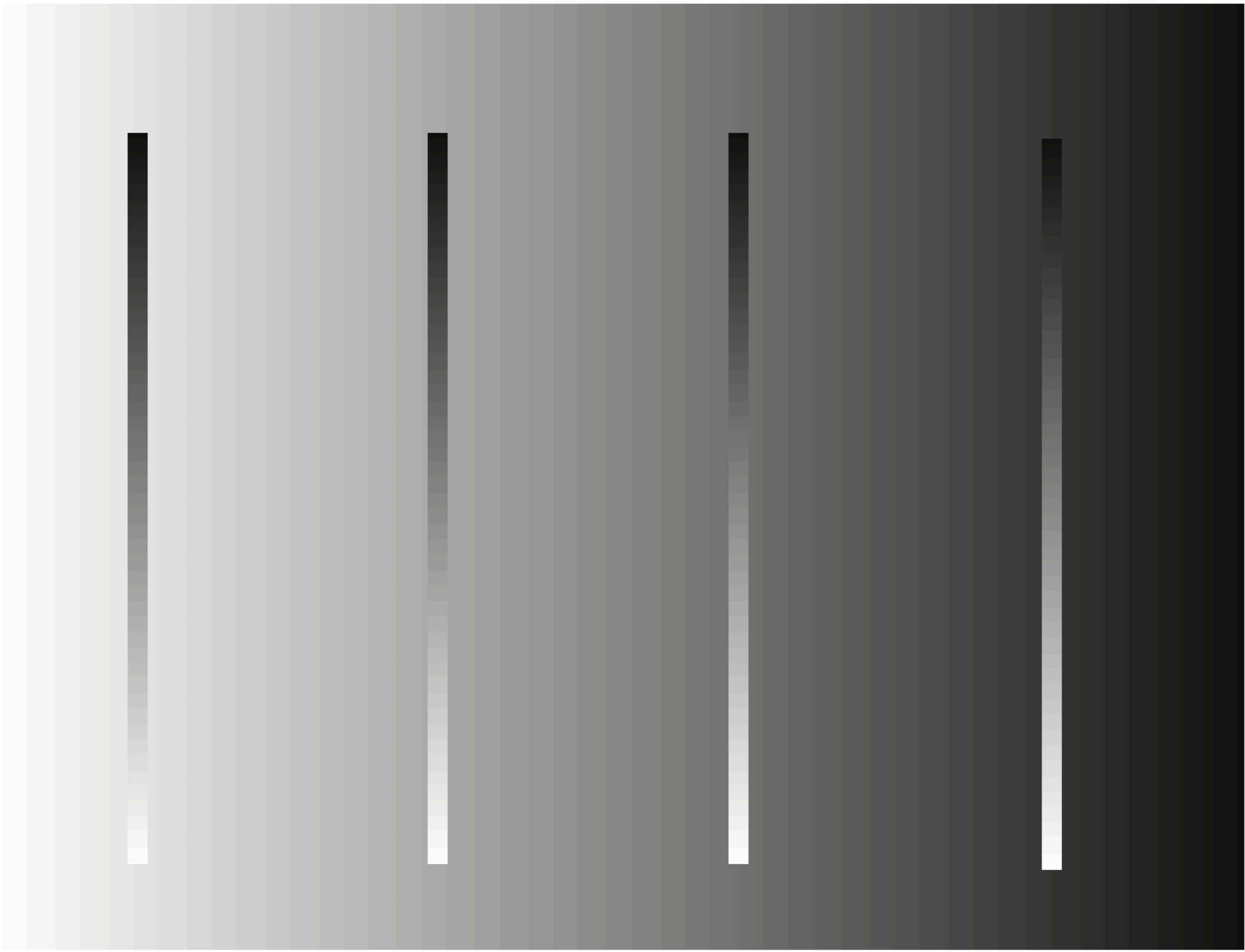
**color, background and adjacent luminance can interfere with our perception**



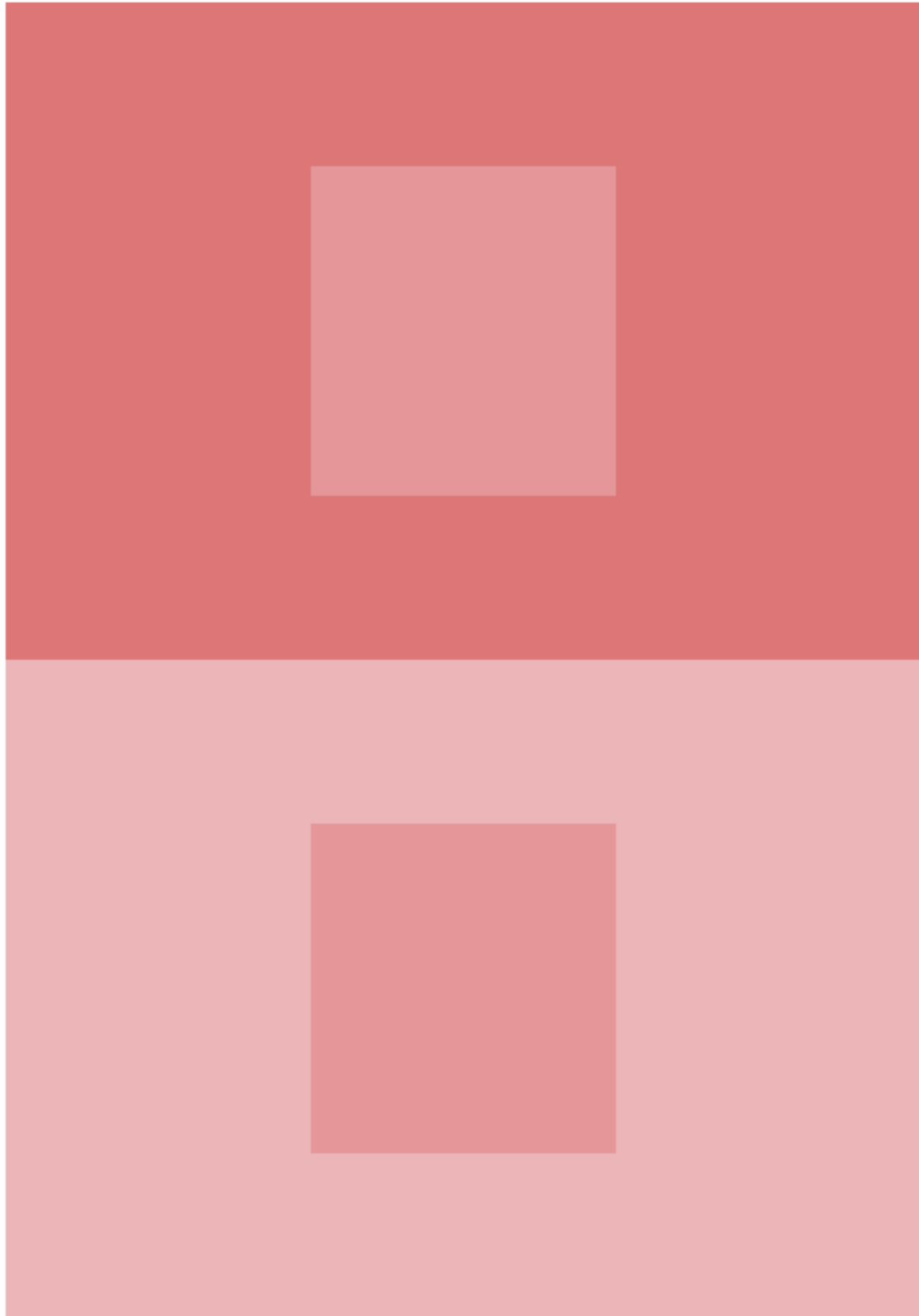
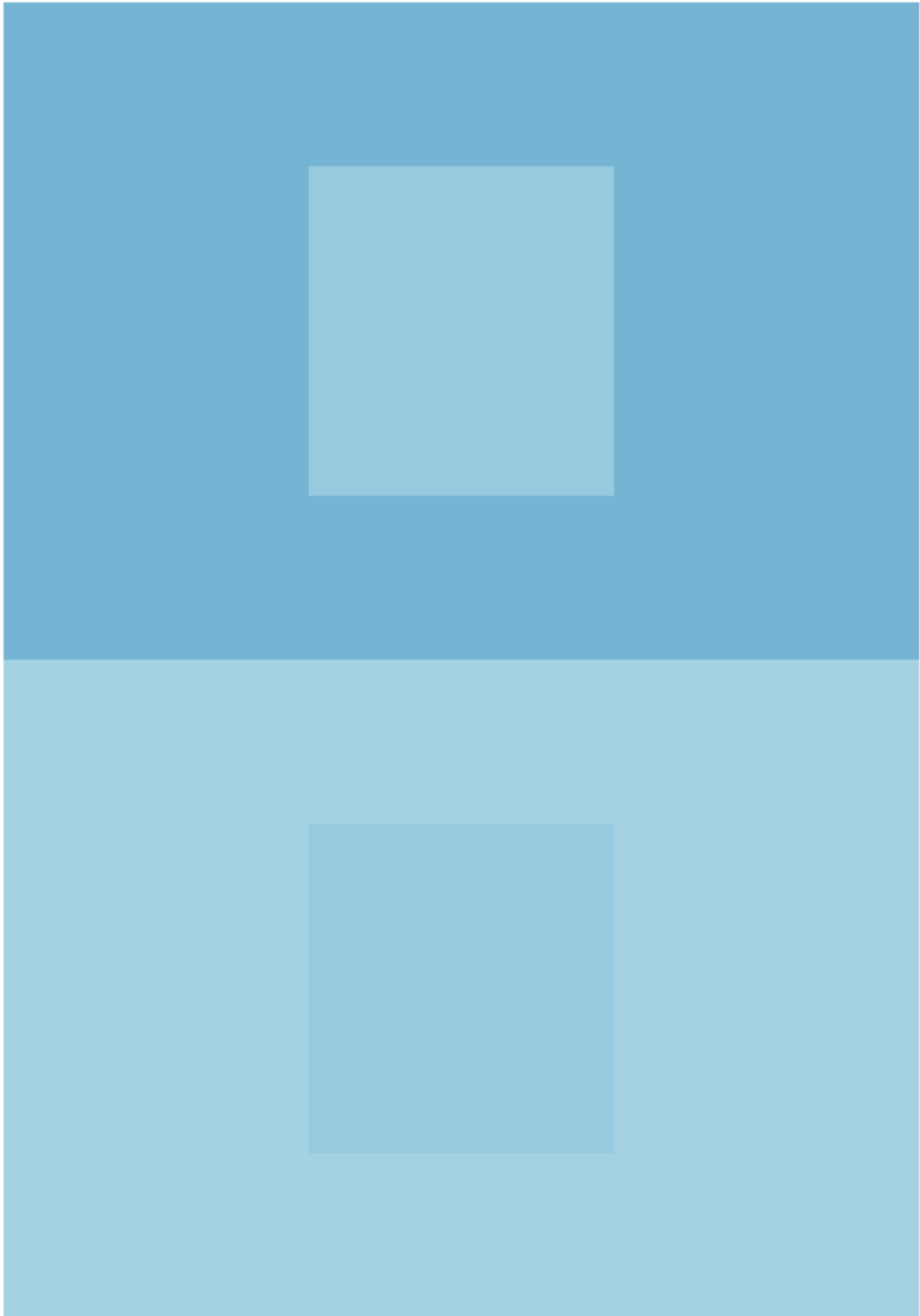
# color, background and adjacent luminance can interfere with our perception



