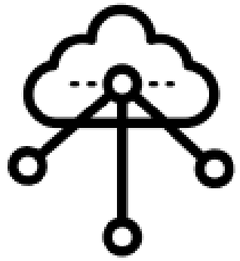
Visualization for Data Science
Perception 4 Design II

Perception in Visualization, Christopher G. Healey
Gestalt principles (part 1). Bang Wong. Nature Methods
Gestalt principles (part 2). Bang Wong. Nature Methods
Information Visualization: Perception for Design Chapter 6 Colin Ware
Dr. Alex Lex

Map



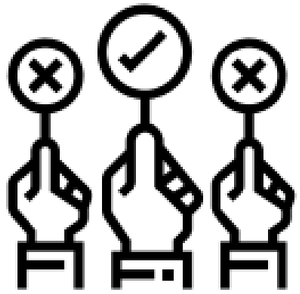
Visualization Theory:

- User-Centered Design
- Data Types
- What is the question?
- Who is the audience?
- What is the data?

Sketch

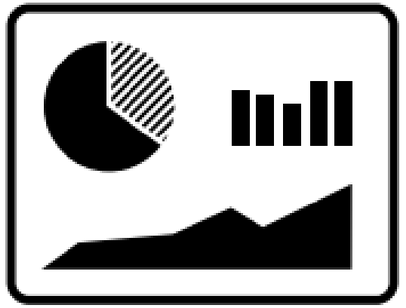
- Sketching
- Tufte's principles of visualization design
- Visual effectiveness
- Graphical Integrity

Decide



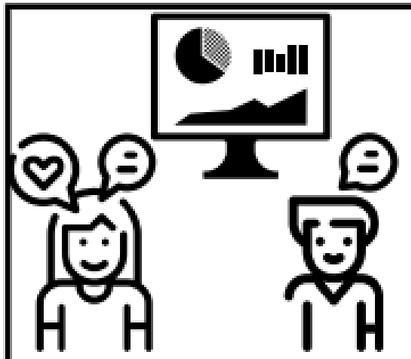
- Visual Perception
- Cognition
- Color design
- Gestalt principles

Prototype



- Basic Chart Types
- Maps
- Storytelling
- Graphic design
- Dashboards

Test



- Qualitative User Evaluation
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https://ieeexplore.ieee.org/document/9547834

Deconstruct Viz Game

- Specify the mark
- Specify the channels being used
- Discuss the effectiveness of the channels being used channel in terms of accuracy, popout, grouping, separability, and discriminability
- Pick one question that the viz can be used for

Channel Characteristics

- Discriminability: how many unique steps can we perceive?
- Separability: is our ability to use this channel affected by another one?
- Popout: can things jump out using this channel?
- **Grouping: can a channel show perceptual grouping of items?**
- Accuracy: how precisely can we tell the difference between encoded items?

Learning Outcomes

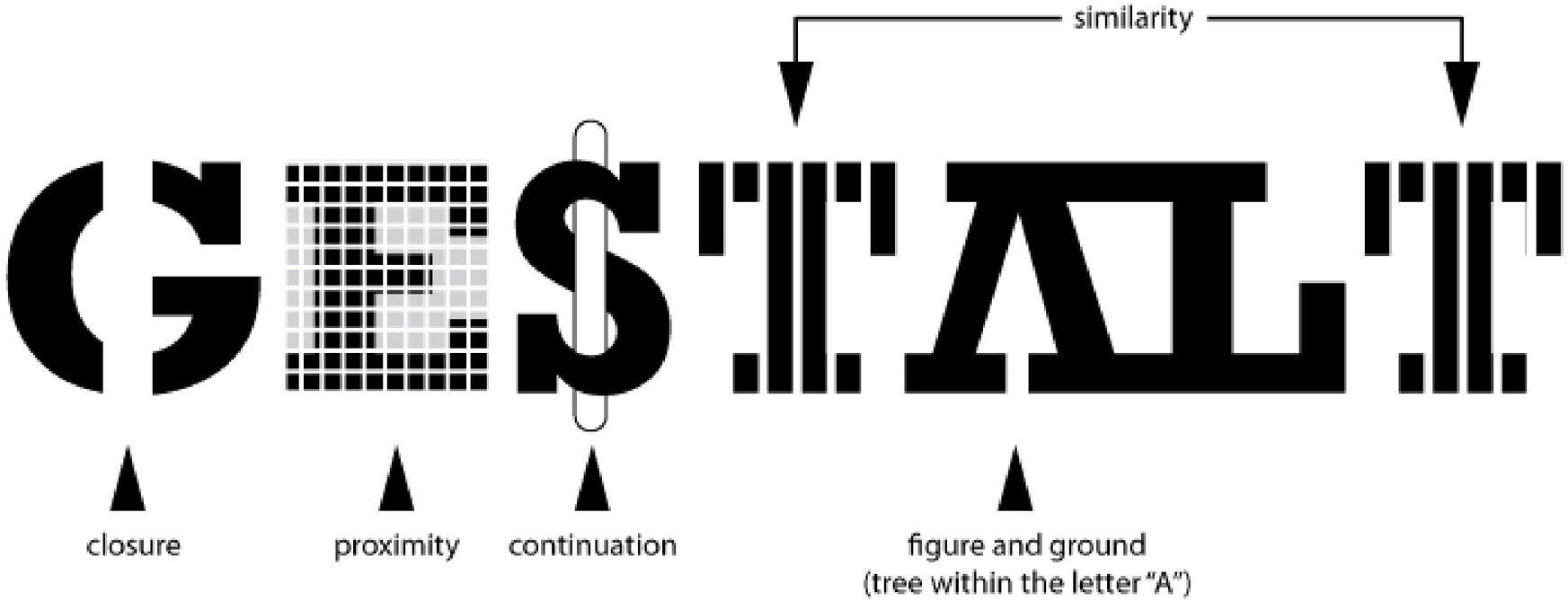
- Describe various grouping gestalt principles
- Describe various emergent gestalt principles
- Identify and critique visualization techniques based on their usage of gestalt principles.

Office hours start this week

- TA Office Hours
  - Tuesdays in RM 238 at 5pm
  - Wednesdays Online on Zoom at 5pm
  - Saturday Online on Zoom at 2pm
  - Sunday Online on EdStem at 4pm
- Instructor Office Hours
  - In Person RM 238 from 1 – 3pm on Wednesdays

Gestalt Principles

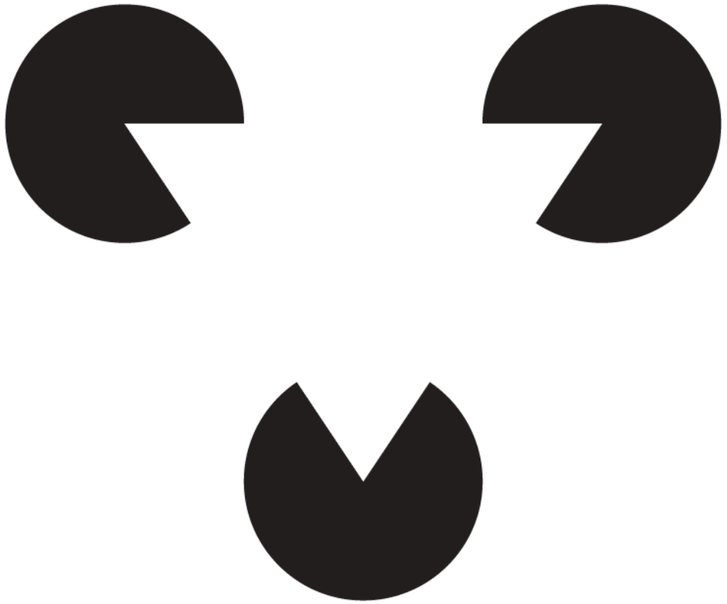
Theories/principles proposed by psychologists in the 1920s to explain how people organize/group information visually, in other words, the ways we visually assemble objects into groups.



