

# **Cody Dunne**

Northeastern University



**COLOR, PAPER PROTOTYPES,  
DESIGN STUDIES**

# CHECKING IN

# READING QUIZ

6 min

# GOALS FOR TODAY: LEARN...

- to use tools for picking colormaps
- how popout effects can draw attention
- to use paper prototyping to show interactions
- to conduct a simple design study

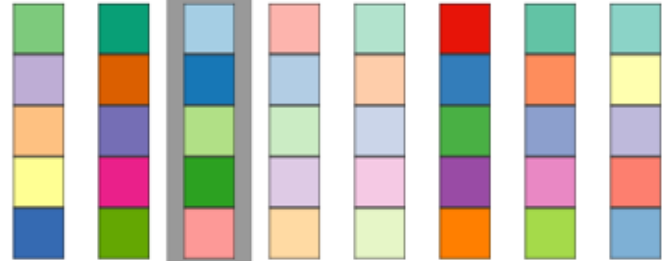
# TOOLS FOR PICKING COLOORMAPS

# Color Brewer

Number of data classes: 6 how to use | updates | downloads | credits

Nature of your data:  sequential  diverging  qualitative

Pick a color scheme:



Only show:  colorblind safe  print friendly  photocopy safe

Context:  roads  cities  borders

Background:  solid color  terrain

color transparency

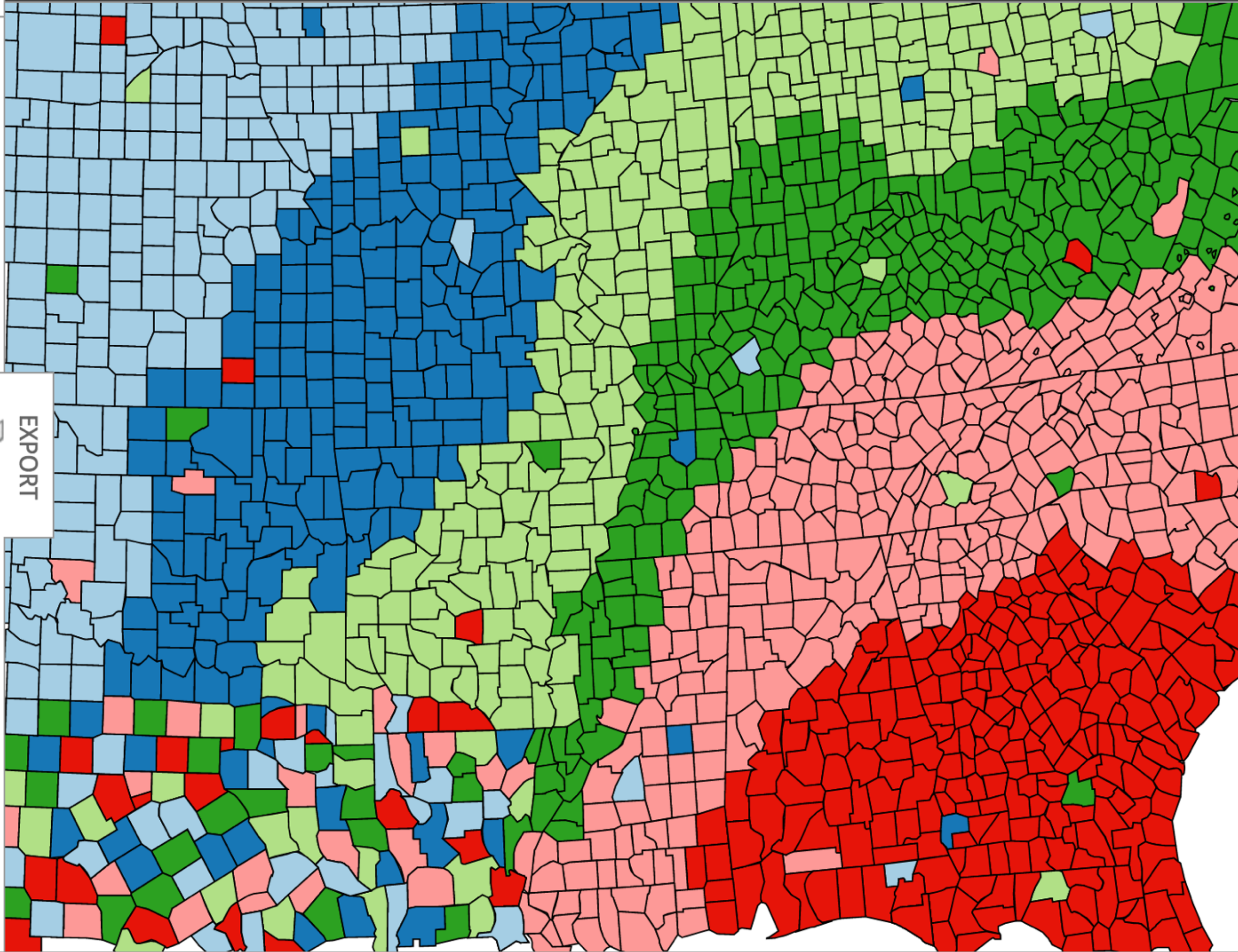
6-class Paired

EXPORT

HEX

- #a6cee3
- #1f78b4
- #b2df8a
- #33a02c
- #fb9a99
- #e31a1c

**COLORBREWER 2.0**  
color advice for cartography



<http://colorbrewer2.org>

# Colorgorical

Colorgorical Source

Generate

Results: Color space Hex RGB Lab LCH Array format " ' No quote Charts Clear all

Number of colors: 5

Score importance: Perceptual Distance, Name Difference, Pair Preference, Name Uniqueness

Select hue filters: 90°, 180°, 270°, 0°

Results: ["rgb(57,146,131)", "rgb(148,210,207)", "rgb(25,79,70)", "rgb(57,238,192)"]

rgb(57,146,131) + start

rgb(148,210,207) + start

rgb(25,79,70) + start

rgb(57,238,192) + start

## Instructions

To generate a palette with  $n$  colors, just enter the number of colors you want and click *Generate*. Bigger palettes will take longer than smaller palettes to make. Results will automatically appear when ready.

For greater detail, please consult our [paper](#) or the [source code](#).

## Score Importance

### Perceptual Distance

Increasing *Perceptual Distance* favors palette colors that are more easily discriminable to the human eye. To accurately model human color acuity, this is performed using CIEDE2000 in CIE Lab color space.

### Name Difference

Increasing *Name Difference* favors palette colors that share few common names

## About

Colorgorical was built by Connor Gramazio with advisement from David Laidlaw and Karen Schloss.

## Documentation

If you'd like to read more about how Colorgorical works, please read our paper [here](#). If you're curious about the implementation, please see the Colorgorical GitHub repository located [here](#).

If you use Colorgorical, please use the following citation:

```
@article{gramazio-2017-ccd,
  author={Gramazio, Connor C. and Laidlaw, David H. and Schloss, Karen},
  journal={IEEE Transactions on Visualization and Computer Graphics},
  title={Colorgorical: creating discriminable and preferable color palettes}
```

# Other Useful Tools

- Get a list of colors from an image:  
<https://html-color.codes/color-from-image>
- Analyze your palette: <https://projects.susielu.com/viz-palette>
- Analyze the name similarity of colors in your palette:  
<http://vis.stanford.edu/color-names/analyzer/>
- Details on multi-hued color scales:  
<https://www.vis4.net/blog/2013/09/mastering-multi-hued-color-scales/#combining-bezier-interpolation-and-lightness-correction>
- Easy picking a multi-hued color scale: <http://tristen.ca/hcl-picker/>
- Easily correcting darkness (lightness) for a scale: <http://gka.github.io/palettes/>
- Do a ton programmatically: <https://gka.github.io/chroma.js/>
- viridis colors:  
<https://cran.r-project.org/web/packages/viridis/vignettes/intro-to-viridis.html>



# Color Advice Summary

Use a limited hue palette

- Control color “pop out” with low-saturation colors
- Avoid clutter from too many competing colors

Use neutral backgrounds

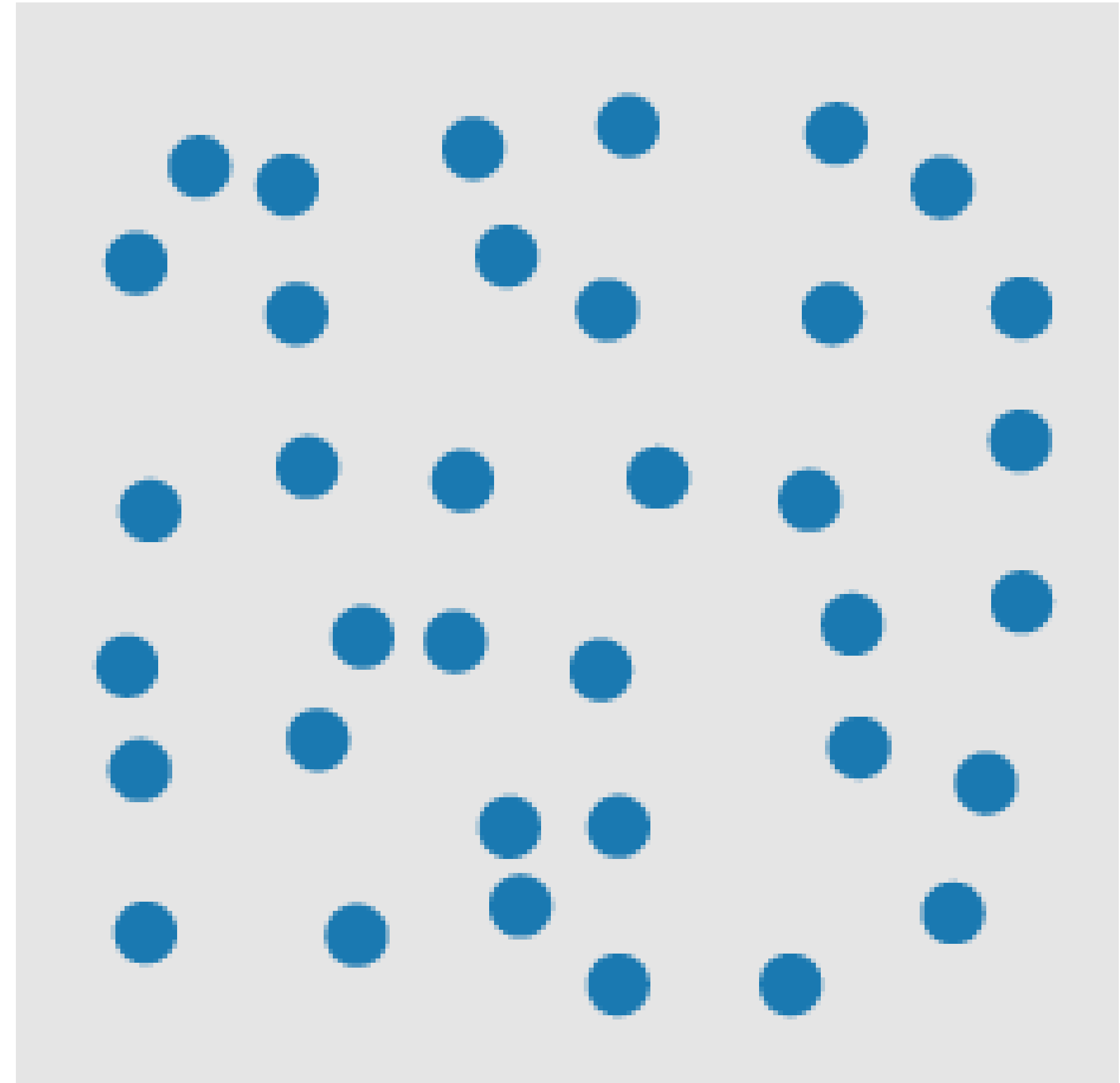
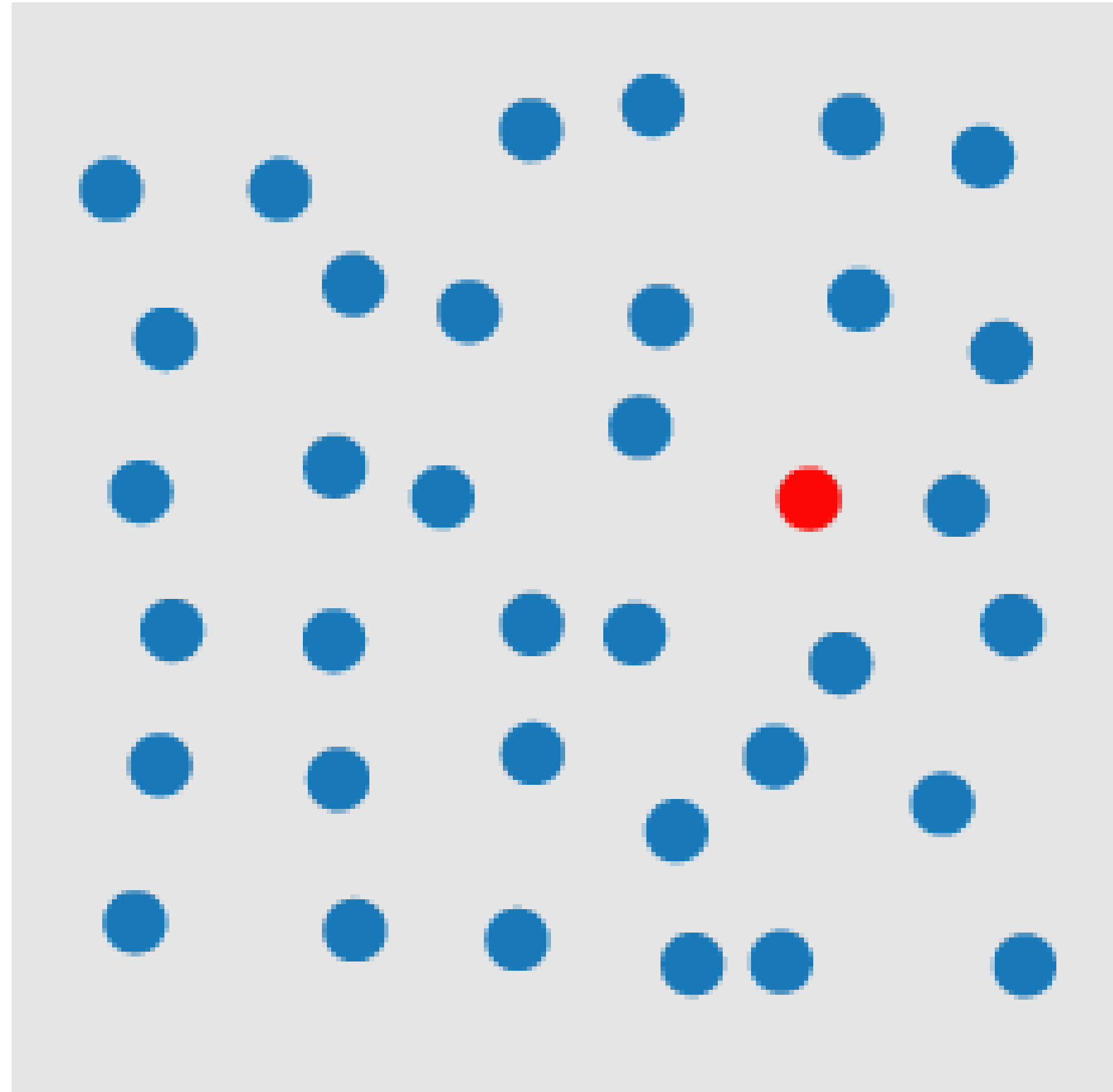
- Control **impact** of color
- Minimize simultaneous contrast