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

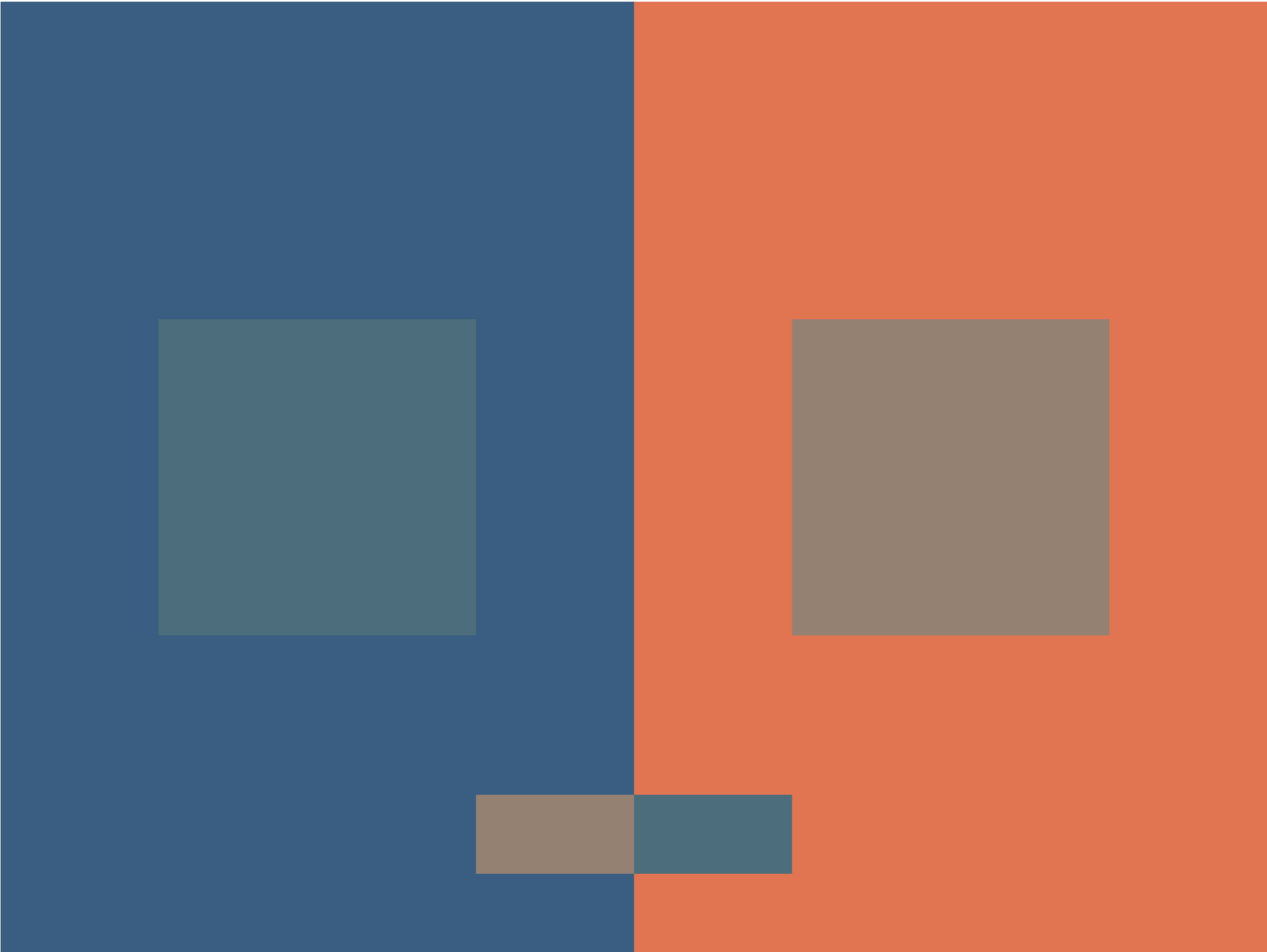


# interaction of color, one color appearing as two

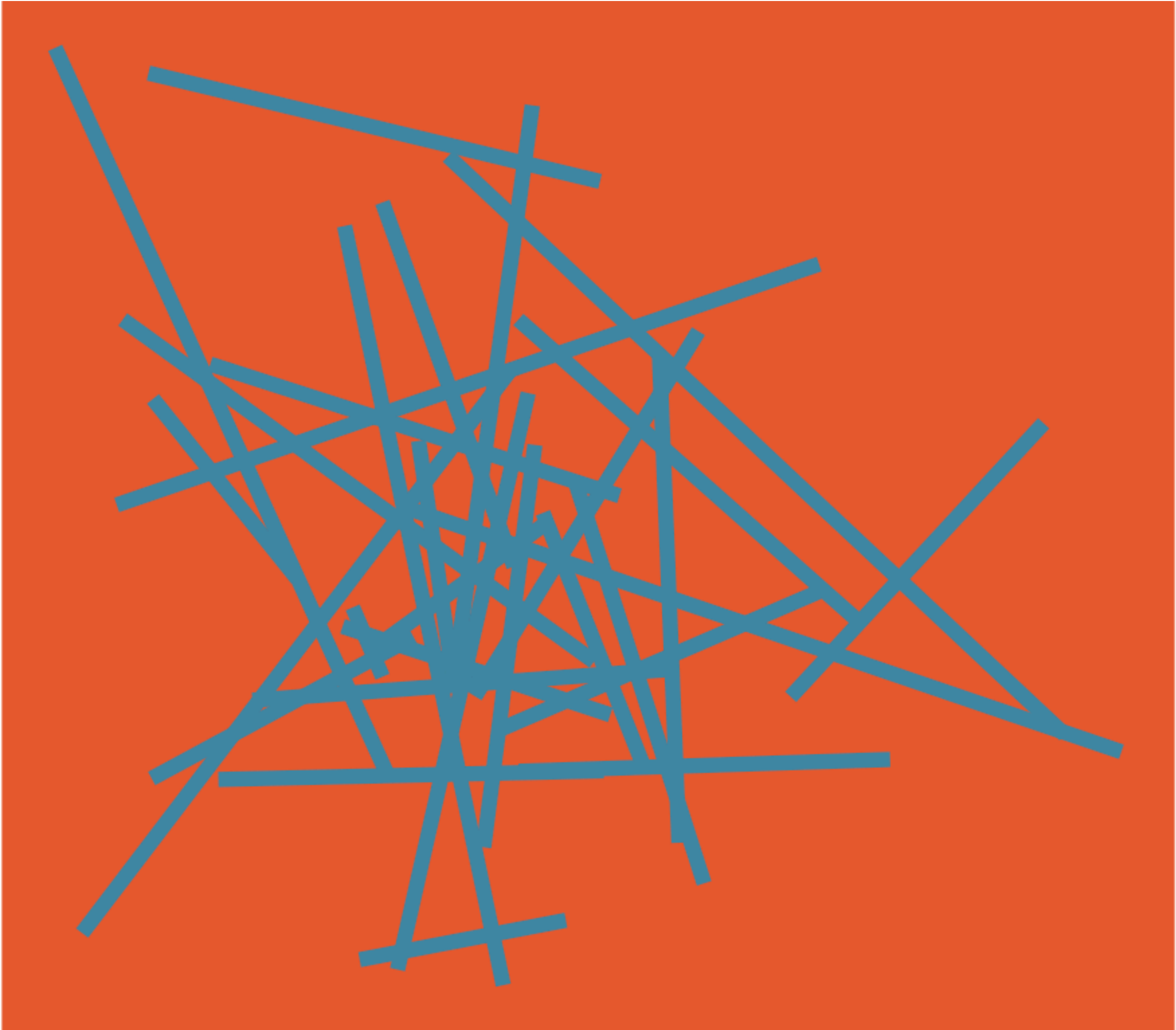




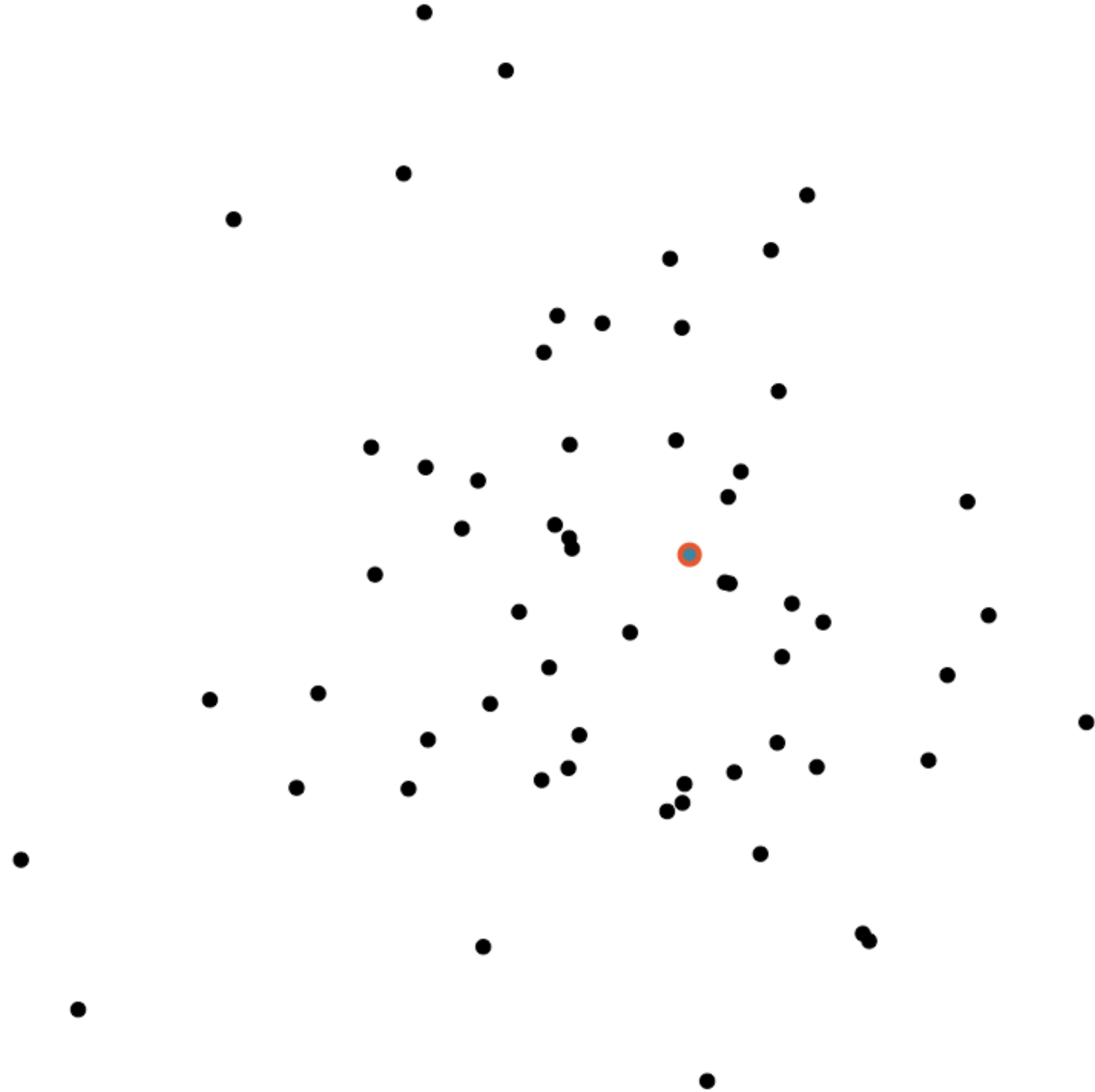
# interaction of color, two different colors look alike



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



# interaction of color, experimentation with vibrating boundaries to focus attention



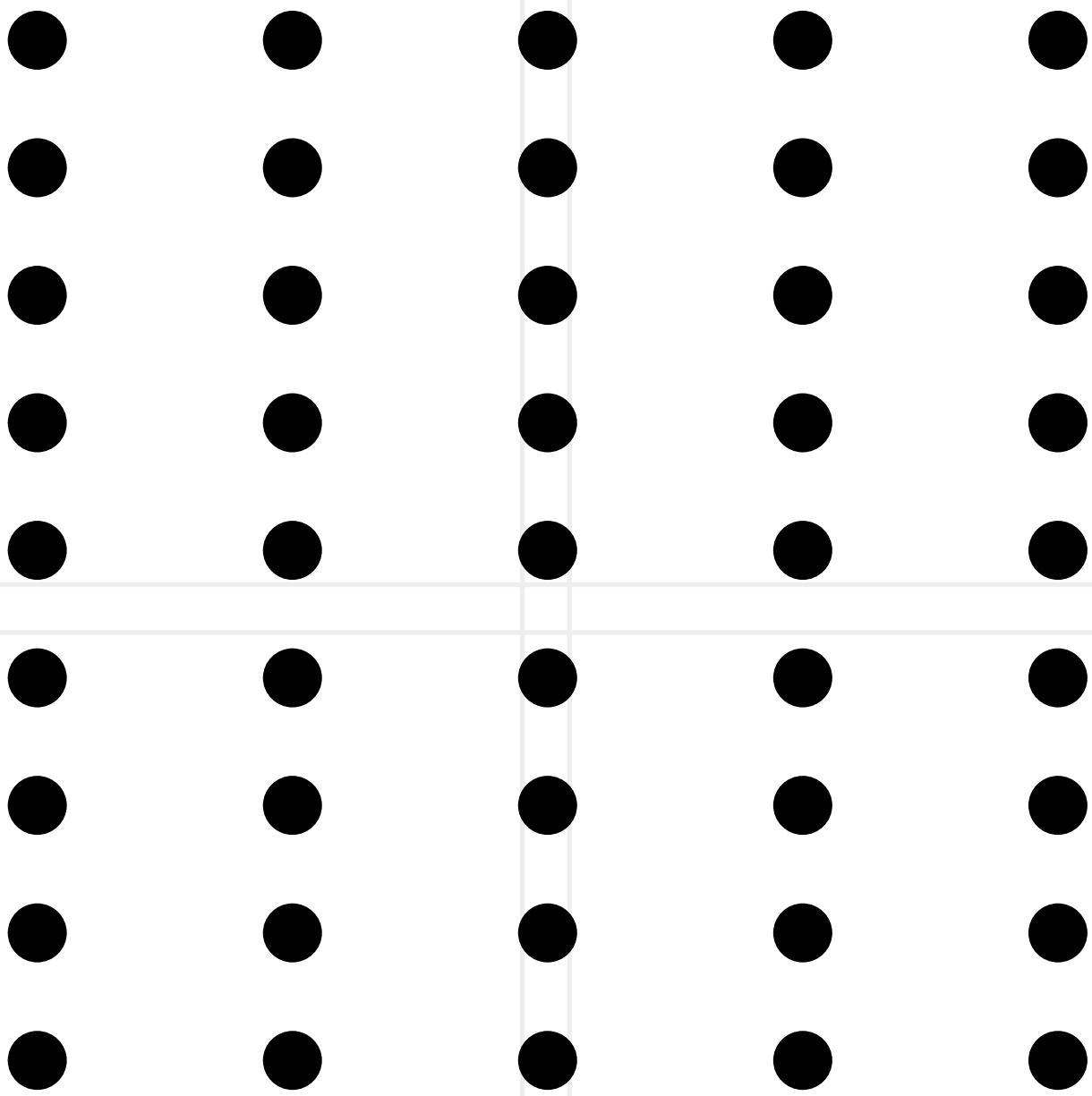
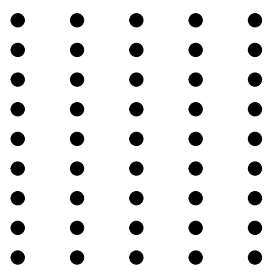
**group work — color encoding “research”**

**design mini-review**



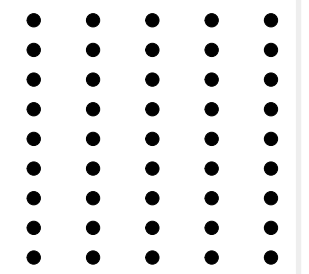
# design mini-review | aligning and organizing information reduces cognitive load — *proximity*

Proximity

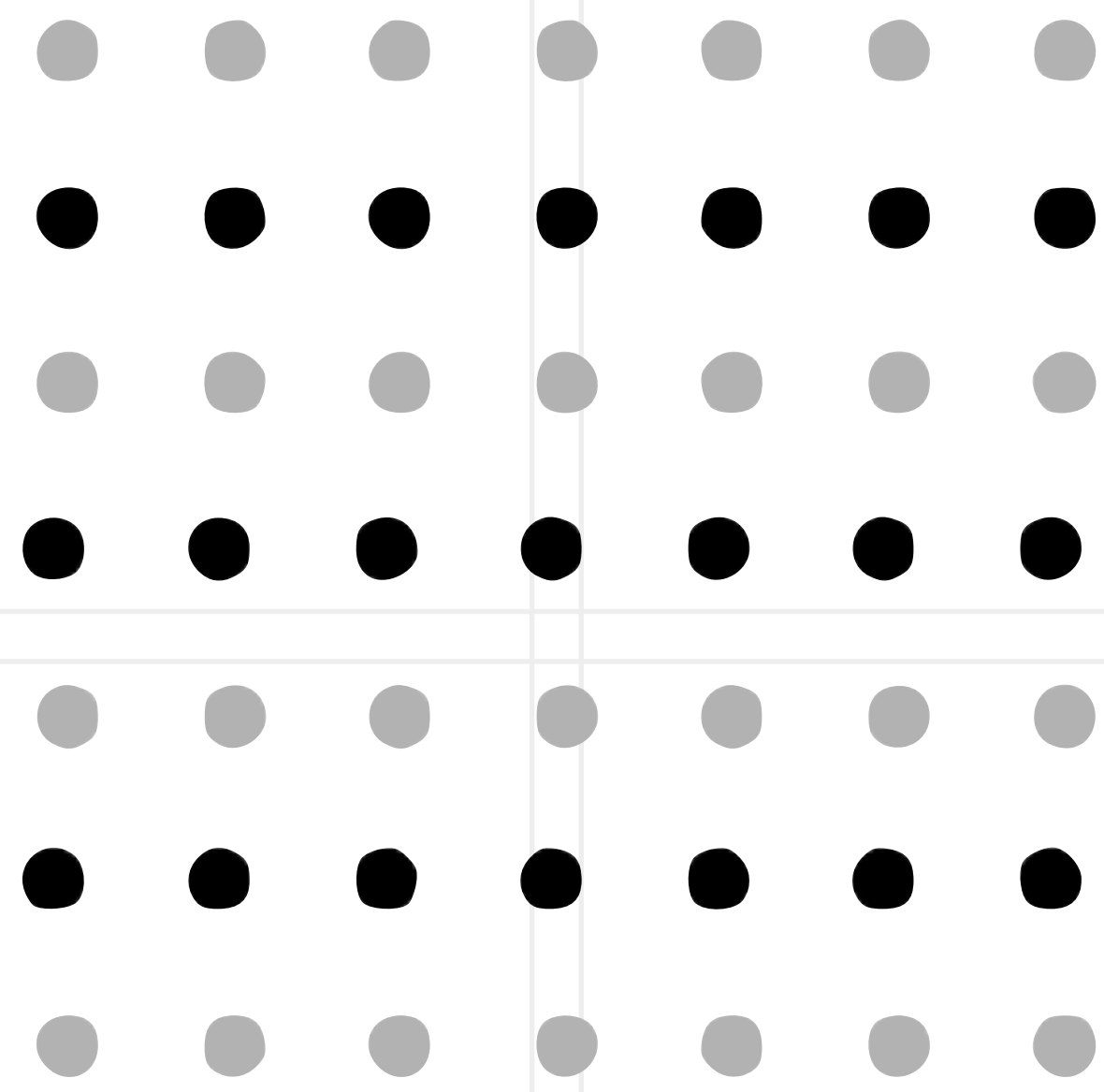
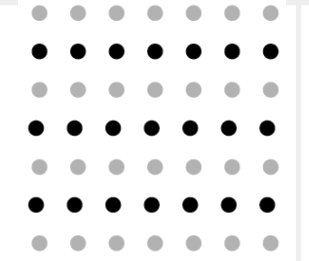


# design mini-review | aligning and organizing information reduces cognitive load — *similarity*

Proximity

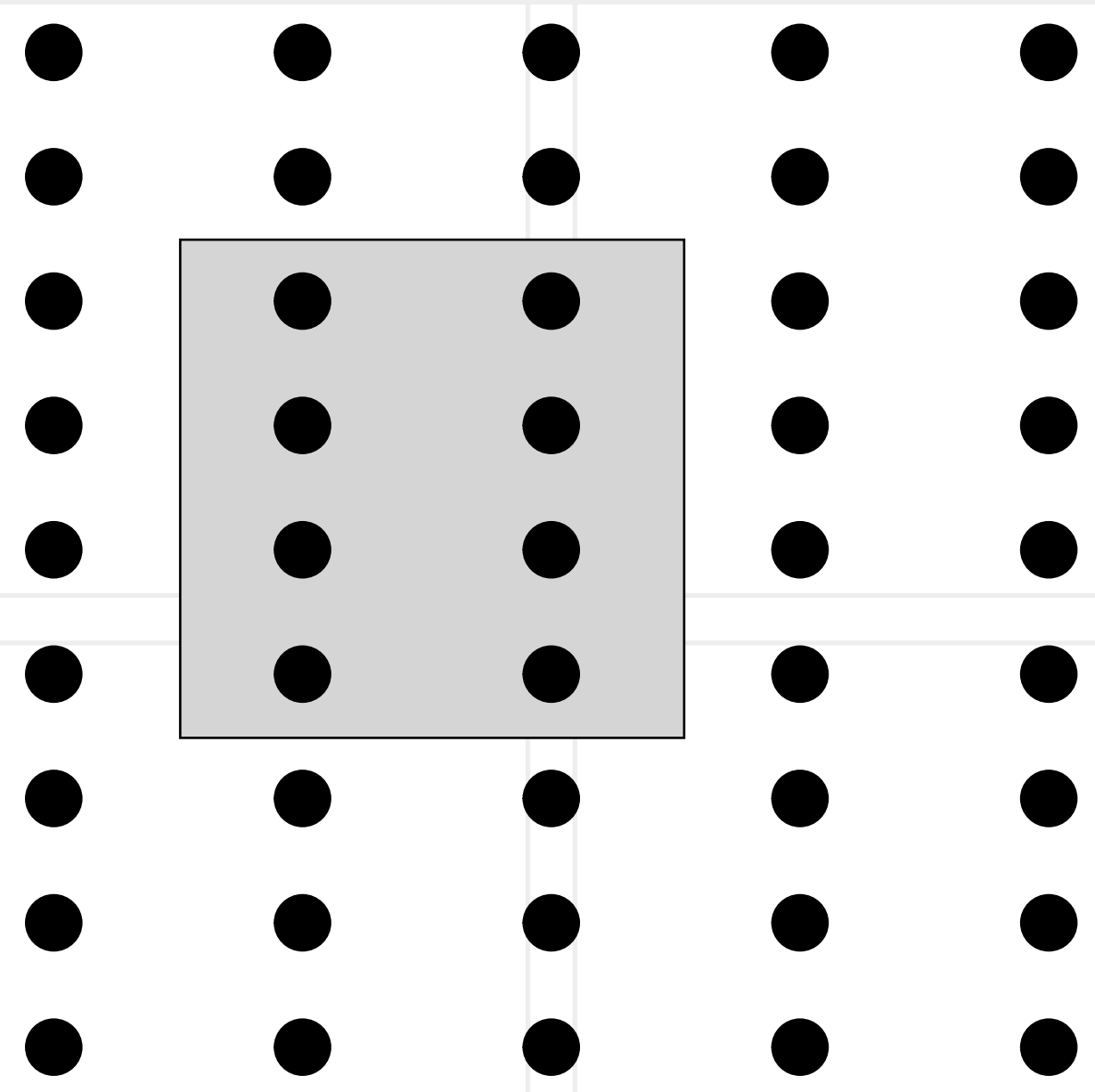
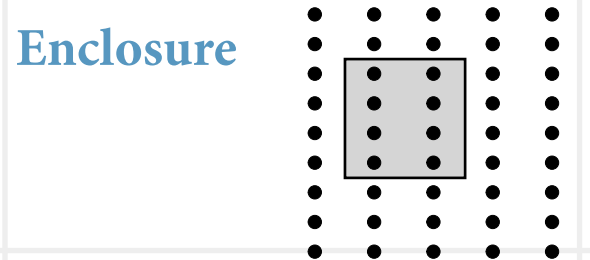
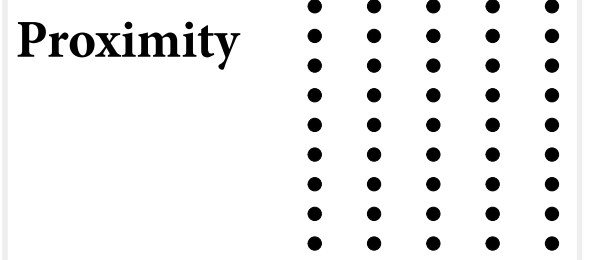


