Perception II

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CS 294-10: Visualization
Fall 2007

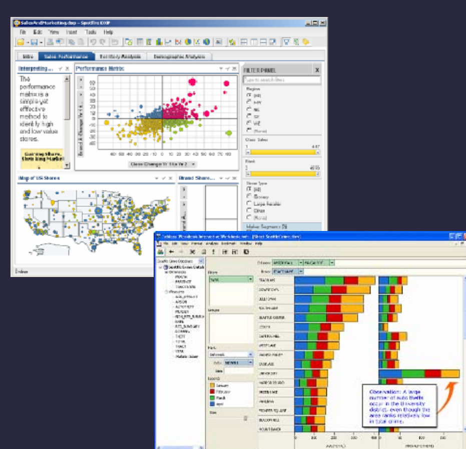
Assignment 2: Creating Visualizations

Use existing software to formulate & answer questions

First steps
- Step 1: Pick a domain
- Step 2: Pose question
- Step 3: Find data
- May need to iterate

Create visualization
- Interact with data
- Question will evolve
- Tableau or Spotfire DXP

Make wiki notebook
- Keep record of all steps you took to answer the questions



Due before class on Sep 24, 2007

Cleveland and McGill

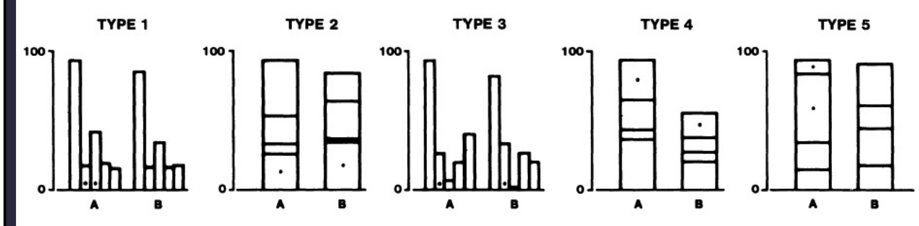


Figure 4. Graphs from position–length experiment.

[Cleveland and McGill 84]

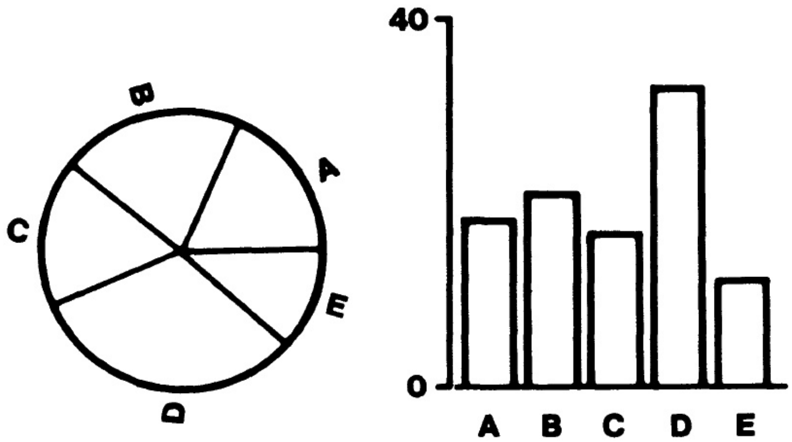


Figure 3. Graphs from position–angle experiment.

[Cleveland and McGill 84]

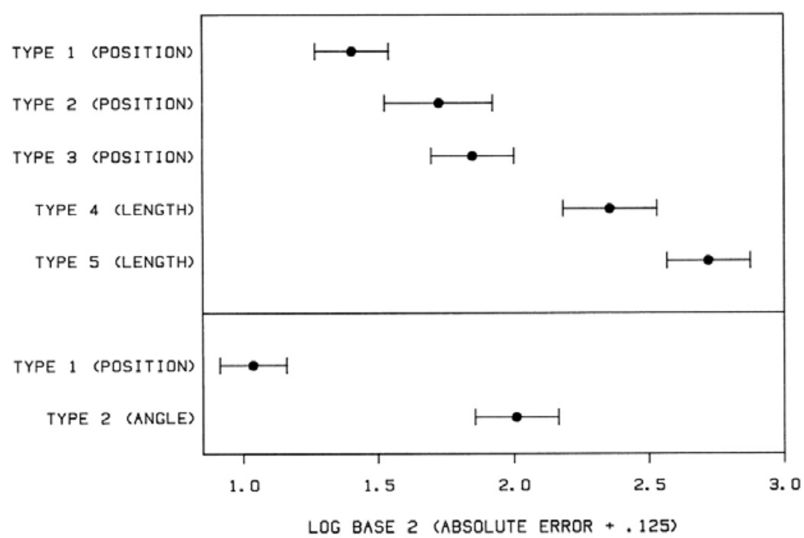


Figure 16. Log absolute error means and 95% confidence intervals for judgment types in position–length experiment (top) and position–angle experiment (bottom).