Gestalt Basics

*“The whole is ‘**other**’ than the sum of its parts.”*
- Dr. Kurt Koffka

This is different from *‘the whole is **greater** than the sum of its parts’.*



Patterns that transcend the visual stimuli that produced them

Emergent semantics – by this we mean how we ascribe meaning to patterns that emerge from the combination of visual artifacts.

A non-visual representation of Gestalt principles

- **Similarity**: people tend to see things that physically resemble each other as part of the same object
- **Proximity**: how close elements are to one another. Similar things should be close to each other
- **Connection**: grouping effect; we perceive elements as connected to each other thanks to colors, lines, frames, or other shapes
- **Enclosure/Common Region** : we group elements that are in the same closed region
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- **Symmetry**: elements that are symmetrical tend to be perceived as a unified group
- **Figure & Ground**: Your brain distinguishes the foreground and the background
- **Closure**: our eyes tend to add any missing pieces of a familiar shape
- **Common Fate**: people will group together things that point to or are moving in the same direction

Basic 4: Similarity, Proximity, Connection & Enclosure

Perceive objects that

- look alike,
- are placed close together,
- connected by lines or
- enclosed in a common space

as belonging together.

Similarity

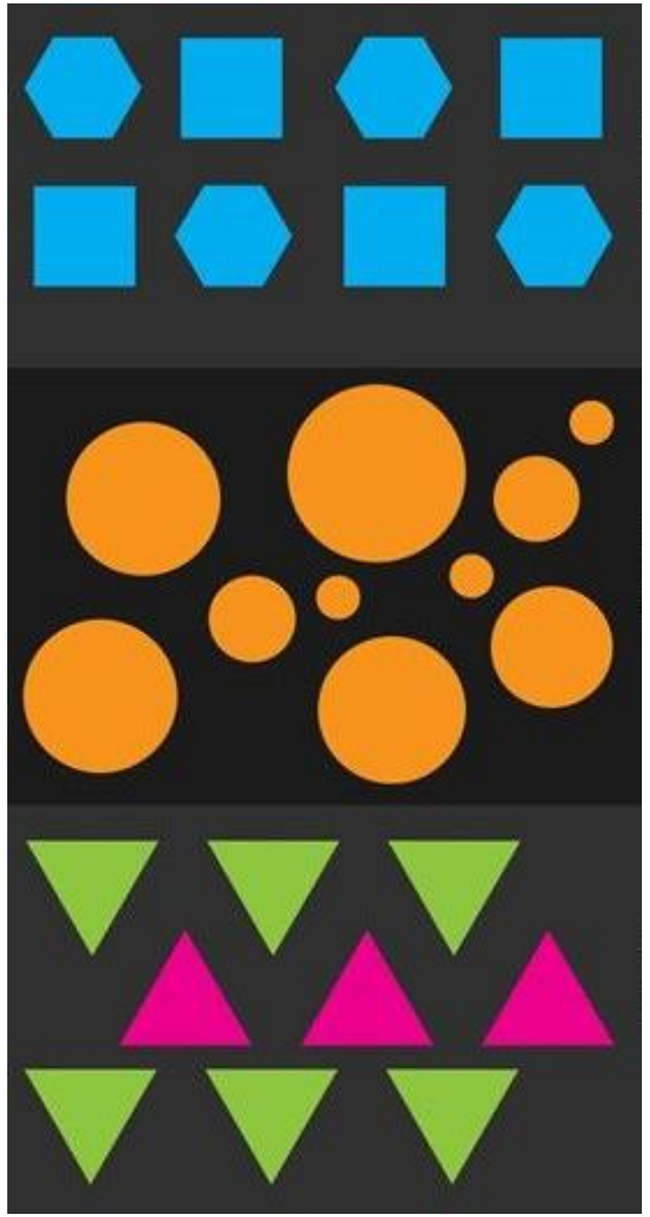
People tend to see things that physically resemble each other as part of the same group.

We typically use

- Shape
- Size
- Color

To organize visual items into groups.

Design Tip: Use the channel that is most effective to highlight the similarities in the data

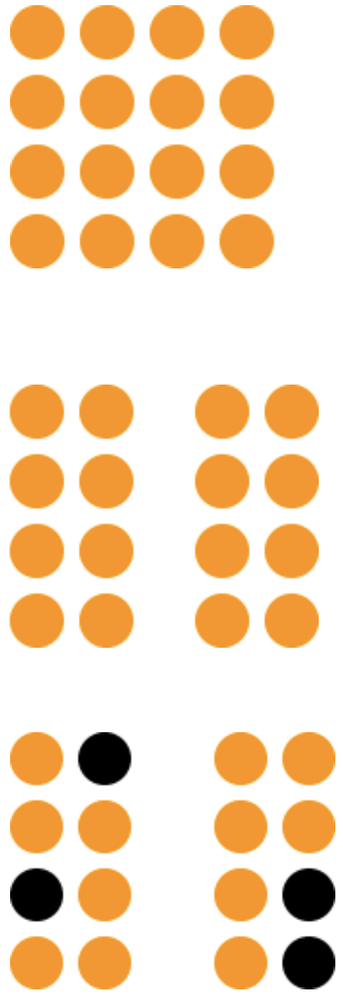


https://www.interaction-design.org/literature/article/the-law-of-similarity-gestalt-principles-1

Proximity

How close elements are to one another

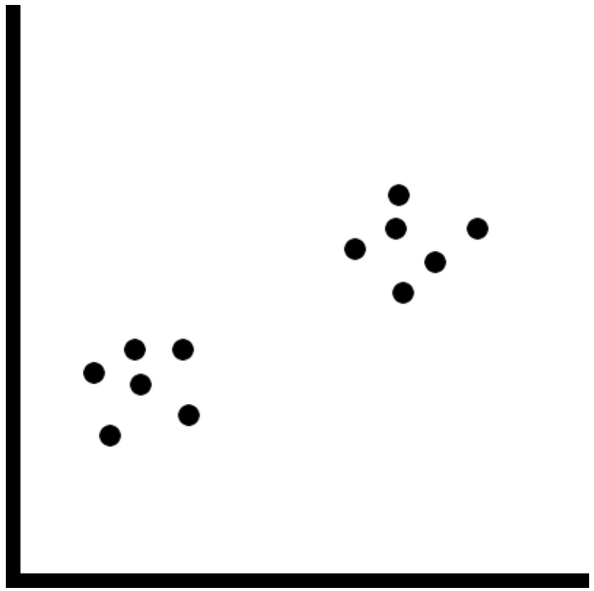
Could be categorized as a special case of similarity (focus is on spatial similarities)

