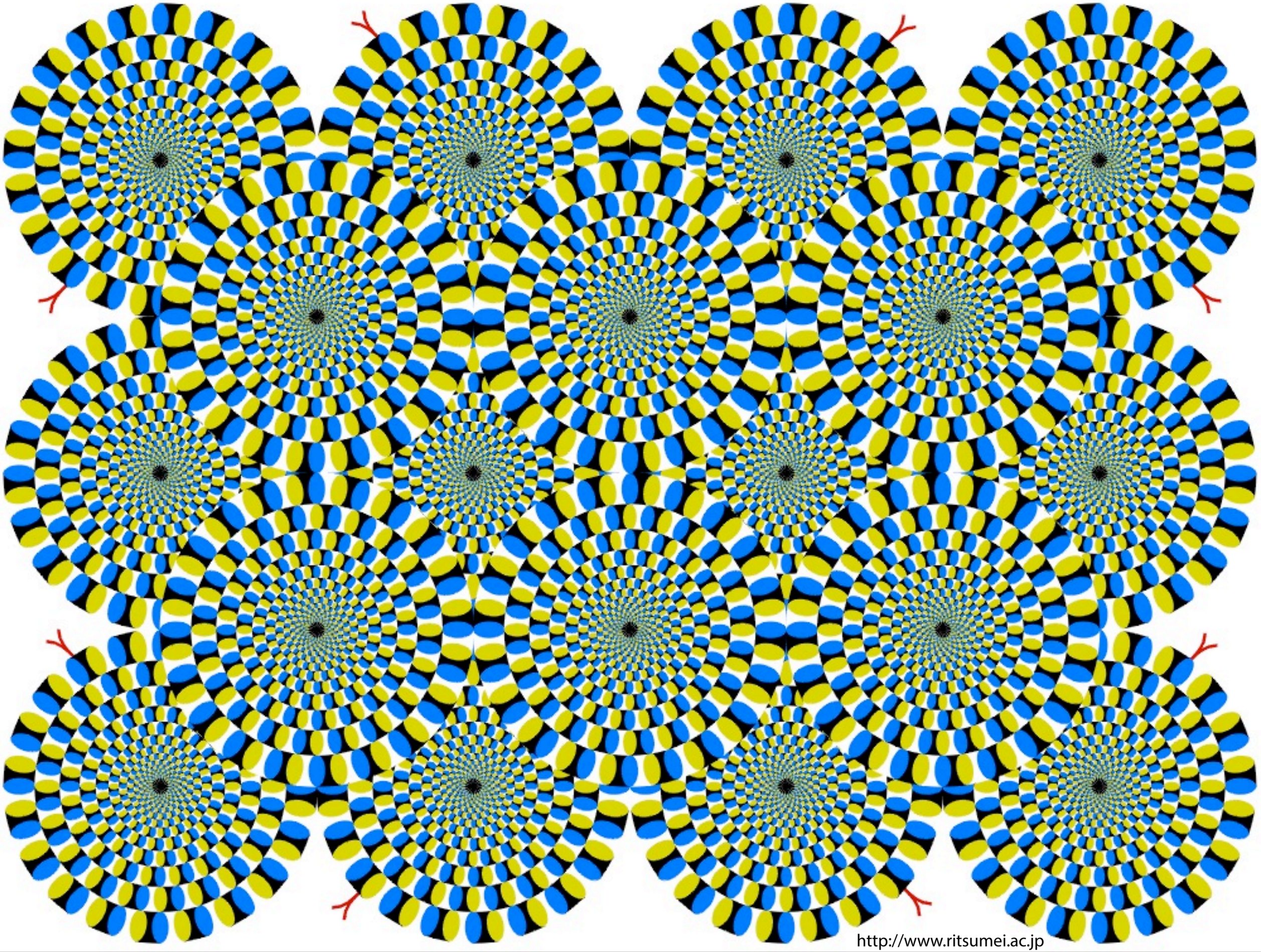
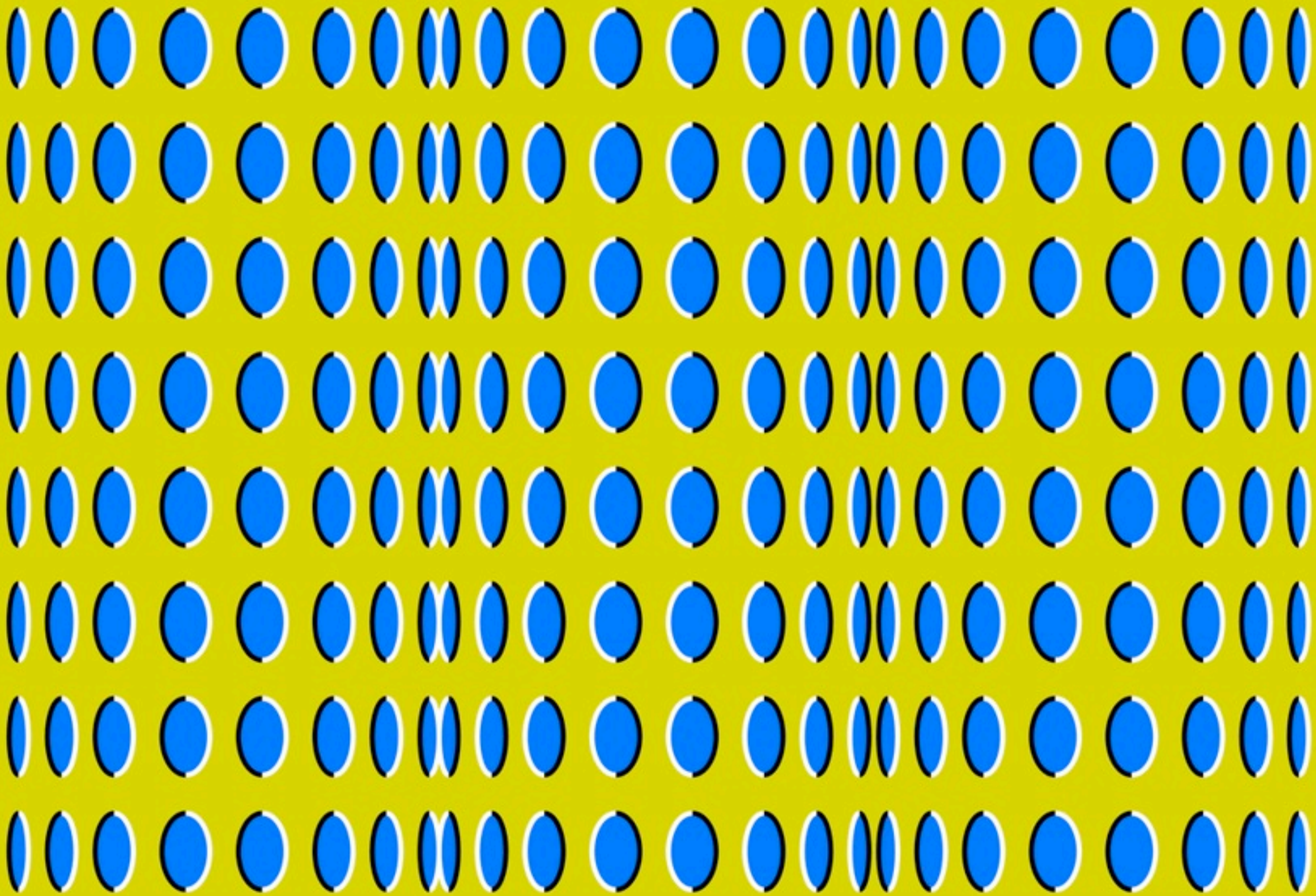
Perception

