Module #3c:
Principle of Grouping

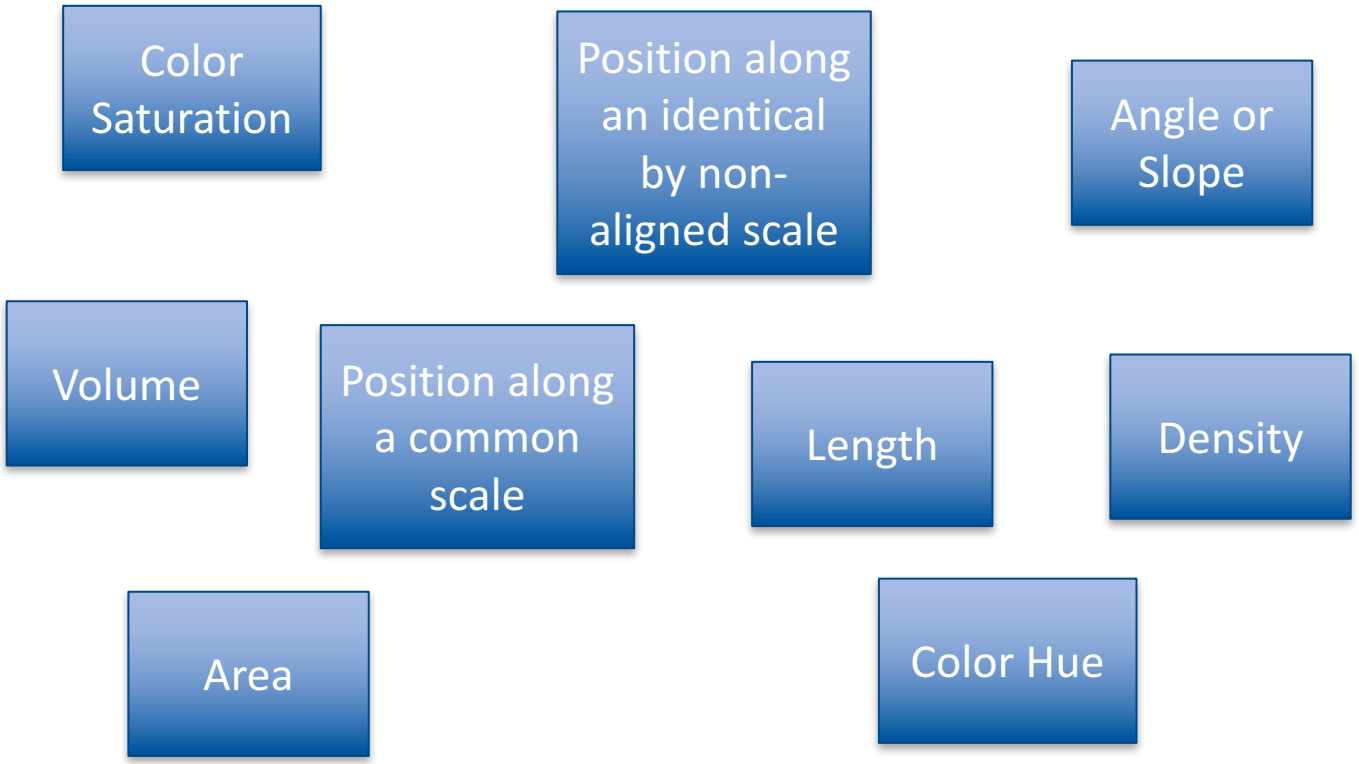
The Visual Variables

- Eight “visual variables”
  1. Position
  2. Mark
  3. Size
  4. Brightness
  5. Color
  6. Orientation
  7. Texture
  8. Motion

- During mapping, we convert attribute values to these visual properties

Relative Interpretation

- Not all visual variables are equal
- Study by Cleveland and McGill examined accuracy of human perception and produced a ranking



Graphical Perception: Theory, Experimentation, and Application of the Development of Graphical Methods. William S. Cleveland and Robert McGill. JSTOR. 1984.