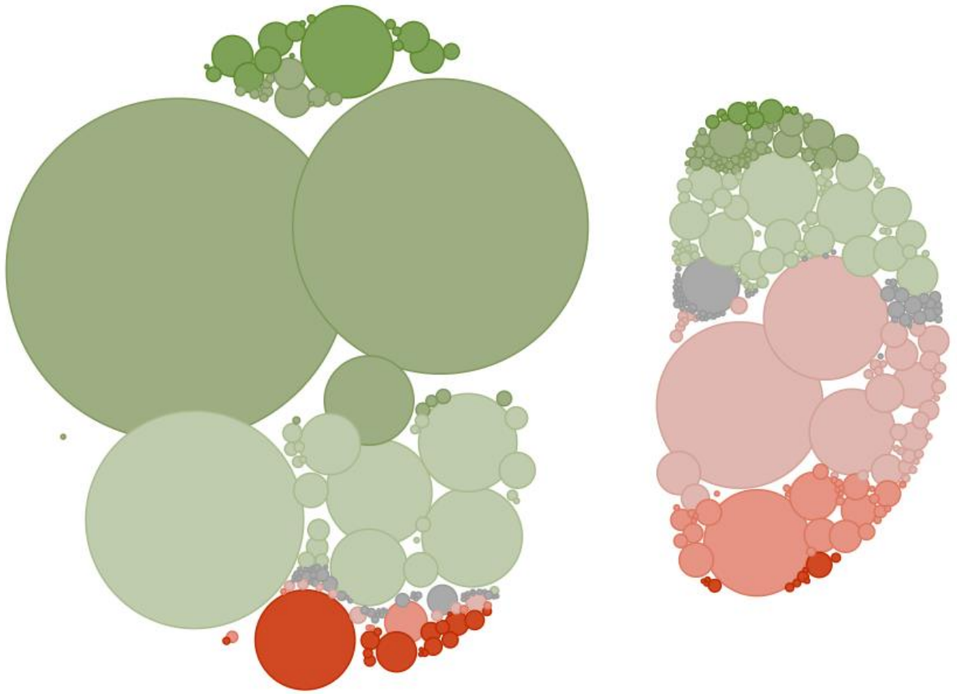


Andy Rutledge,“Gestalt Principles of Perception”

Proximity

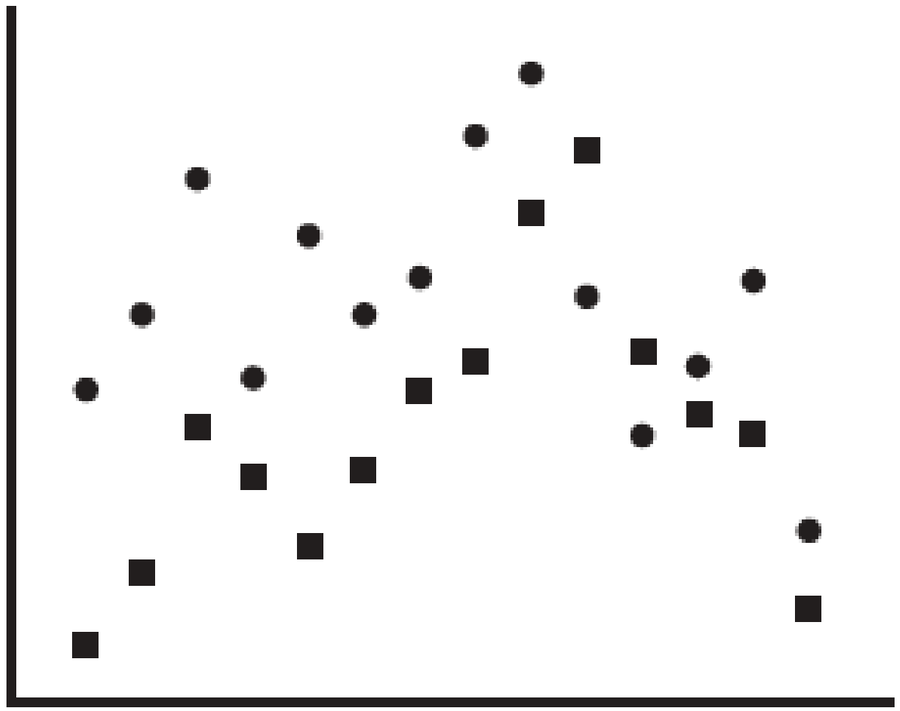
Design Tip: Similar things should be close to each other, group entities in close proximity

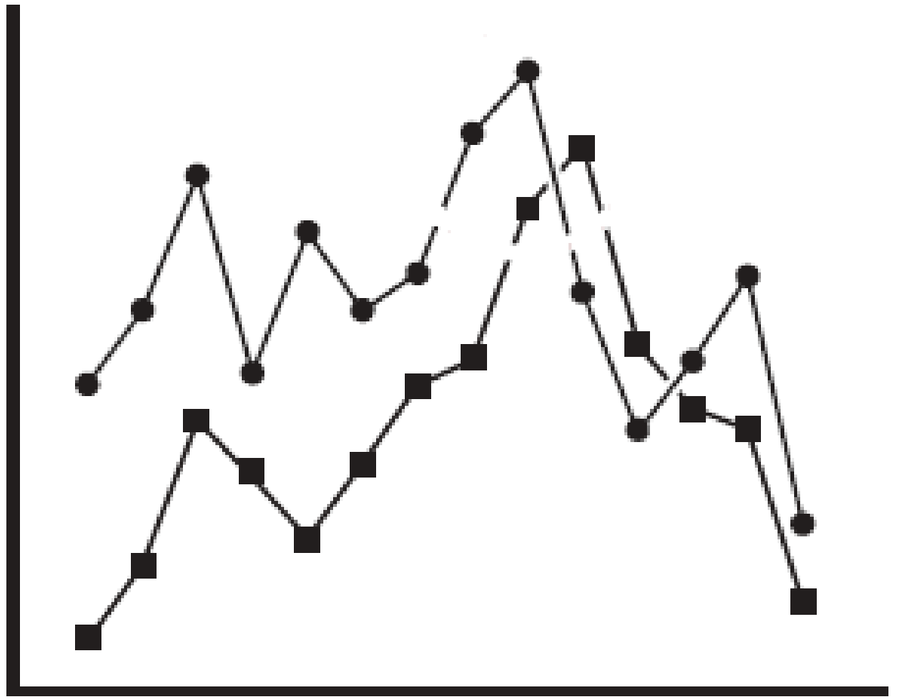




Connectedness

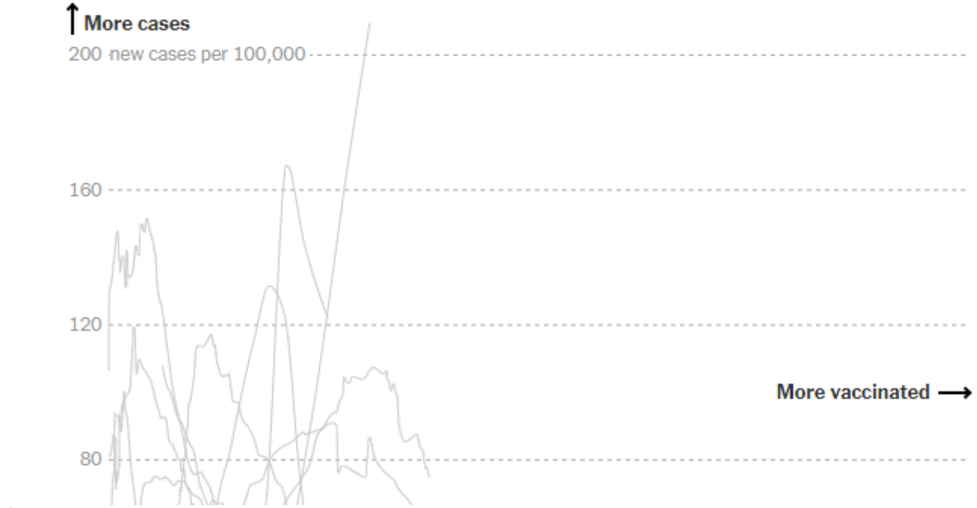
We perceive elements as connected to each other thanks to colors, lines, frames, or other shapes