How our brain perceives and interprets visuals

Feb 19, 2013 – Michael Porath


http://www.ritsumei.ac.jp

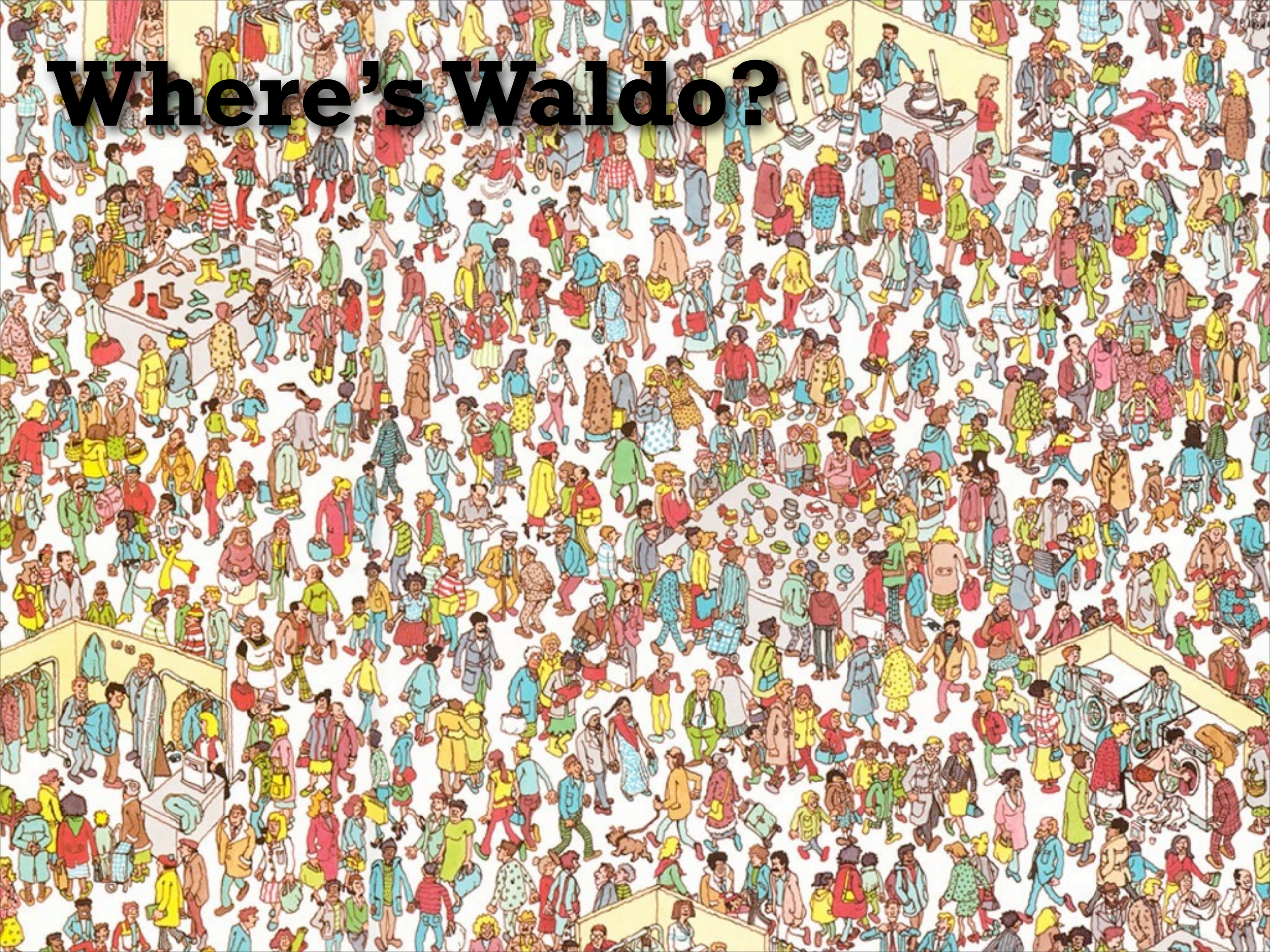


http://www.ritsumei.ac.jp

Pre-attentive Attributes

vs Attentive Attributes

Where's Waldo?



How many 3s?

Ware, 2004

How many 3s?

12817687561389765469856049828267629809858458224509856458940980943585
90910302099059595957750506789045678845789809821677654876360912949686

Ware, 2004

How many 3s?

Ware, 2004

How many 3s?