[Cleveland and McGill 84]

Relative magnitude estimation

Most accurate

Most accurate	Position (common) scale Position (non-aligned) scale
	Length
	Slope
	Angle
	Area
	Volume
Least accurate	Color hue-saturation-density

Mackinlay’s ranking of encodings

QUANTITATIVE	ORDINAL	NOMINAL
Position	Position	Position
Length	Density (Val)	Color Hue
Angle	Color Sat	Texture
Slope	Color Hue	Connection
Area (Size)	Texture	Containment
Volume	Connection	Density (Val)
Density (Val)	Containment	Color Sat
Color Sat	Length	Shape
Color Hue	Angle	Length
Texture	Slope	Angle
Connection	Area (Size)	Slope
Containment	Volume	Area
Shape	Shape	Volume

Conjectured *effectiveness* of visual encodings

Preattentive vs. Attentive

How many 3’s

1281768756138976546984506985604982826762
9809858458224509856458945098450980943585
9091030209905959595772564675050678904567
8845789809821677654876364908560912949686

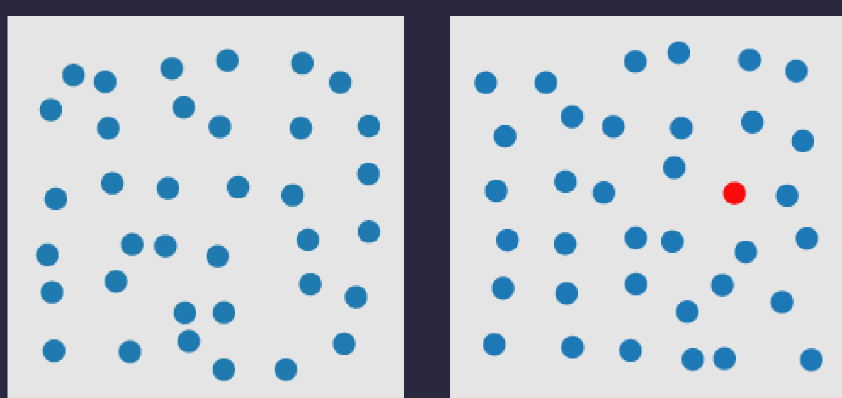
[based on slide from Stasko]

How many 3's

1281768756138976546984506985604982826762
9809858458224509856458945098450980943585
9091030209905959595772564675050678904567
8845789809821677654876364908560912949686

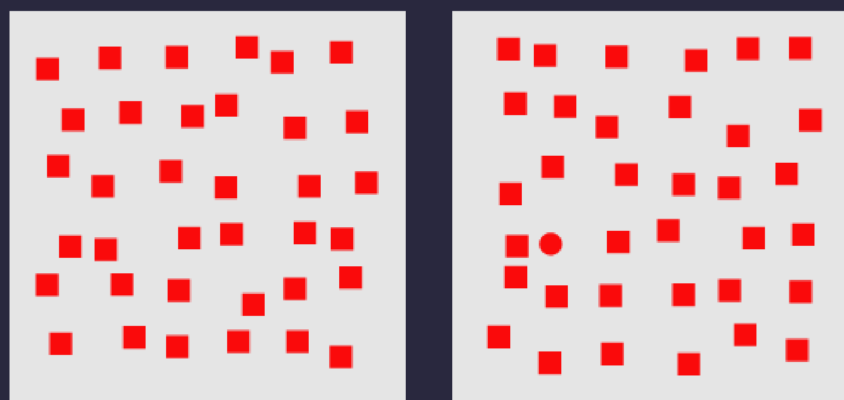
[based on slide from Stasko]

Visual pop-out: Color



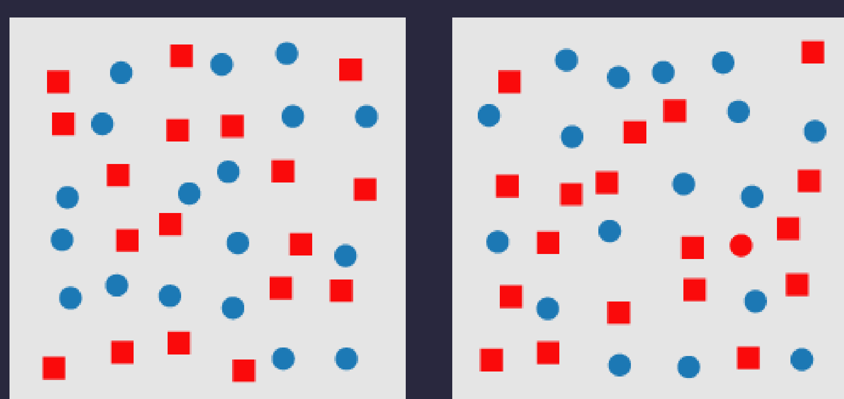
http://www.csc.ncsu.edu/faculty/healey/PP/index.html

Visual pop-out: Shape



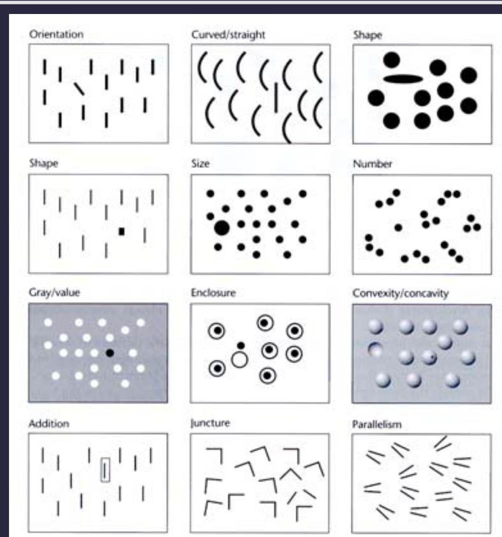
http://www.csc.ncsu.edu/faculty/healey/PP/index.html