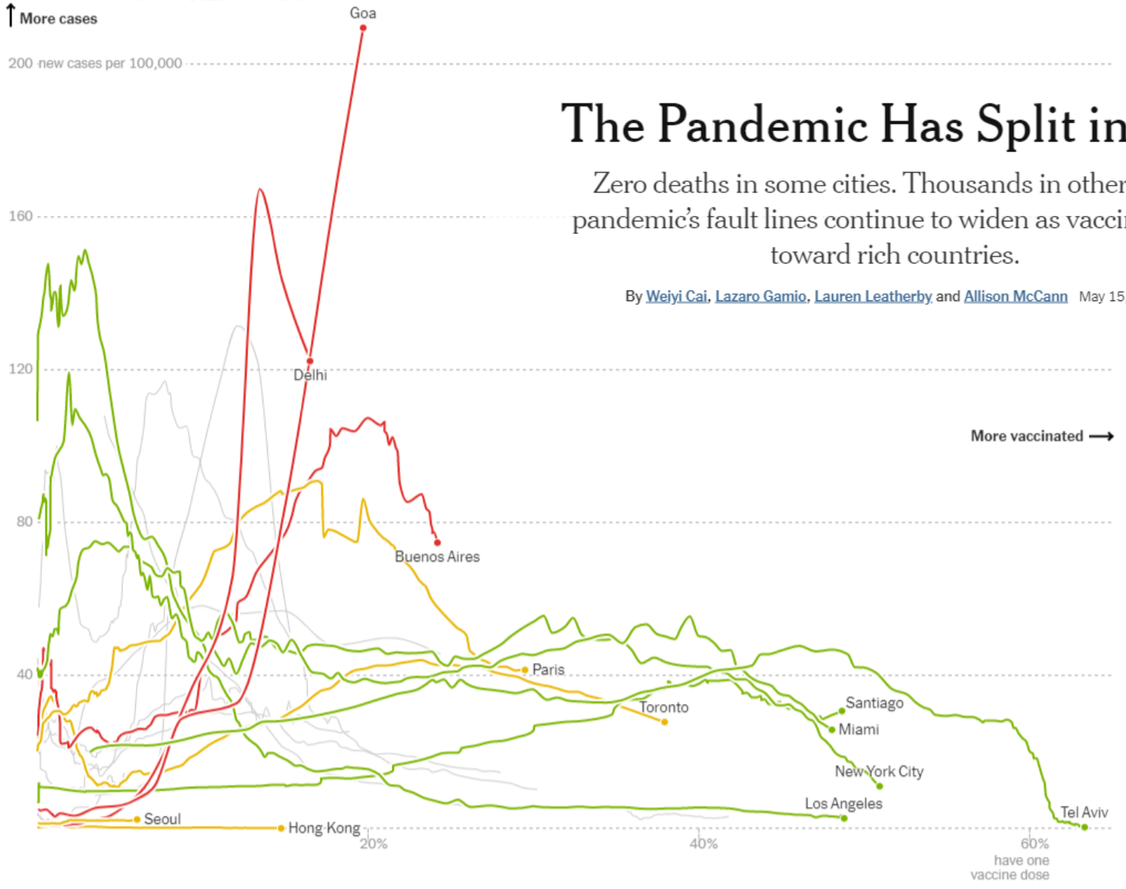




Visit for another example: https://www.nytimes.com/interactive/2021/03/05/us/vaccine-racial-disparities.html

Bang Wong, "Gestalt Principles, 1", Nature Methods

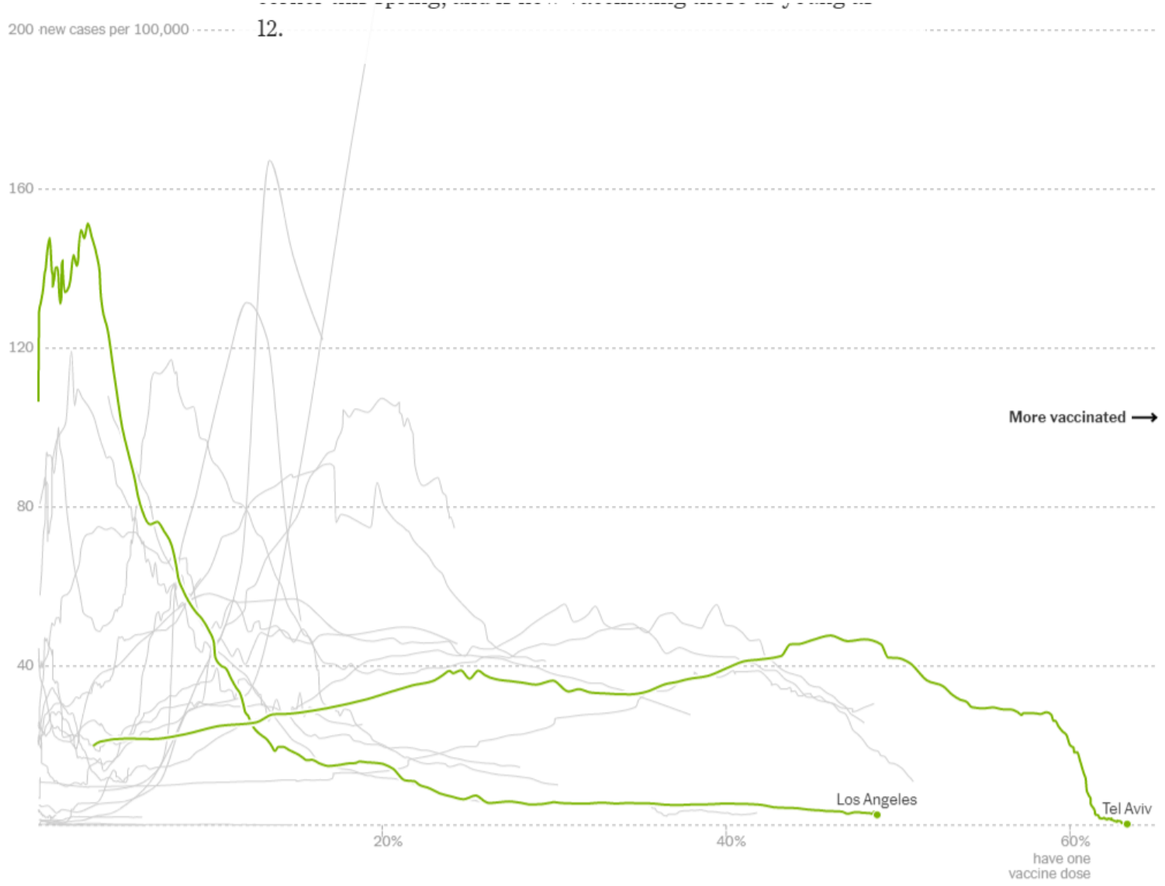




The Pandemic Has Split in Two

Zero deaths in some cities. Thousands in others. The pandemic's fault lines continue to widen as vaccines flow toward rich countries.

By Weiyi Cai, Lazaro Gamio, Lauren Leatherby and Allison McCann May 15, 2021



ν.nytimes.com/interactive/2021/05/15/world/covid-inequality-vaccines.html

Connectedness Varieties

Bubble Sets

Image by [Dinkla et al., 2011]
Technique by [Collins et al.,2009]

Line Sets

[Alper et al., 2011]

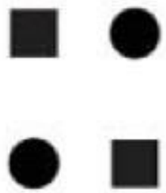
Kelp Diagrams

[Dinkla et al., 2012]

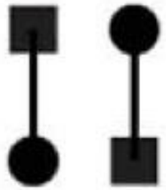
Enclosure / Common Region

We group elements that are in the same closed region

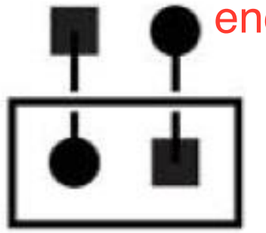
Enclosure is an effective way to draw attention to a group of objects.