Relative Interpretation

- Not all visual variables are equal
- Study by Cleveland and McGill examined accuracy of human perception and produced a ranking

1. **Position along a common scale**
   - Scatter plot, Points on a map
2. **Position along an identical but non-aligned scale**
   - Scatter plot matrix
3. **Length**
   - Bar chart
   - Histogram
4. **Angle and slope**
   - Pie chart
   - Gradient lines
5. **Area**
   - Treemap
   - Bubble chart
6. **Volume, density, and color saturation**
   - 3D visualization
   - Heat map
7. **Color hue**
   - Color scales

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Principle of Grouping

- The principles of grouping are a set of principles in psychology to account for the observation that humans naturally perceive objects as organized patterns and objects

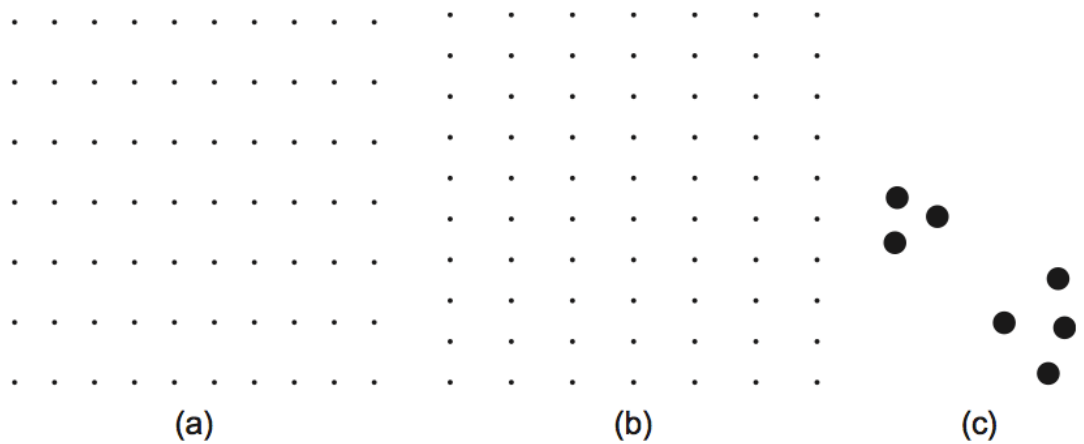
- First proposed by Gestalt psychologists

Gestalt Laws

1. Proximity
2. Similarity
3. Connectedness
4. Continuity
5. Symmetry
6. Closure
7. Figure and Ground

Proximity

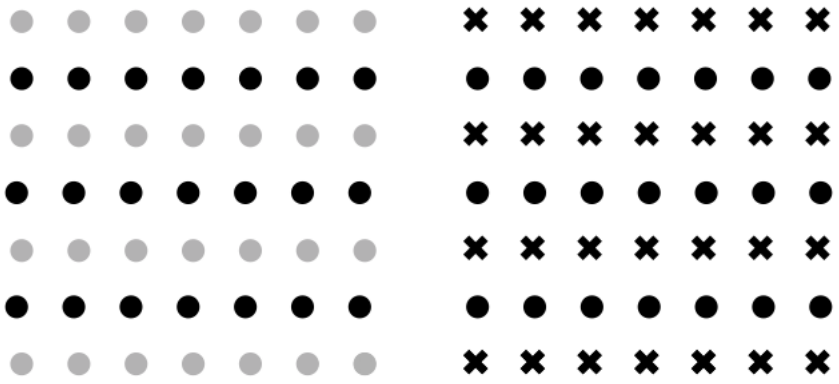
- Items positioned near each other are perceptually grouped together.



- Implication:
  - **Marks representing related information should be positioned close together.**

Similarity

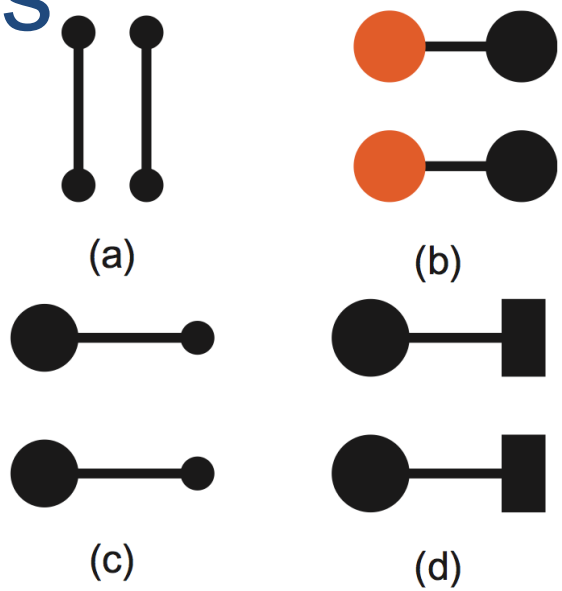
- Items with a similar appearance are perceptually grouped together.