Use Color Brewer etc. for picking scales

*Don't forget aesthetics!*

# POP-OUT EFFECTS

# POP-OUT EFFECTS

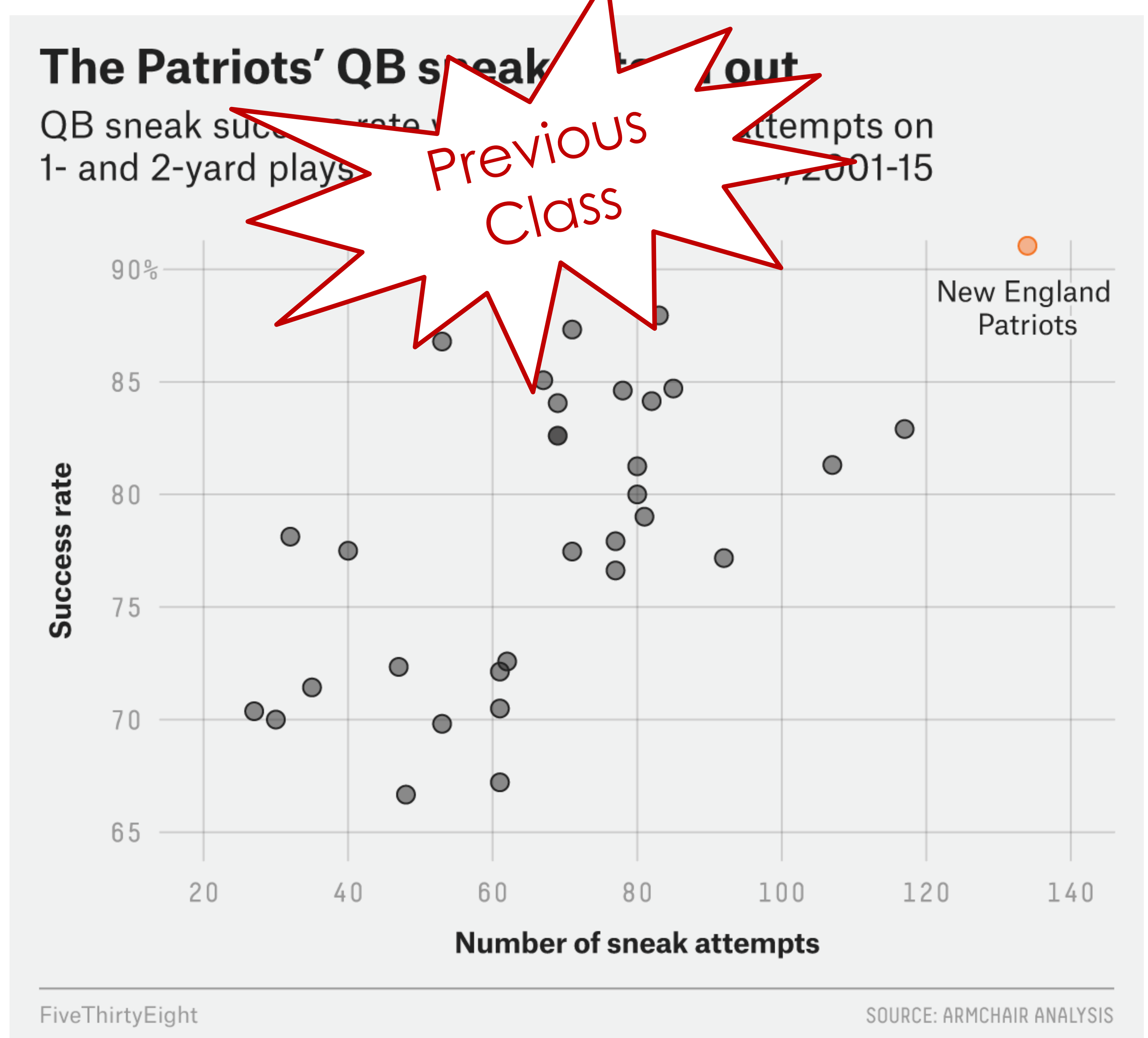


COLOR

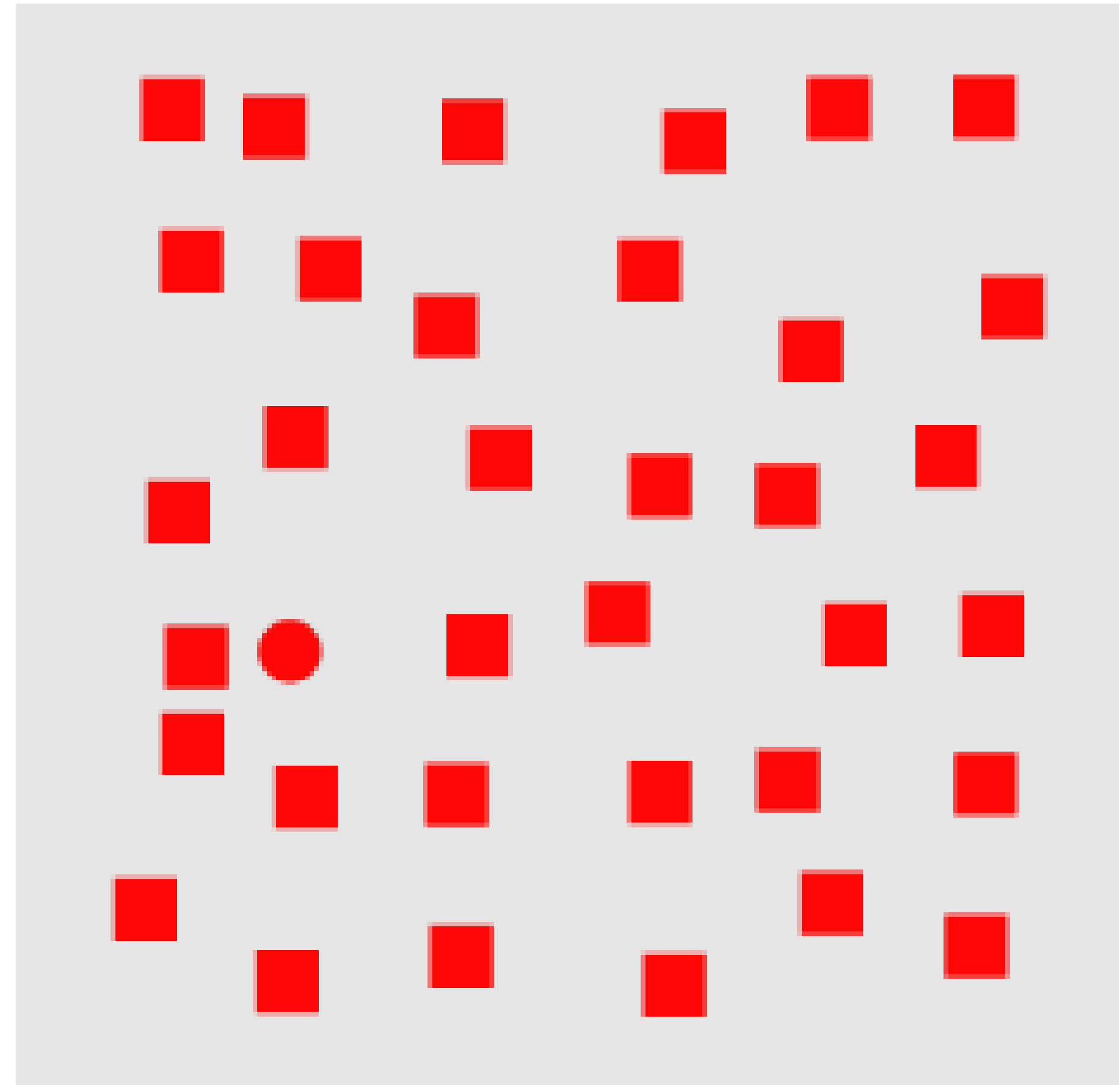
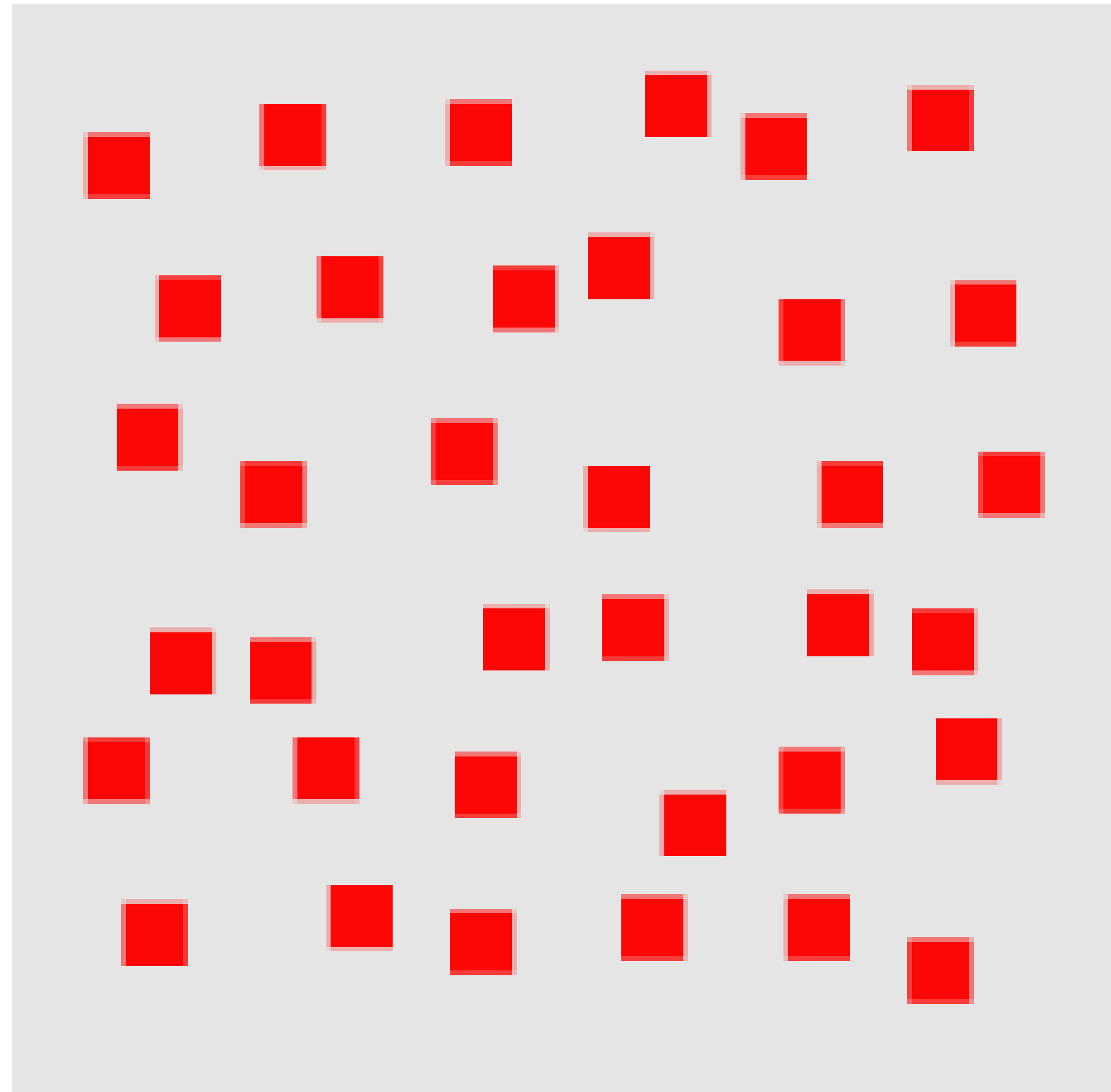
A quarterback sneak is a [play](#) in [American football](#) and [Canadian football](#) in which the [quarterback](#), upon taking the center snap, dives ahead while the offensive line surges forward. It is usually only used in very short yardage situations.

[https://en.wikipedia.org/wiki/Quarterback\\_sneak](https://en.wikipedia.org/wiki/Quarterback_sneak)

Which pop-out effects are used in this example visualization?

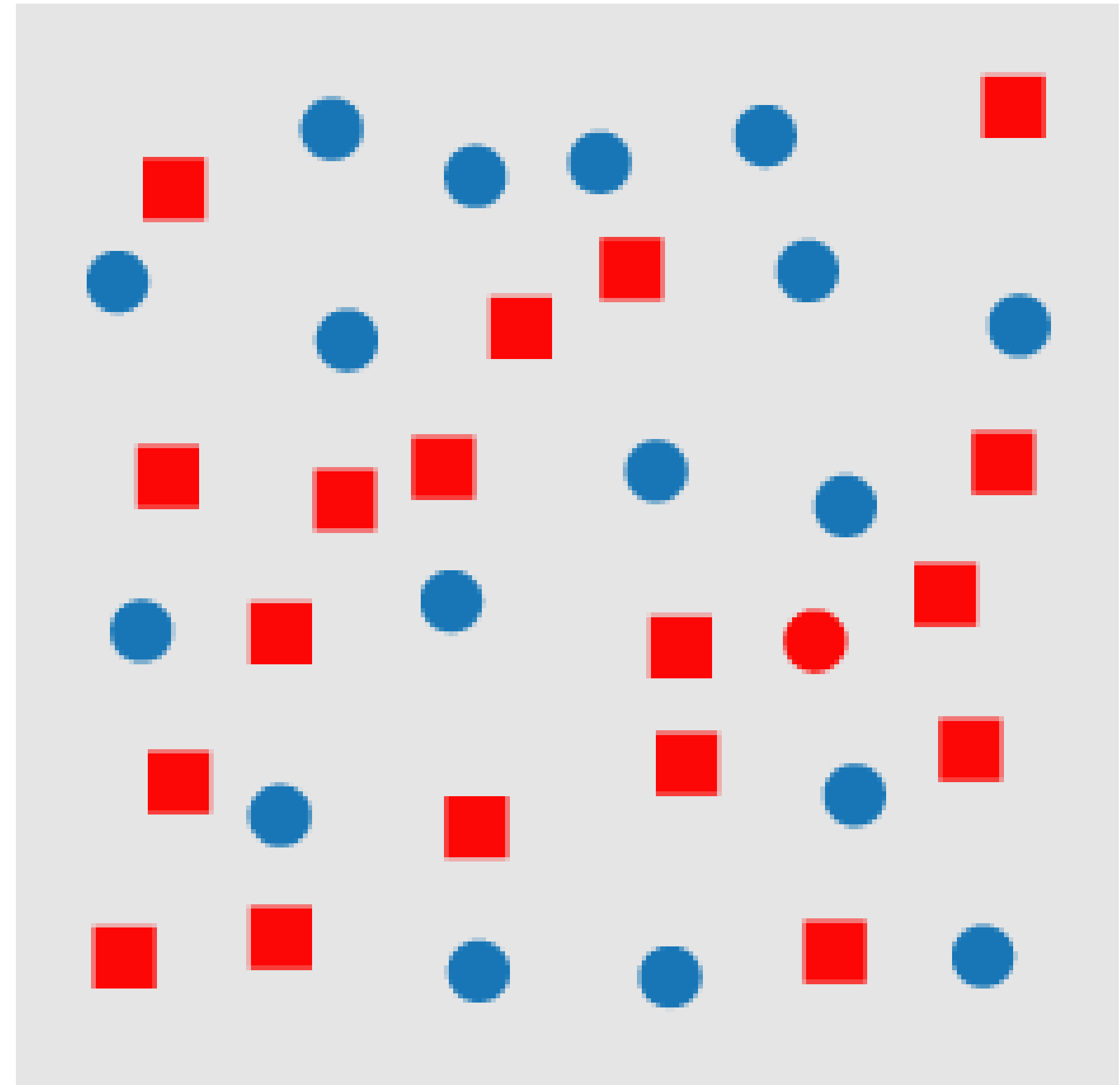
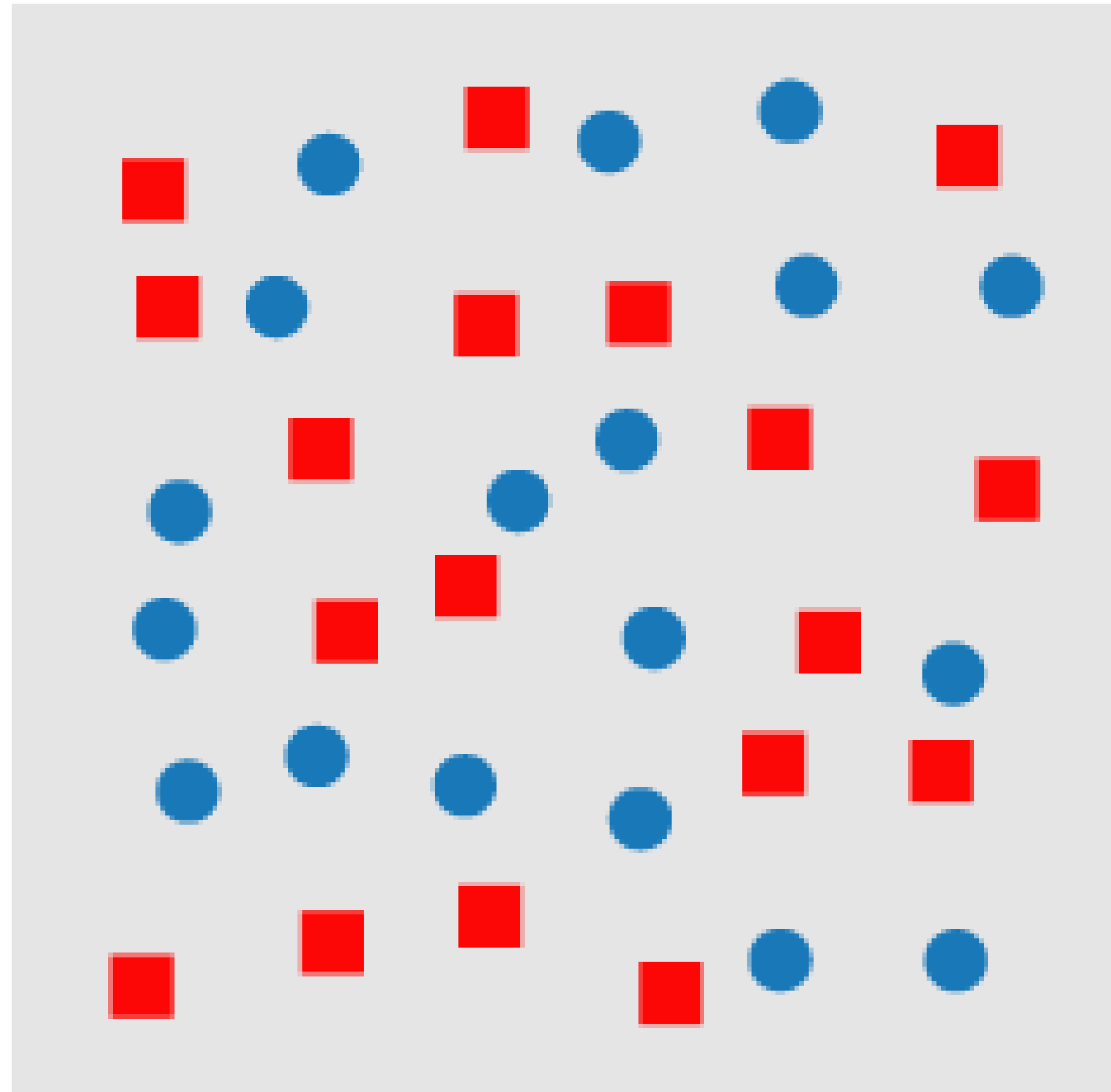