Similarity

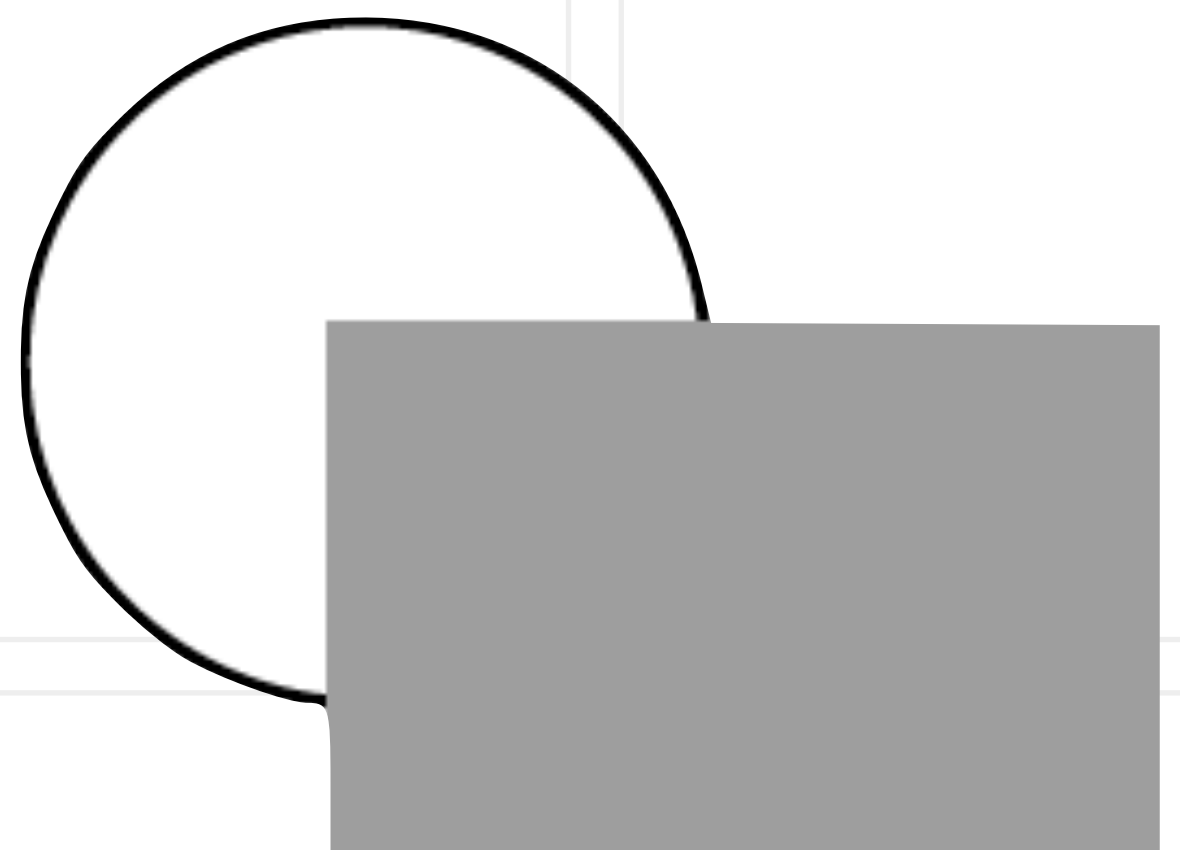
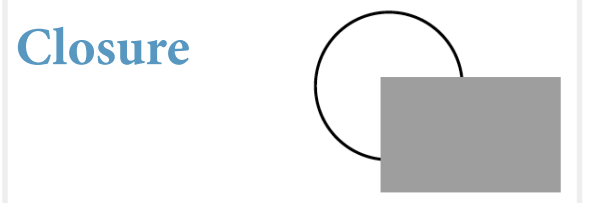
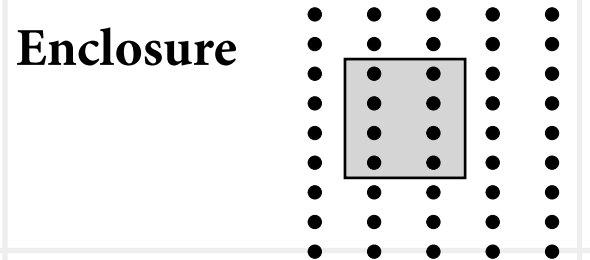
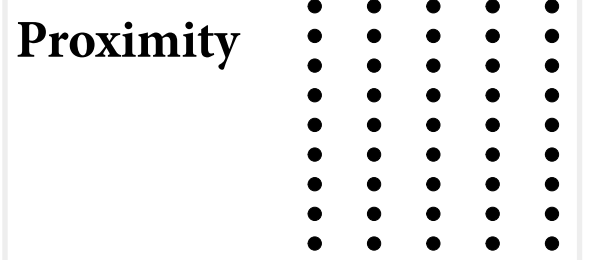




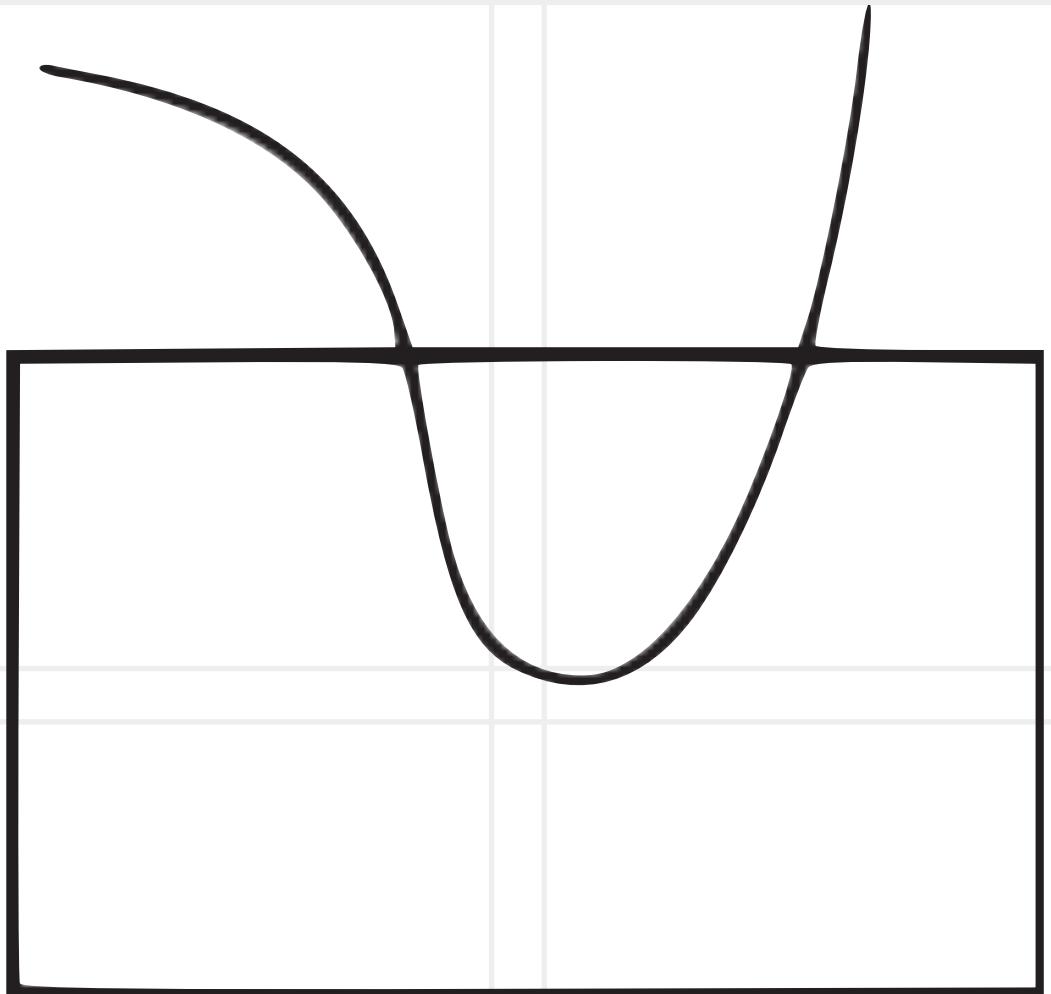
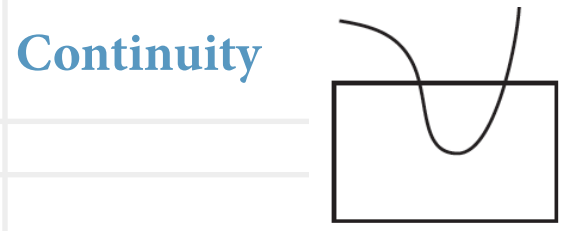
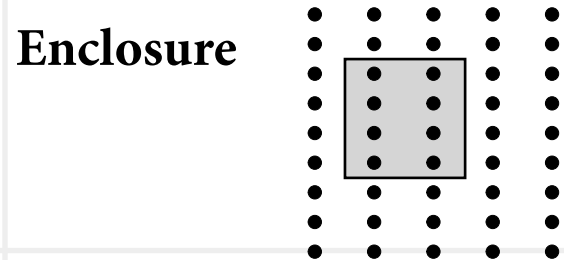
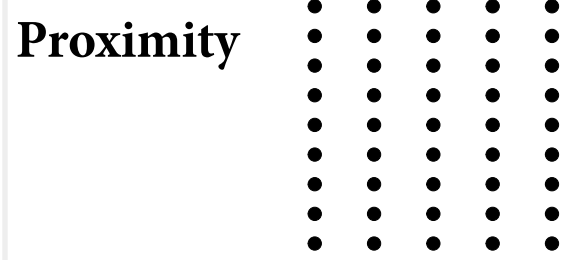
# design mini-review | aligning and organizing information reduces cognitive load — *enclosure*



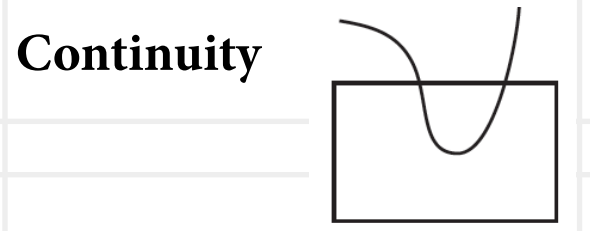
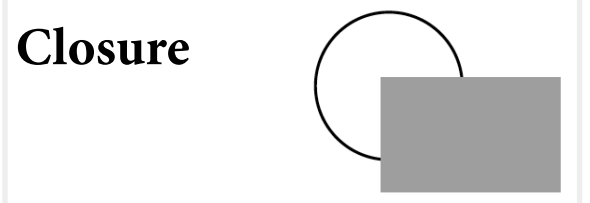
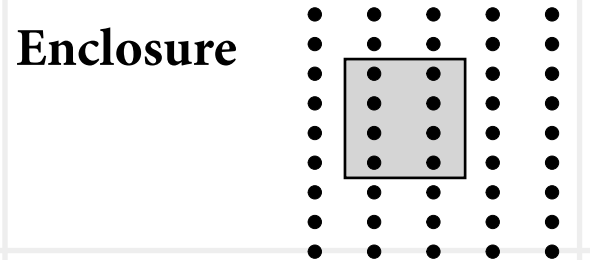
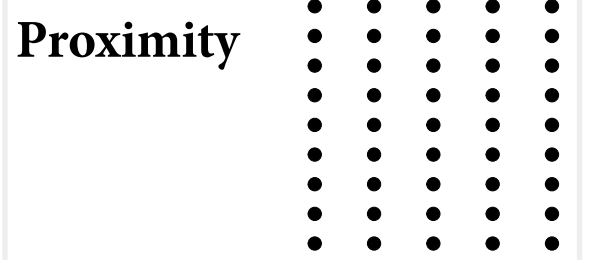
design mini-review | aligning and organizing information reduces cognitive load — *closure*



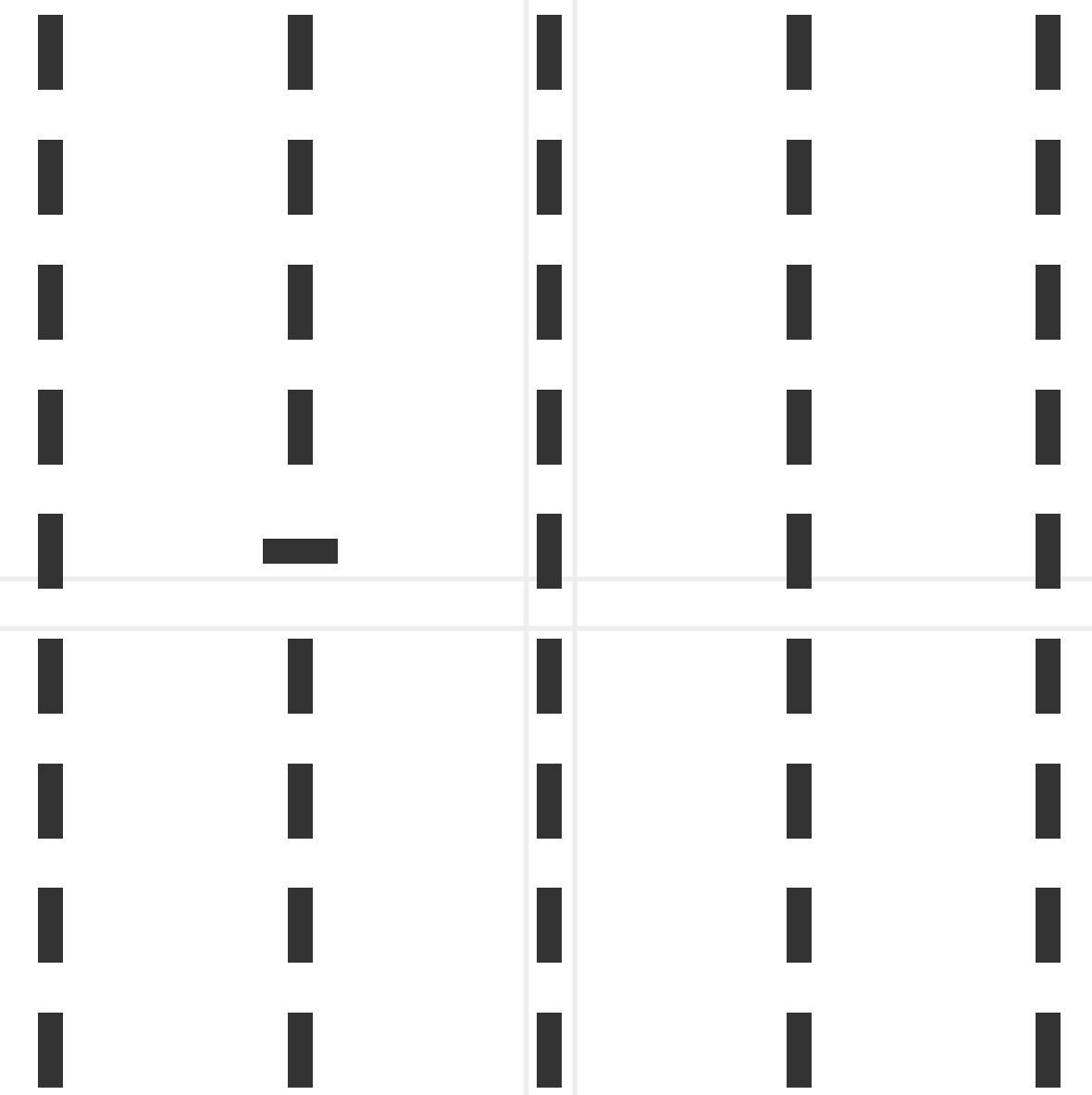
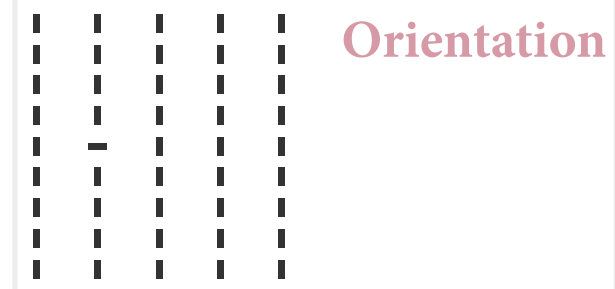
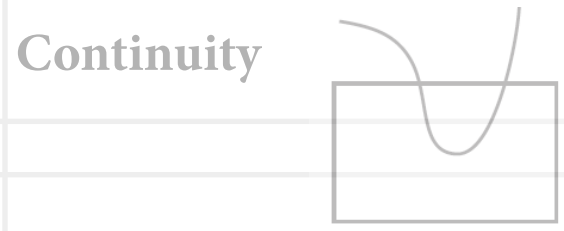
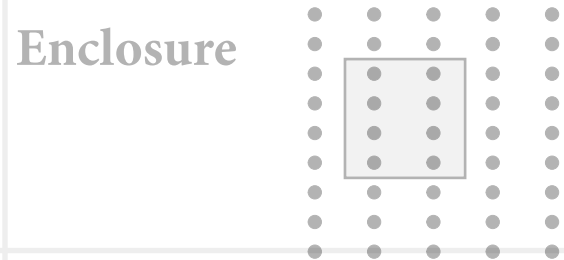
# design mini-review | aligning and organizing information reduces cognitive load — *continuity*



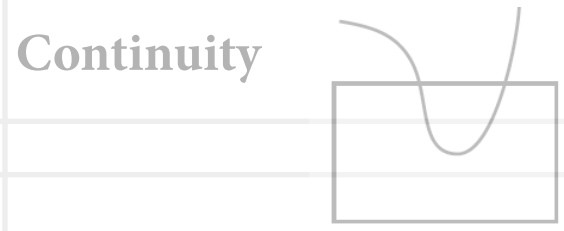
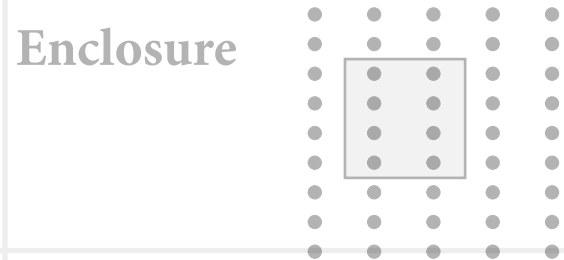
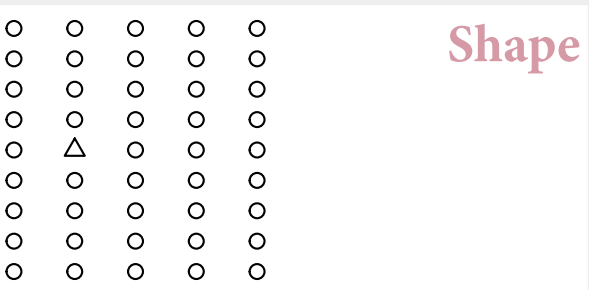
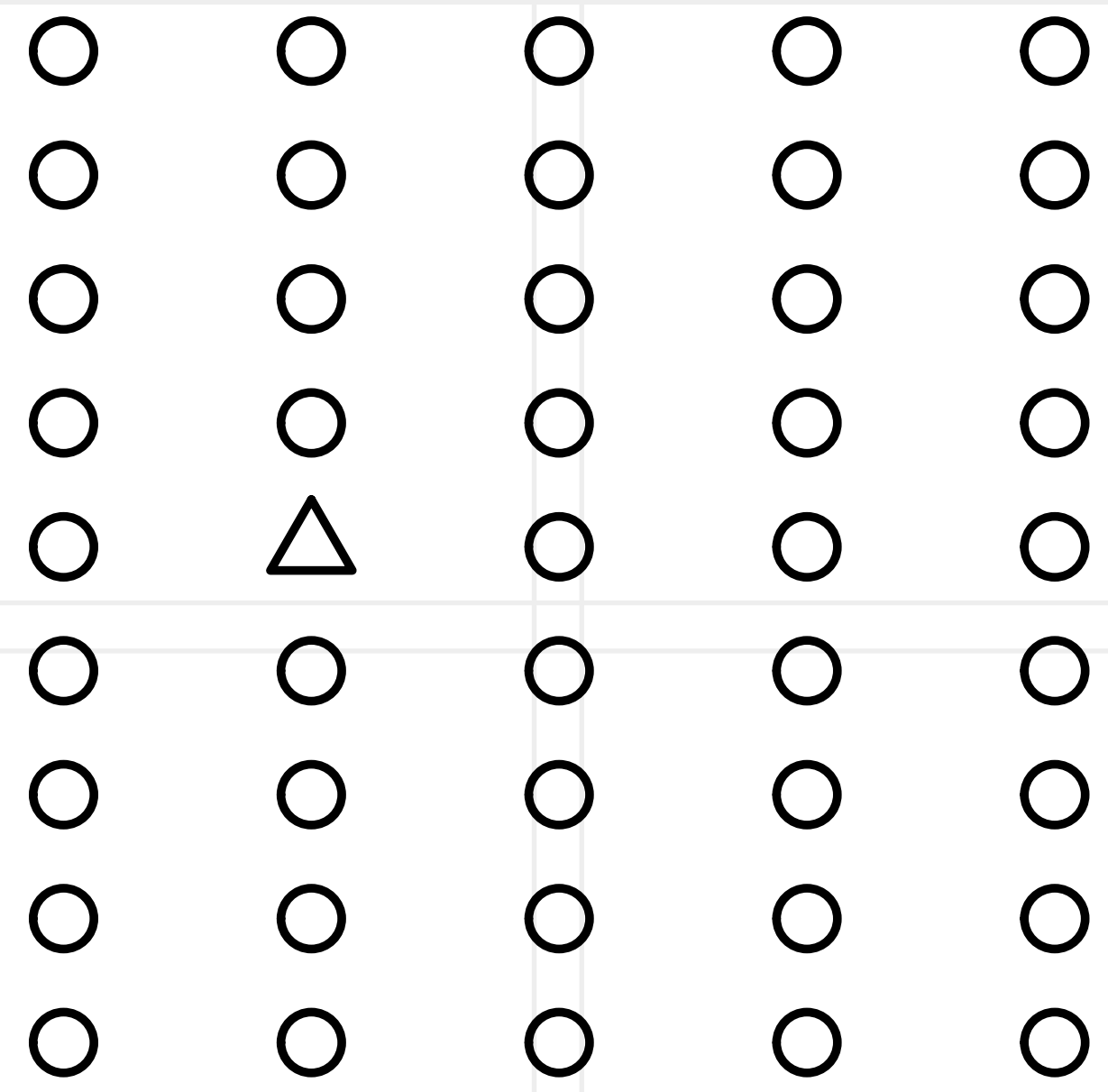
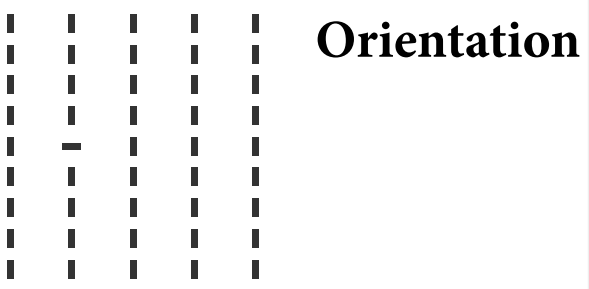
# design mini-review | aligning and organizing information reduces cognitive load — *connection*