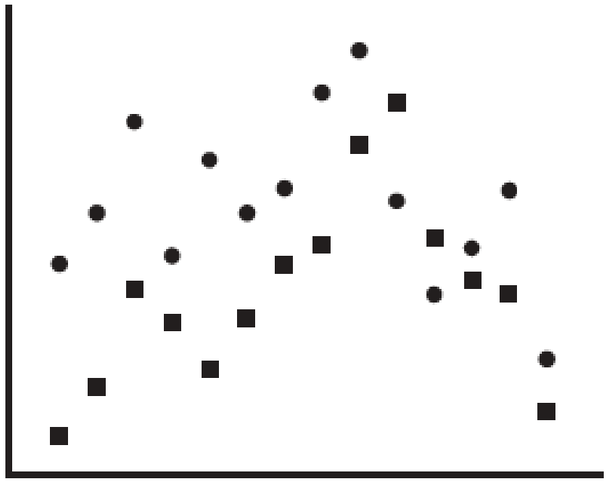
similarly

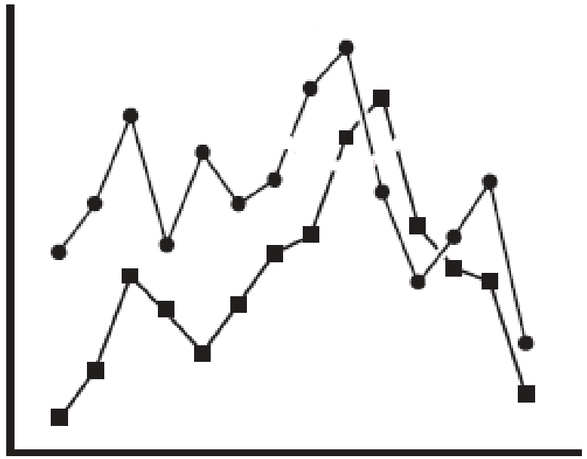


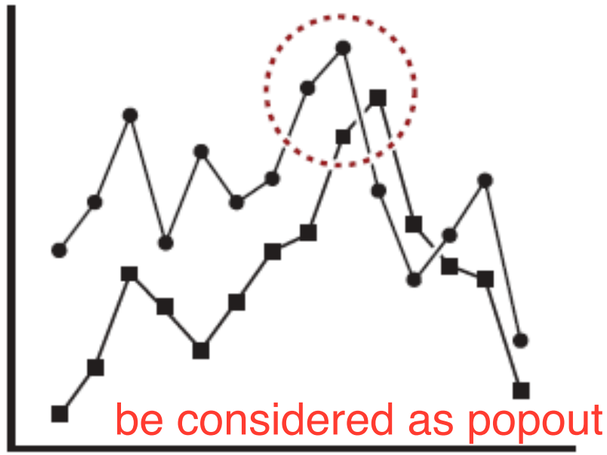
connectedness



enclosure







Design Tip: Use Gestalt principles of proximity, connectedness, and common region to associate written labels with graphical elements.

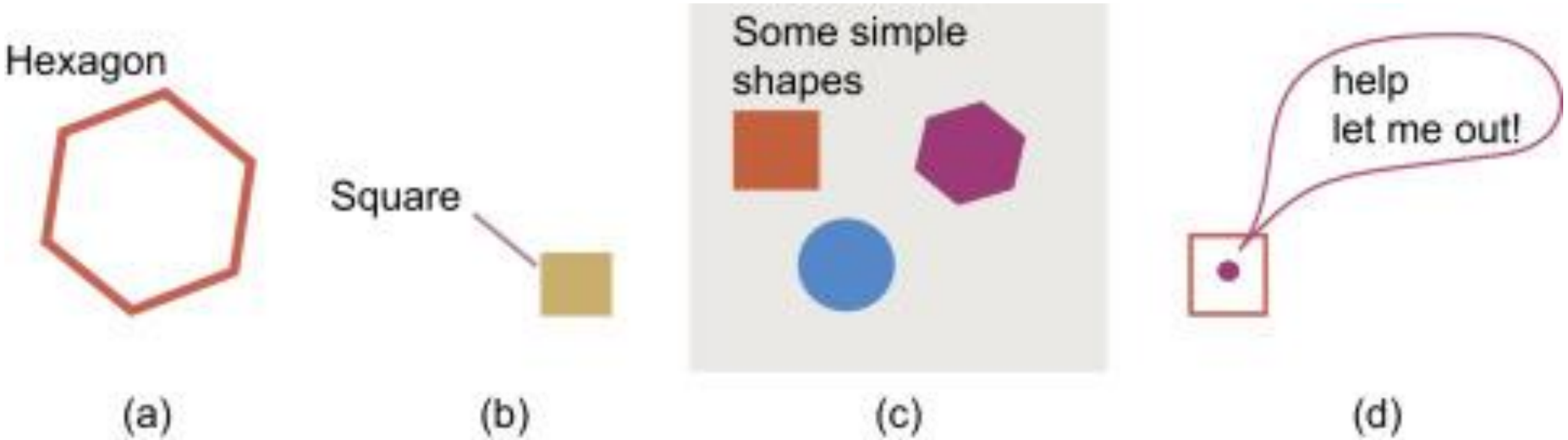


Figure 8.24. Gestalt principles used to guide the linking of text and graphics: (a) Proximity. (b) Continuity/connectedness. (c) Common region. (d) Common region combined with connectedness.

Information Visualization. Colin Ware.

Gestalt principles

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Gestalt Effects for “Emergence”

“Our visual system attempts to structure what we see into patterns to make sense of information” Bang Wong

Objects emerge and we assign meaning to them, through

- Visually interpolation
- Visually completion

We perceive things that may not exist

Continuity

Because of visual interpolation our internal representation tends to be smooth and continuous.

Objects that create a continuous pattern or are seen as being connected appear to be grouped together