# POP-OUT EFFECTS



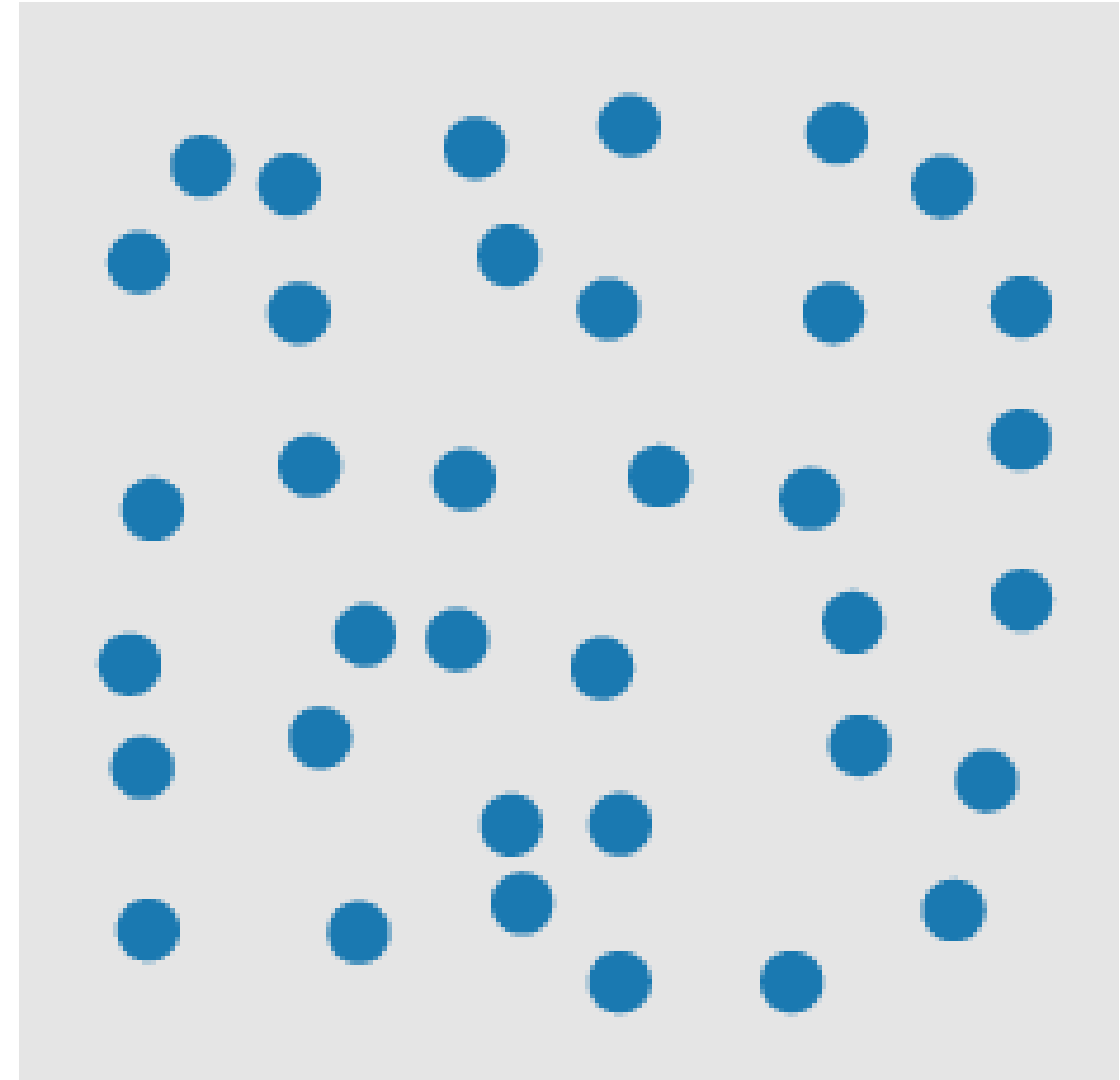
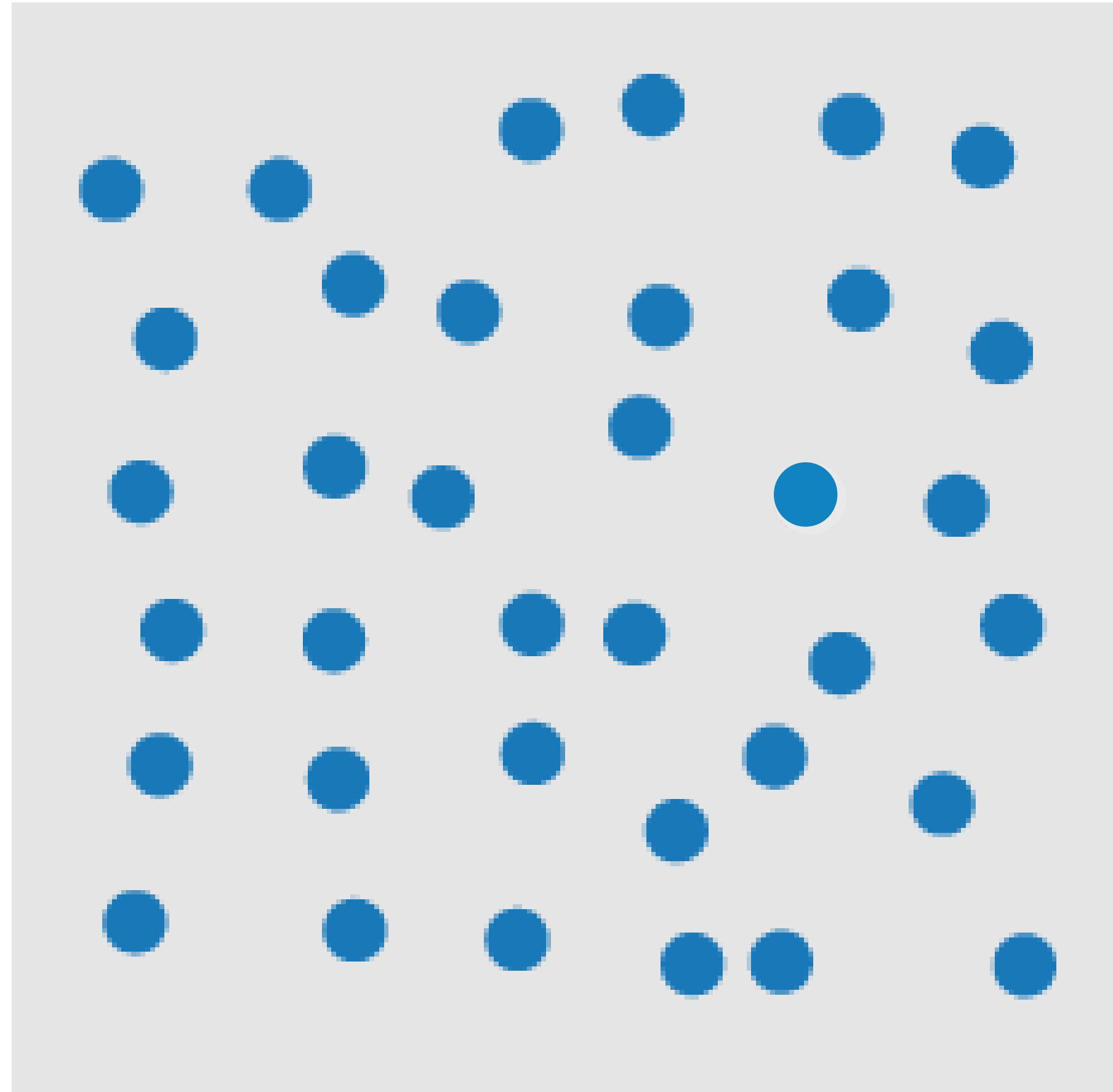
SHAPE

# POP-OUT EFFECTS



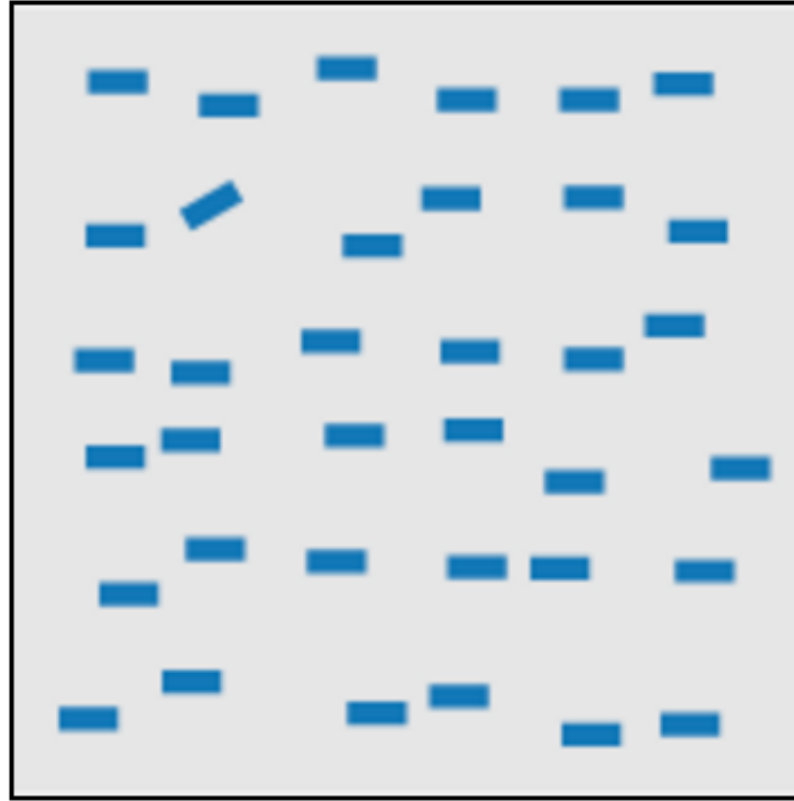
“CONJUNCTION” (HARDER TO FIND RED CIRCLE!)

# POP-OUT EFFECTS

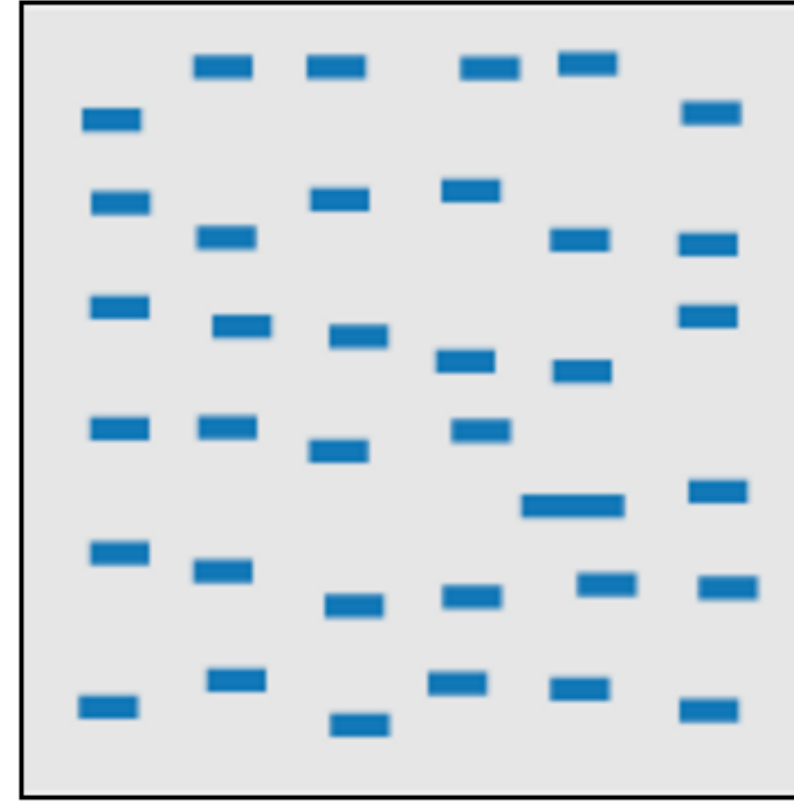


MOTION

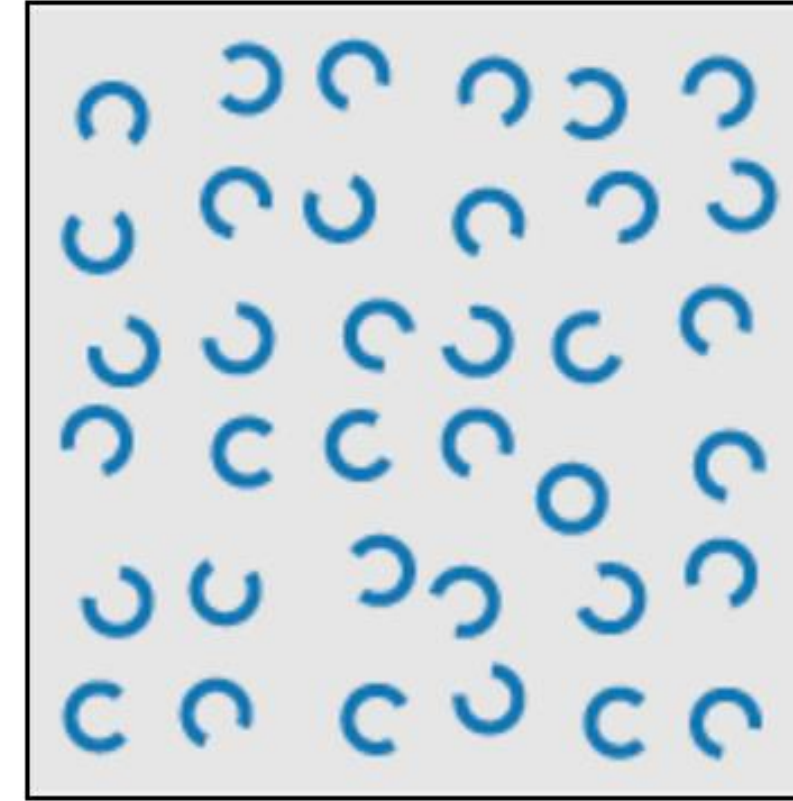
# POP-OUT EFFECTS



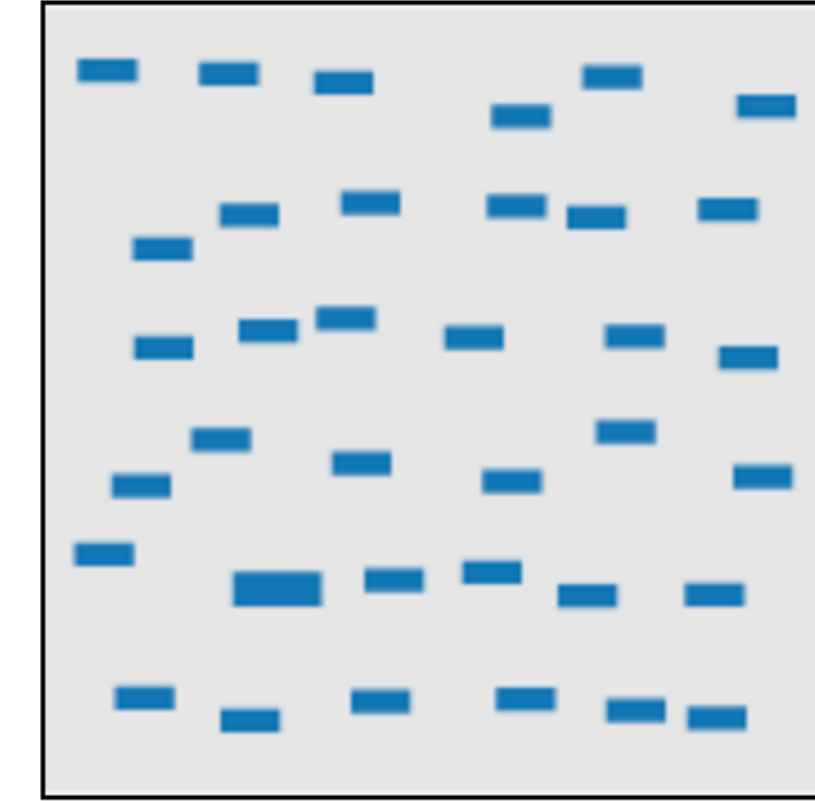
**line (blob) orientation**  
Julész & Bergen 83; Sagi & Julész 85a, Wolfe et al. 92; Weigle et al. 2000



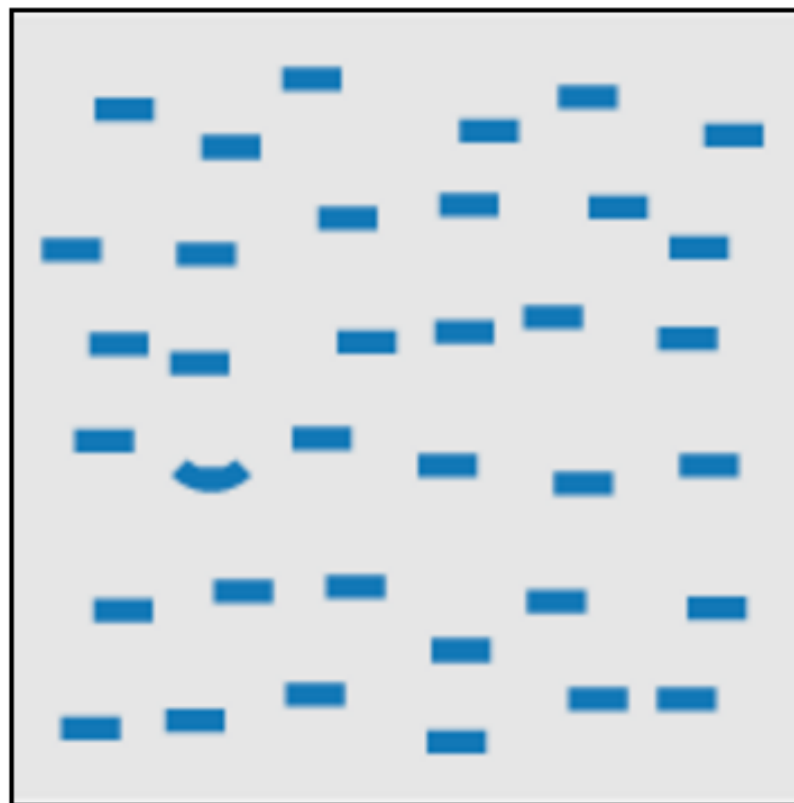
**length, width**  
Sagi & Julész 85b; Treisman & Gormican 88