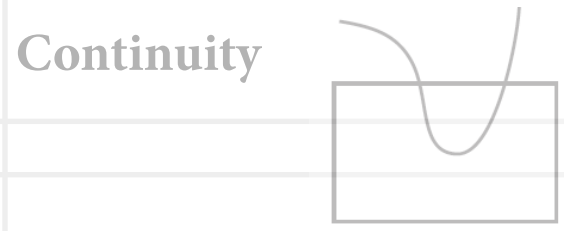
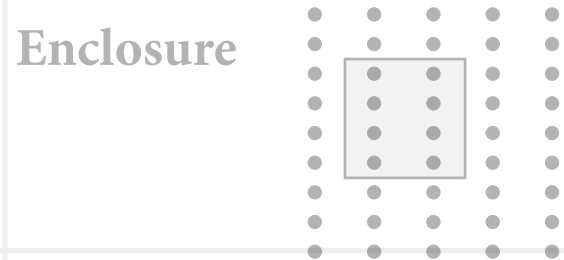
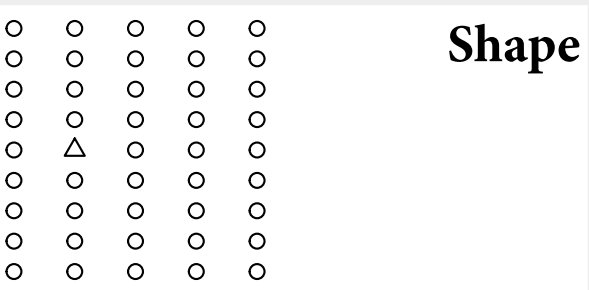
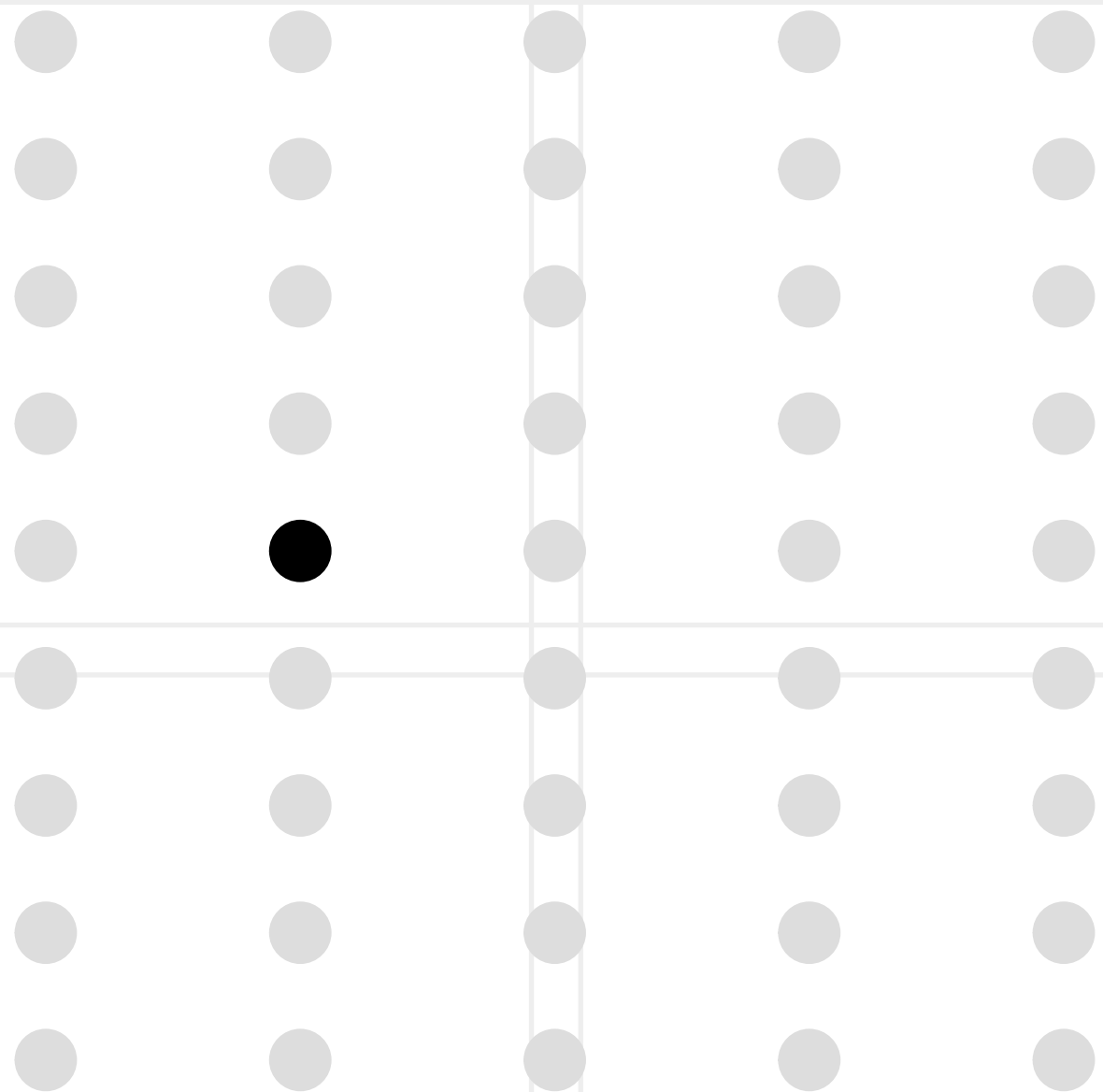
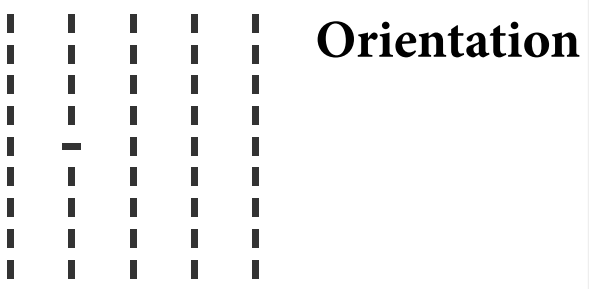
# design mini-review | purposeful change of a visual channel can focus attention — *orientation*



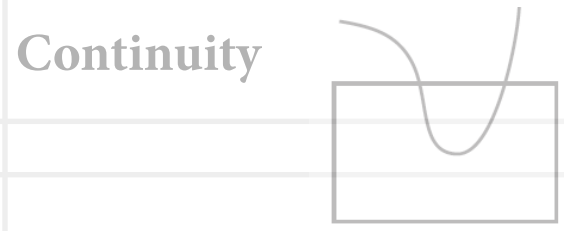
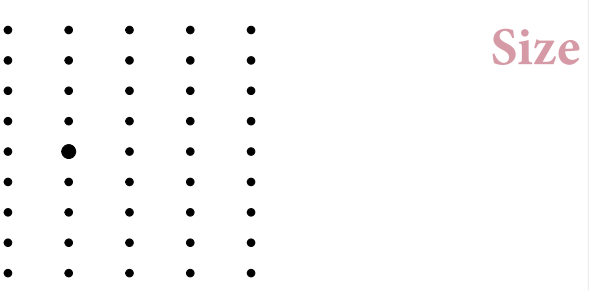
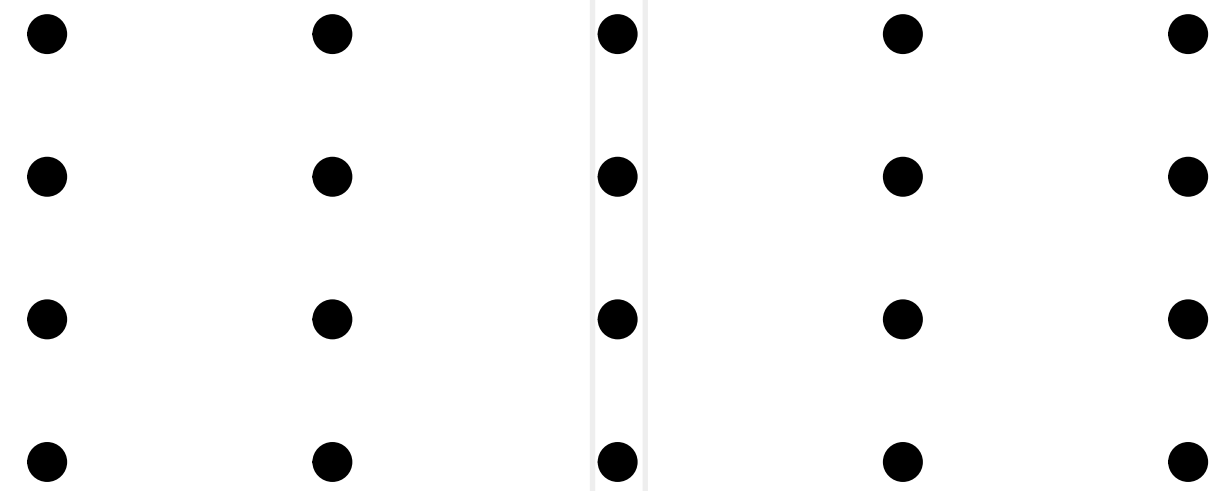
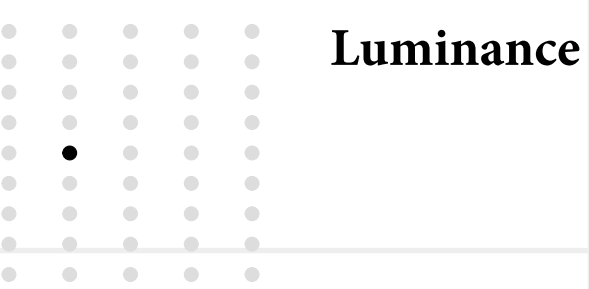
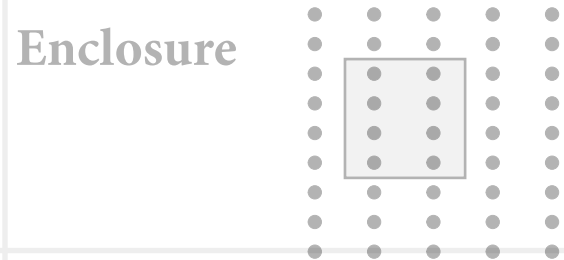
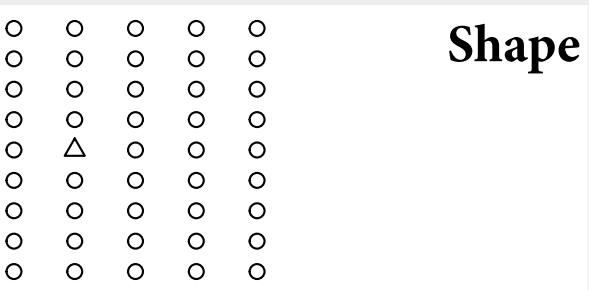
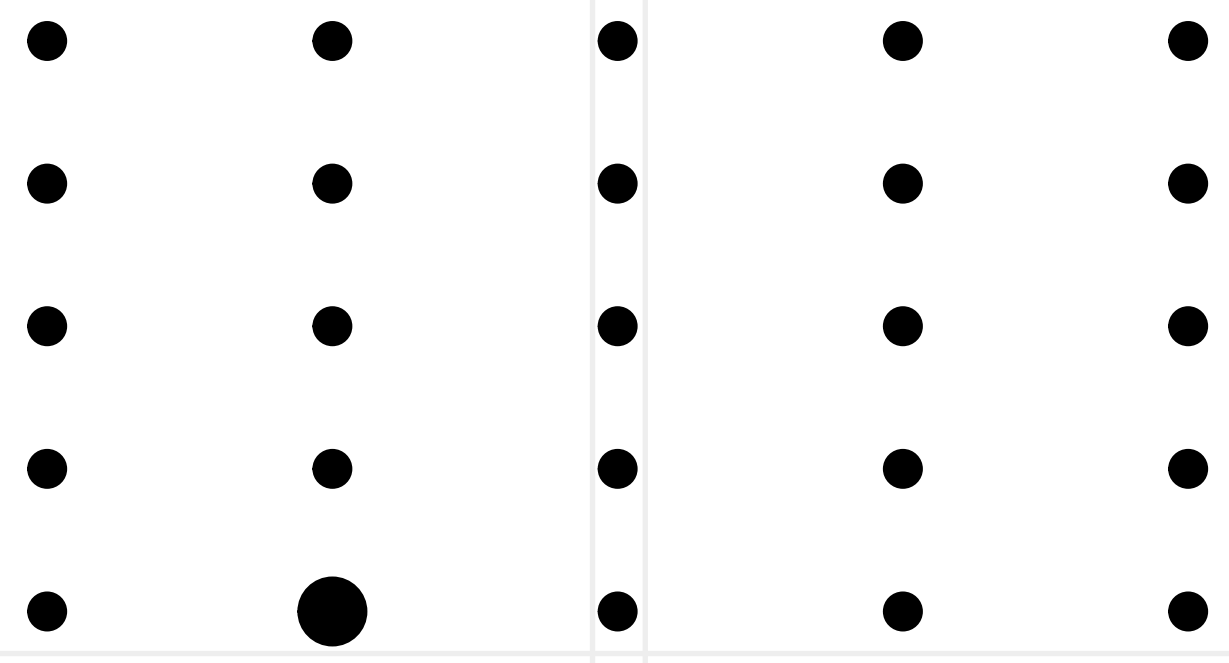
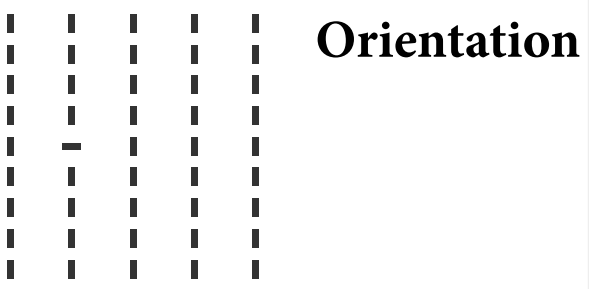
# design mini-review | purposeful change of a visual channel can focus attention — *shape*