Feature conjunctions



http://www.csc.ncsu.edu/faculty/healey/PP/index.html

Preattentive features



[Information Visualization. Figure 5. 5 Ware 04]

More preattentive features

Line (blob) orientation	**Julesz & Bergen [1983]; Wolfe et al. [1992]**
Length	**Triesman & Gormican [1988]**
Width	**Julesz [1985]**
Size	**Triesman & Gelade [1980]**
Curvature	**Triesman & Gormican [1988]**
Number	**Julesz [1985]; Trick & Pylyshyn [1994]**
Terminators	**Julesz & Bergen [1983]**
Intersection	**Julesz & Bergen [1983]**
Closure	**Enns [1986]; Triesman & Souther [1985]**
Colour (hue)	**Nagy & Sanchez [1990, 1992]; D'Zmura [1991]; Kawai et al. [1995]; Bauer et al. [1996]**
Intensity	**Beck et al. [1983]; Triesman & Gormican [1988]**
Flicker	**Julesz [1971]**
Direction of motion	**Nakayama & Silverman [1986]; Driver & McLeod [1992]**
Binocular lustre	**Wolfe & Franzel [1988]**
Stereoscopic depth	**Nakayama & Silverman [1986]**
3-D depth cues	**Enns [1990]**
Lighting direction	**Enns [1990]**

http://www.csc.ncsu.edu/faculty/healey/PP/index.html

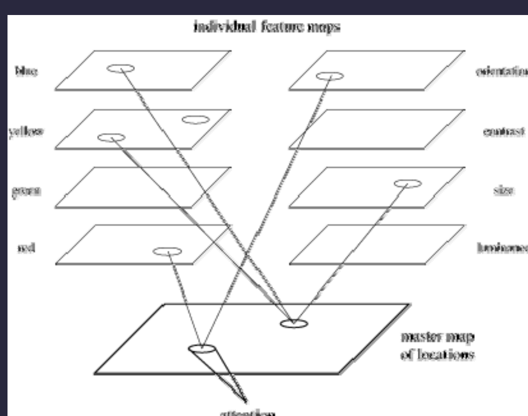
Preattentive conjunctions

Spatial conjunctions are often preattentive

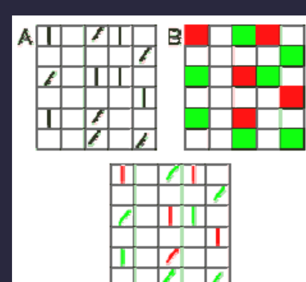
- Motion and 3D disparity
- Motion and color
- Motion and shape
- 3D disparity and color
- 3D disparity and shape

Most conjunctions are not preattentive

Feature-integration theory



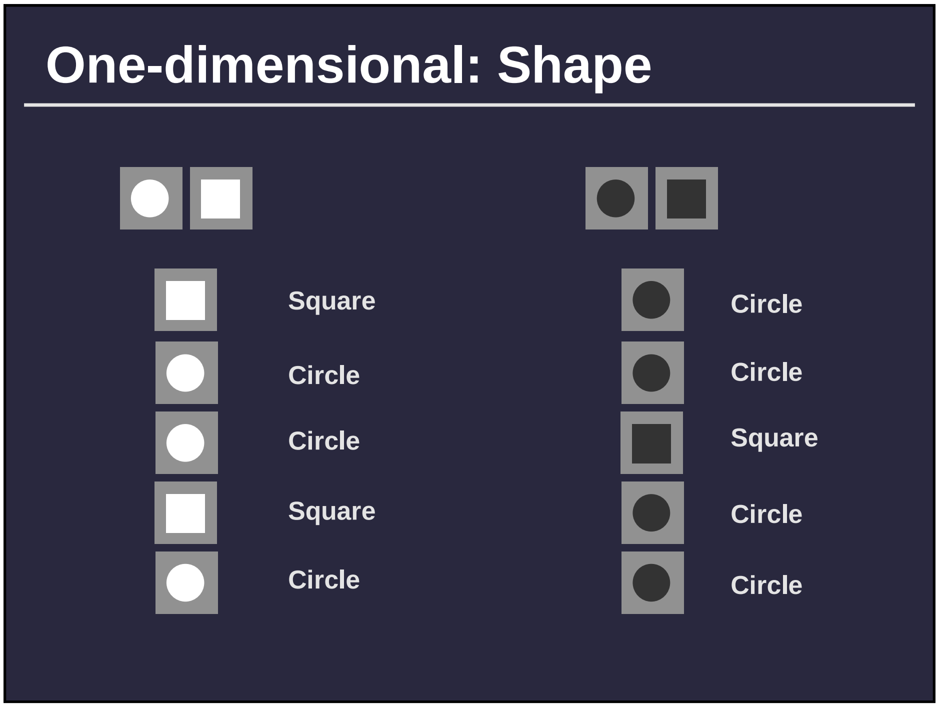
Treisman’s feature integration model [Healey04]