5813120624510462757776443227882568

8540085481532851714248582146284078

1041710341052577585177276725911070

4512525182715140123882064857804410

Ware, 2004

Pre-attentive vs Attentive

Differences in speed of perception

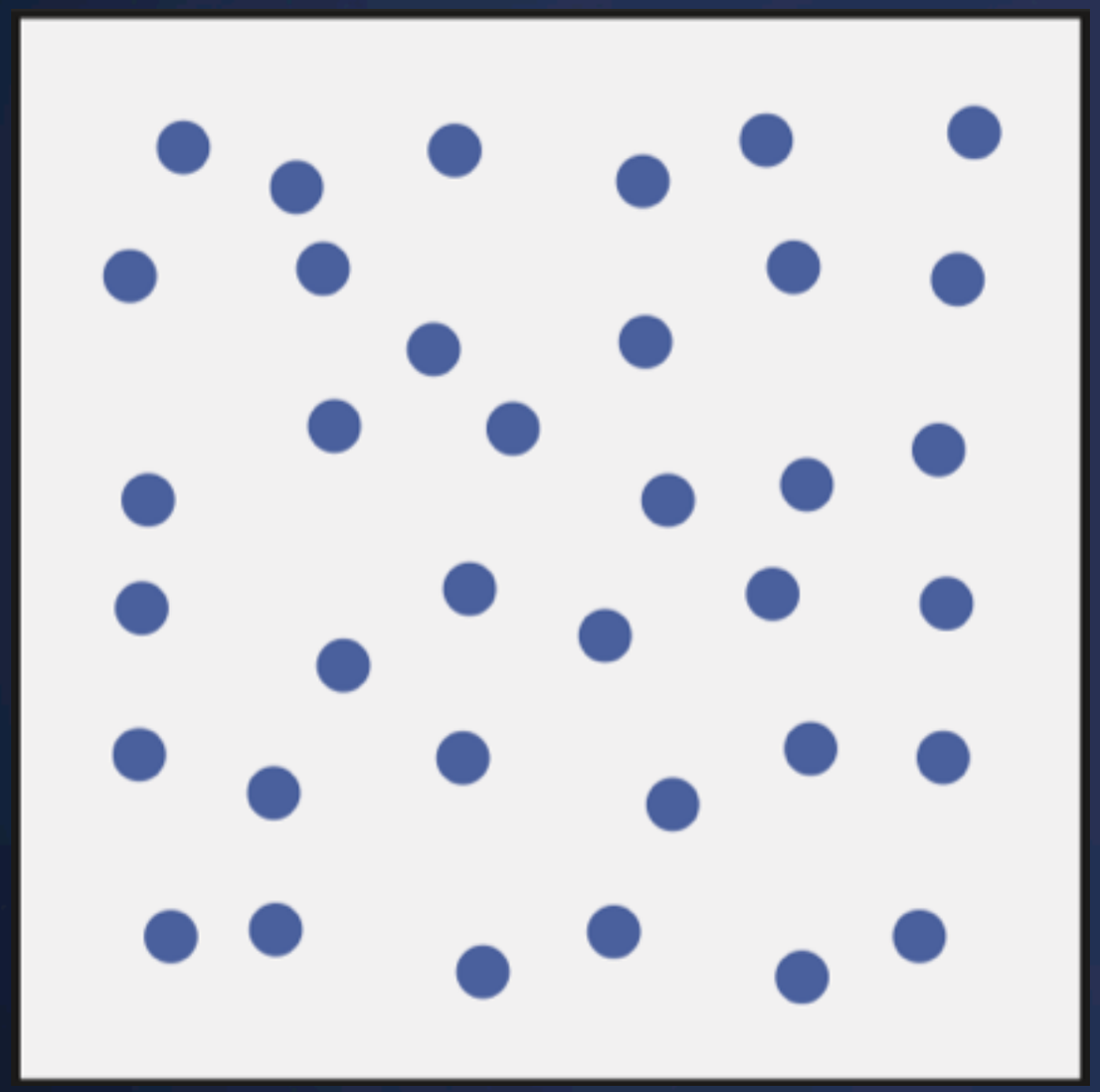
pre-attentive ***attentive***

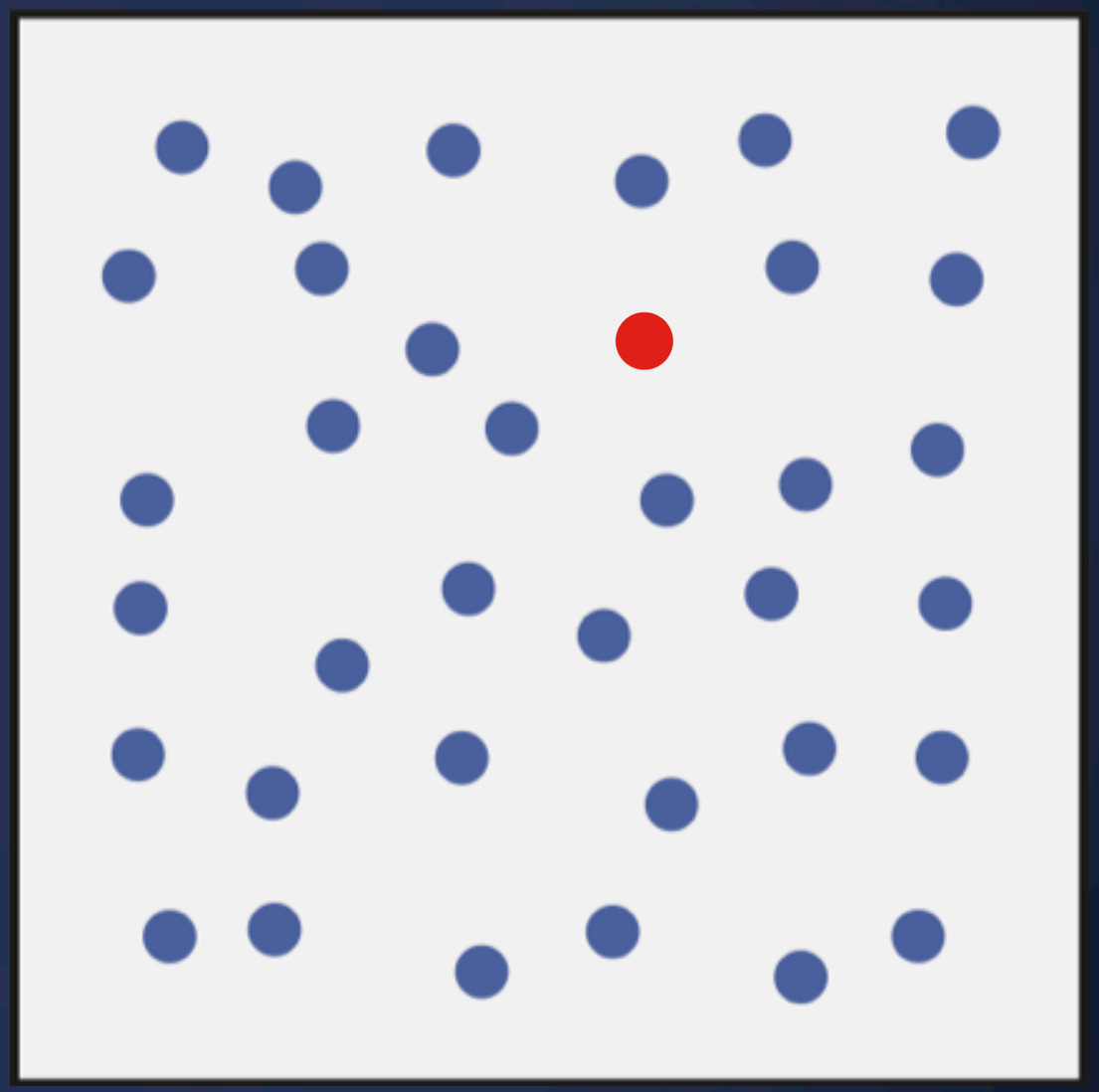
Pre-attentive vs Attentive

Differences in speed of perception

pre-attentive		***attentive***
≤ 500ms	Task	> 500ms
≤ 10ms	indiv. obj.	> 10ms
parallel processing		*sequential processing*