- Implication:
  - **Use similar graphics define rows, columns or other groupings of marks.**

Connectedness

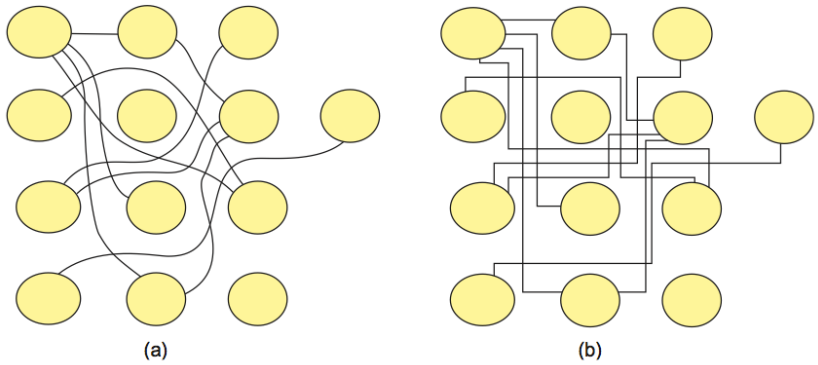
- Connecting marks also define groups
  - Typically more powerful than proximity or similarity
  - Not part of original Gestalt principles



- Implication:
  - **Use connectors to link grouped marks**
  - Caveat:
    - Adds “ink” to the screen, making it “messier” than proximity and similarity ***(visual complexity)***

Continuity

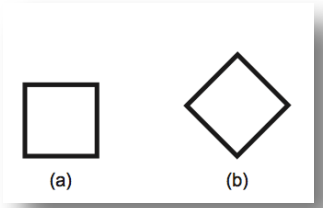
- Our minds more naturally interpolate smooth shapes
  - Which paths are easier for you to trace?



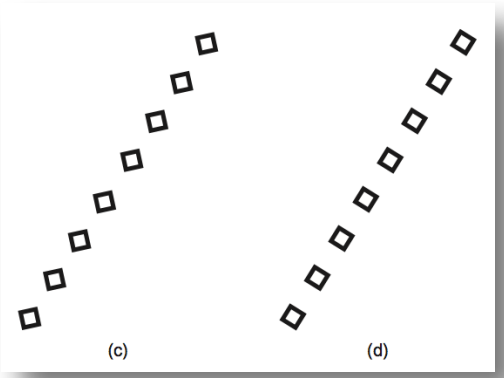
- Implication:
  - **Avoid discontinuities or abrupt changes in shape**
  - e.g., curves instead of “Manhattan”-style lines

Symmetry

- We seek balanced, symmetric interpretations of shape
  - In isolation, we use **horizontal** and **vertical** axes