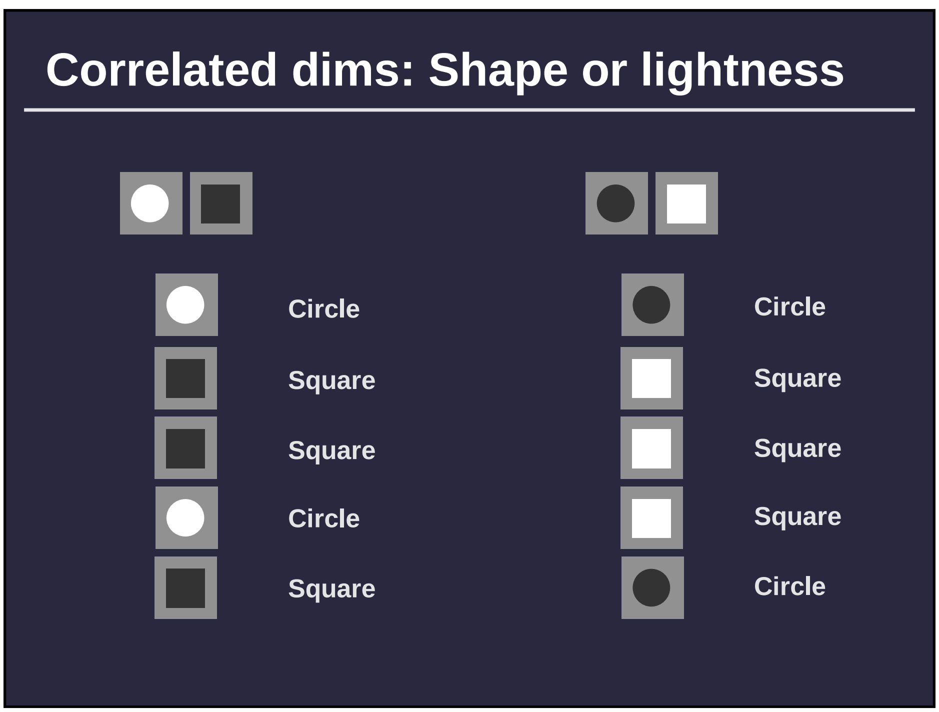


Feature maps for orientation & color [Green]

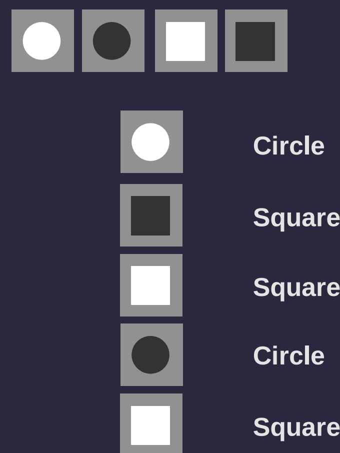
Multiple Attributes

One-dimensional: Lightness


One-dimensional: Shape
Square
Circle
Circle
Square
Circle
Circle
Circle
Square
Circle
Circle


Correlated dims: Shape or lightness
Circle
Square
Square
Circle
Square
Circle
Square
Square
Square
Circle

Orthogonal dims: Shape & lightness



Speeded classification

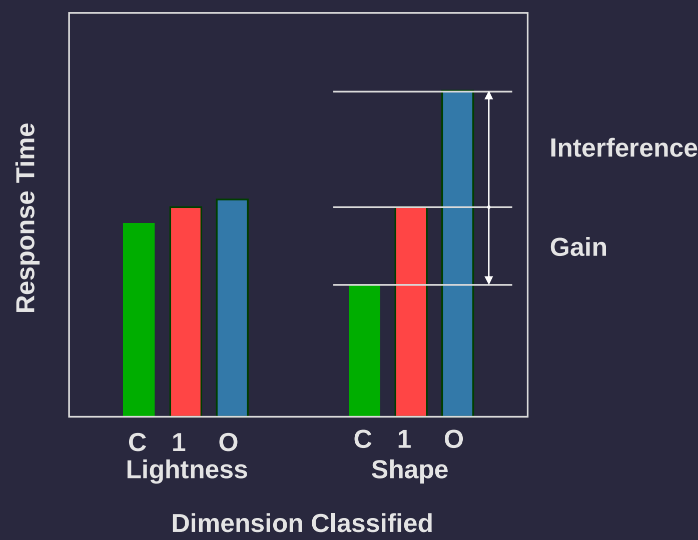
Redundancy gain

Facilitation in reading one dimension when the other provides redundant information

Filtering interference

Difficulty in ignoring one dimension while attending to the other

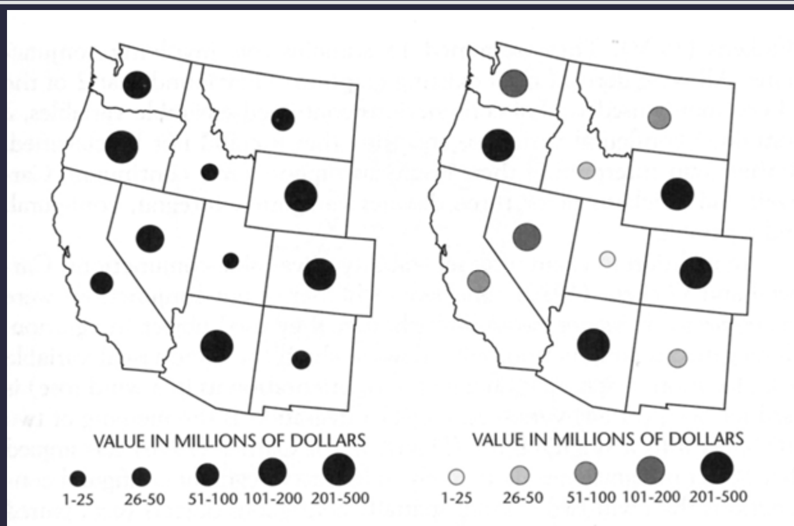
Speeded classification



Types of dimensions

- **Integral**
  - Filtering interference and redundancy gain
- **Separable**
  - No interference or gain
- **Configural**
  - Only interference, but no redundancy gain
- **Asymmetrical**
  - One dimension separable from other, not vice versa
    - Stroop effect – Color naming influenced by word identity, but word naming not influenced by color