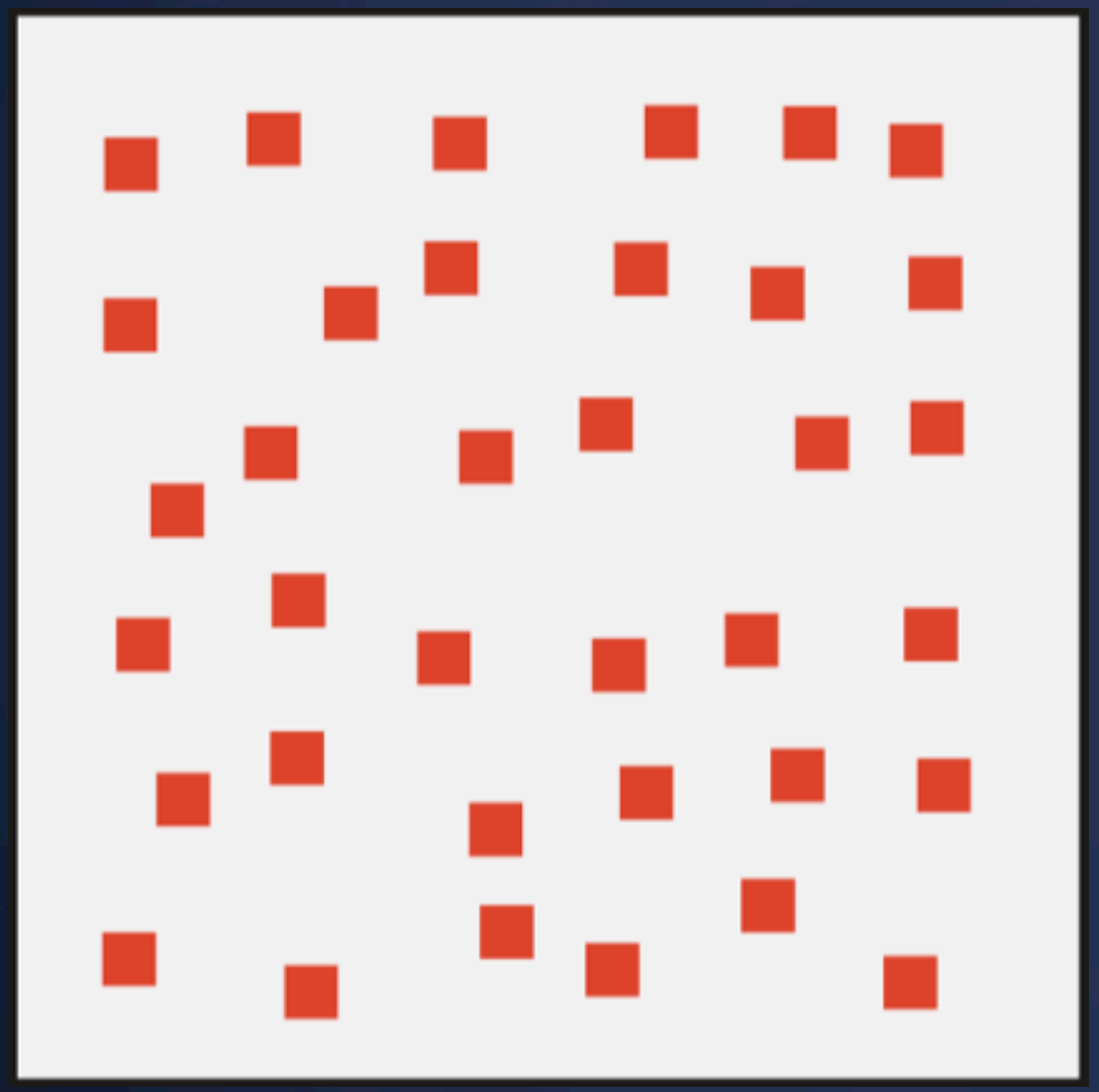
Visual Pop-Out: Color

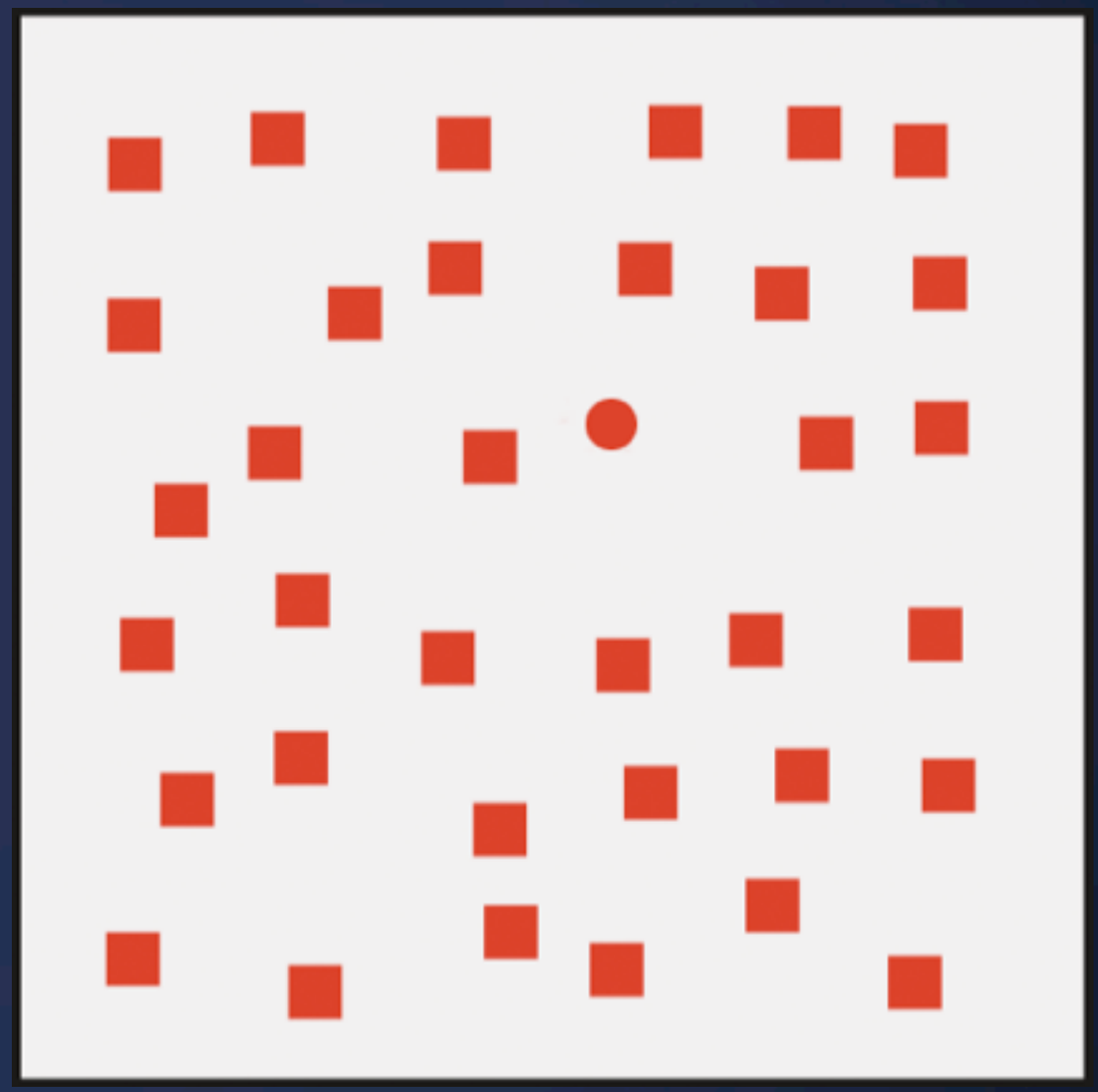




Healey (2011)