# design mini-review | purposeful change of a visual channel can focus attention — *luminance*

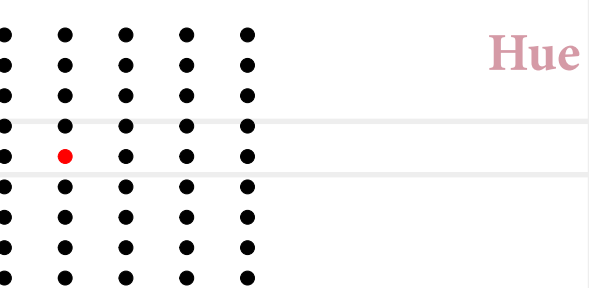
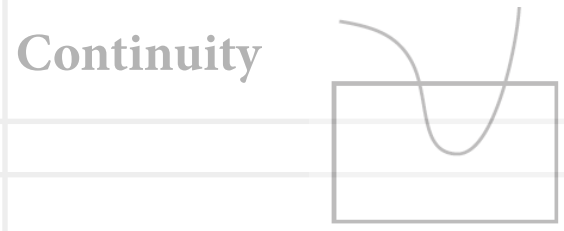
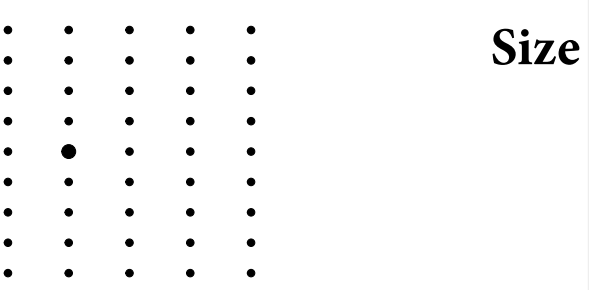
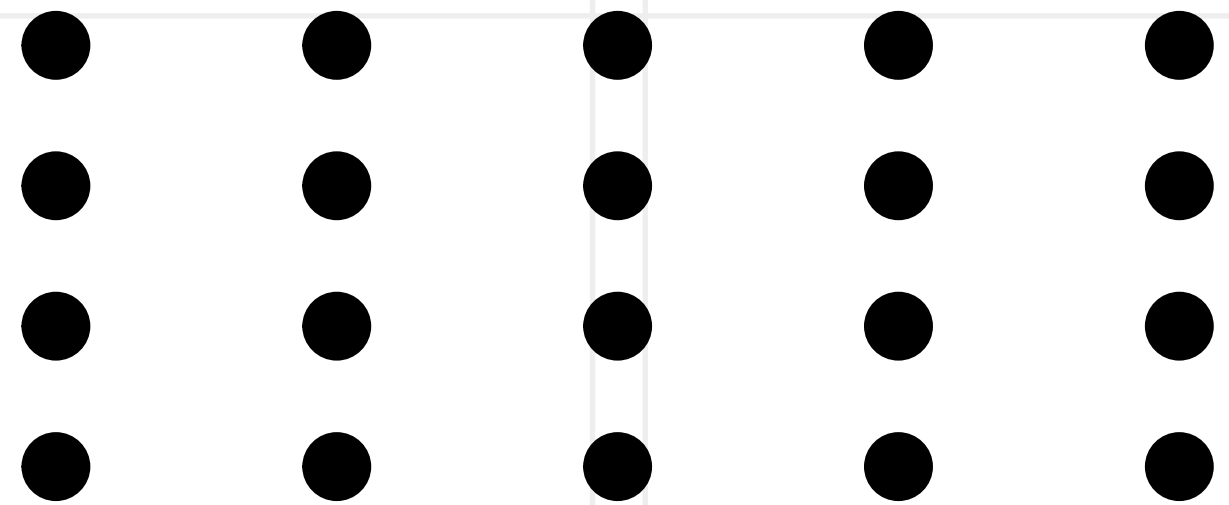
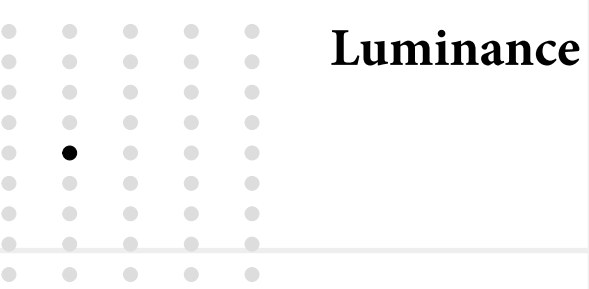
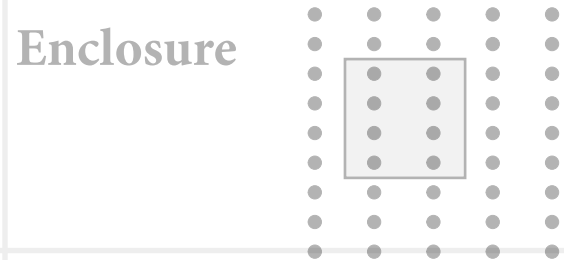
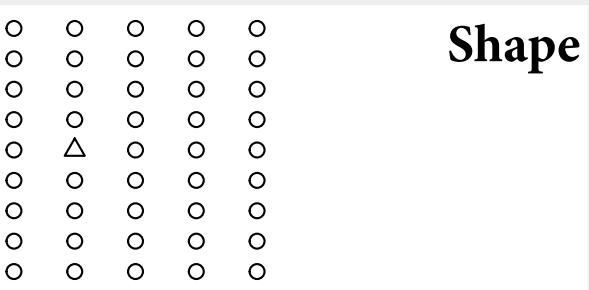
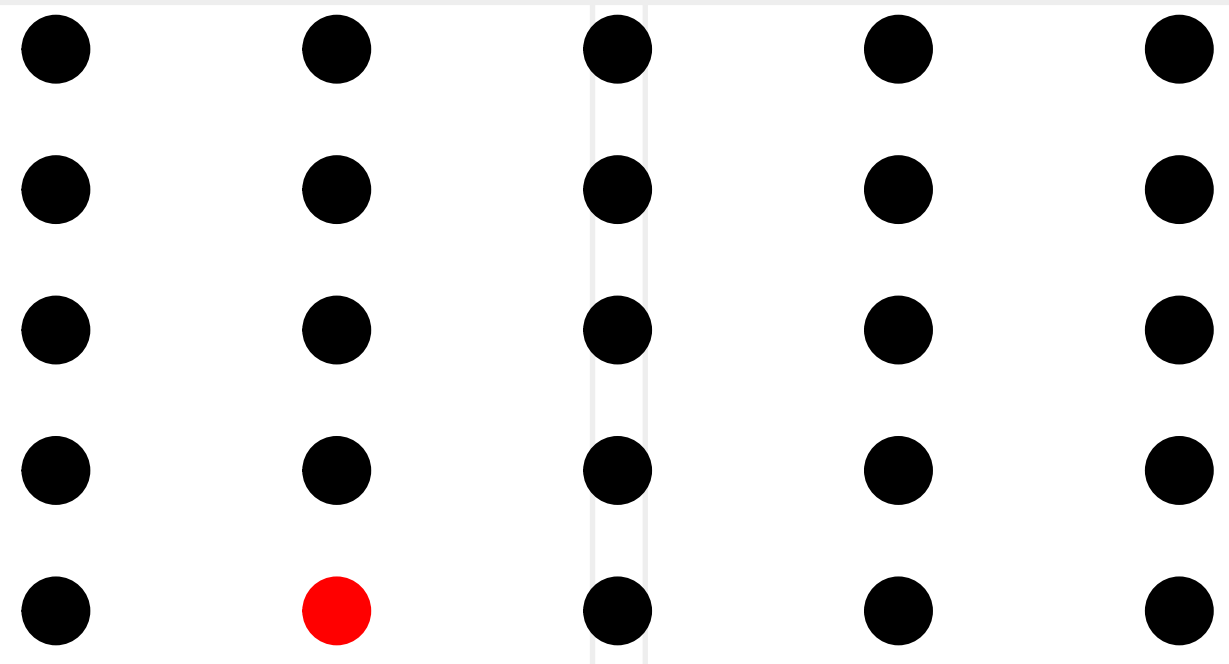
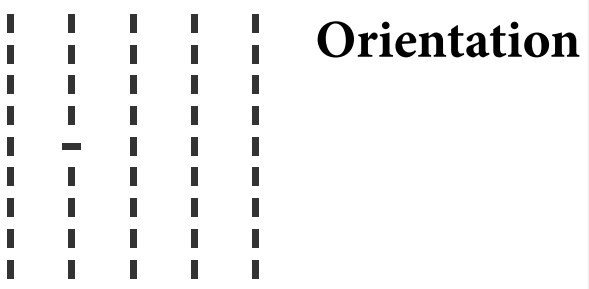


# design mini-review | purposeful change of a visual channel can focus attention — *size*

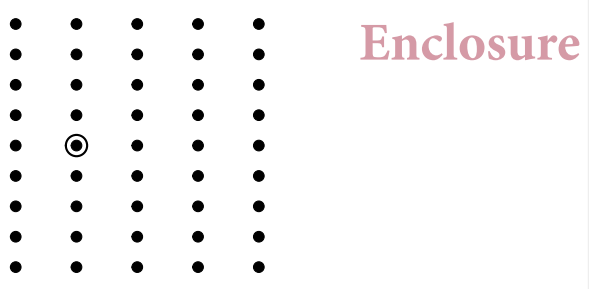
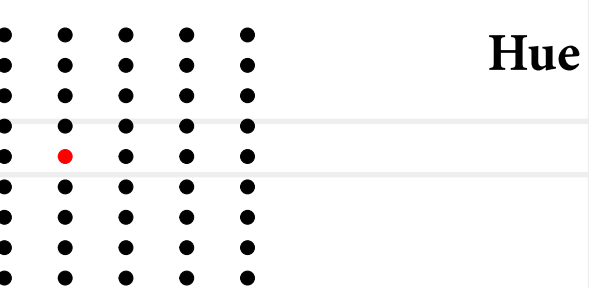
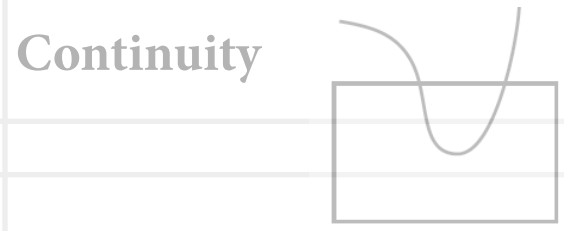
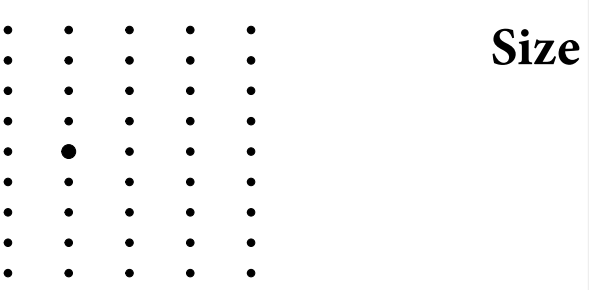
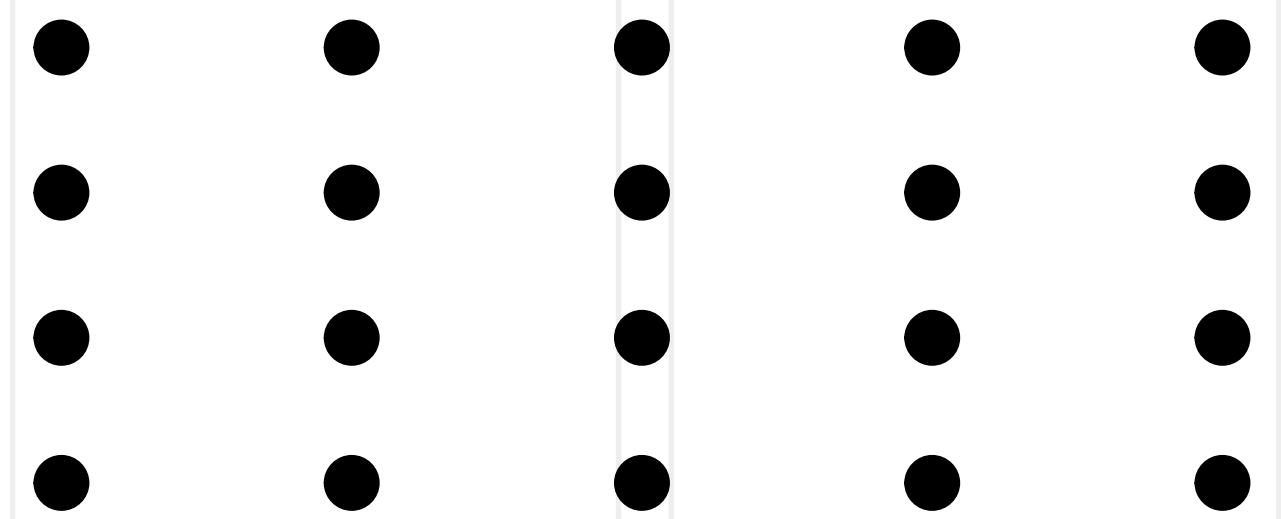
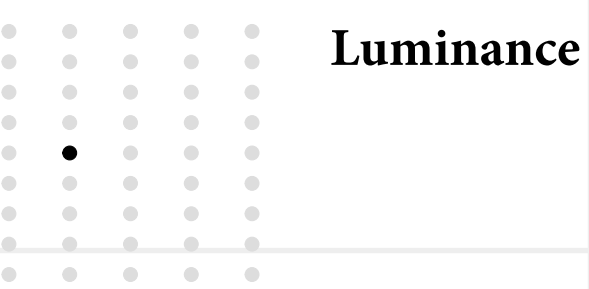
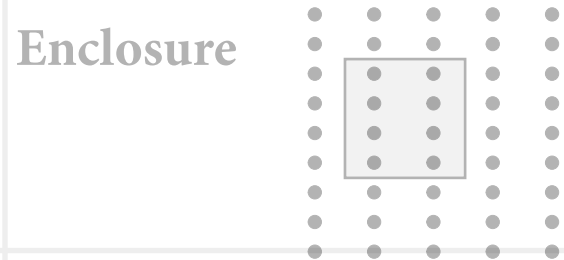
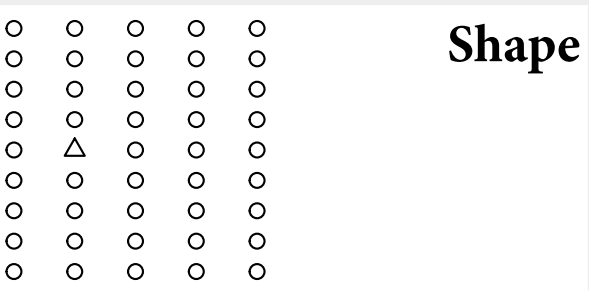
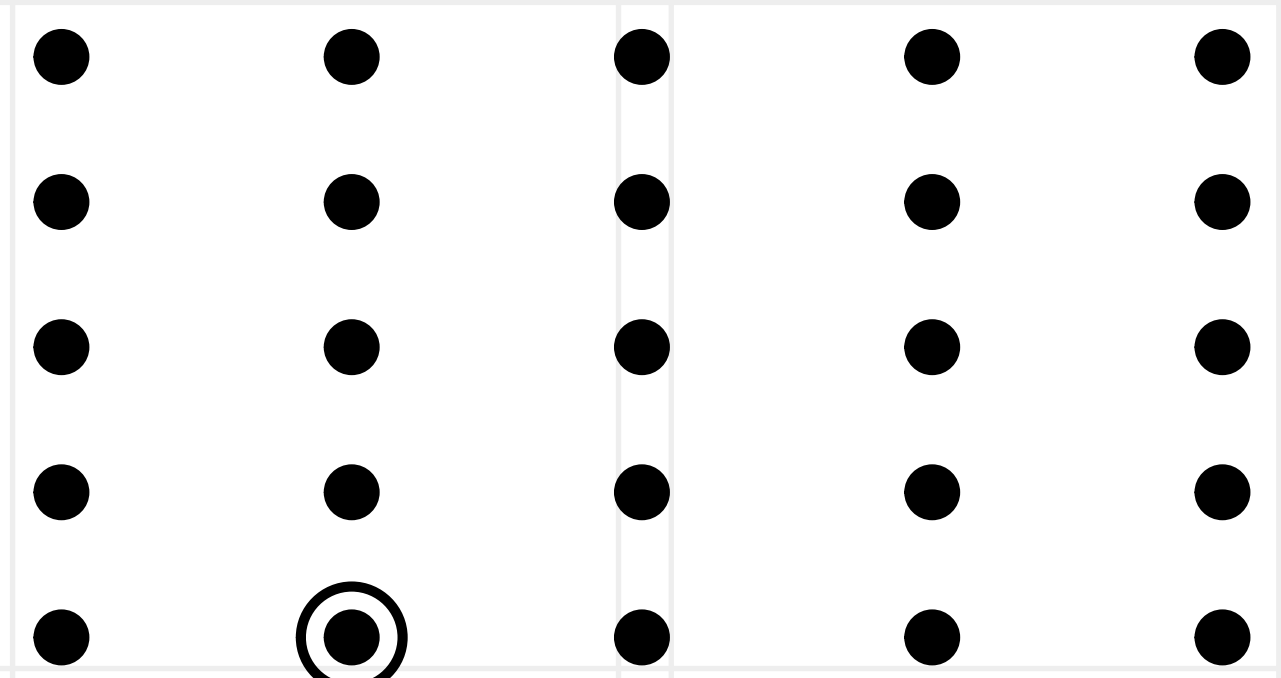
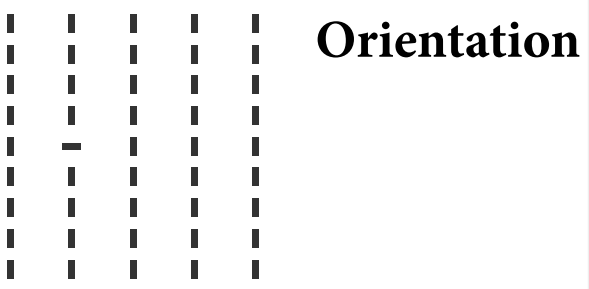




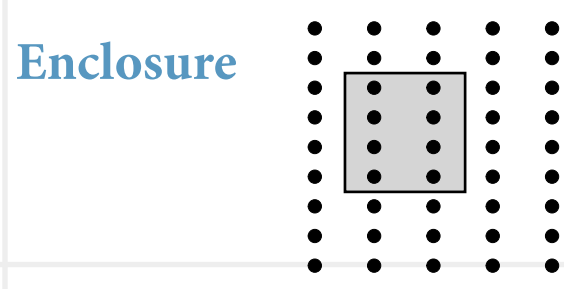
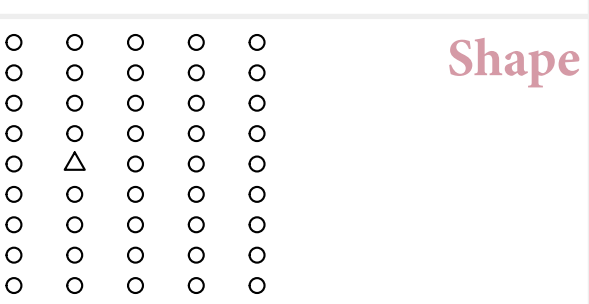
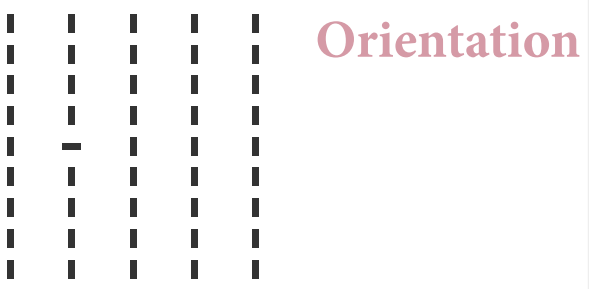
# design mini-review | purposeful change of a visual channel can focus attention — *hue*



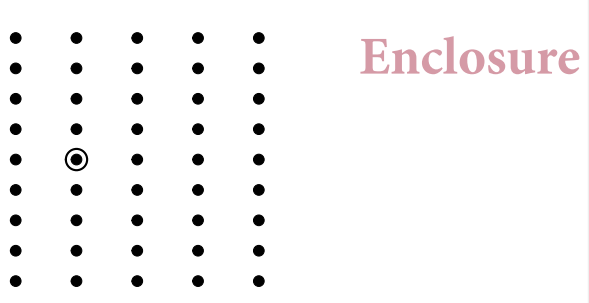
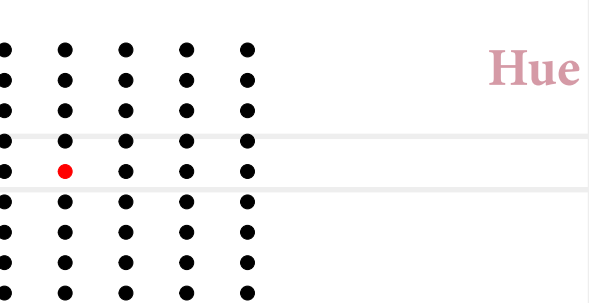
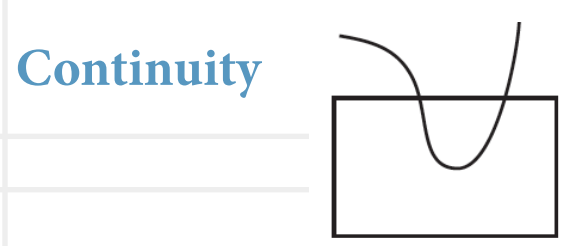
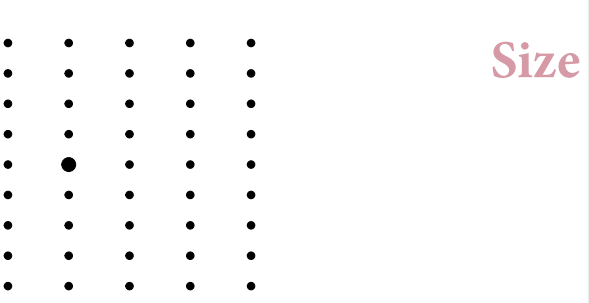
# design mini-review | purposeful change of a visual channel can focus attention — *enclosure*