Correlated dims: Size and value



W. S. Dobson, Visual information processing and cartographic communication: The role of redundant stimulus dimensions, 1983 (reprinted in MacEachren, 1995)

Othogonal dims: Aspect ratio

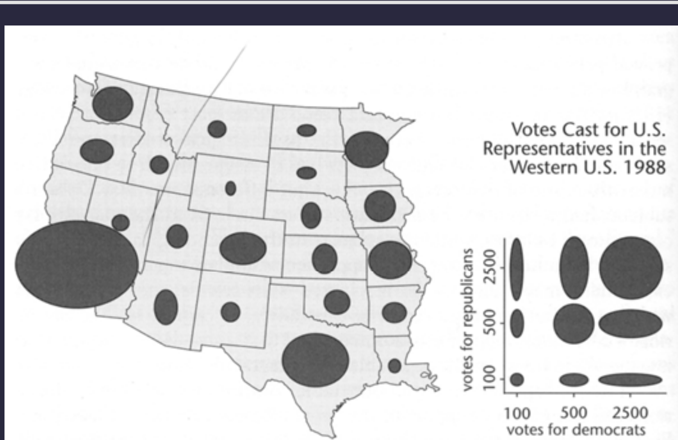
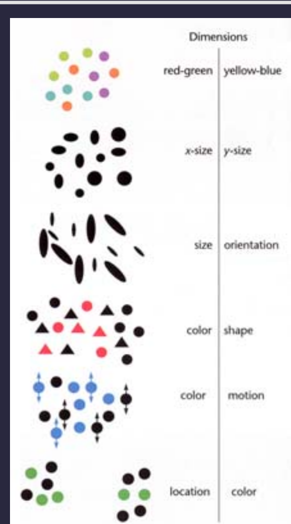


FIGURE 3.38. An example of the use of an ellipse as a map symbol in which the horizontal and vertical axes represent different (but presumably related) variables.

[MacEachren 95]

Summary of Integral-Separable



Integral

Separable

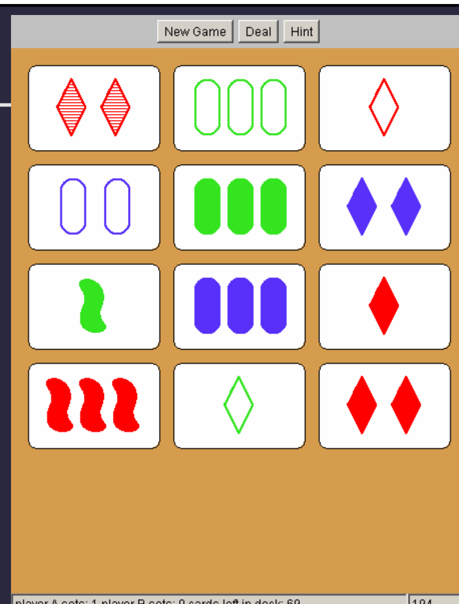
[Figure 5.25, Color Plate 10, Ware 00]

Set

Each card has 4 features:

- Color
- Symbol
- Number
- Shading/Texture

A set consists of 3 cards in which each feature is the **SAME** or **DIFFERENT** on each card.



Adrien Treuille's applet

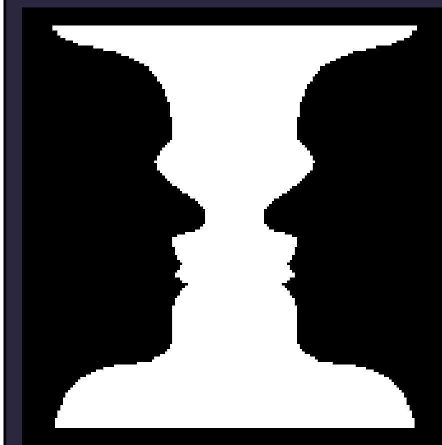
http://www.cs.washington.edu/homes/treuille/resc/set

Gestalt

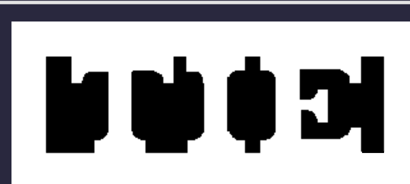
Principles

- figure/ground
- proximity
- similarity
- symmetry
- connectedness
- continuity
- closure
- common fate
- transparency