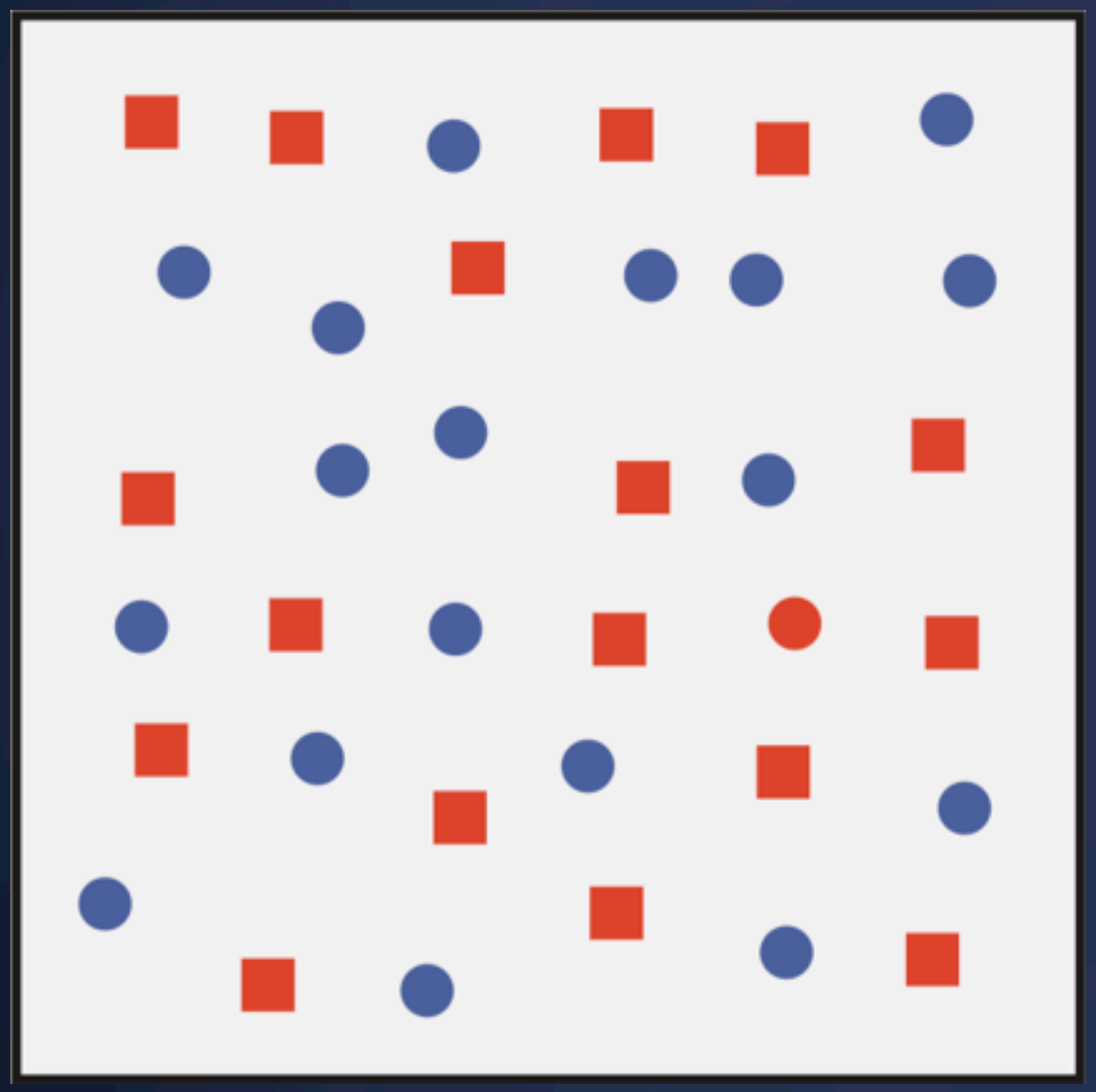
Visual Pop-Out: Shape

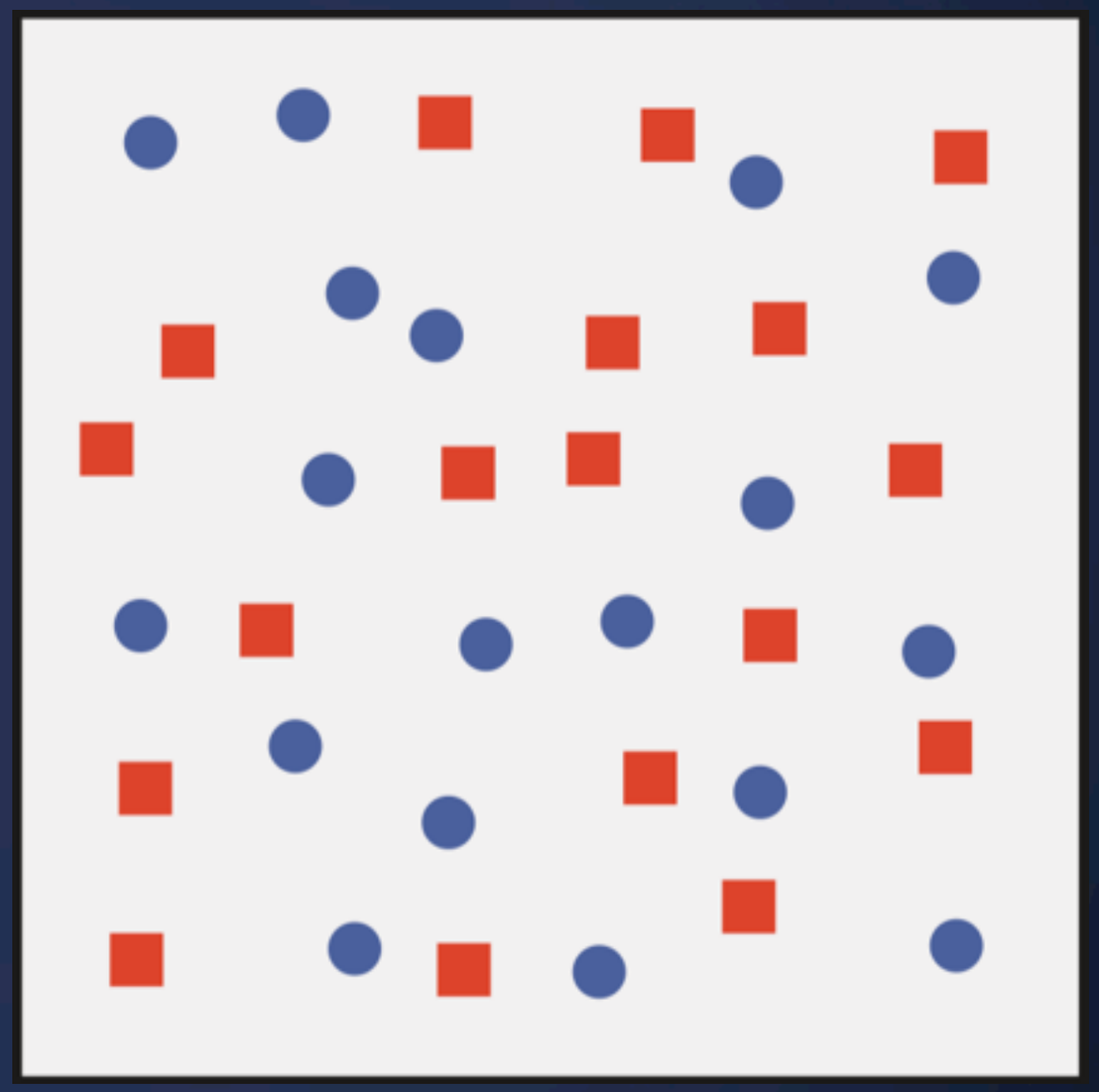




Healey (2011)

Feature Conjunctions

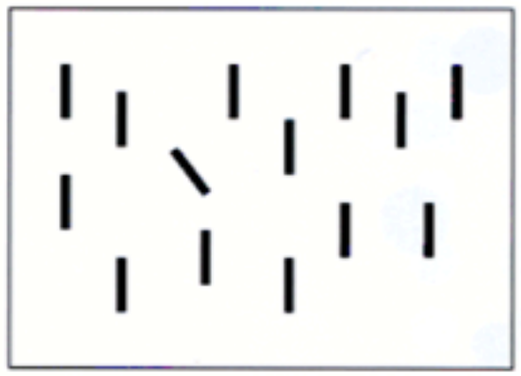




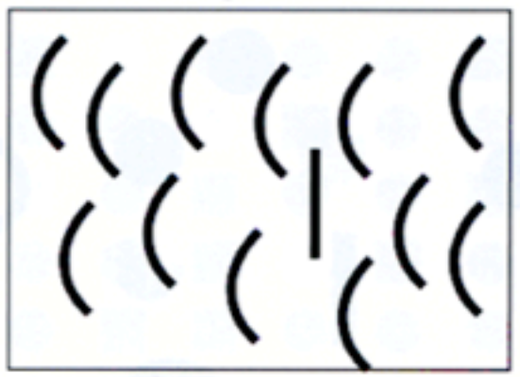
Healey (2011)