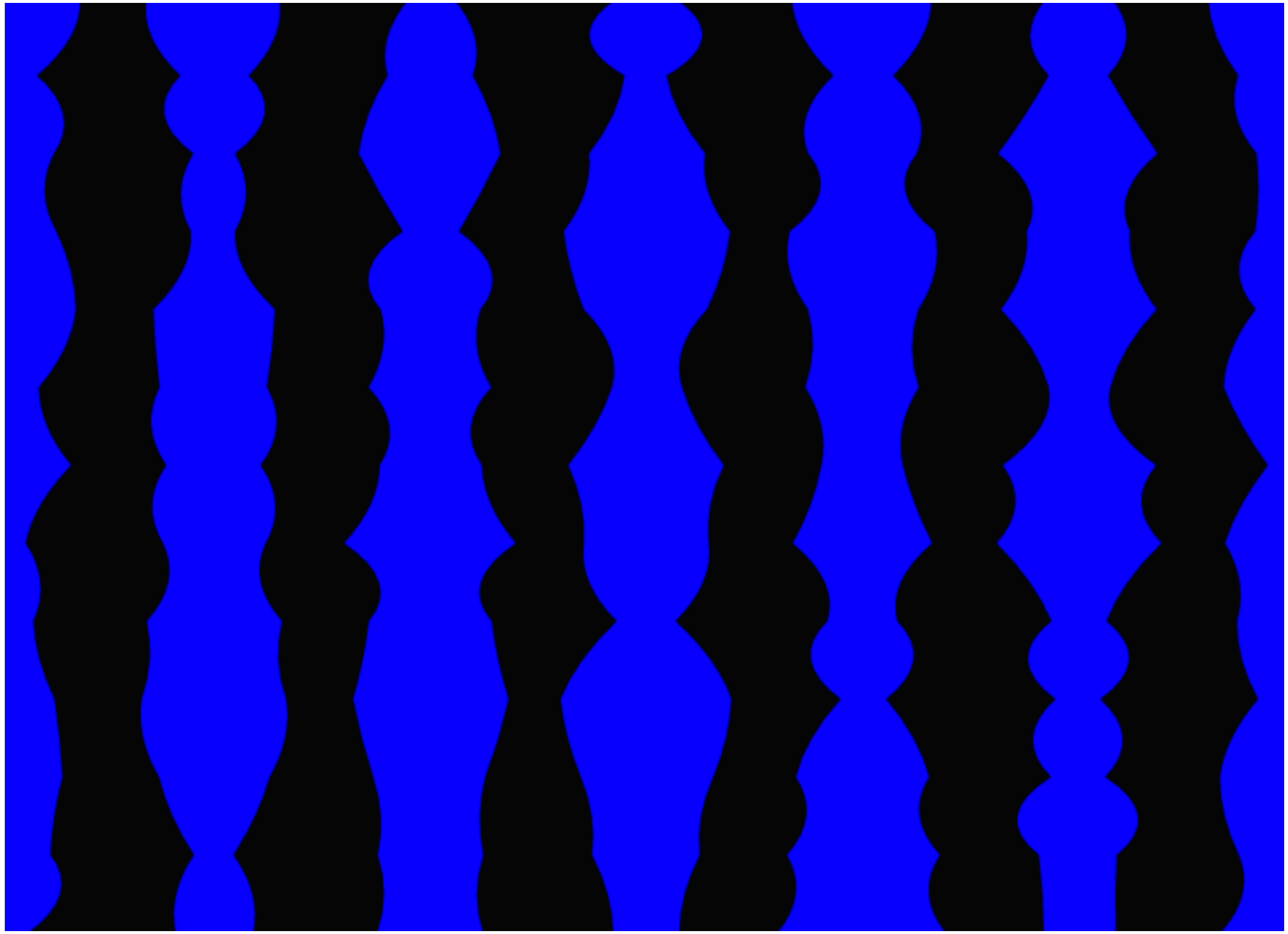


- **Larger patterns** can provide alternative frames of reference



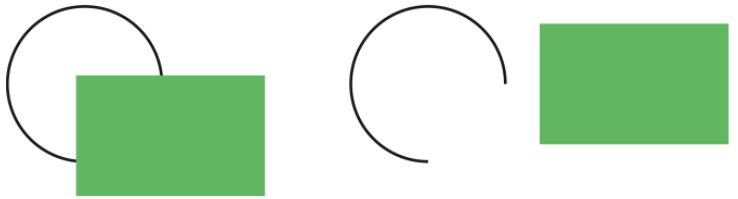
- Implication:
  - **Use axes or other frames of reference to support the intended interpretation of your design**

Symmetry



Closure

- We tend to perceive closed contours.

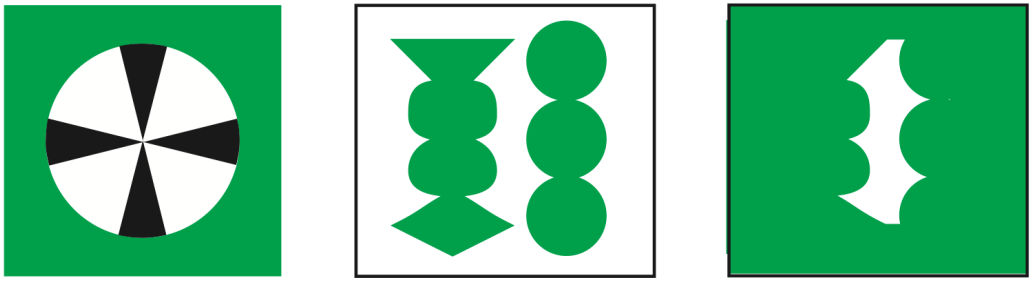


- Our minds attempt to “complete” a shape, guessing what is behind an occluding object

- Implications:
  - Occluding shapes **can produce incorrect assumptions**
  - **Background contours** (and other containing boundaries) can effectively **denote groups** even if partially obscured

Figure and Ground

- Smaller parts of a pattern are perceived as “in the foreground” (the *figure*)
- Larger parts appear “in the background” (the *ground*)



(a) (b) (c)

- Implication:
  - Smaller areas within larger boundaries will be the objects which users first attempt to interpret for meaning

Conclusion

- **Visual Variables** and **Gestalt Laws** give us “ground rules for design”
  - What can be controlled?
  - How are those things perceived?

- Based on rules…
  - Define **mapping function** to convert **data** to a **geometric representation**

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