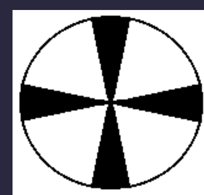
Figure/Ground



Ambiguous



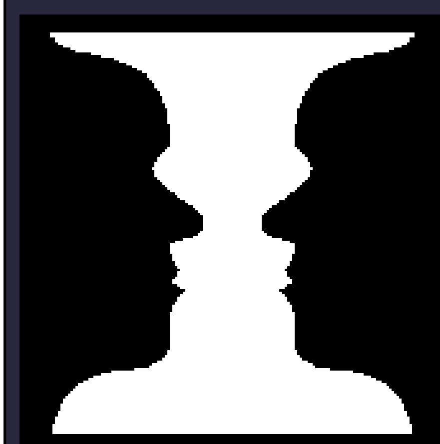
Principle of surroundedness



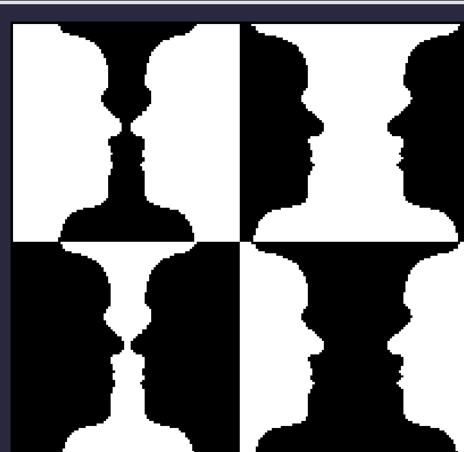
Principle of relative size

http://www.aber.ac.uk/media/Modules/MC10220/visper06.html

Figure/Ground



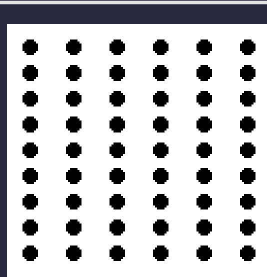
Ambiguous

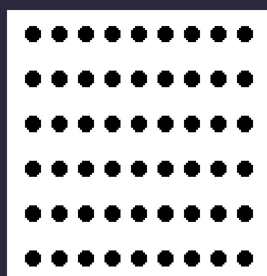


Unambiguous

http://www.aber.ac.uk/media/Modules/MC10220/visper06.html

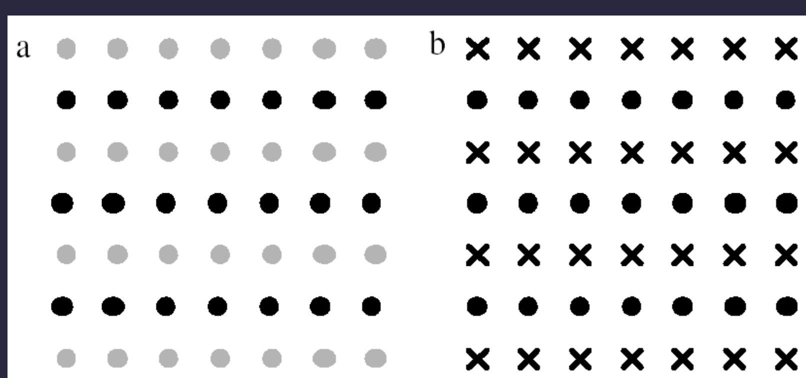
Proximity





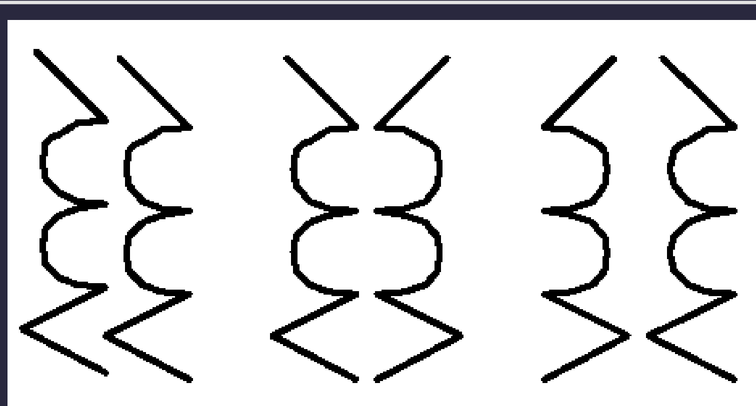
[Ware 00]

Similarity



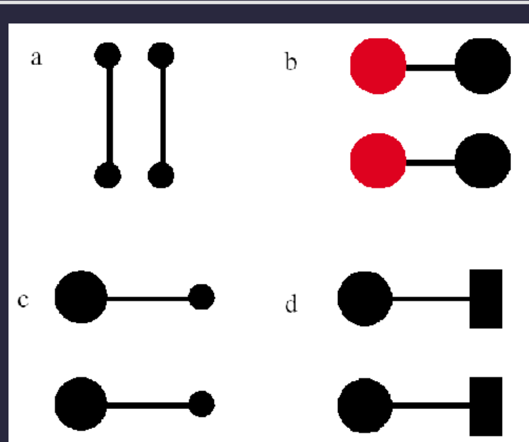
Rows dominate due to similarity [from Ware 04]

Symmetry



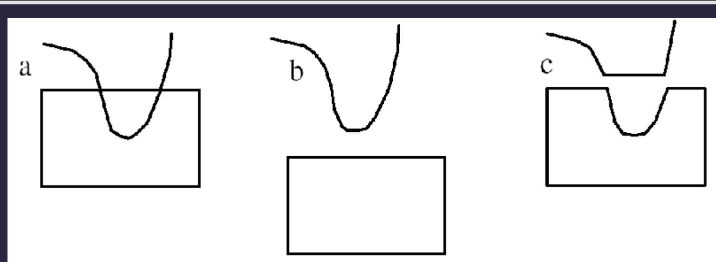
Bilateral symmetry gives strong sense of figure [from Ware 04]