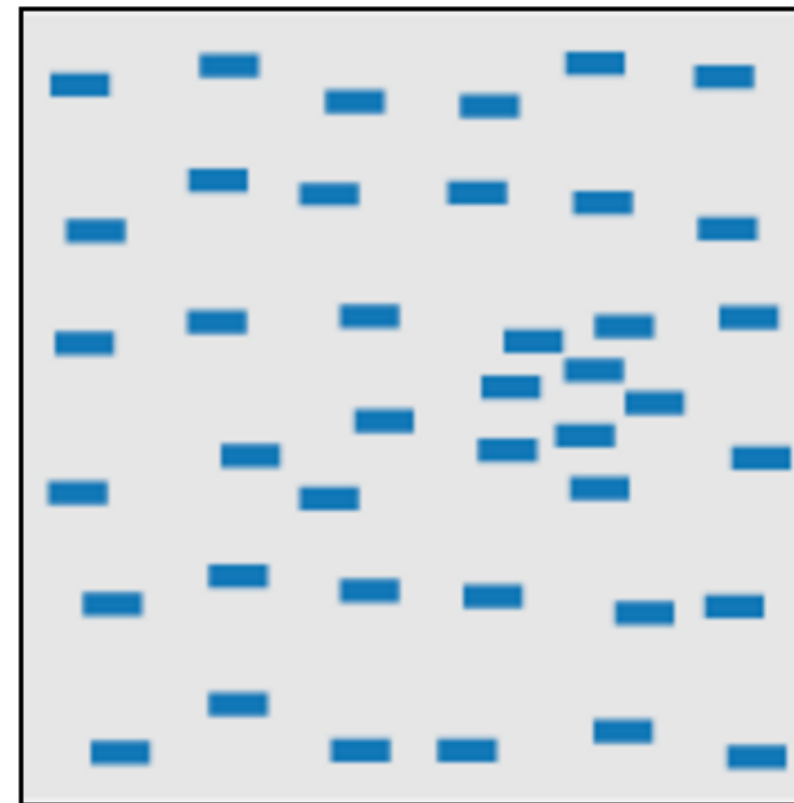
**closure**  
Julész & Bergen 83



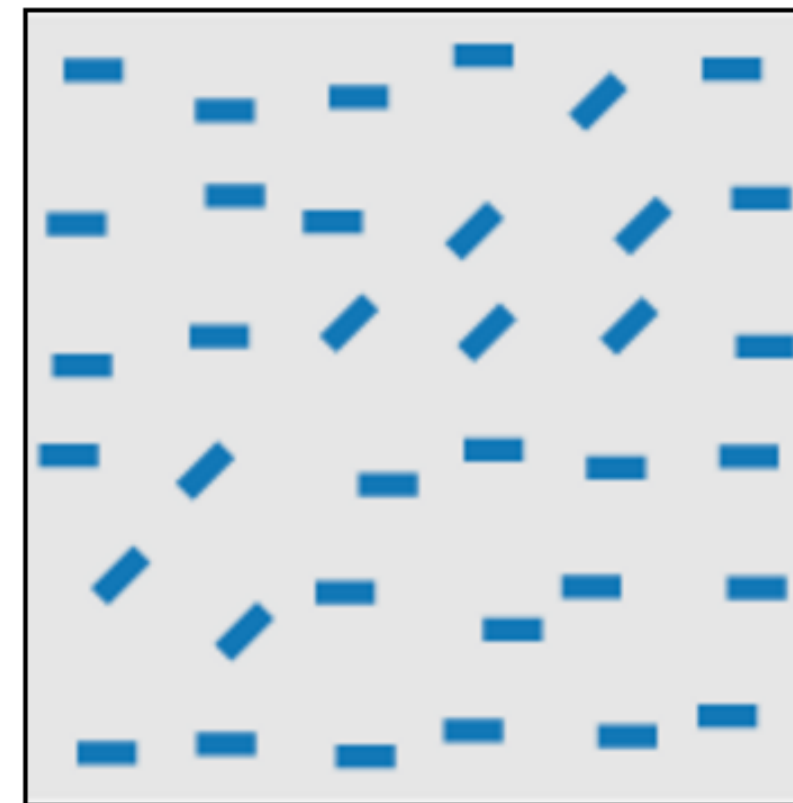
**size**  
Treisman & Gelade 80; Healey & Enns 98; Healey & Enns 99



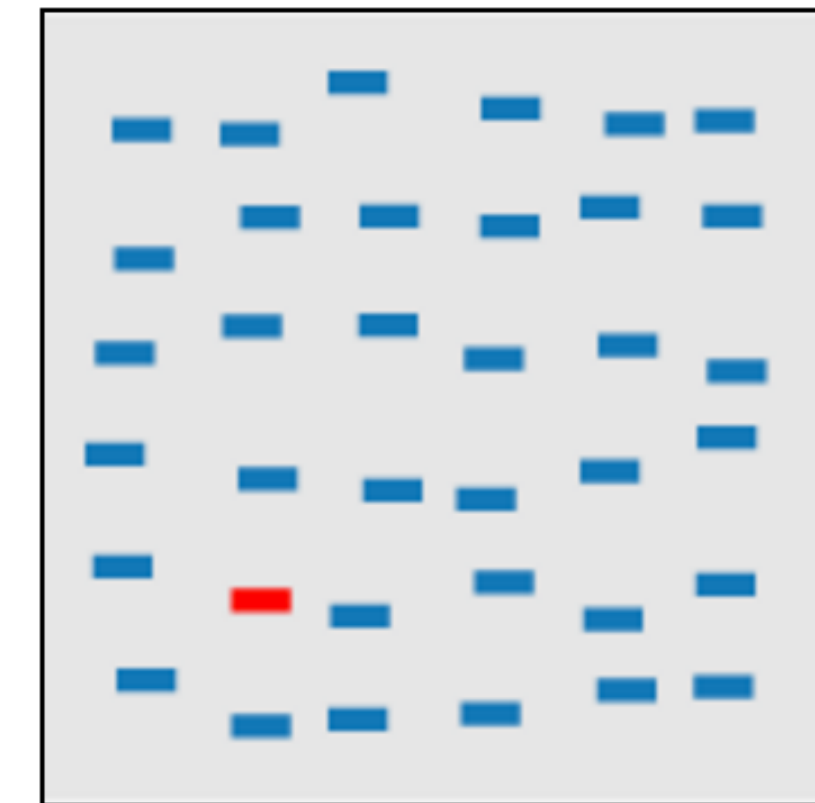
**curvature**  
Treisman & Gormican 88



**density, contrast**  
Healey & Enns 98; Healey & Enns 99



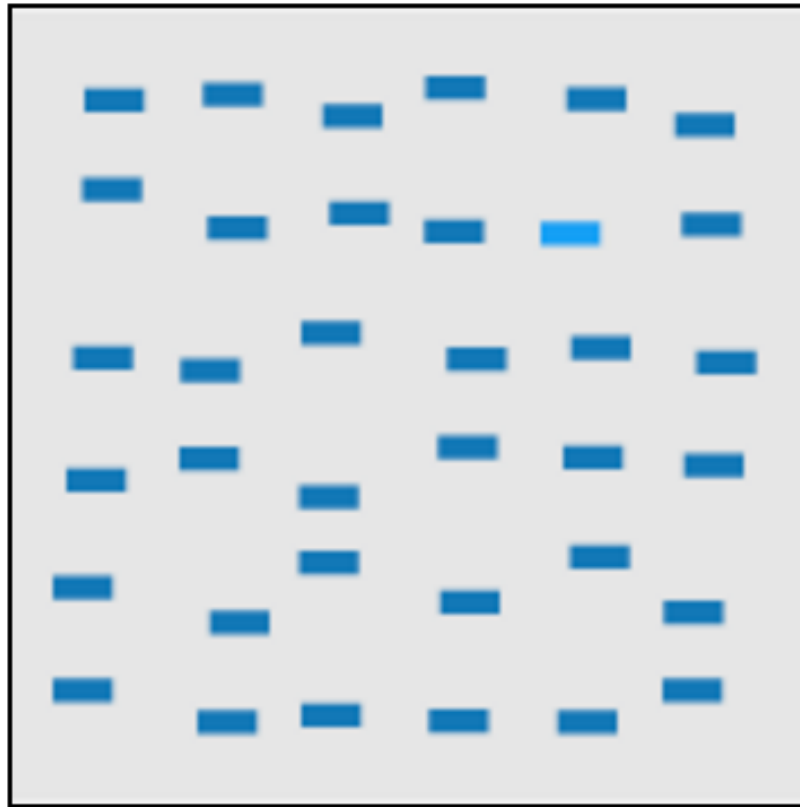
**number, estimation**  
Sagi & Julész 85b; Healey et al. 93; Trick & Pylyshyn 94



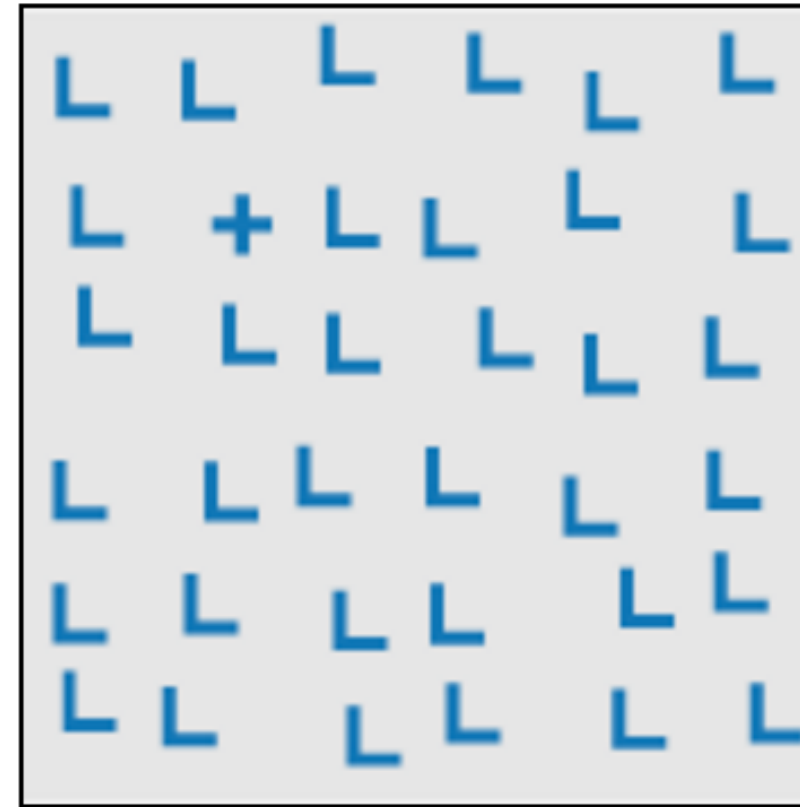
**colour (hue)**  
Nagy & Sanchez 90; Nagy et al. 90; D'Zmura 91; Kawai et al. 95; Bauer et al. 96; Healey 96; Bauer et al. 98; Healey & Enns 99



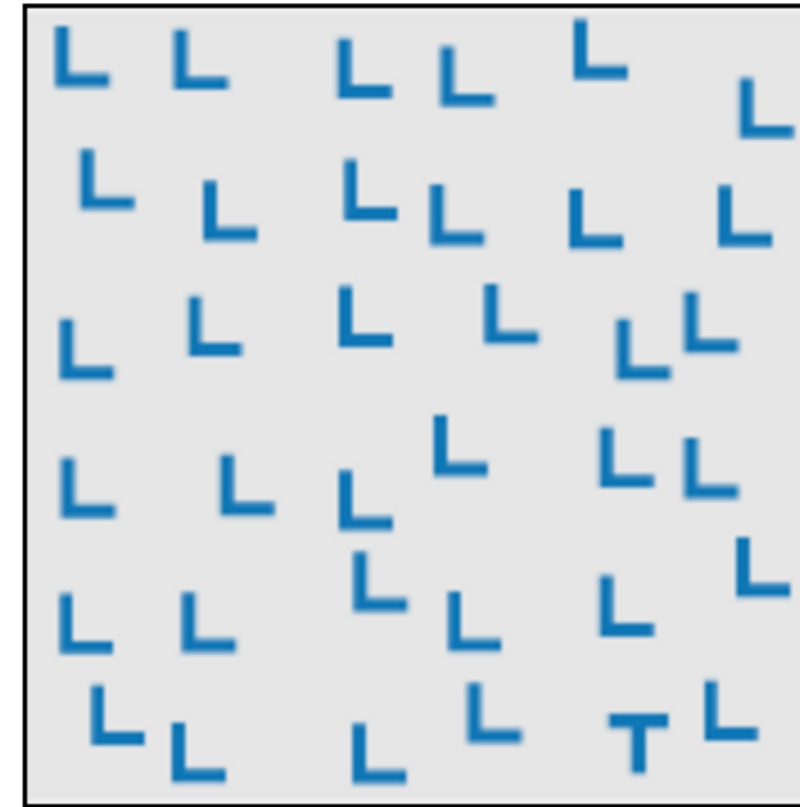
# POP-OUT EFFECTS



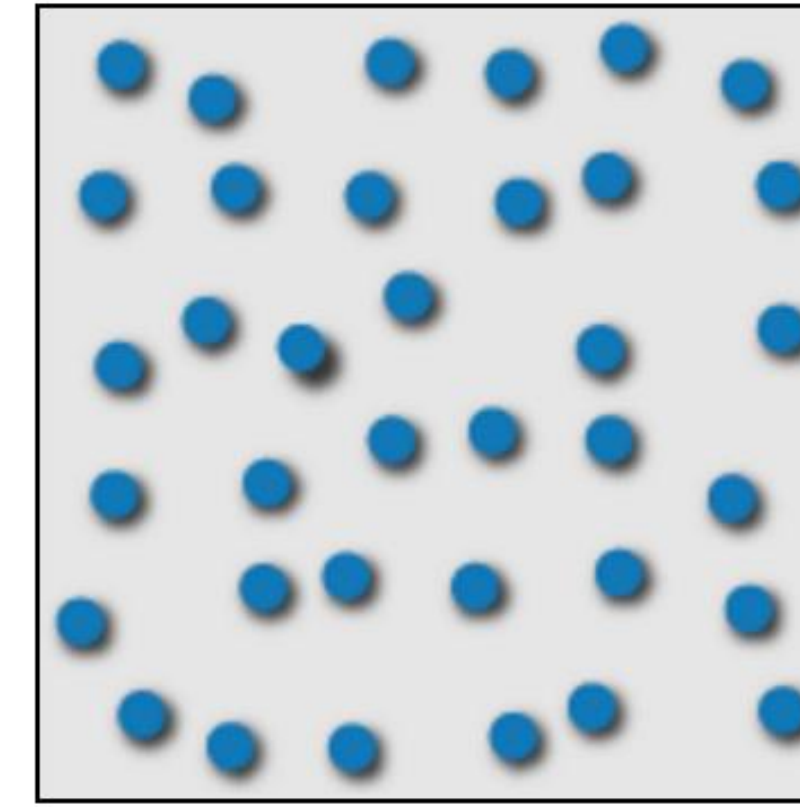
**intensity, binocular lustre**  
Beck et al. 83; Treisman & Gormican 88; Wolfe & Franzel 88



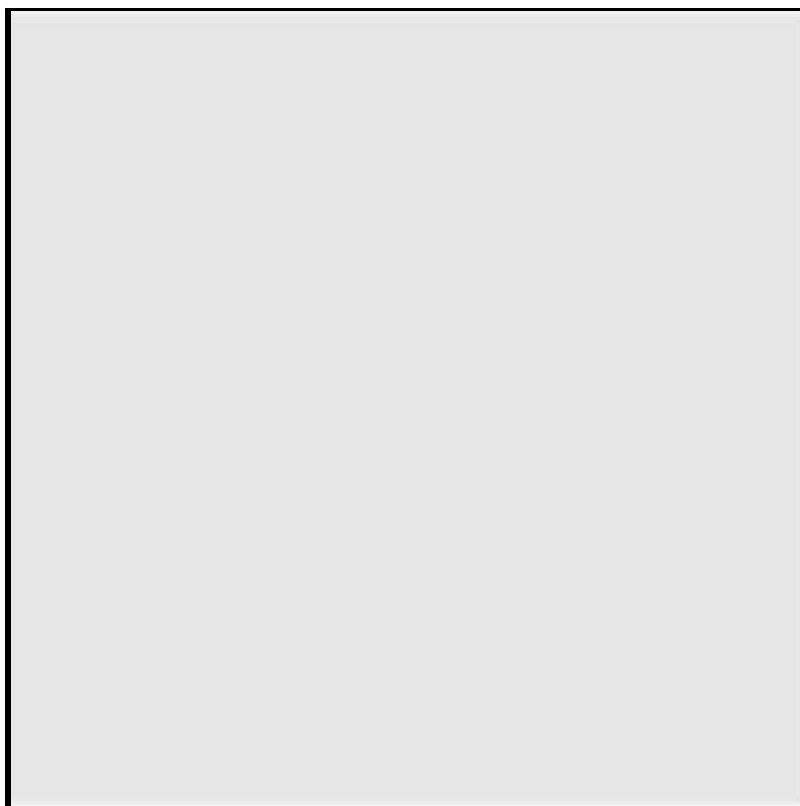
**intersection**  
Julész & Bergen 83



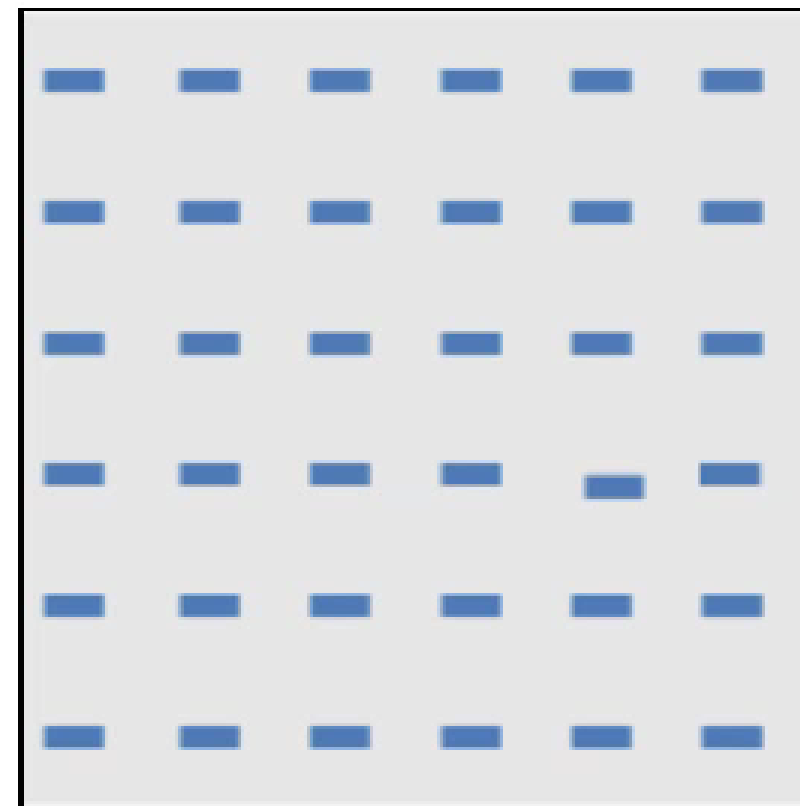
**terminators**  
Julész & Bergen 83



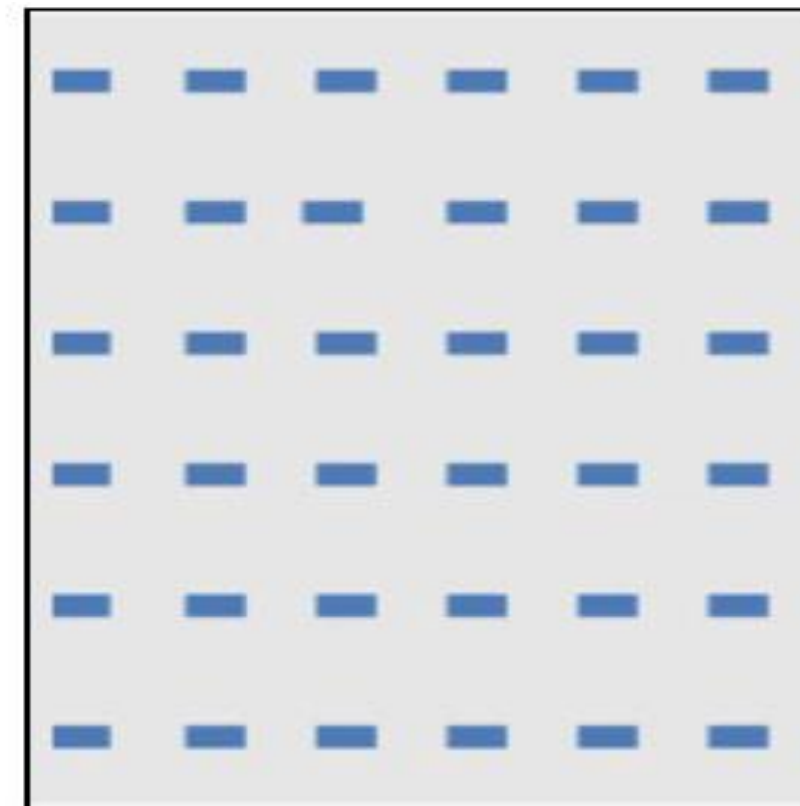
**3D depth cues**  
Enns 90b; Nakayama & Silverman 86