Pre-attentive Features

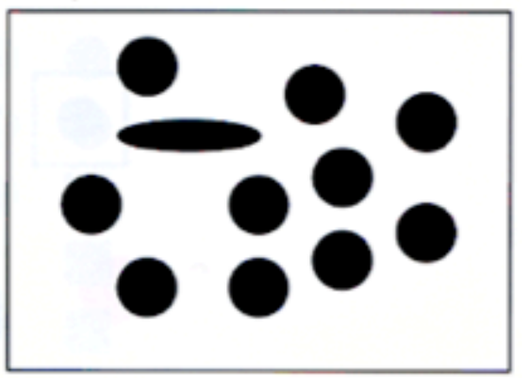
Orientation



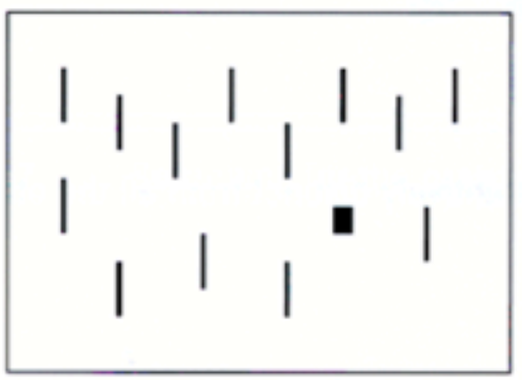
Curved/straight



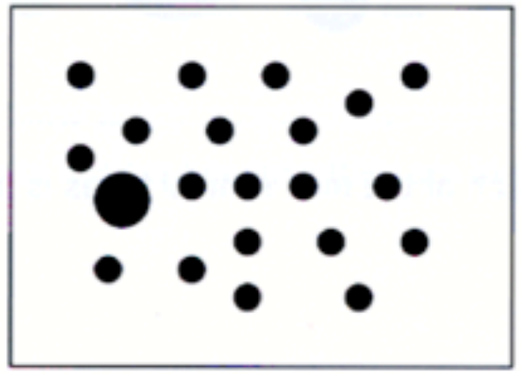
Shape



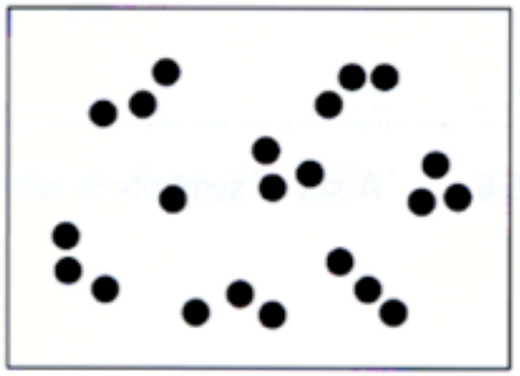
Shape



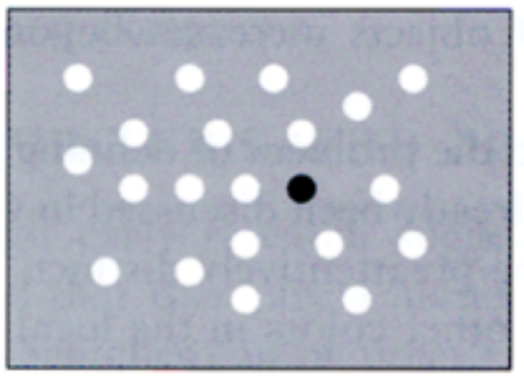
Size



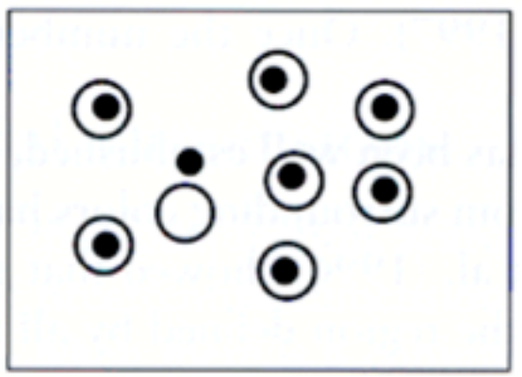
Number



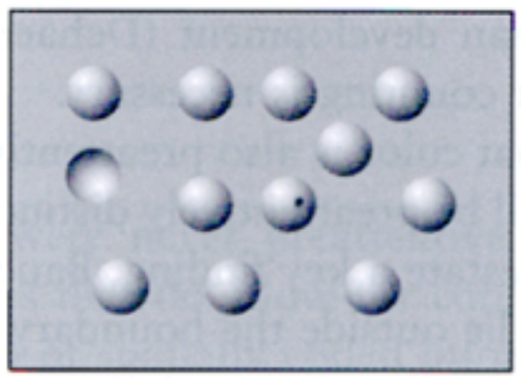
Gray/value



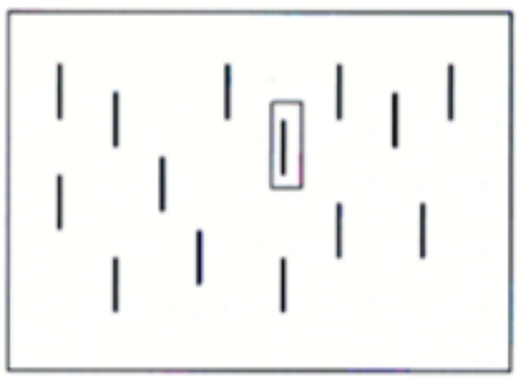
Enclosure



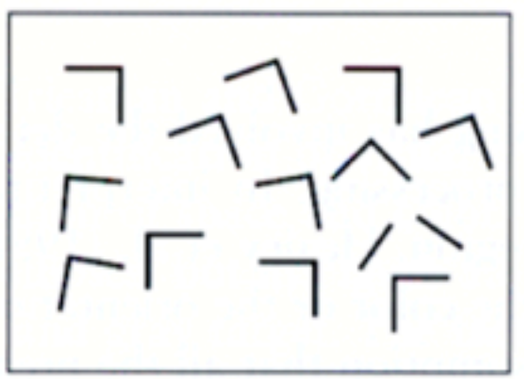
Convexity/concavity



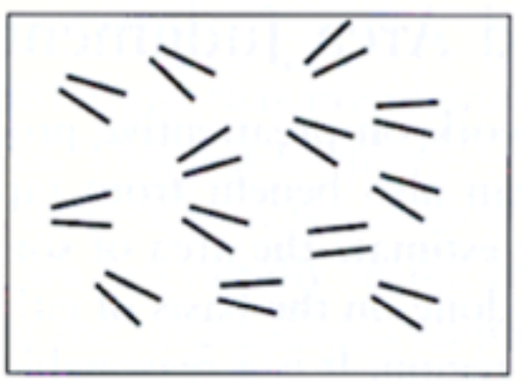
Addition



Juncture



Parallelism



Ware, 2004

More Pre-attentive Features

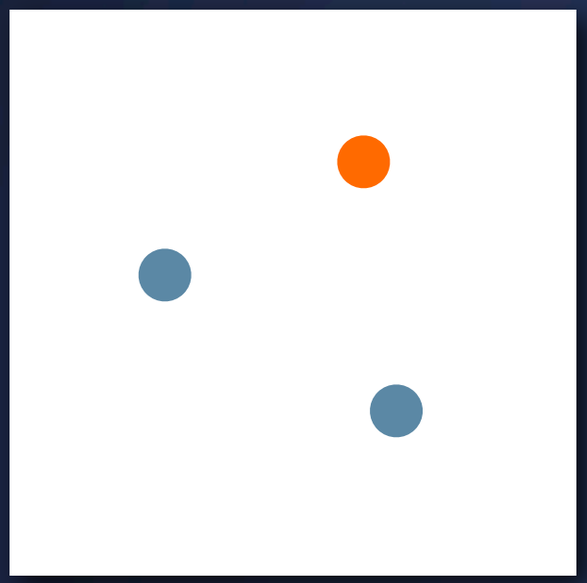
Line (blob) orientation
Length
Width
Size
Curvature
Number
Terminators
Intersection
Closure

Color (hue)
Intensity
Flicker
Direction of motion
Binocular lustre
Stereoscopic depth
3-D depth cues
Lighting direction