We move our eyes from one object to another

Bang Wong, “Gestalt Principles, II”, Nature Methods

Continuity

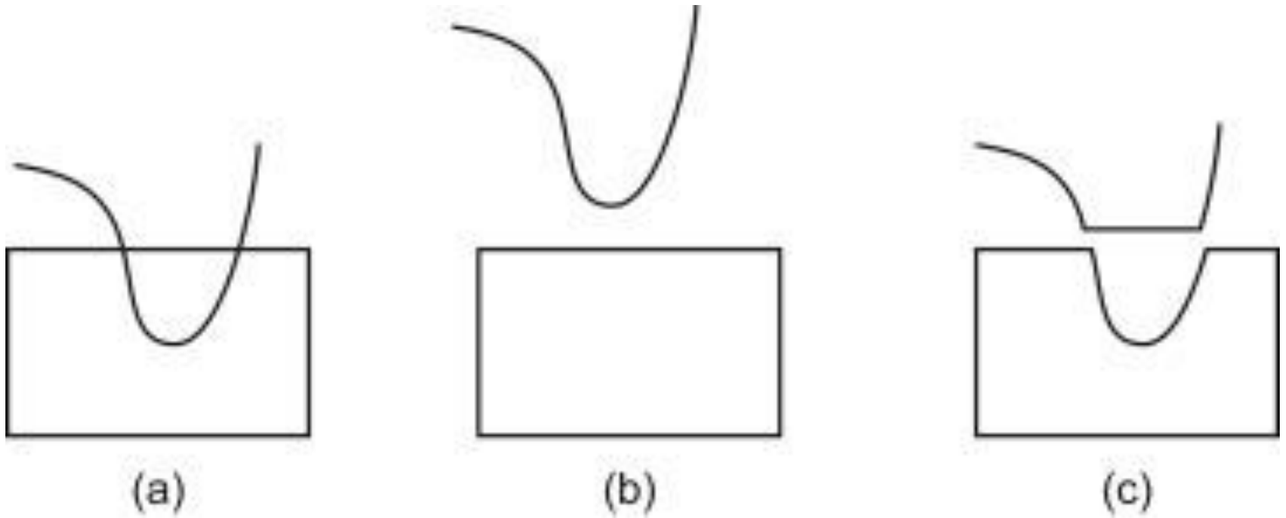
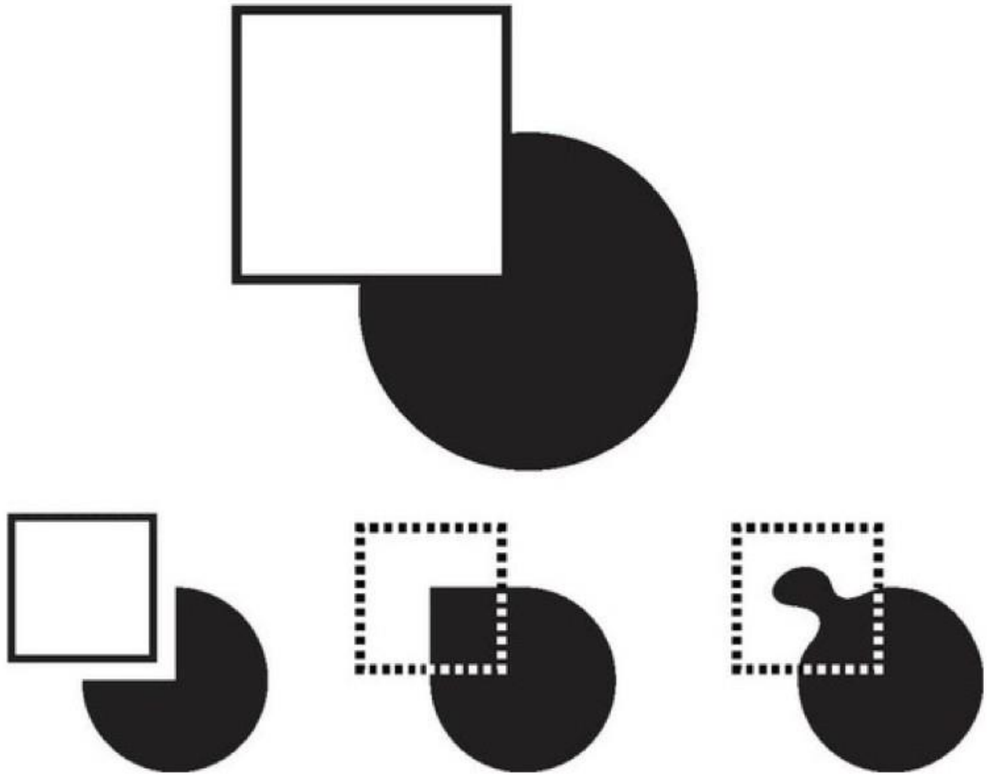


Figure 6.6. Information Visualization. Perception for Design Colin Ware

Closure

Because of visual completion we have a strong tendency to seen shapes as continuous, our eyes (remember the 3 stages of visual processing) tends to add any missing pieces and forms familiar shapes

A closed contour tends to be seen as an object.



Bang Wong, “Gestalt Principles, II”, Nature Methods

Closure / Completion

Symmetry

Elements that are symmetrical tend to be perceived as a unified group

“The pairs of lines shown in Fig. 6.9(b) are perceived more strongly as forming a visual whole than the lines with parallel symmetry (Fig. 6.9a). Also, when edges instead of lines are used, symmetry is more difficult to perceive if the polarity is reversed on the edges (Fig. 6.9(c)).”