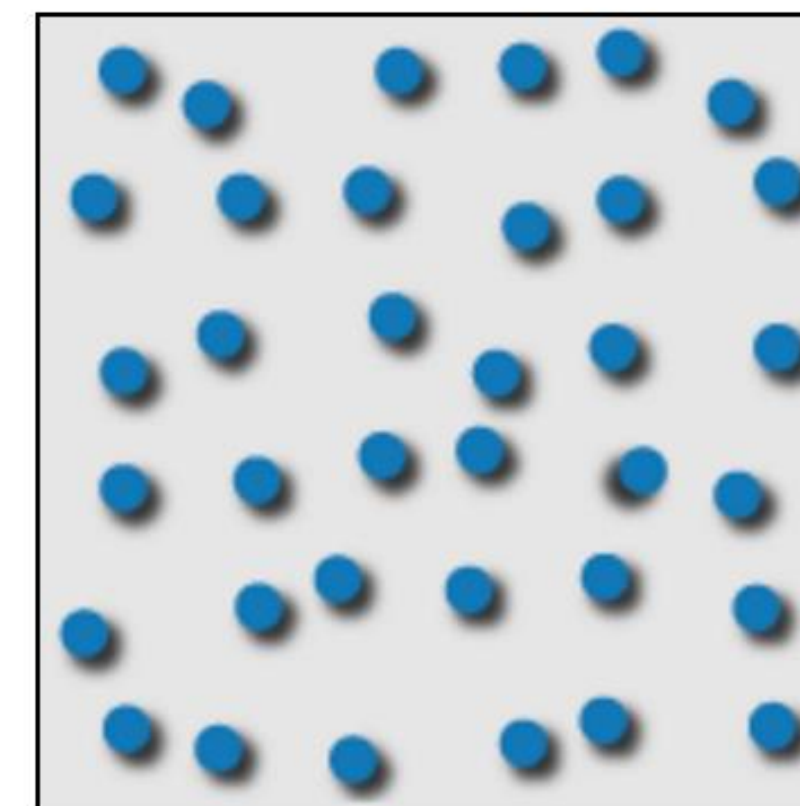
**flicker**  
Gebb et a. 55; Mowbray & Gebhard 55; Brown 65; Julész 71; Huber & Healey 2005



**direction of motion**  
Nakayama & Silverman 86; Driver & McLeod 92; Huber & Healey 2005



**velocity of motion**  
Tynan & Sekuler 82; Nakayama & Silverman 86; Driver & McLeod 92; Hohnsbein & Mateeff 98; Huber & Healey 2005

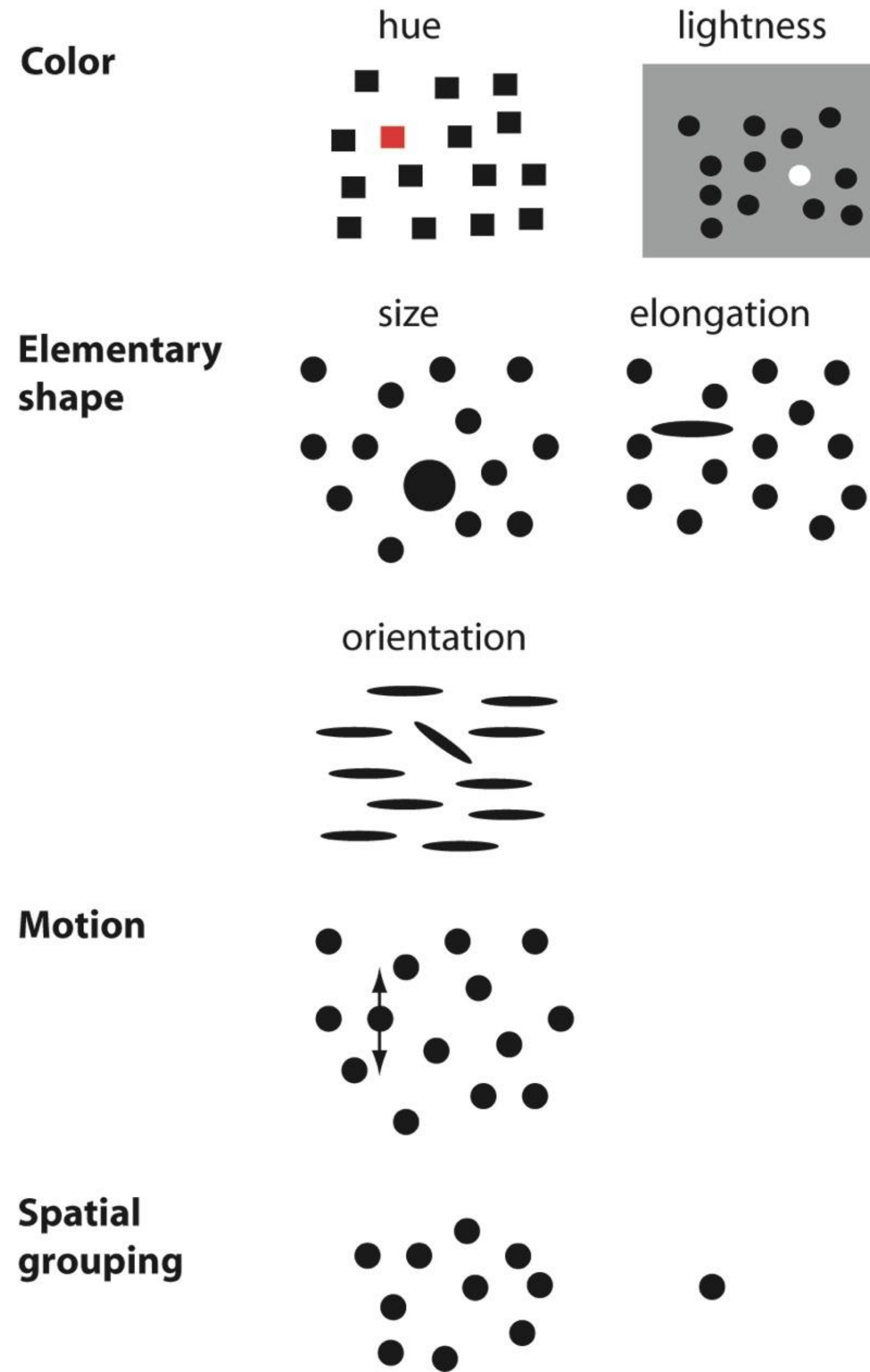


**lighting direction**  
Enns 90a

*Use these “popout” effects to help design effective visualizations!*

*(E.g., draw viewer’s attention to main points, effective redundant encodings, etc.)*

## Basic Popout Channels



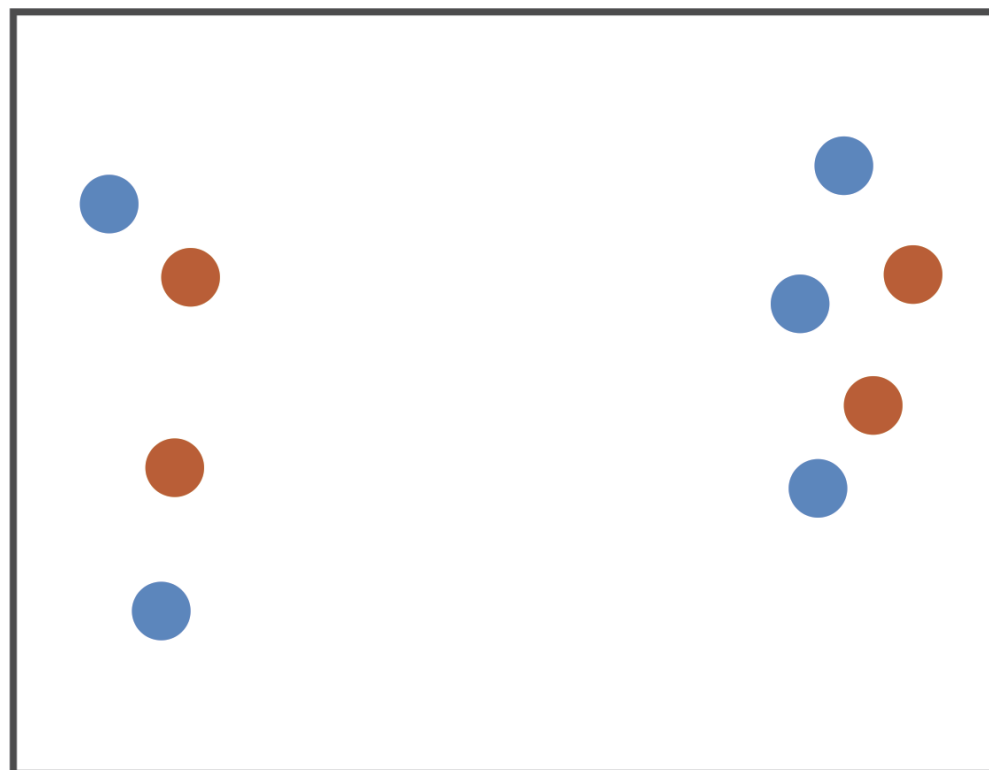
*Use these “popout” effects to help design effective visualizations!*

*(E.g., draw viewer’s attention to main points, effective redundant encodings, etc.)*

# Discriminability and Separability

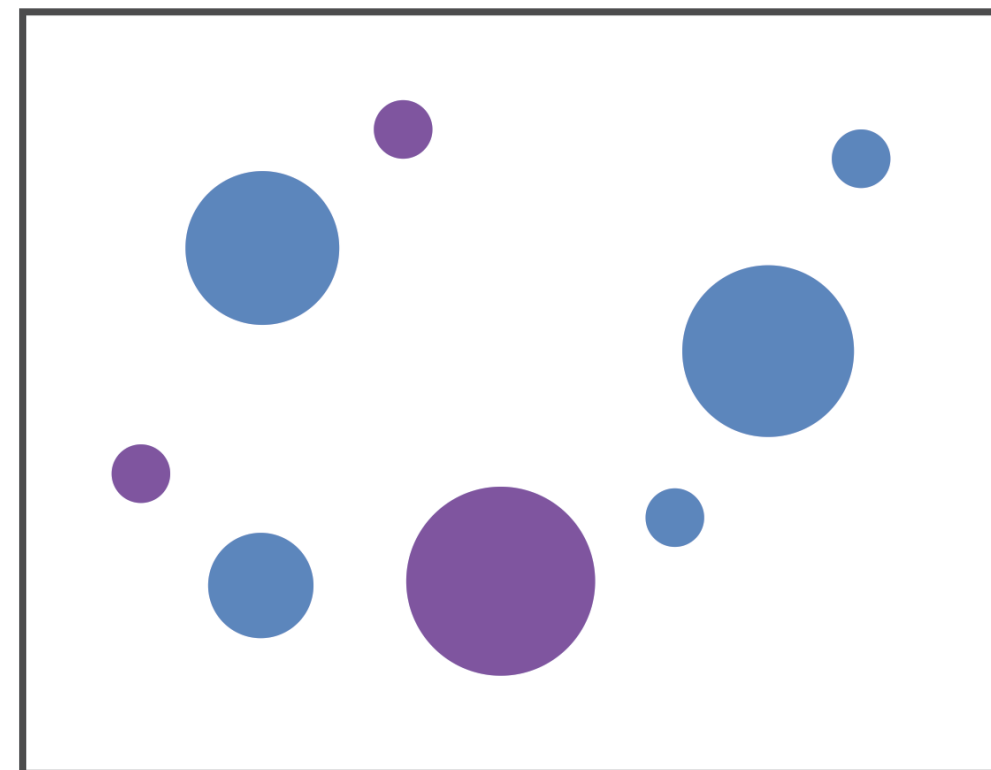
The question of discriminability is: if you encode data using a particular visual channel, are the differences between items perceptible to the human as intended?

Position  
+ Hue (Color)



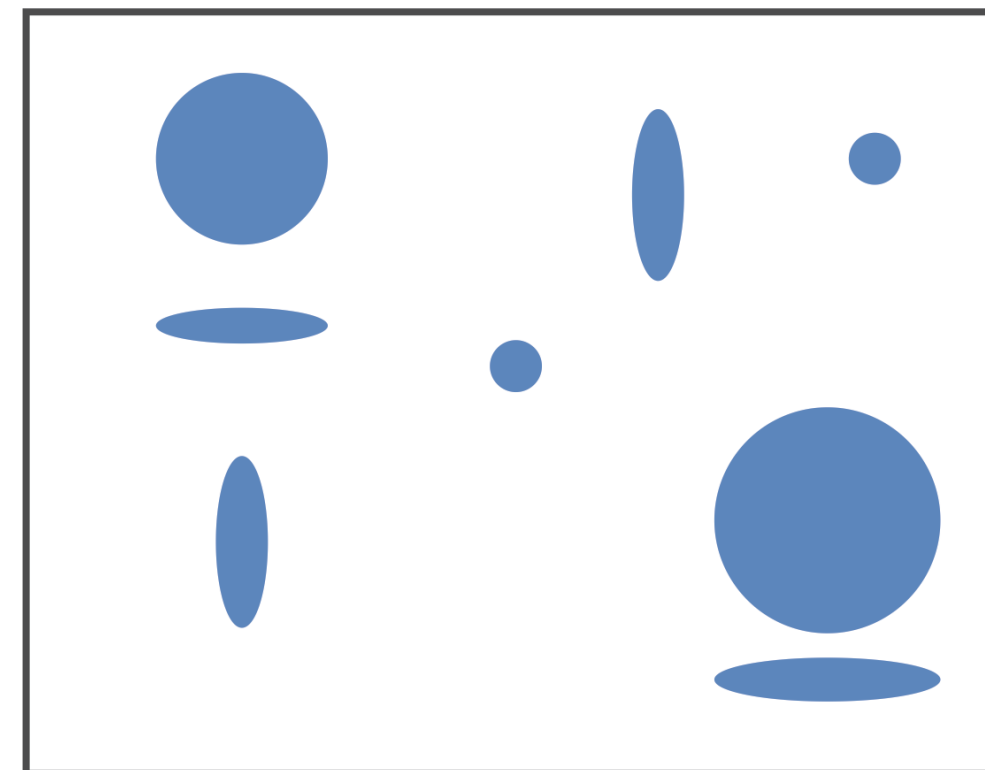
Fully separable

Size  
+ Hue (Color)