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

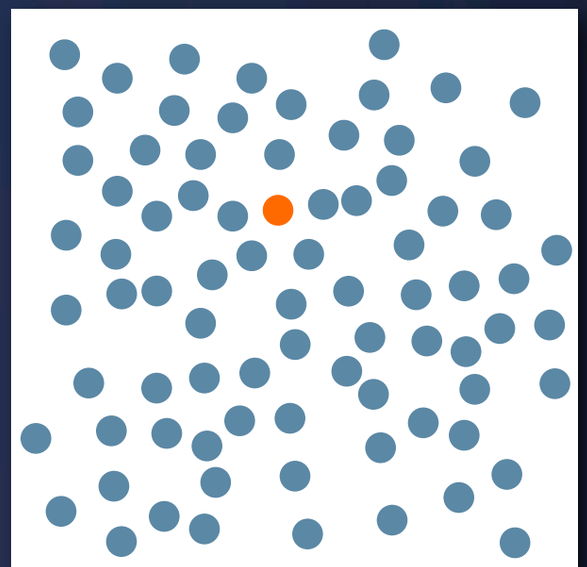
Distractors - Pre-attentive

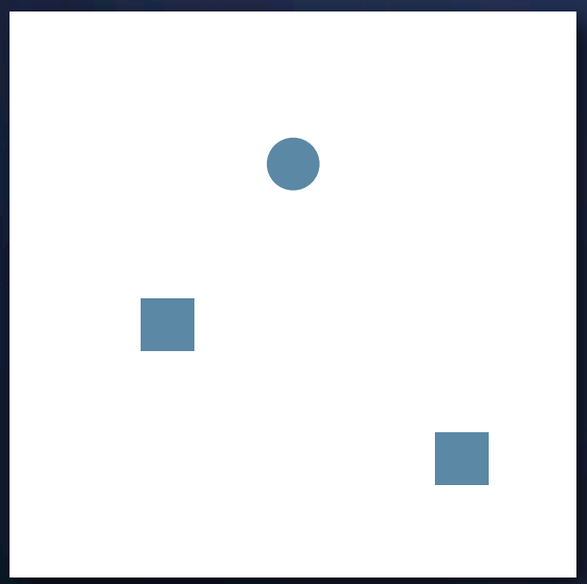
Few

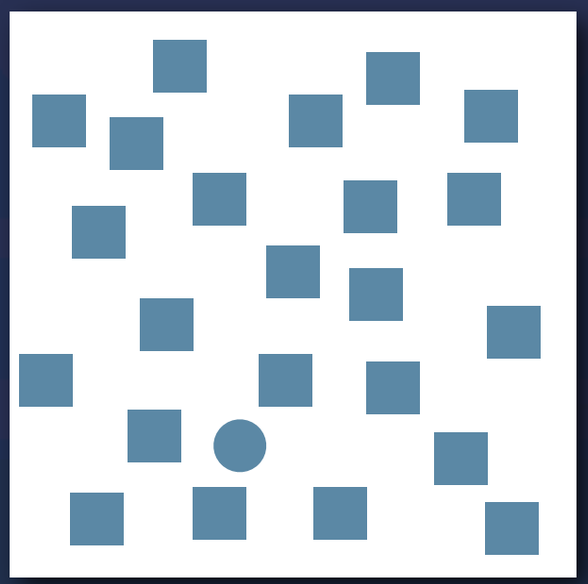


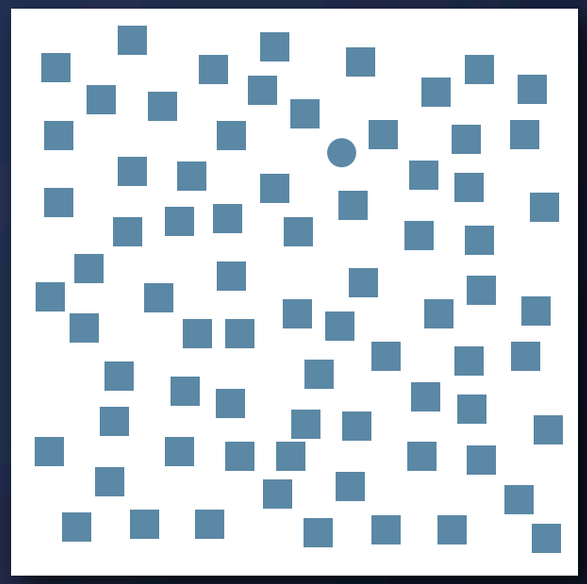
More

A lot