Connectedness

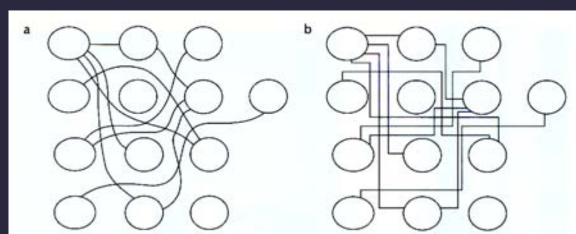


Connectedness overrules proximity, size, color shape [from Ware 04]

Continuity

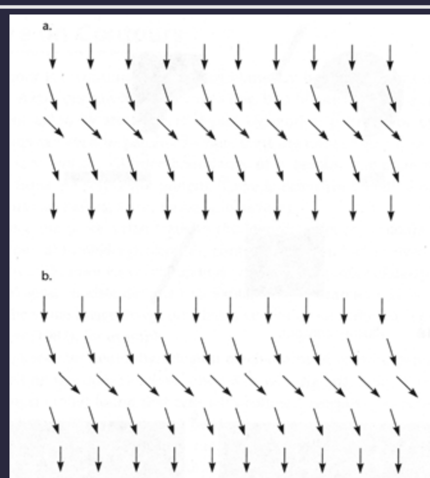


We prefer smooth not abrupt changes [from Ware 04]



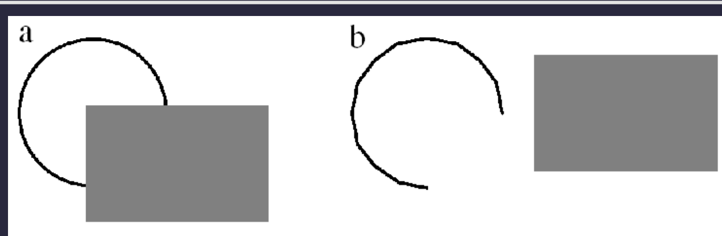
Connections are clearer with smooth contours [from Ware 04]

Continuity: Vector fields

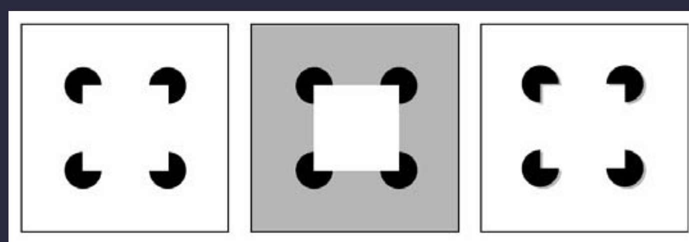


Prefer field that shows smooth continuous contours [from Ware 04]

Closure

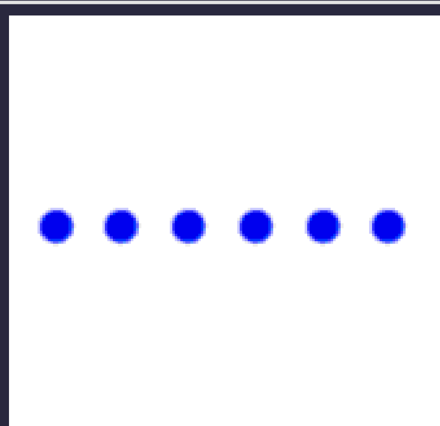


We see a circle behind a rectangle, not a broken circle [from Ware 04]



Illusory contours [from Durand 02]

Common fate



Dots moving together are grouped

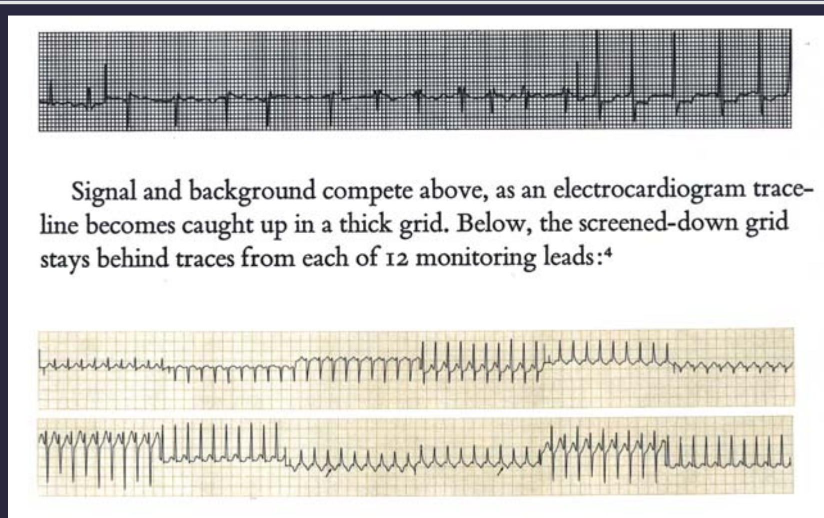
http://coe.sdsu.edu/eet/articles/visualperc1/start.htm

Transparency

Requires continuity and proper color correspondence [from Ware 04]

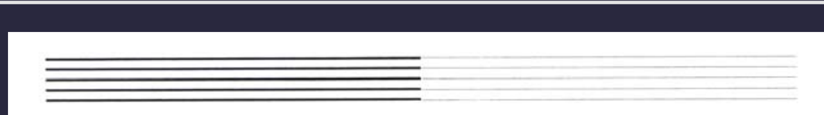
Layering and Small Multiples

Layering: Gridlines


Signal and background compete above, as an electrocardiogram trace-line becomes caught up in a thick grid. Below, the screened-down grid stays behind traces from each of 12 monitoring leads:[4]