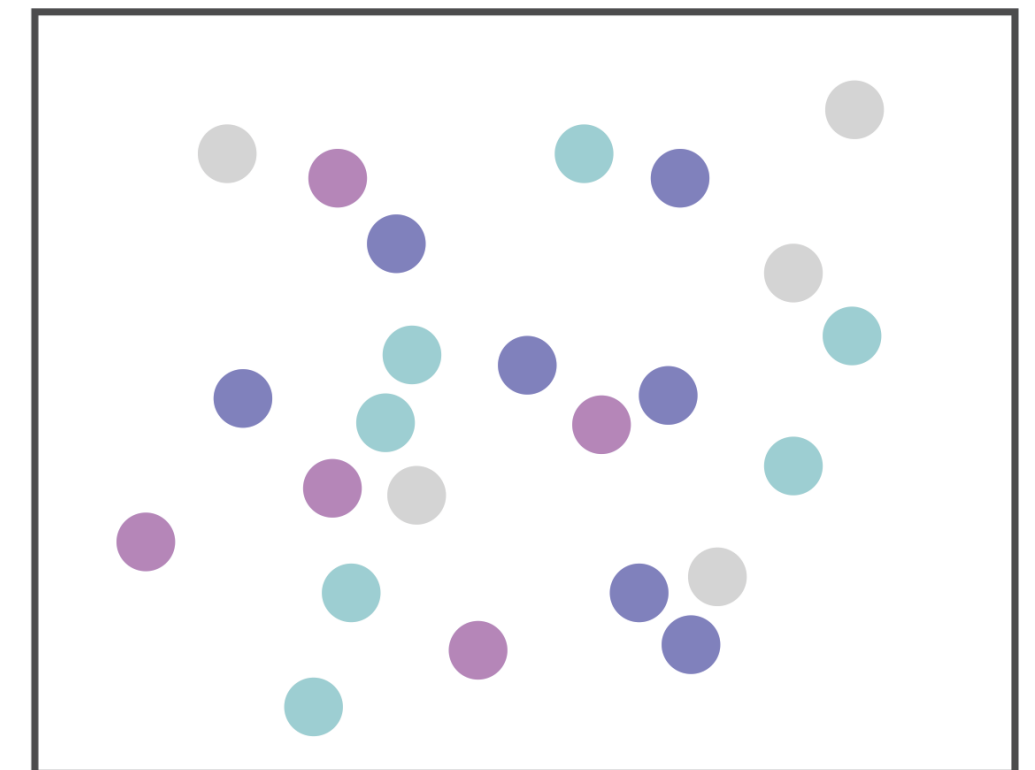
Some interference

Width  
+ Height



Some/significant  
interference

Red  
+ Green

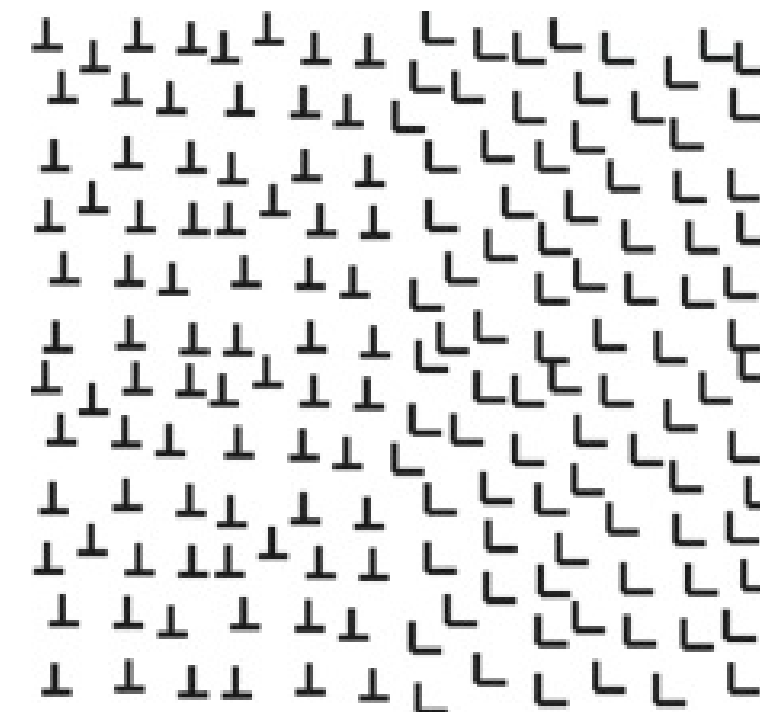
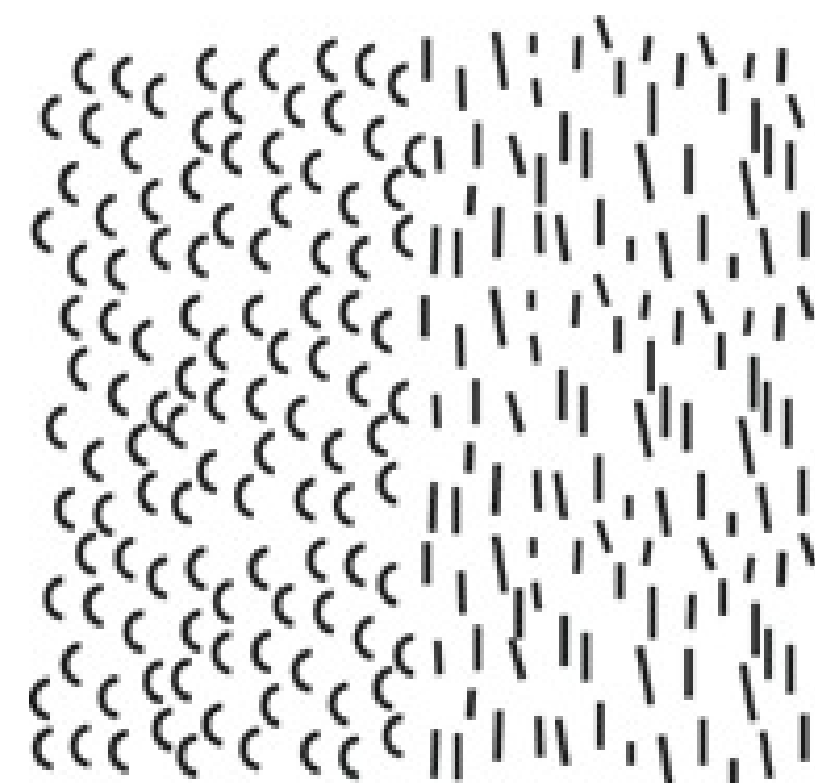
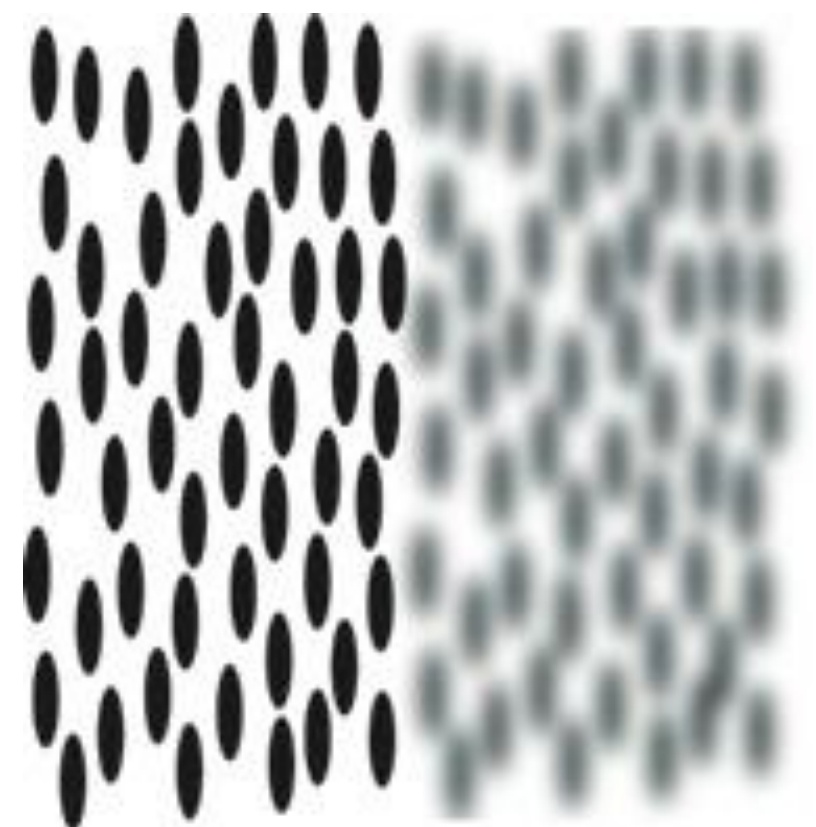
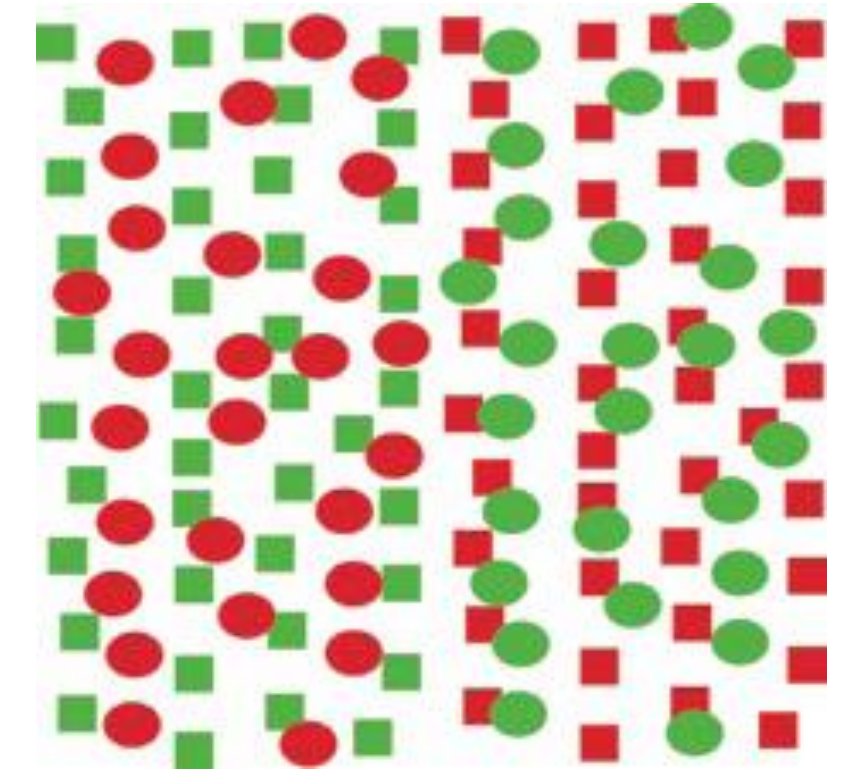
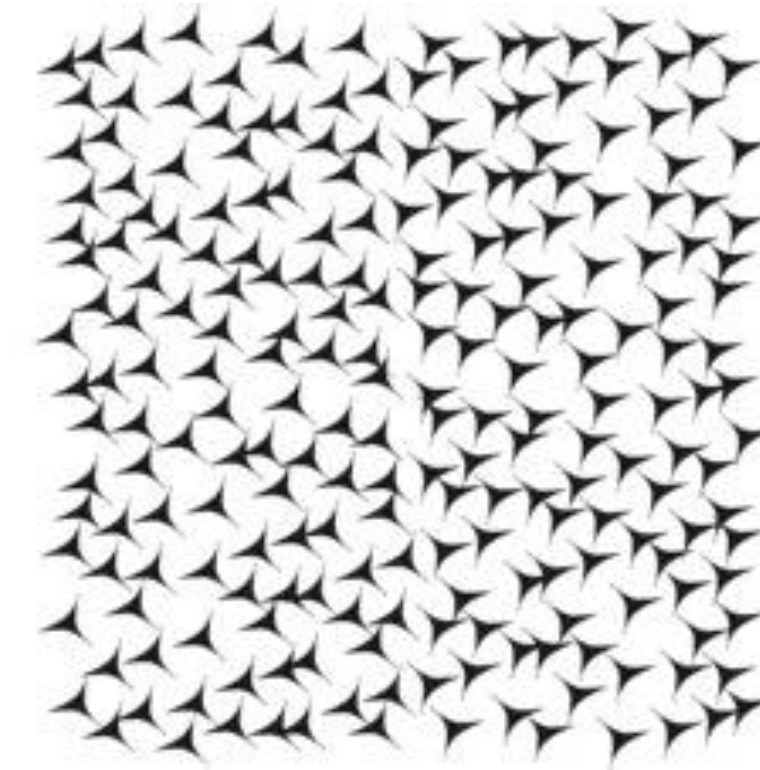
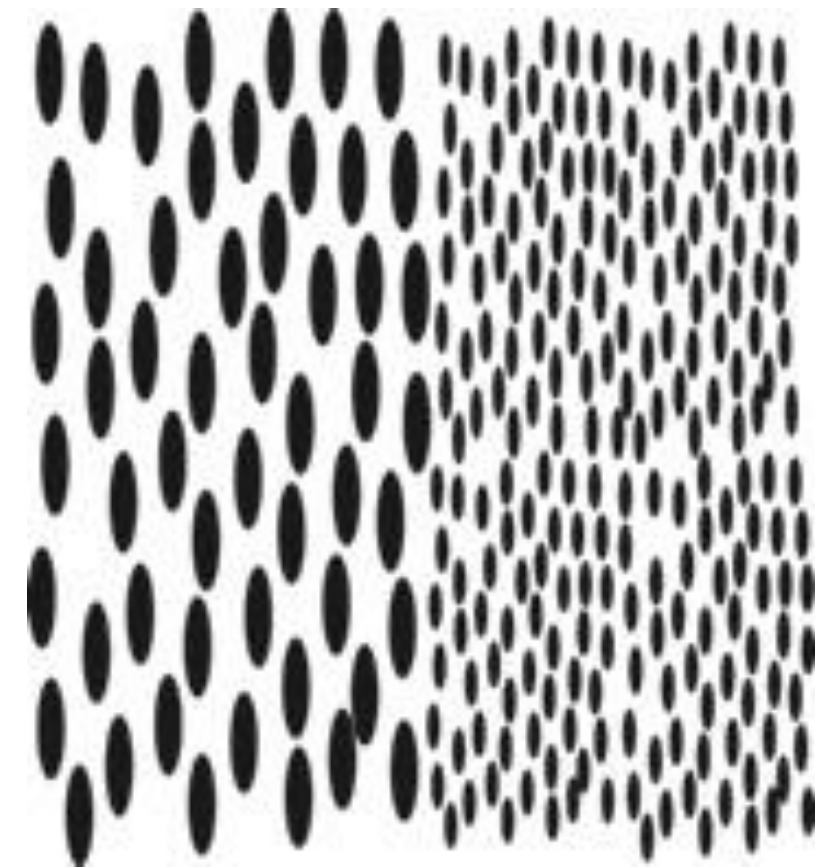
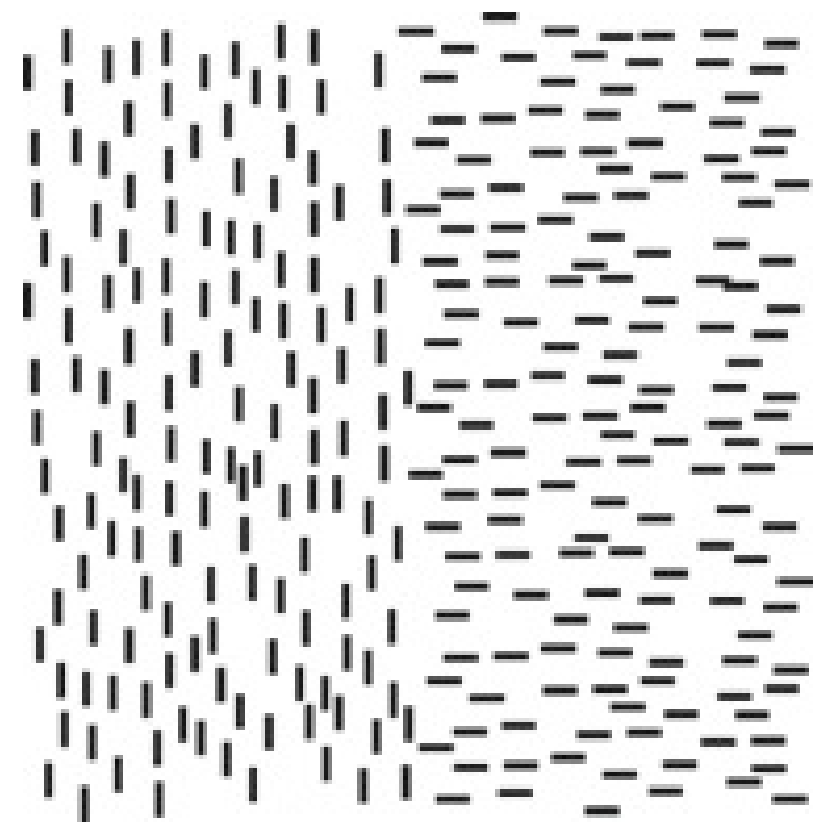


Major interference

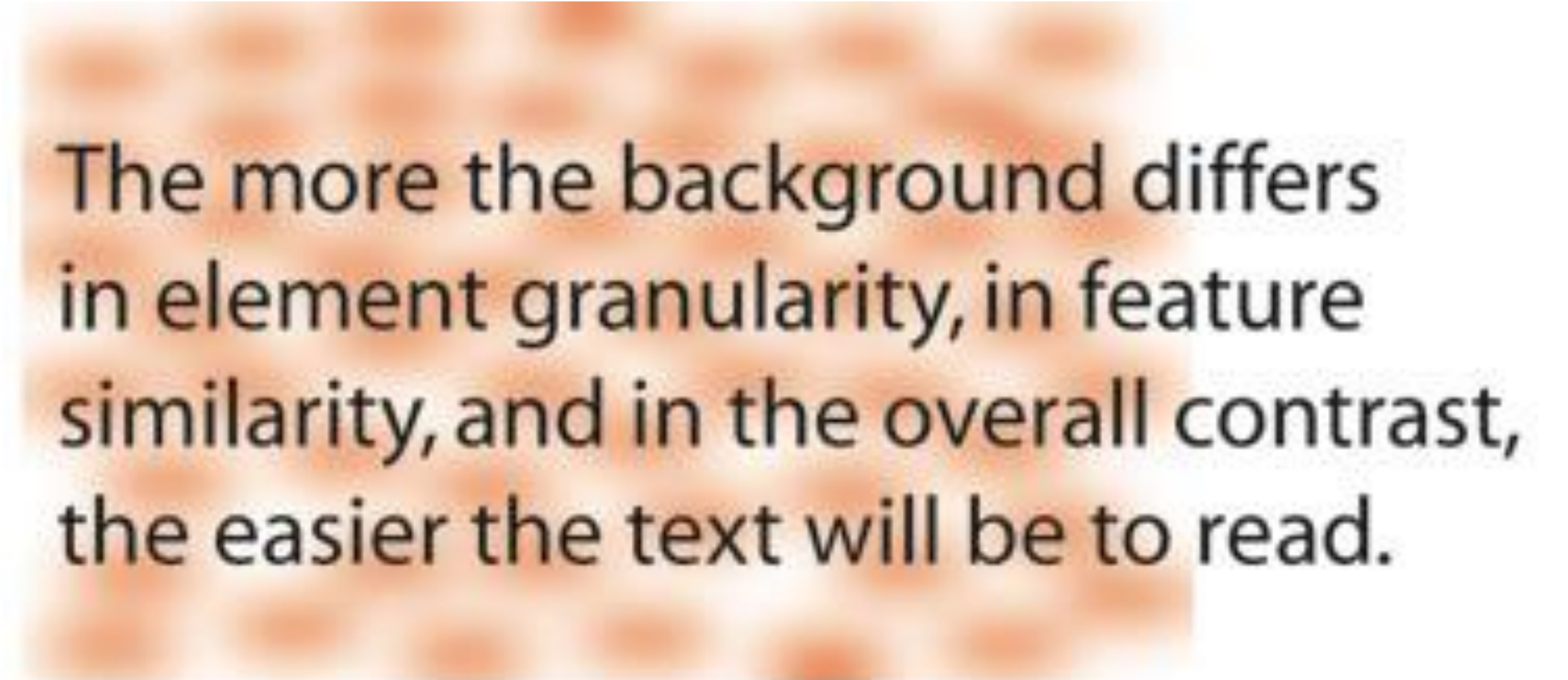
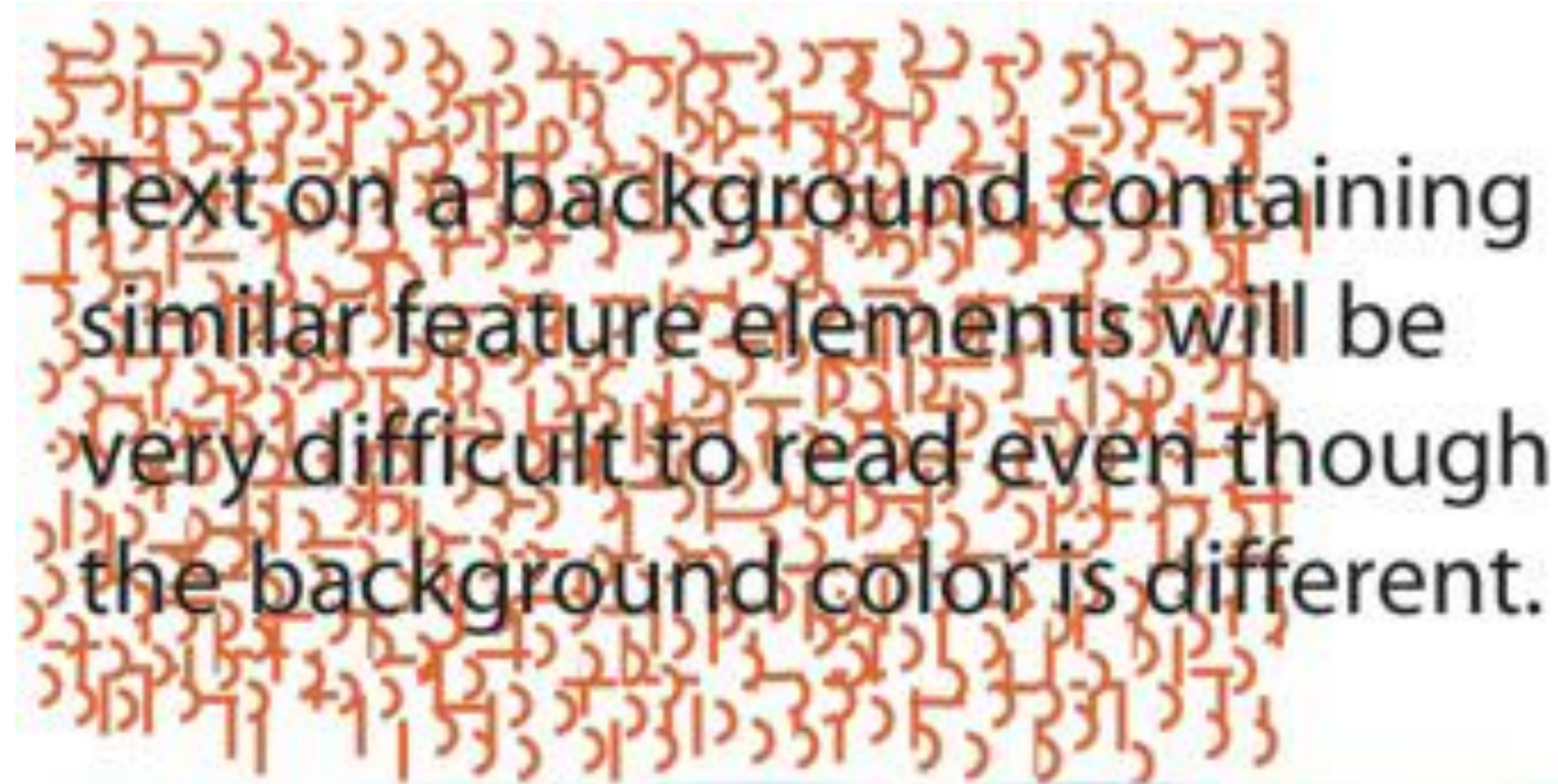
# Textures