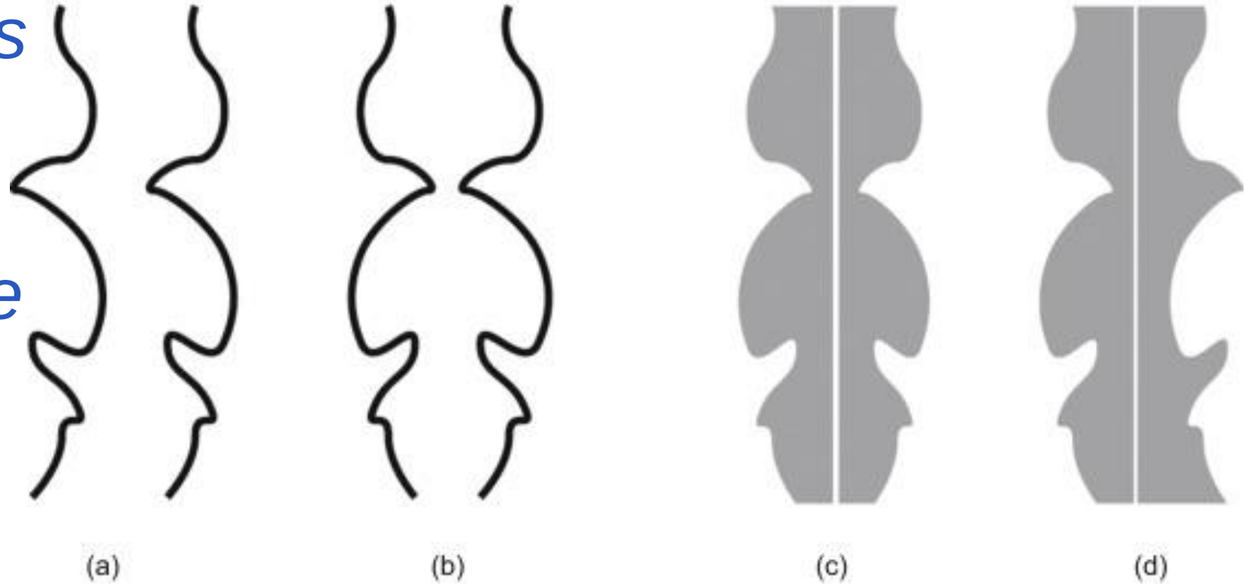
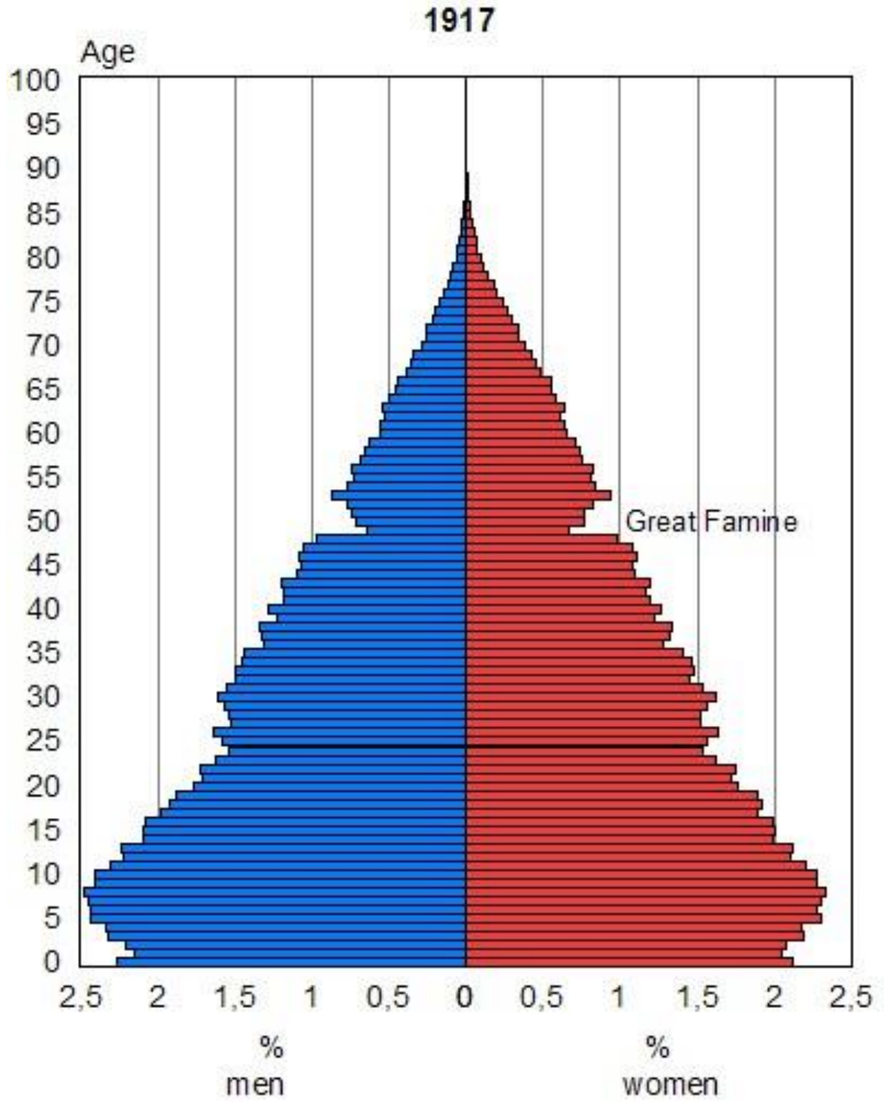
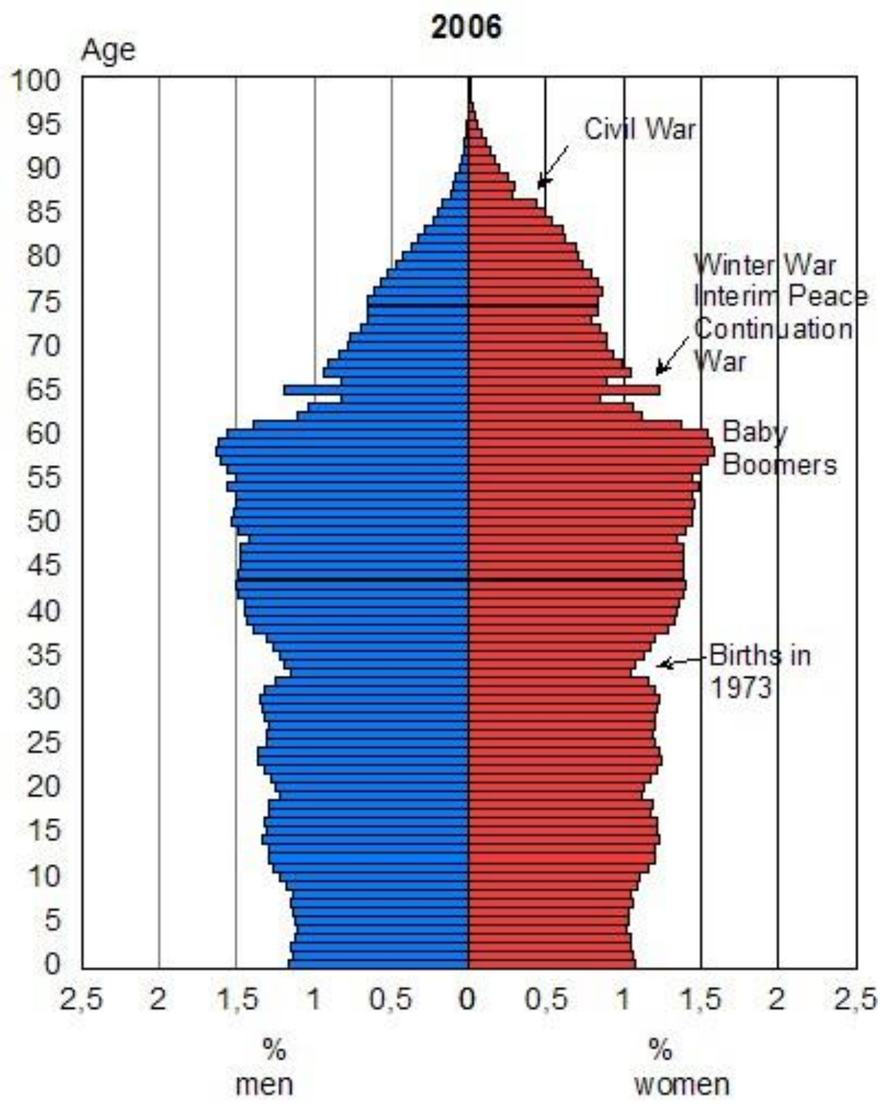
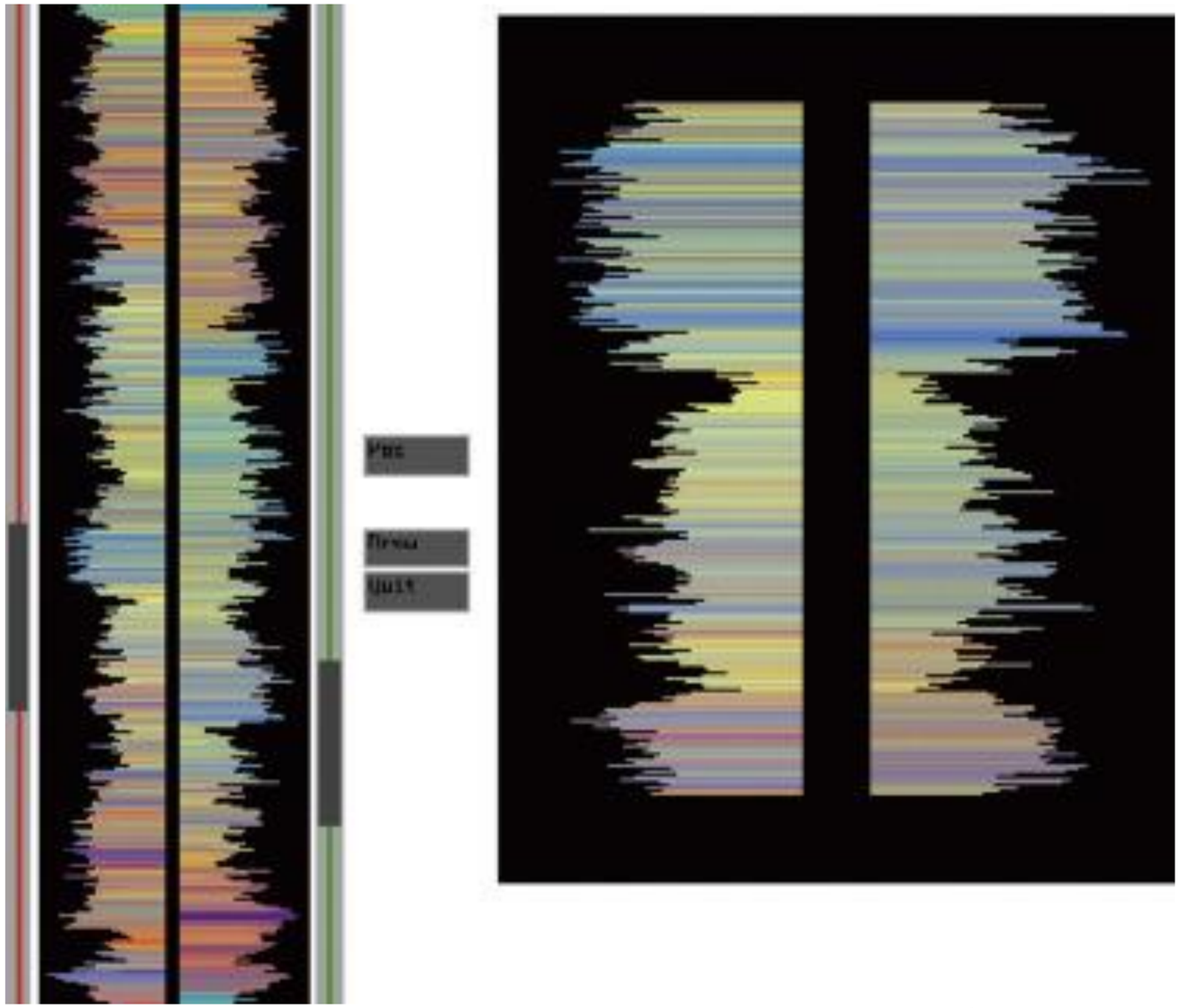