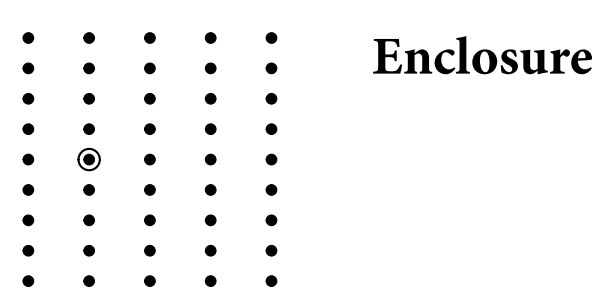
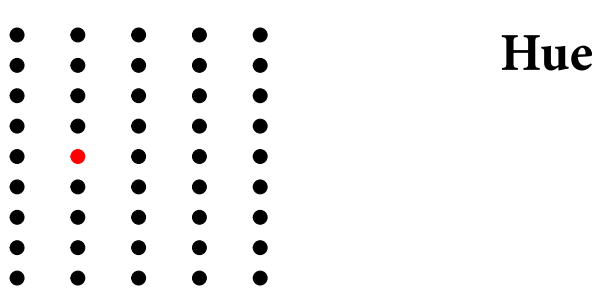
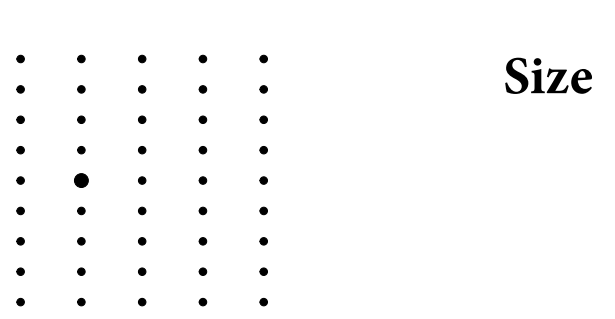
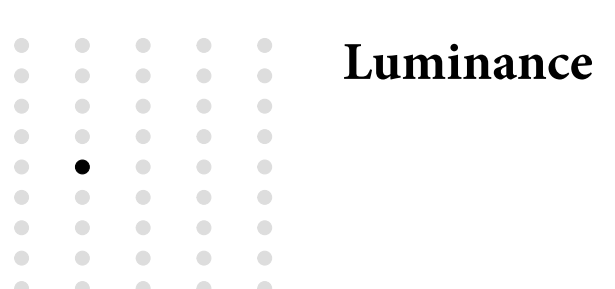
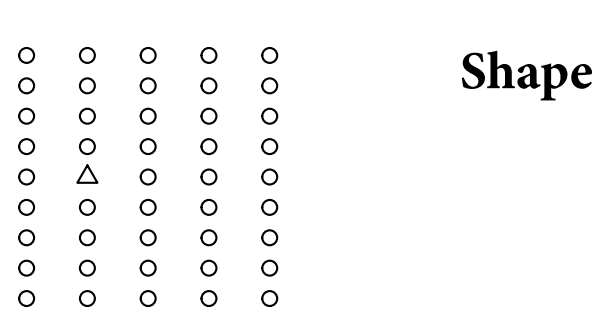
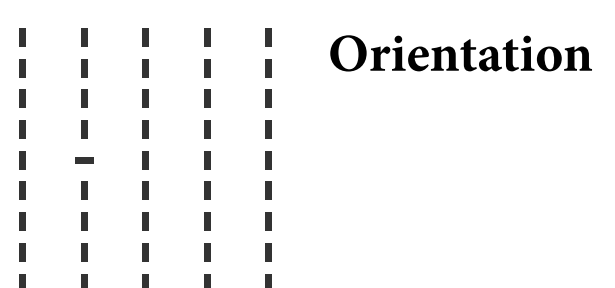
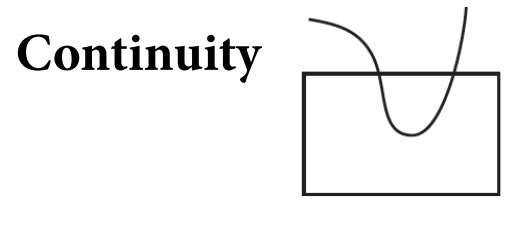
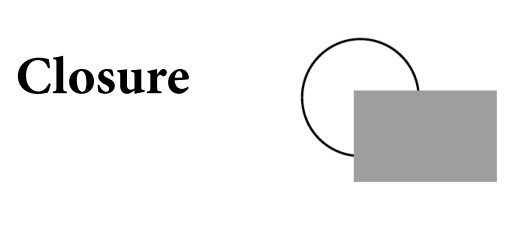
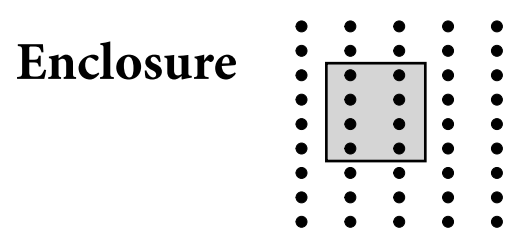
# design mini-review



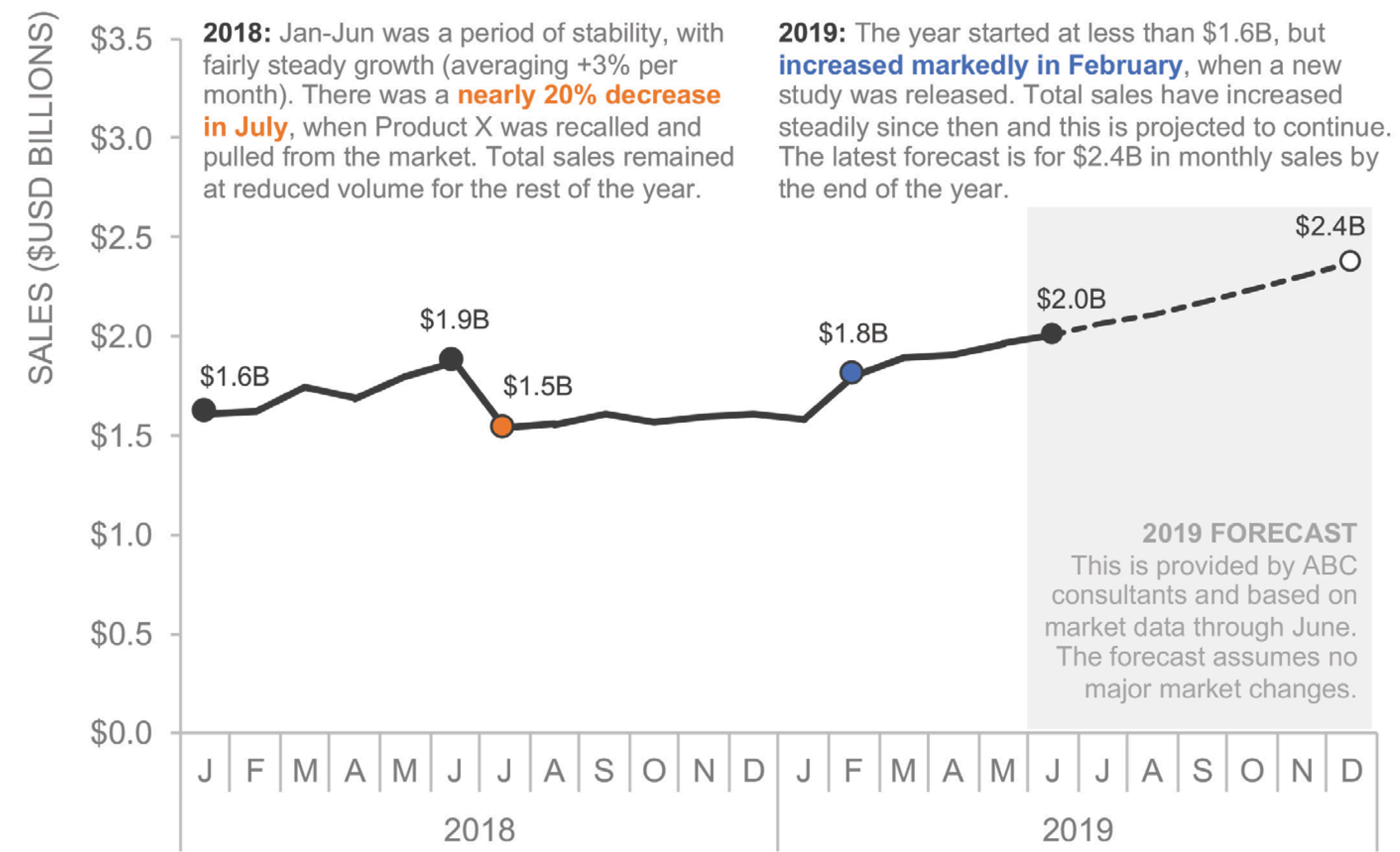
grids, Gestalt principles, and  
preattentive attributes may be combined



# design mini-review | what Gestalt principles are used in this data graphic? How is attention focused?

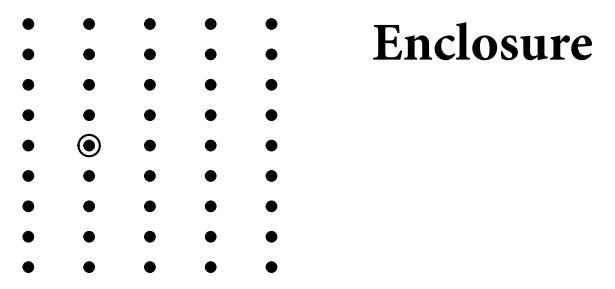
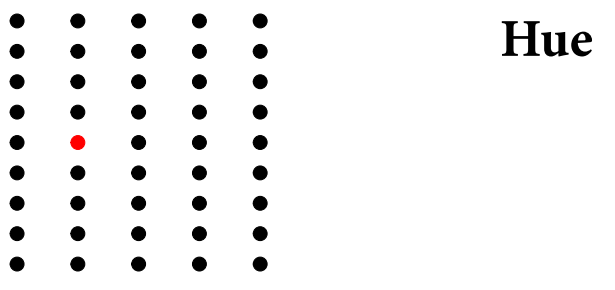
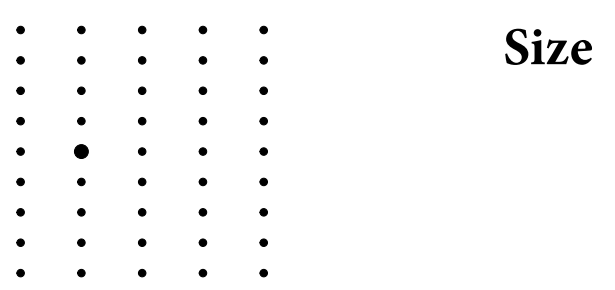
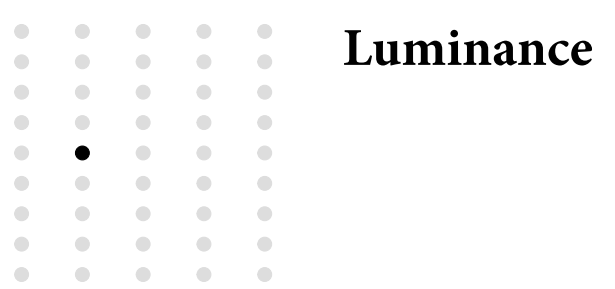
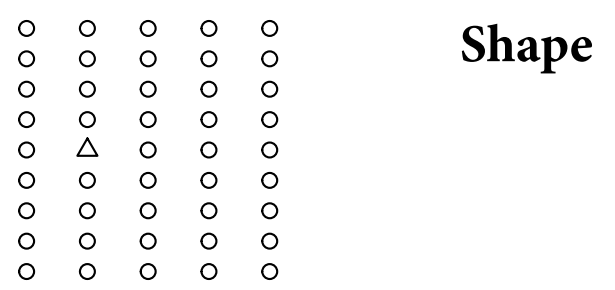
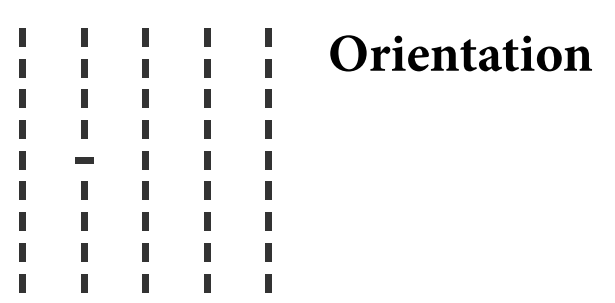
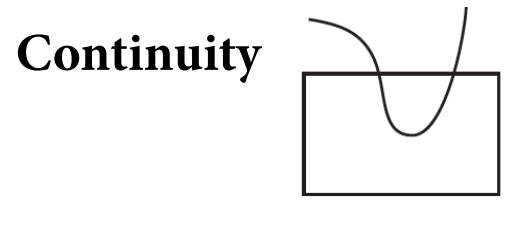
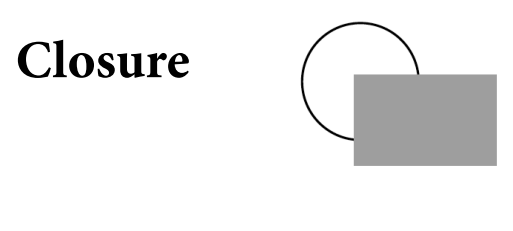
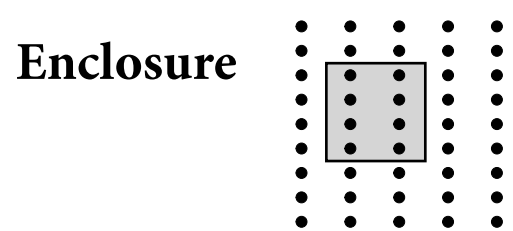
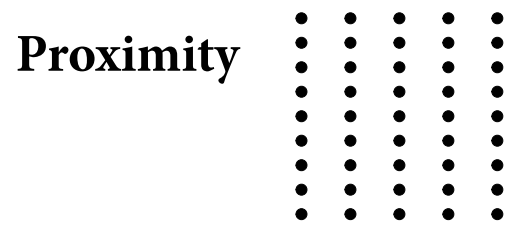


## Market size over time



Example from: Knaflic, Cole Nussbaumer. *Storytelling with Data: Let's Practice!* Hoboken, New Jersey: John Wiley & Sons, Inc, 2019.

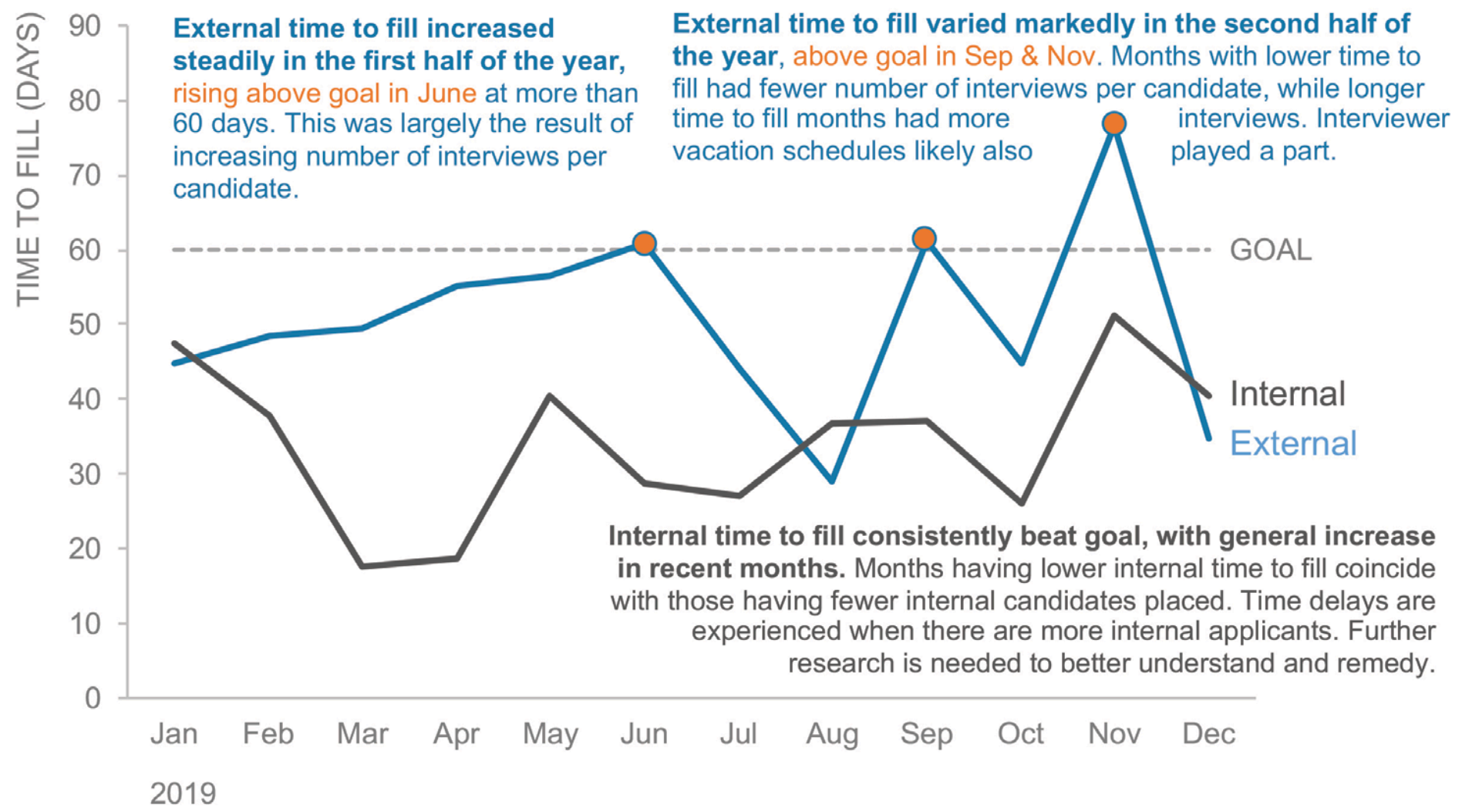
# design mini-review | what Gestalt principles are used in this data graphic? How is attention focused?



## Time to fill role discussion needed: where do we go from here?

Both **External** and **Internal** time to fill have varied in the past year. Understanding contributing factors—number of interviews, vacation schedules, and current internal transfer volume constraints—can help us better plan for the future.