easy

hard



# Textures: Interference



Subtle, low contrast background texture with little feature similarity will interfere less.

# More (13!) Color Design Tips

R1: Vivid colors (bright, saturated colors) stand out. They guide attention to a particular feature, generating the pop-out effect.

R2: An excessive amount of vivid colors is perceived as unpleasant and overwhelming; use them between duller background tones.

R3: Foreground-background separation works best if the foreground color is bright and highly saturated, while the background is de-saturated.

R4: Colors can be better discriminated if they differ simultaneously in hue, saturation and darkness.

R5: The low-end darkness steps should be very small, while the high end requires larger steps (Weber's Law).

R6: Discrimination is poorer for small objects. Hue, saturation and darkness discrimination all decrease.

R7: Complementary (opponent) colors are located opposite on the color wheel and have the highest chromatic contrast. When mixing opponent colors they may cancel each other, giving neutral grey.

R8: Some hues appear inherently more saturated than others. Yellow has the least number of perceived saturation steps (10). For hues on both sides of yellow, the saturation steps increase linearly.

R9: An opposite effect of R8 is that the brightest lights fall in the yellow range, while blues, violets (purples) and reds are least bright.

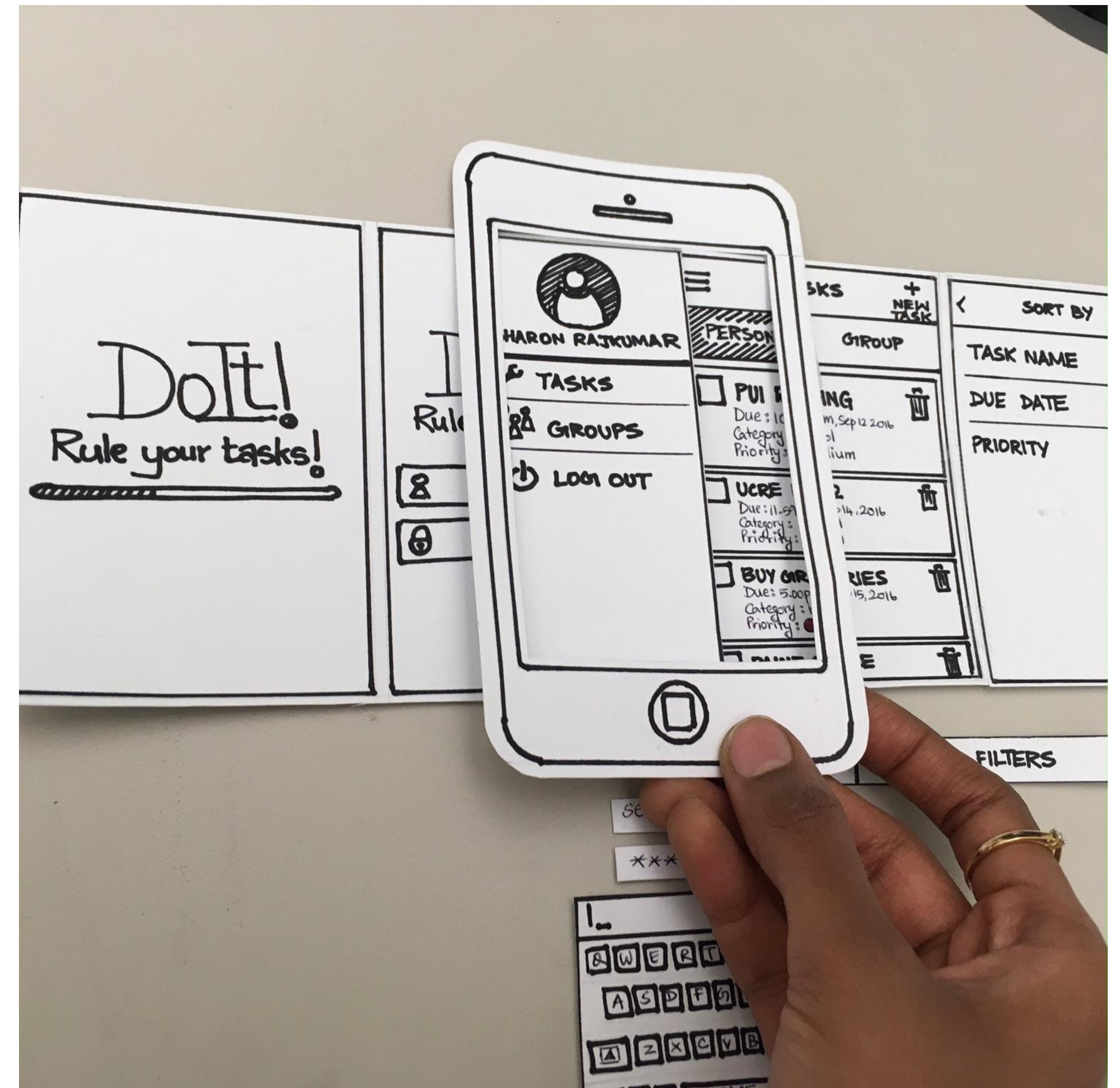
R10: For labeling, apart from black, white, grey, there are 4 primary colors (red, green, blue, yellow) and 4 secondary colors (brown, orange, purple, pink). Also, the number of color labels should be  $\leq 6-7$ .

R11: Warm colors (red, orange, yellow) excite emotions, grab attention. Cold colors (green to violet) create openness and distance.

R12: Important for hue-based labeling is the fact that increasing the darkness (and saturation) does not change the perceived hue.

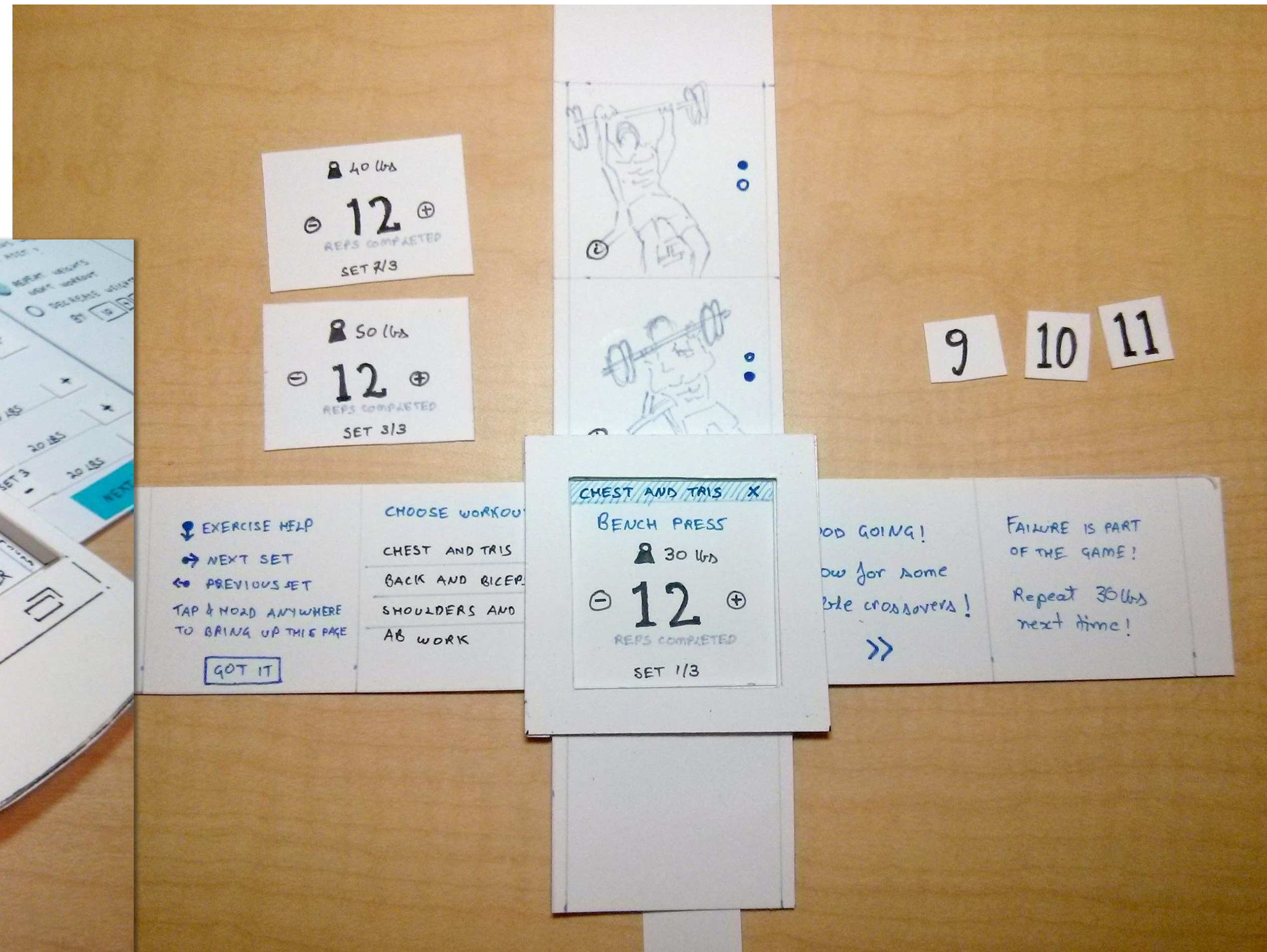
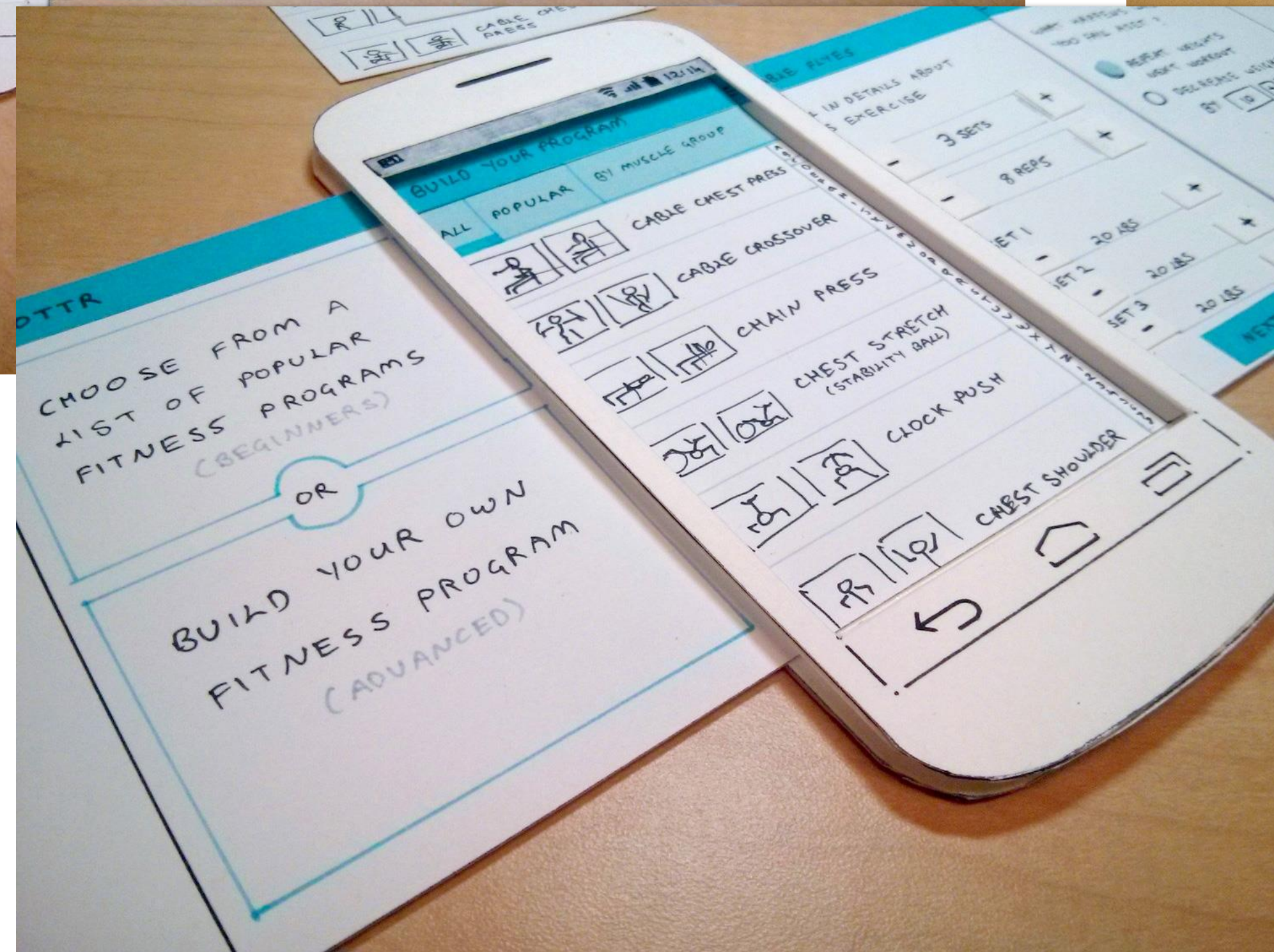
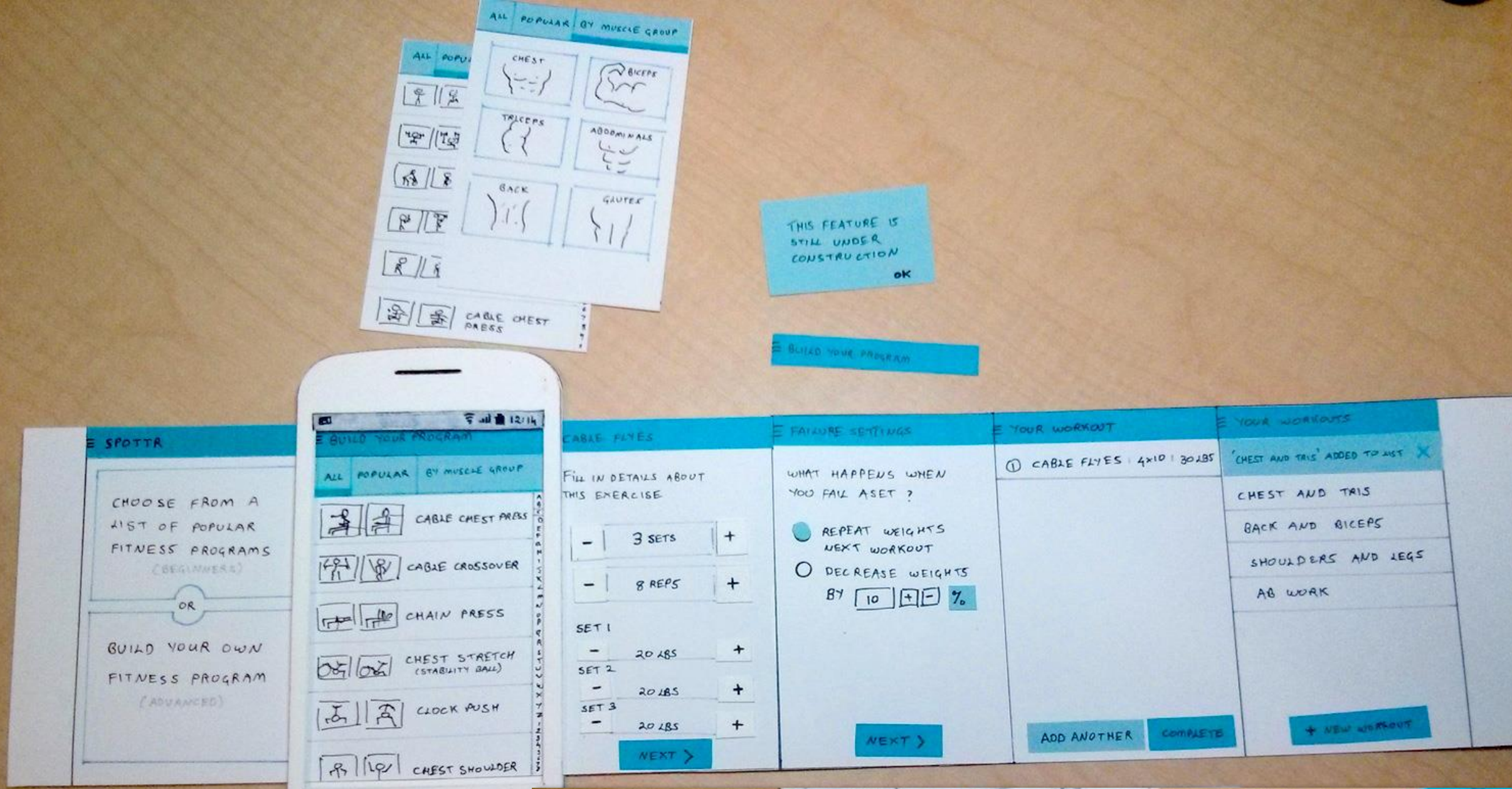
R13: Also important for labeling is that objects of similar hue are perceived as a group, while objects of different hues are perceived as belonging to different groupings.