Figure 6.9. Information Visualization. Perception for Design Colin Ware

Symmetry Example: Population Pyramid







should be small

Figure 6.10. Information Visualization. Perception for Design Colin Ware

Figure / Ground

Your brain distinguishes the foreground and the background

usually smaller

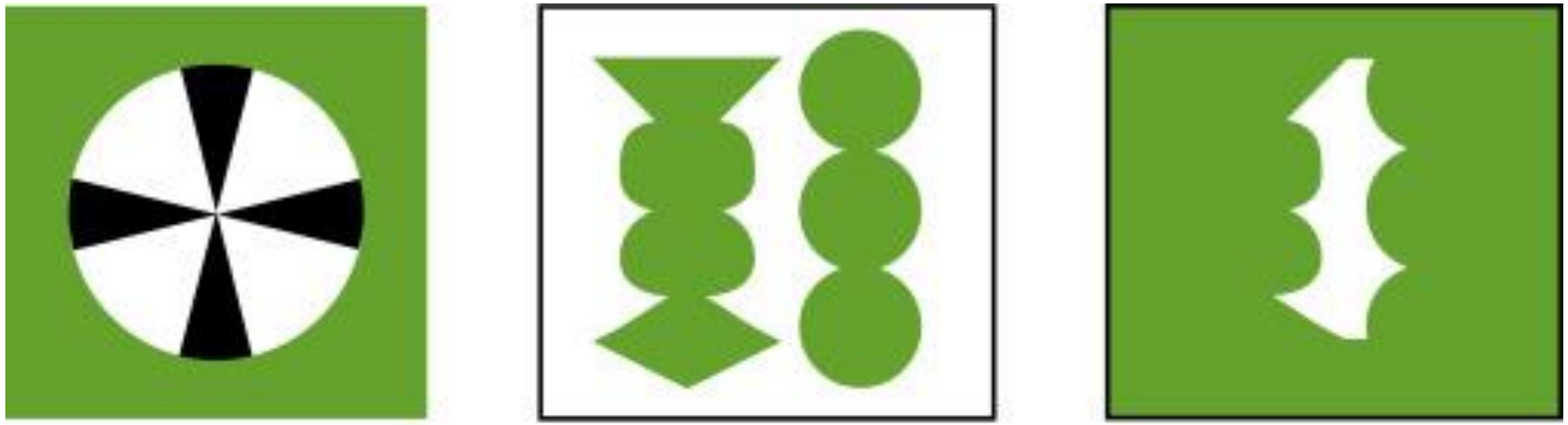


Figure 6.10. Information Visualization. Perception for Design Colin Ware

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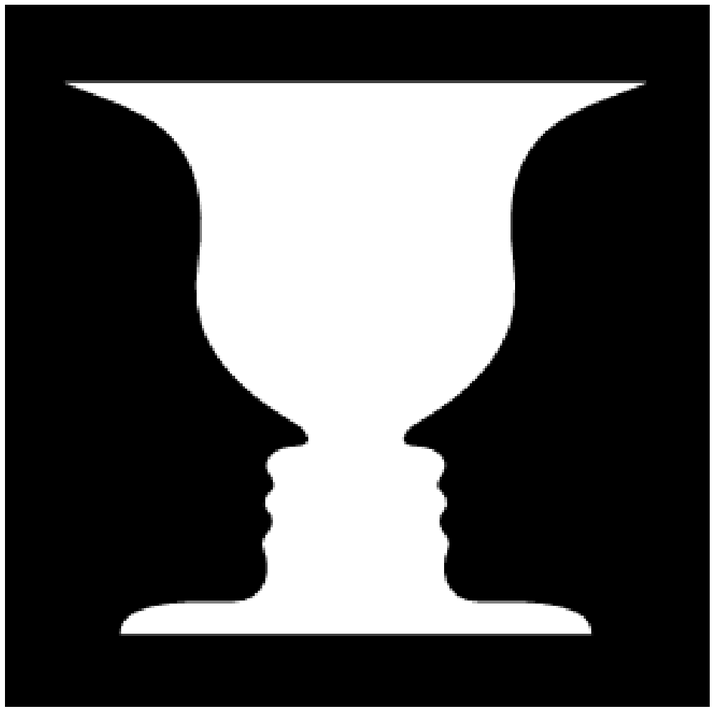

CQ: Which Gestalt Principle is Used in the Following Image

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combine all

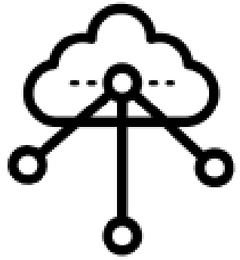
Deconstruct Viz Game

- For your viz technique mention if any of the gestalt principles are being used for grouping
- In addition, if any of the other emergent gestalt principles are being used discuss as well.

Next on Viz

- Lab 3 due on Thursday
- Assignment 2 due on Wednesday Feb 1st

Map



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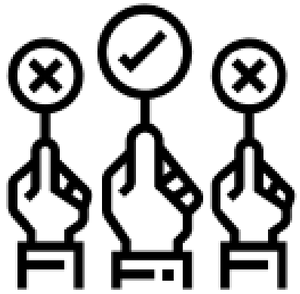

- Visual Perception
- Cognition
- Color design
- Gestalt principles

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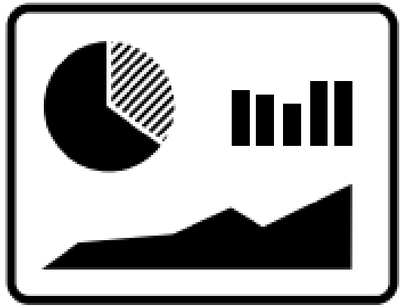

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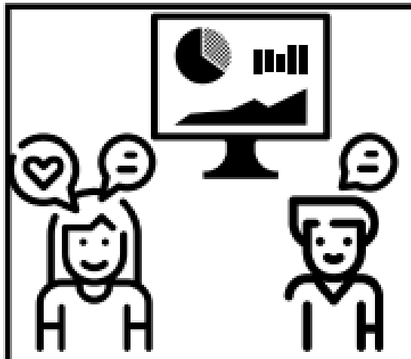

- Qualitative User Evaluation
- Think Aloud Study
- Re-Design

https://ieeexplore.ieee.org/document/9547834

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