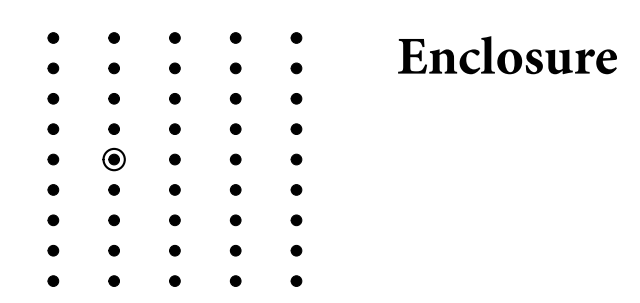
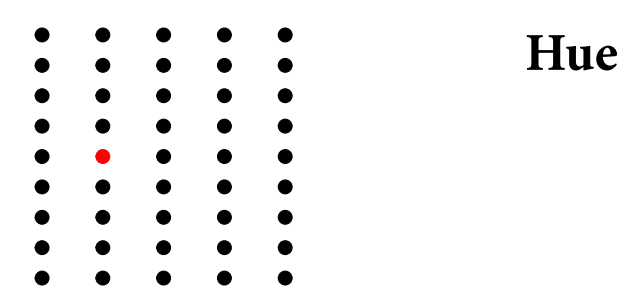
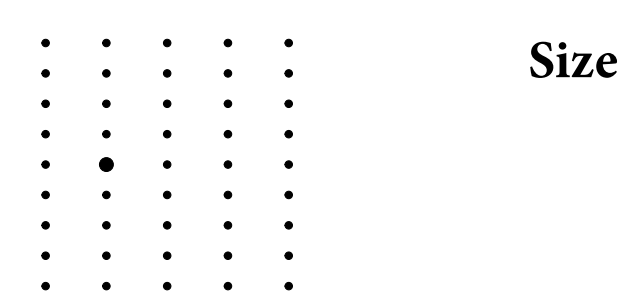
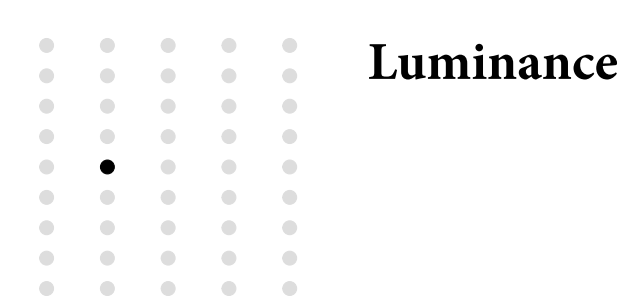
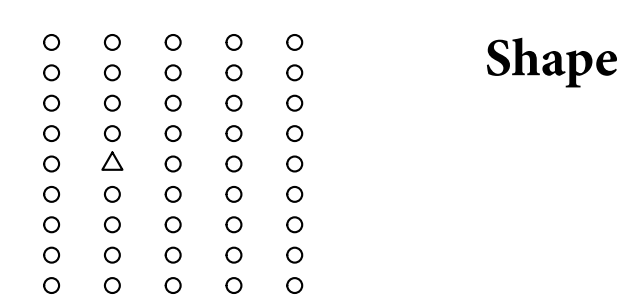
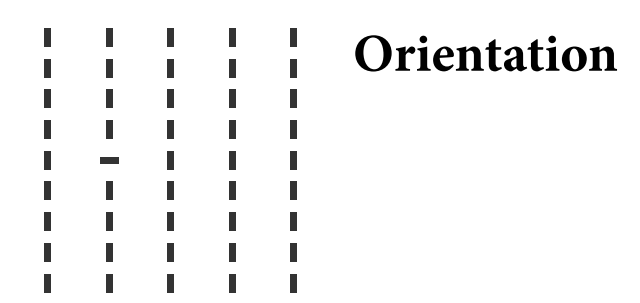
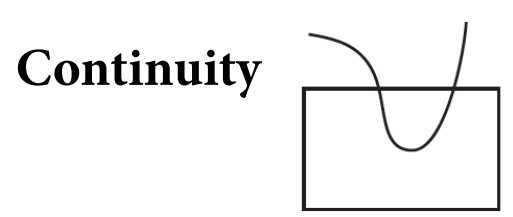
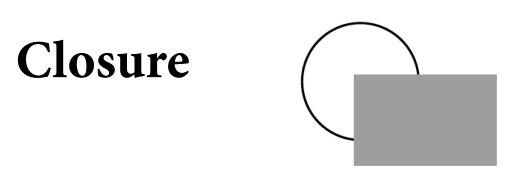
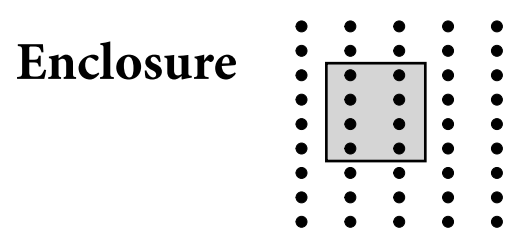
### Time to fill



**LET'S DISCUSS:** Should we put stricter guidelines around maximum number of interviews? How can we keep vacation schedules from impacting time to hire? What can we do to improve efficiency of internal transfer process in order to better handle higher volumes?

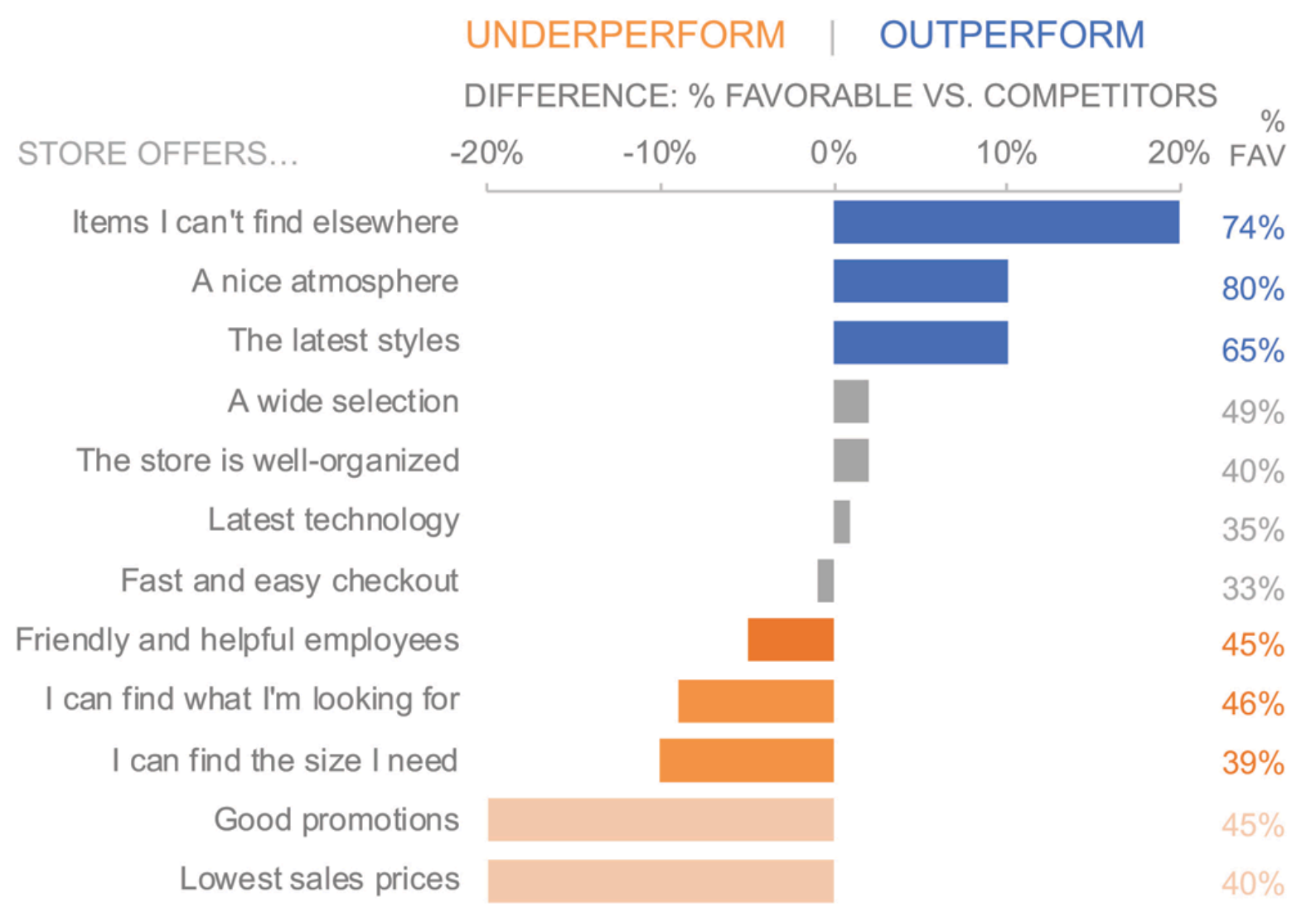
Example from: Knaflic, Cole Nussbaumer. *Storytelling with Data: Let's Practice!* Hoboken, New Jersey: John Wiley & Sons, Inc, 2019.

# design mini-review | what Gestalt principles are used in this data graphic? How is attention focused?



## Action needed: invest in employee training

### Back-to-school shopping: consumer sentiment



**THE GOOD NEWS:**  
We're beating the competition when it comes to **the latest styles that people can't find elsewhere and store atmosphere.**

**WE CAN IMPROVE:**  
We score low and lower than the competition in areas related to **helpful employees and customers being able to find what they are looking for.** We also score lower than the competition on promotions/sales, but don't recommend focusing here.

**RECOMMENDATION:**  
**Invest in employee training to improve customer experience.**

Data Source: 2019 Back-to-School shopping survey (represents 21,862 survey responses). Additional survey and methodology details available upon request. Reach out to Insights Team.

Example from: Knaflic, Cole Nussbaumer. *Storytelling with Data: Let's Practice!* Hoboken, New Jersey: John Wiley & Sons, Inc, 2019.

**comparing visually-encoded data**

## comparison | necessary for meaning

The idea of comparison is crucial. To make a point that is at all meaningful, statistical presentations must refer to differences between observation and expectation, or differences among observations.

— Abelson, Robert, *Statistician, Professor*

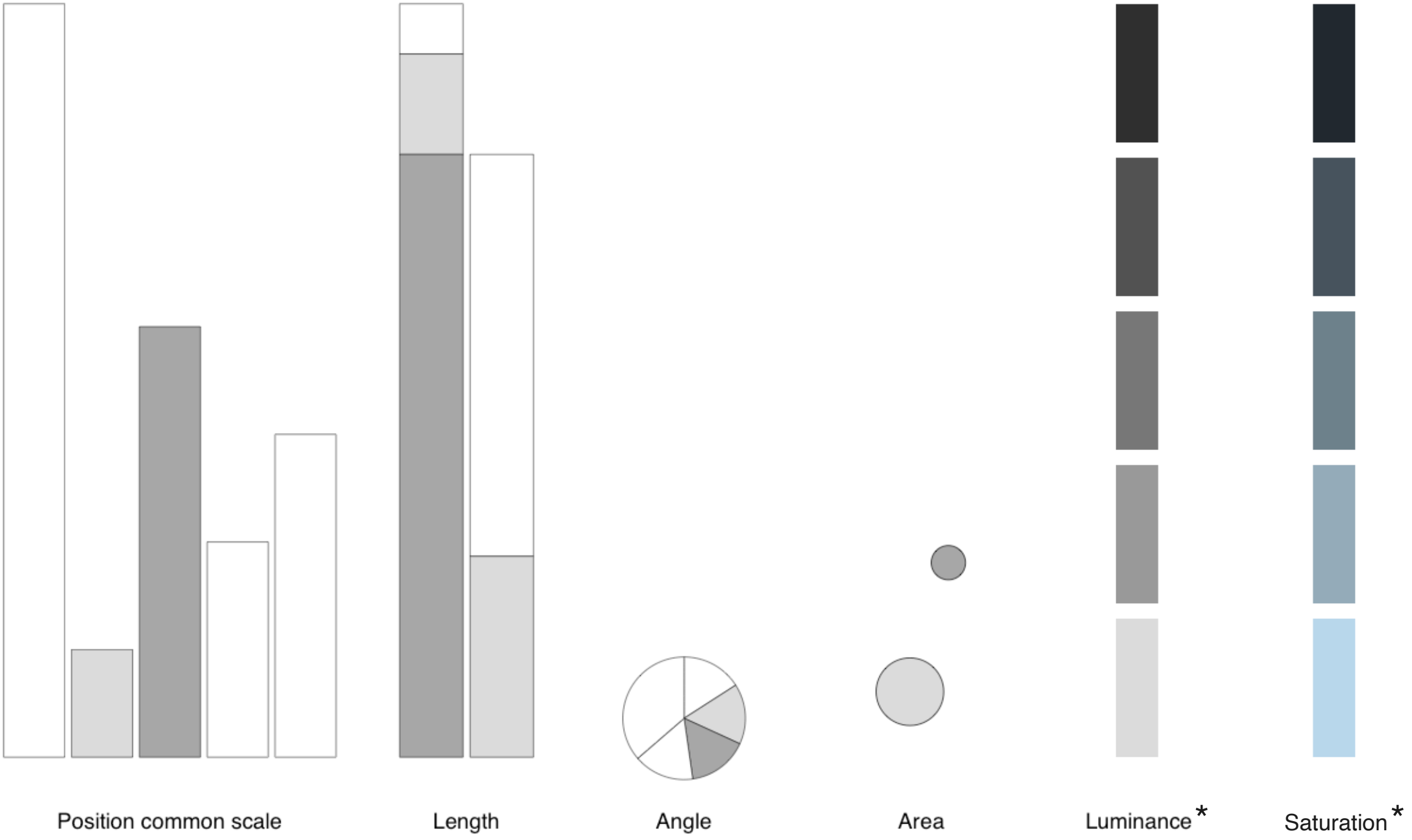
The fundamental analytical act in statistical reasoning is to answer the question ‘Compared with what?’

— Tufte, Edward, *Statistician, Professor, Data Visualization Expert*



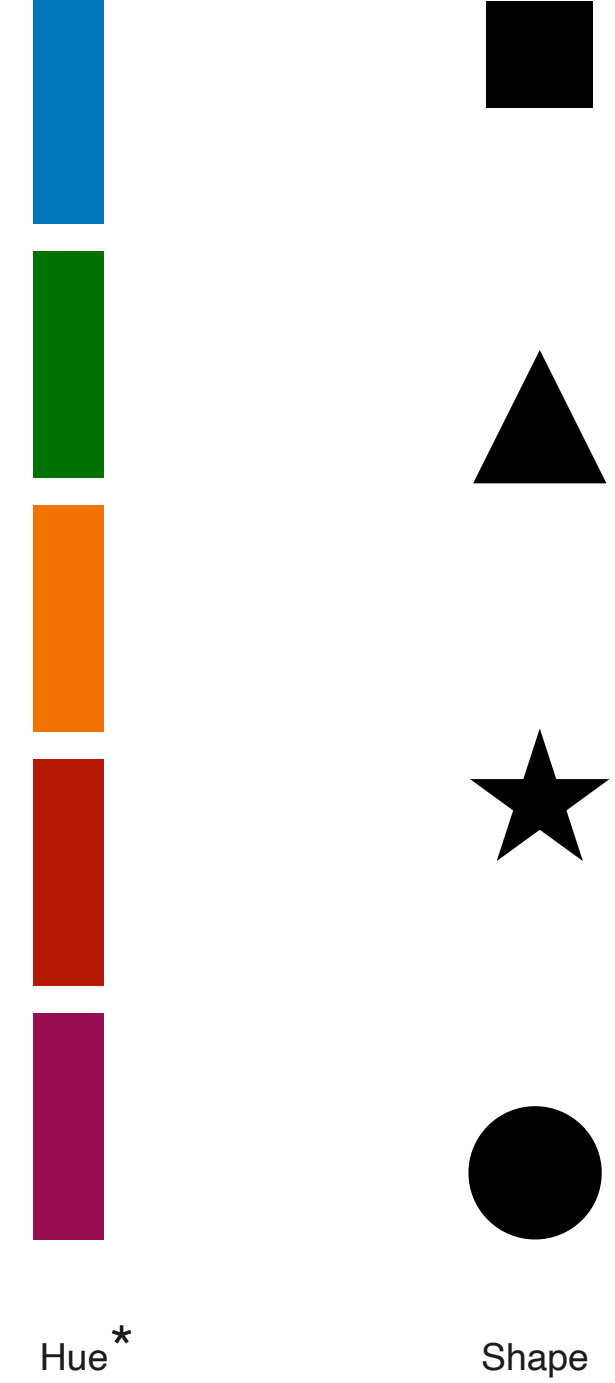
# general channel effectiveness, comparing encoded data