# Paper Prototyping

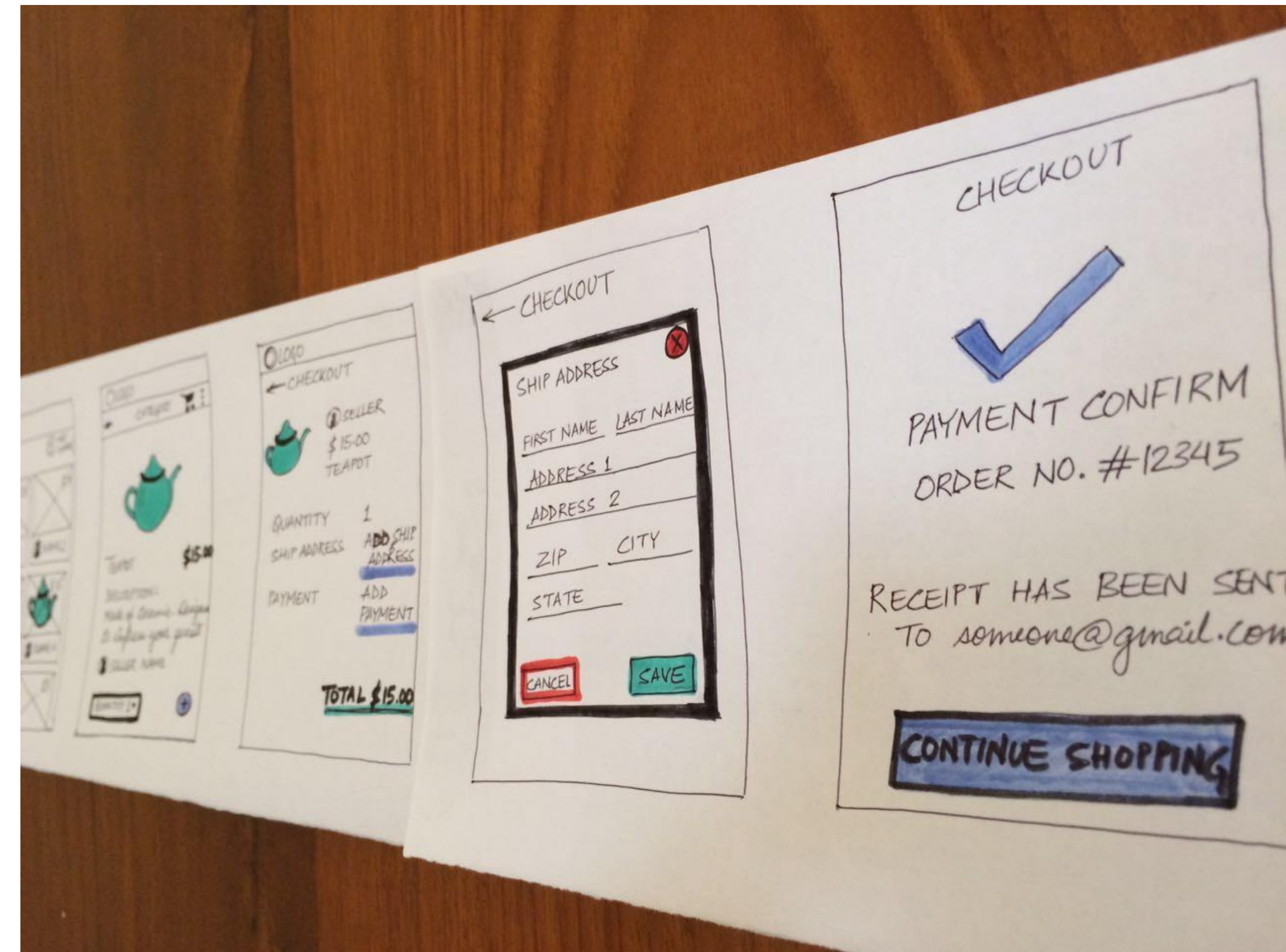
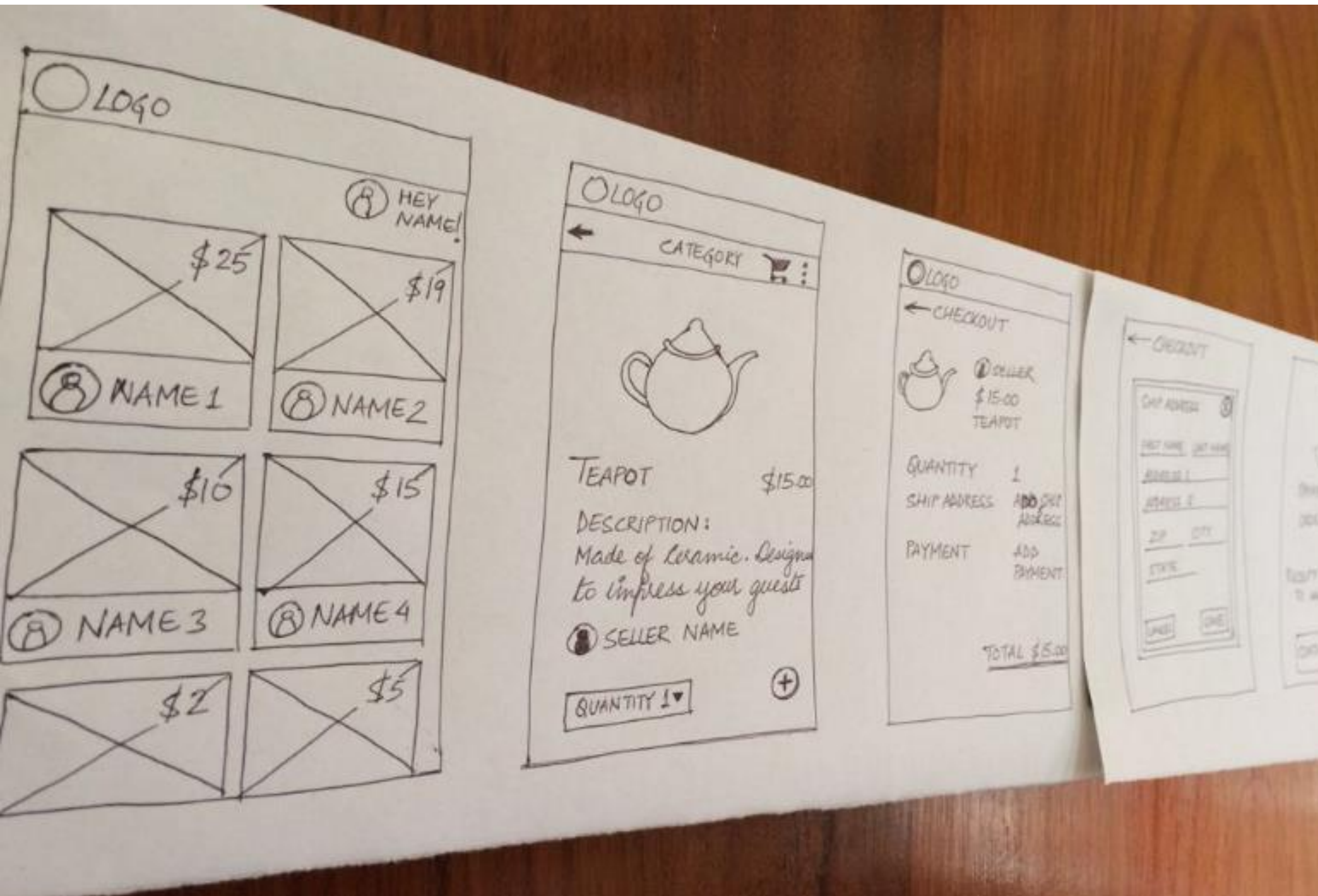




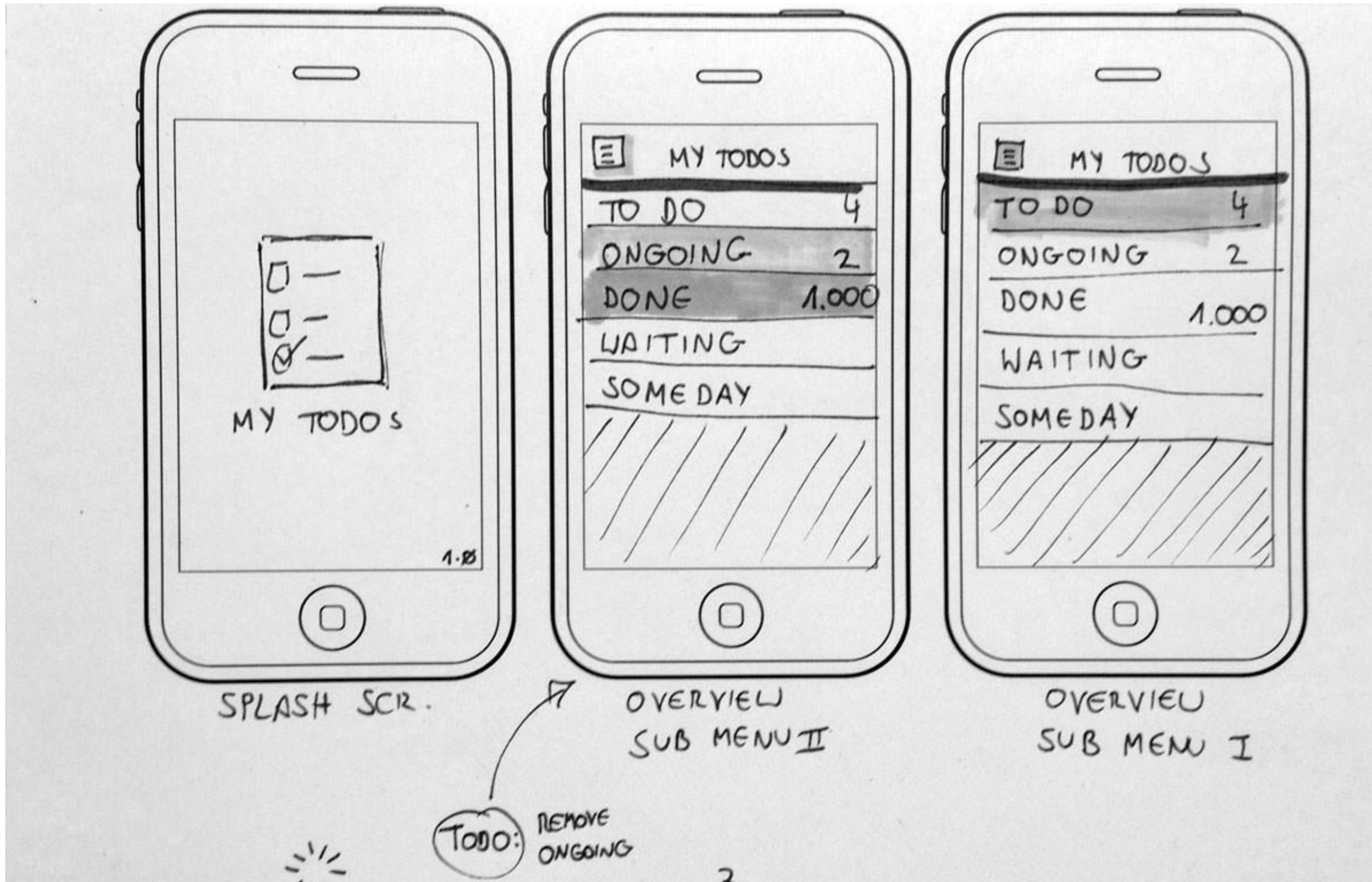
# Paper Prototyping



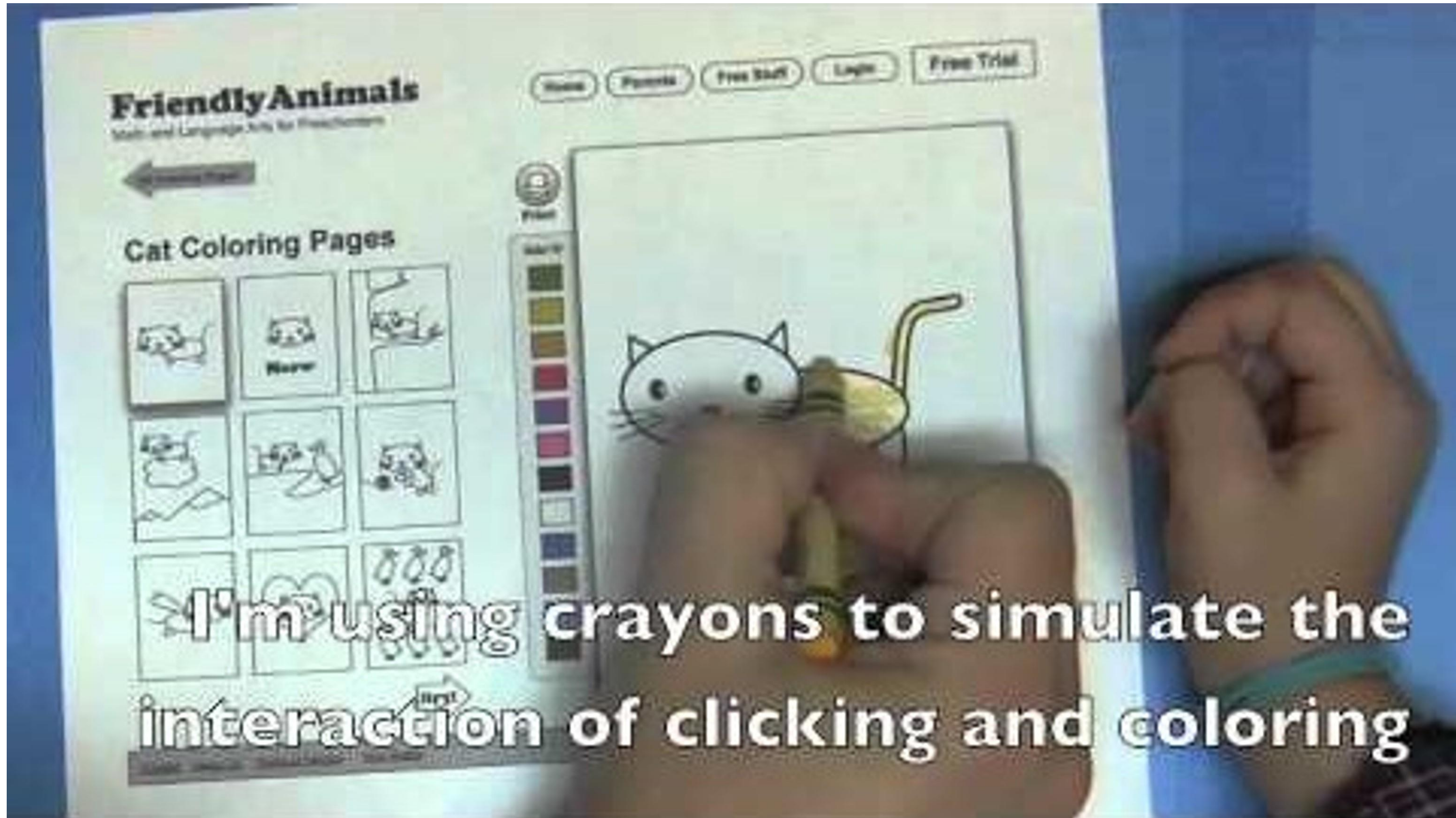
# Low Fidelity to High Fidelity



# Sketching of Interactivity



# Example Usability Test with a Paper Prototype



# COLORING PAGES



CAT

10 PAGES



PANDA

10 PAGES



GIRAFFES

10 PAGES



DOG



SNAKE

10 PAGES



FISH

10 PAGES

# IN-CLASS DESIGN STUDY— PUBLIC TRANSIT DEVELOPMENT

*~48 min total*

# For Next Time

[neu-ds-4200-f23.github.io/schedule/](https://neu-ds-4200-f23.github.io/schedule/)

Look at the upcoming assignments and deadlines

- Textbook, Readings, & Reading Quizzes—Variable days
- In-Class Activities—If due, they are due 11:59pm the same day as class

Everyday Required Supplies:

- 5+ colors of pen or marker
- White paper
- Laptop and charger

Use Slack for general questions, email [codydunne-and-tas@ccs.neu.edu](mailto:codydunne-and-tas@ccs.neu.edu) for questions specific to you.

Week 5: Interaction and Animation, Reduce and Embed	
<b>Tue, Oct 03</b> <i>Interaction, Animation (offset by 1 lecture)</i> Required Readings:  1 VAD Chapter 13—Reduce Items and Attributes  2 VAD Chapter 14—Embed: Focus + Context	<b>Fri, Oct 06</b> <i>Reduce and Embed (offset by 1 lecture)</i>  4—Altair basic charts due at 11:59pm
Week 6: Networks and Trees; Spatial, 3D, and SciVis	
<b>Tue, Oct 10</b> <i>Networks and Trees</i> Required Readings:  1 VAD Chapter 9—Arrange Networks and Trees	<b>Fri, Oct 13</b> <i>Spatial, 3D, and scientific visualization</i> Required Readings:  1 VAD Chapter 8—Arrange Spatial Data