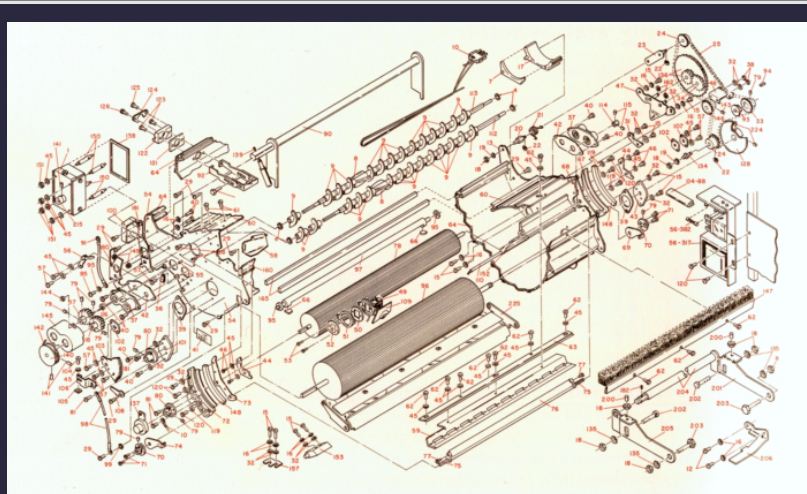
Electrocardiogram tracelines [from Tufte 90]

Layering: Gridlines



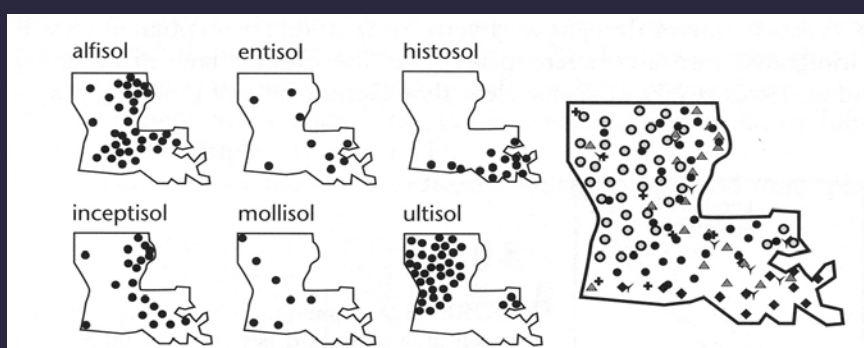
Stravinsky score [from Tufte 90]

Layering: Color and line width



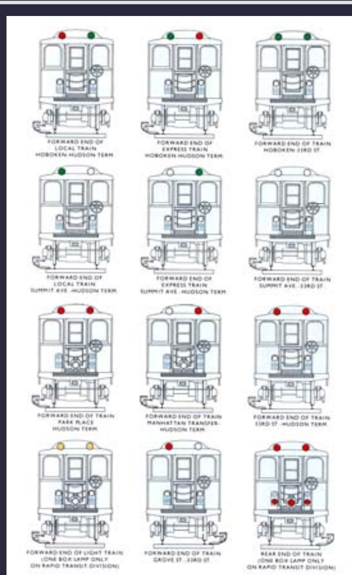
IBM Series III Copier [from Tufte 90]

Small multiples



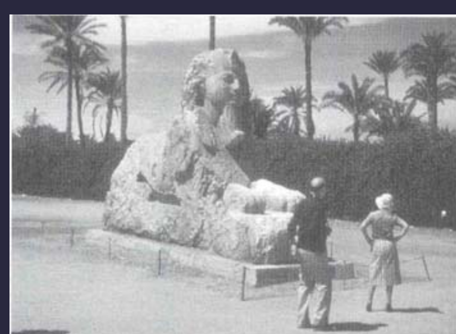
[Figure 2.11, p. 38, MacEachren 95]

Small multiples



Operating trains. Redrawn by Tufte to emphasize colored lights. [fromTufte 90]

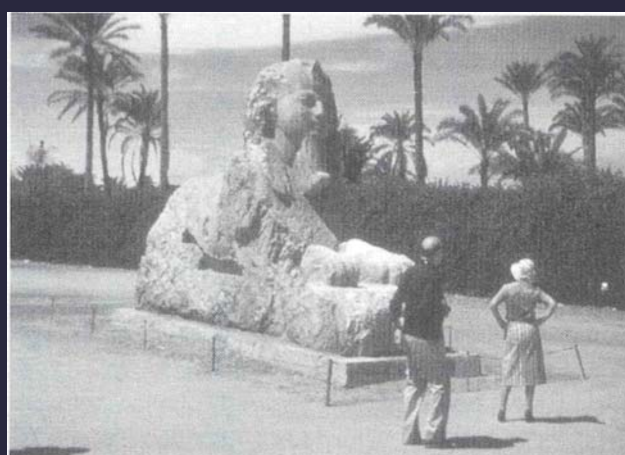
Change blindness



[Example from Palmer 99, originally due to Rock]

Change detection

Change detection



Rensink's demonstration

http://www.usd.edu/psyc301/Rensink.htm

Summary

Choosing effective visual encodings requires knowledge of visual perception

Visual features/attributes

- Individual attributes often preattentive
- Multiple attributes may be separable, often integral

Gestalt principles provide higher level design guidelines

We don't always see everything that is there