## ratio, interval, and ordered



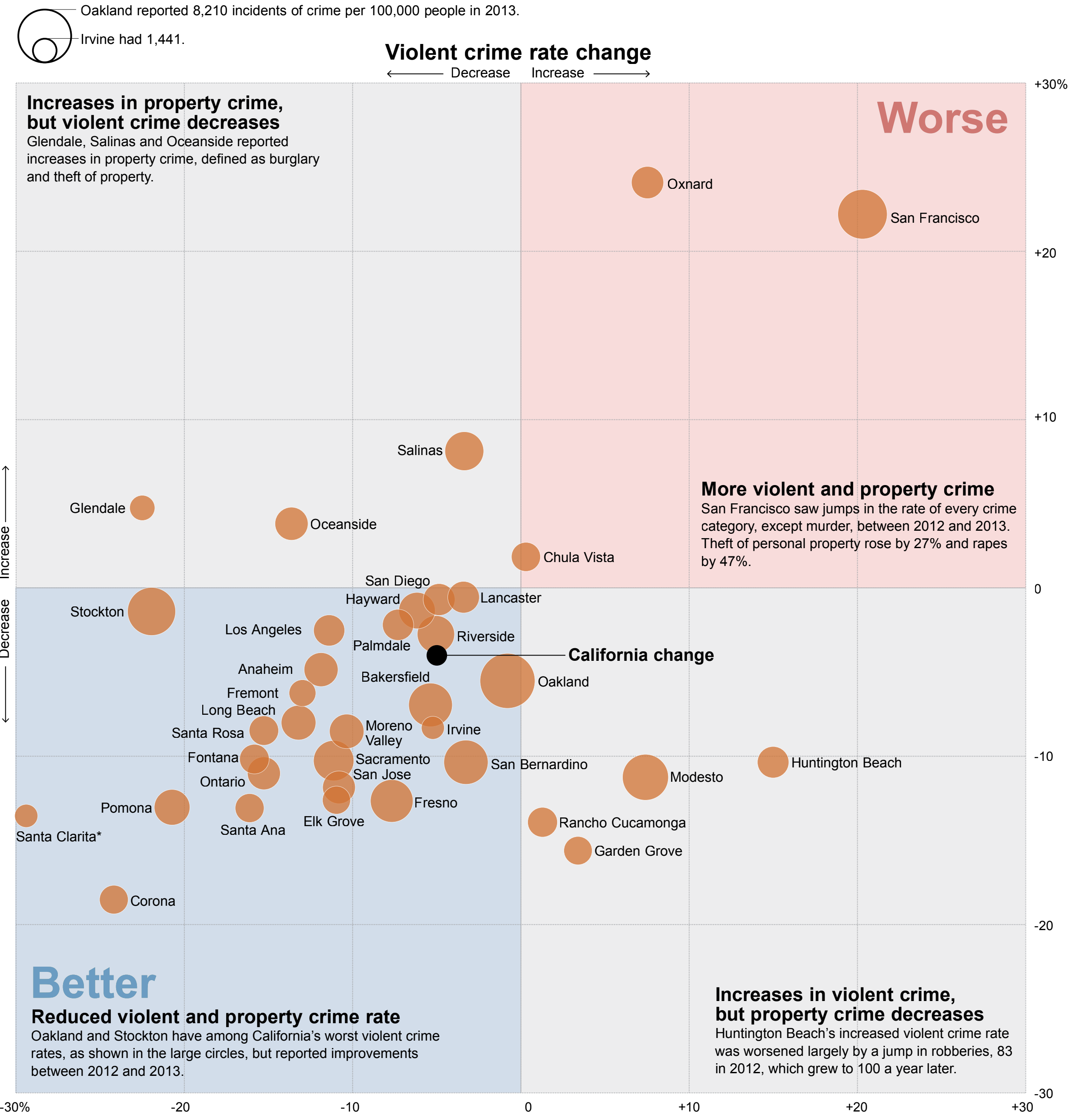
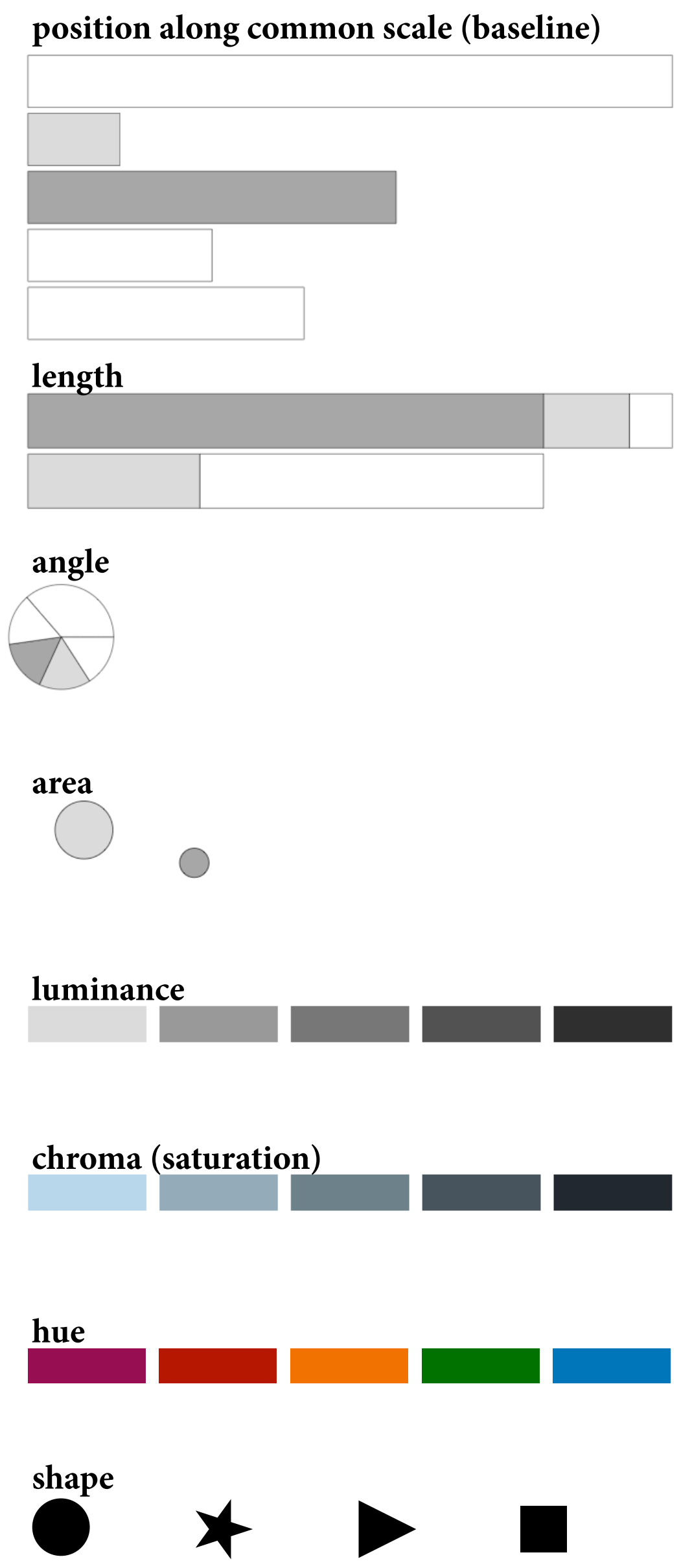
more effective ←————→ less effective

## categorical

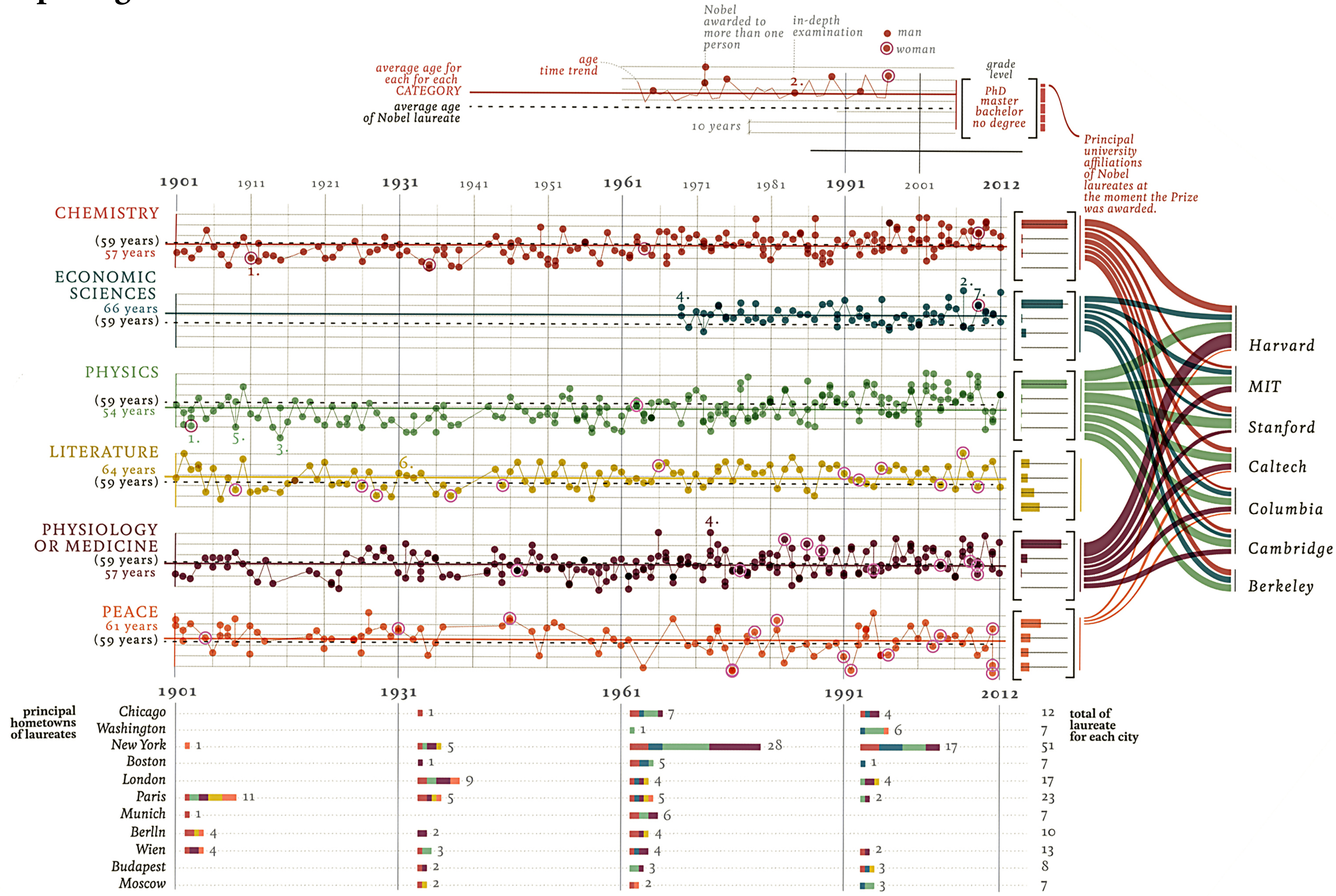
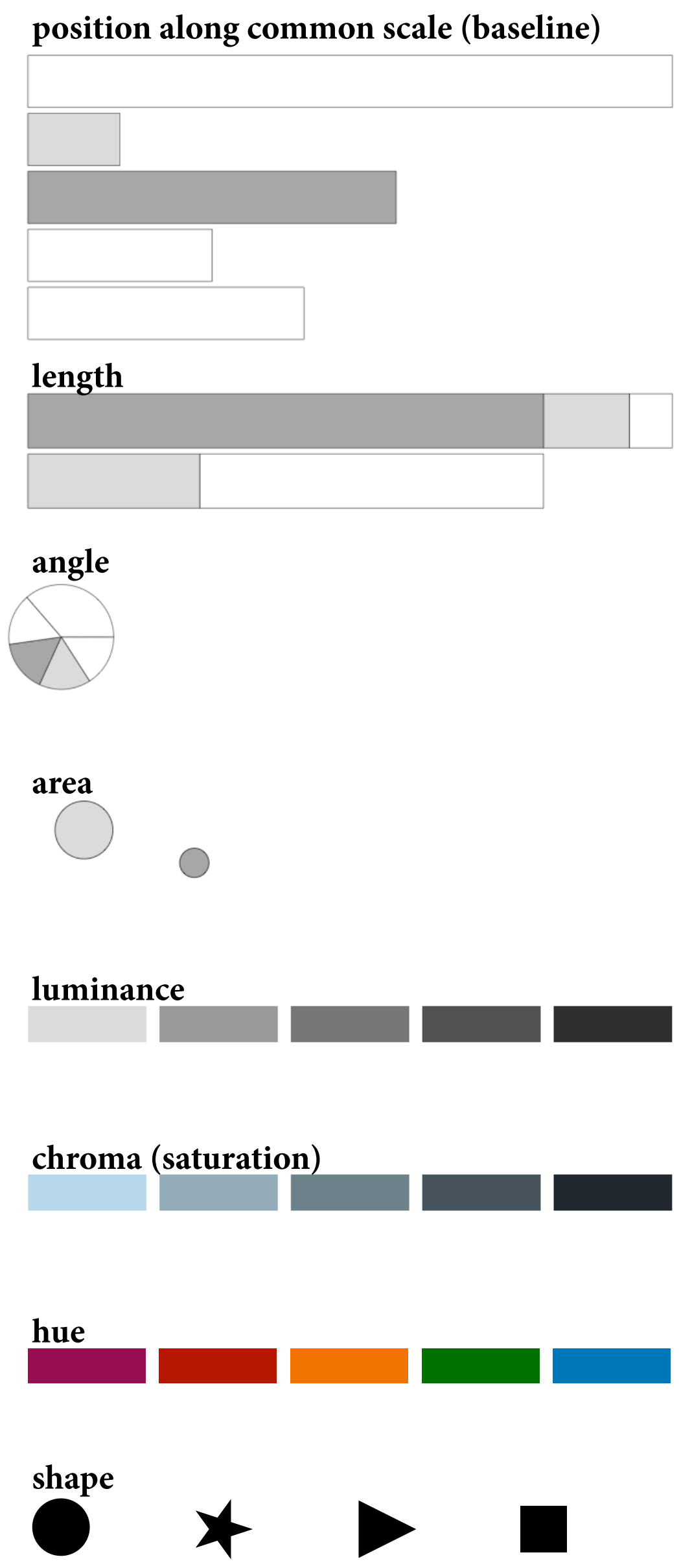


more effective ←————→ less effective

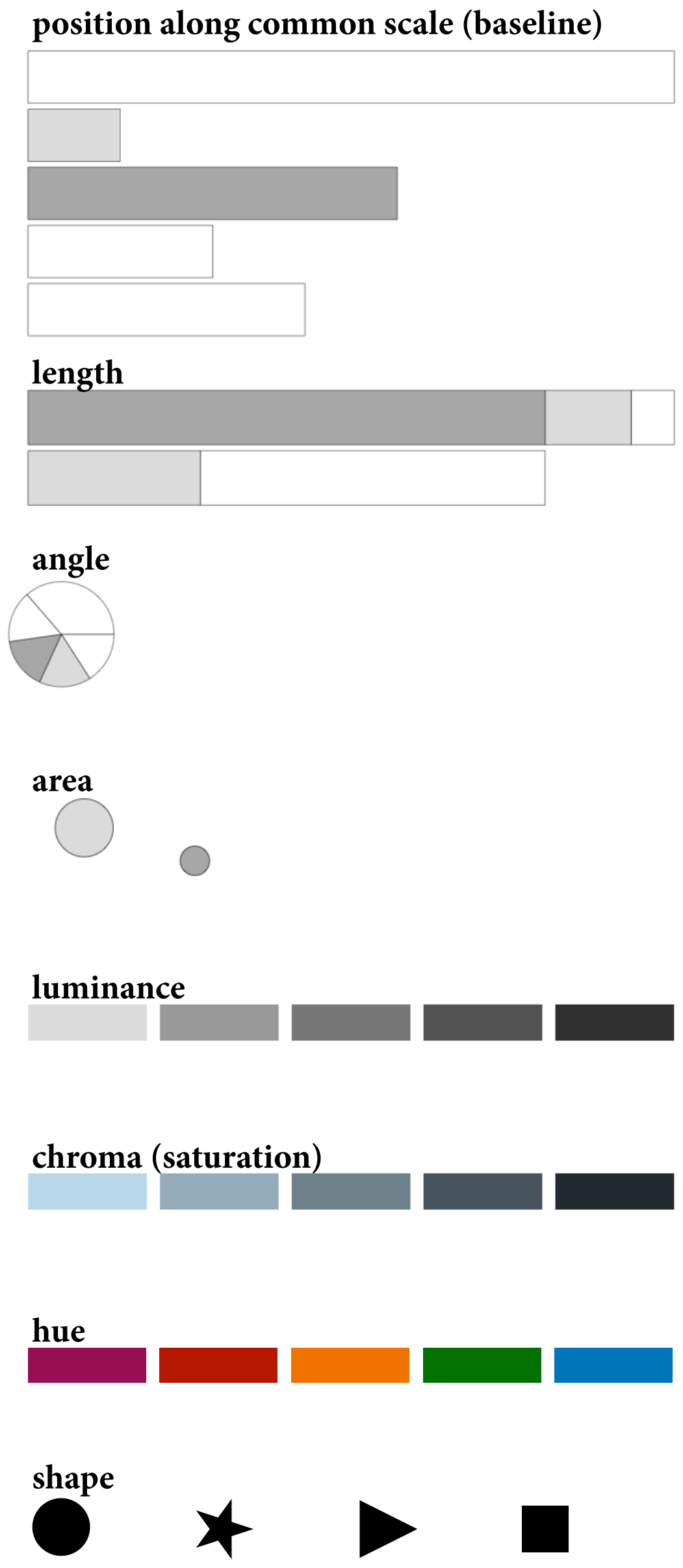
# general channel effectiveness, comparing encoded data — discuss



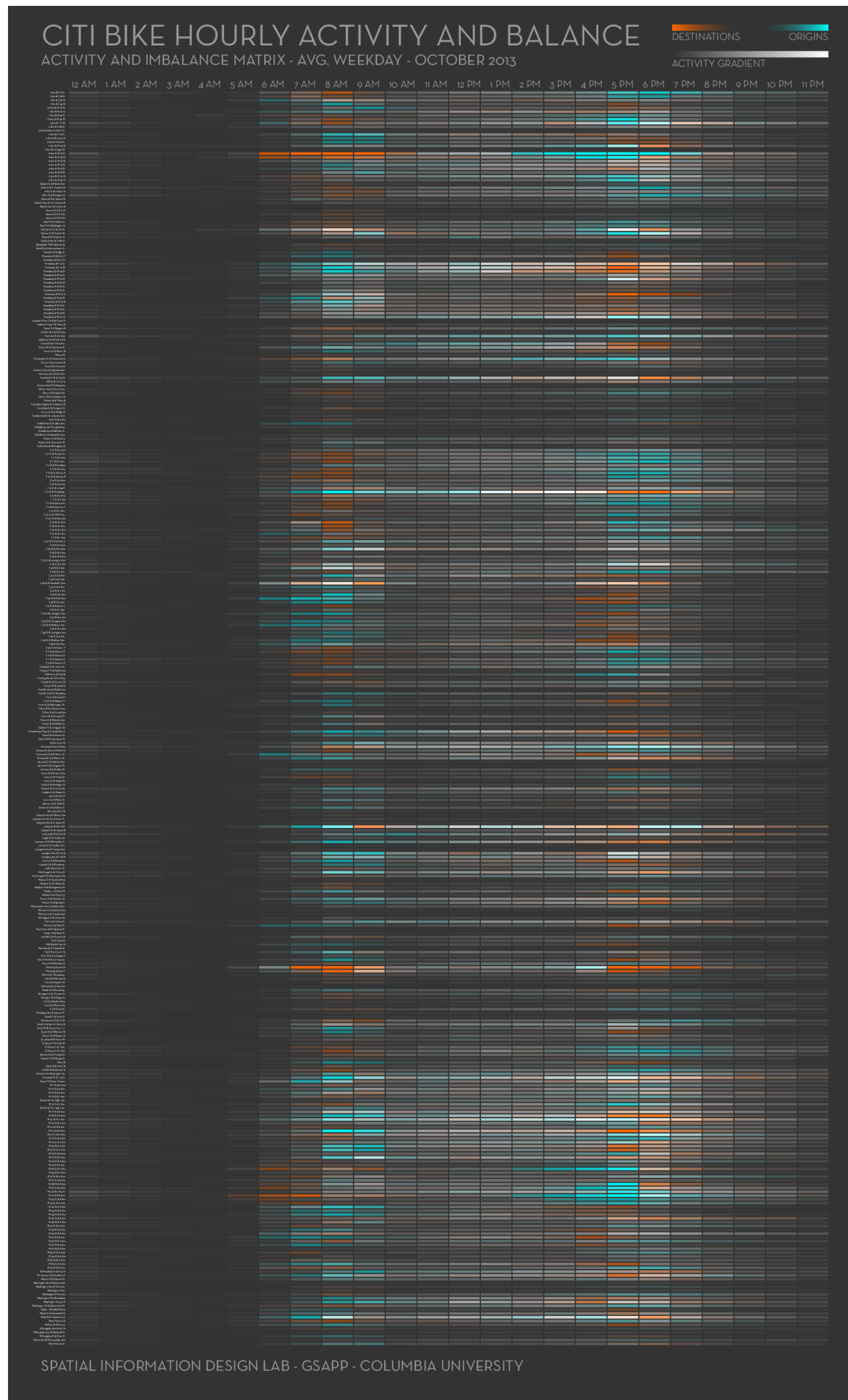
# general channel effectiveness, comparing encoded data — discuss



# general channel effectiveness, comparing encoded data — discuss



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**resources**

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