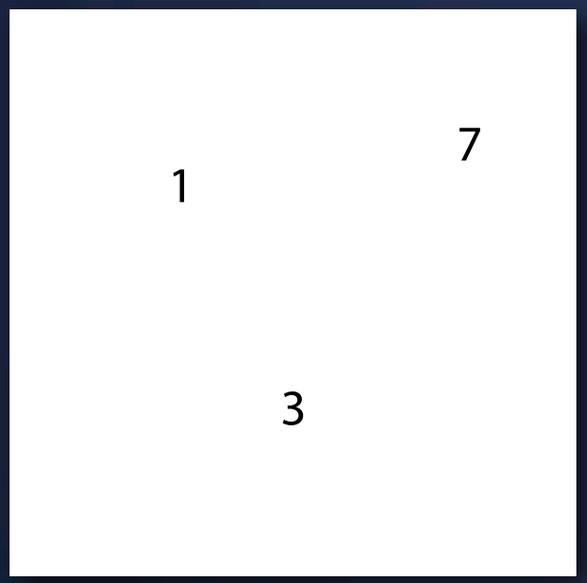




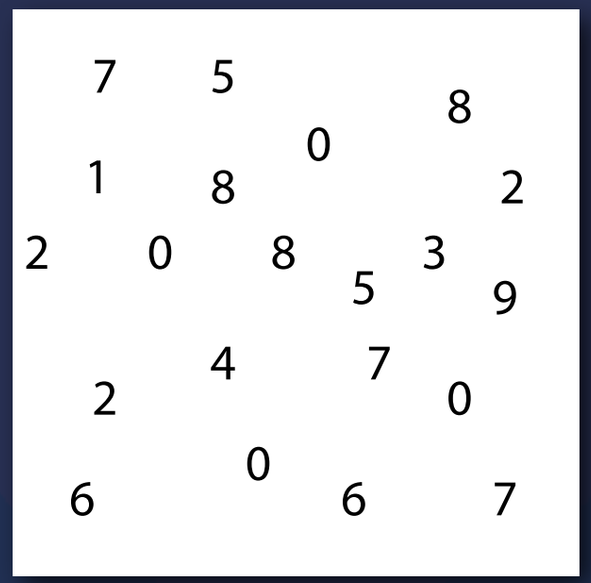


Distractors - Attentive

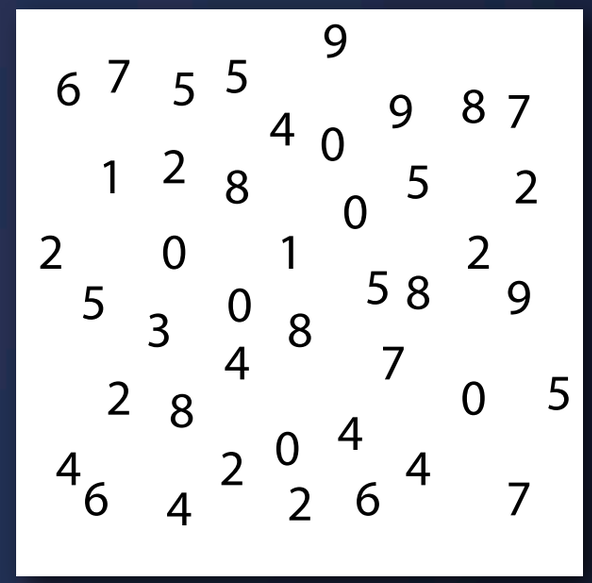
Few



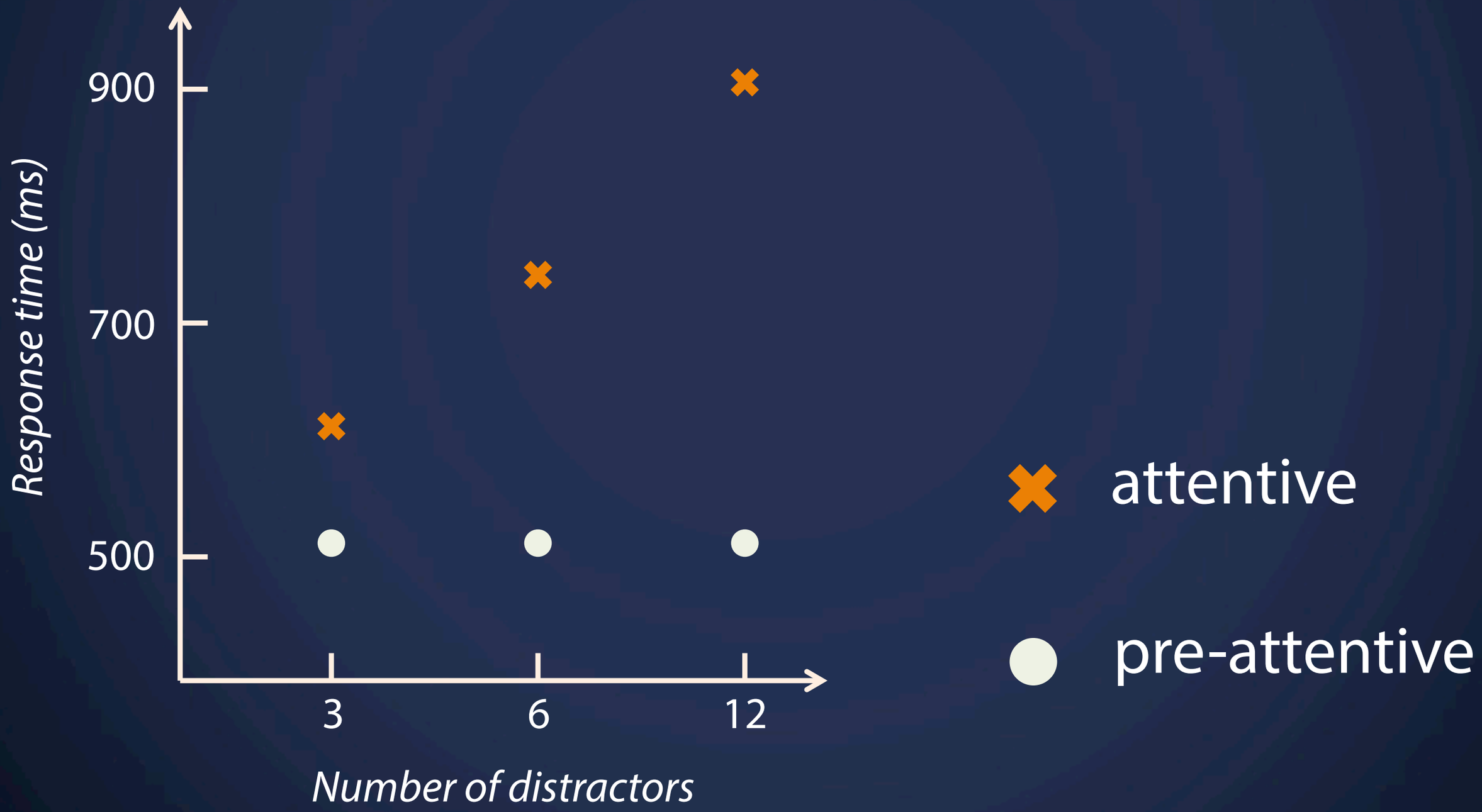
More



A lot

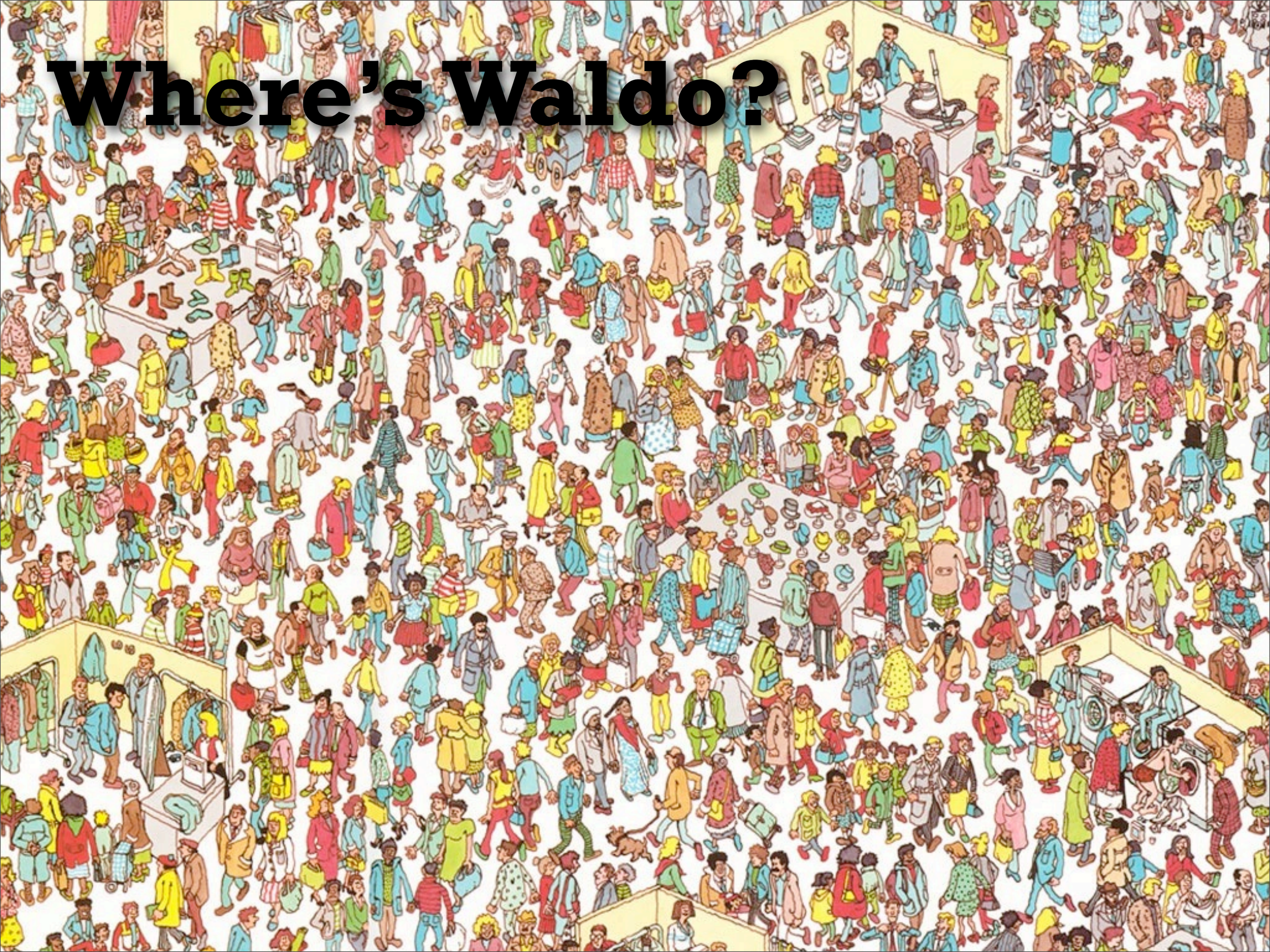


Distractors

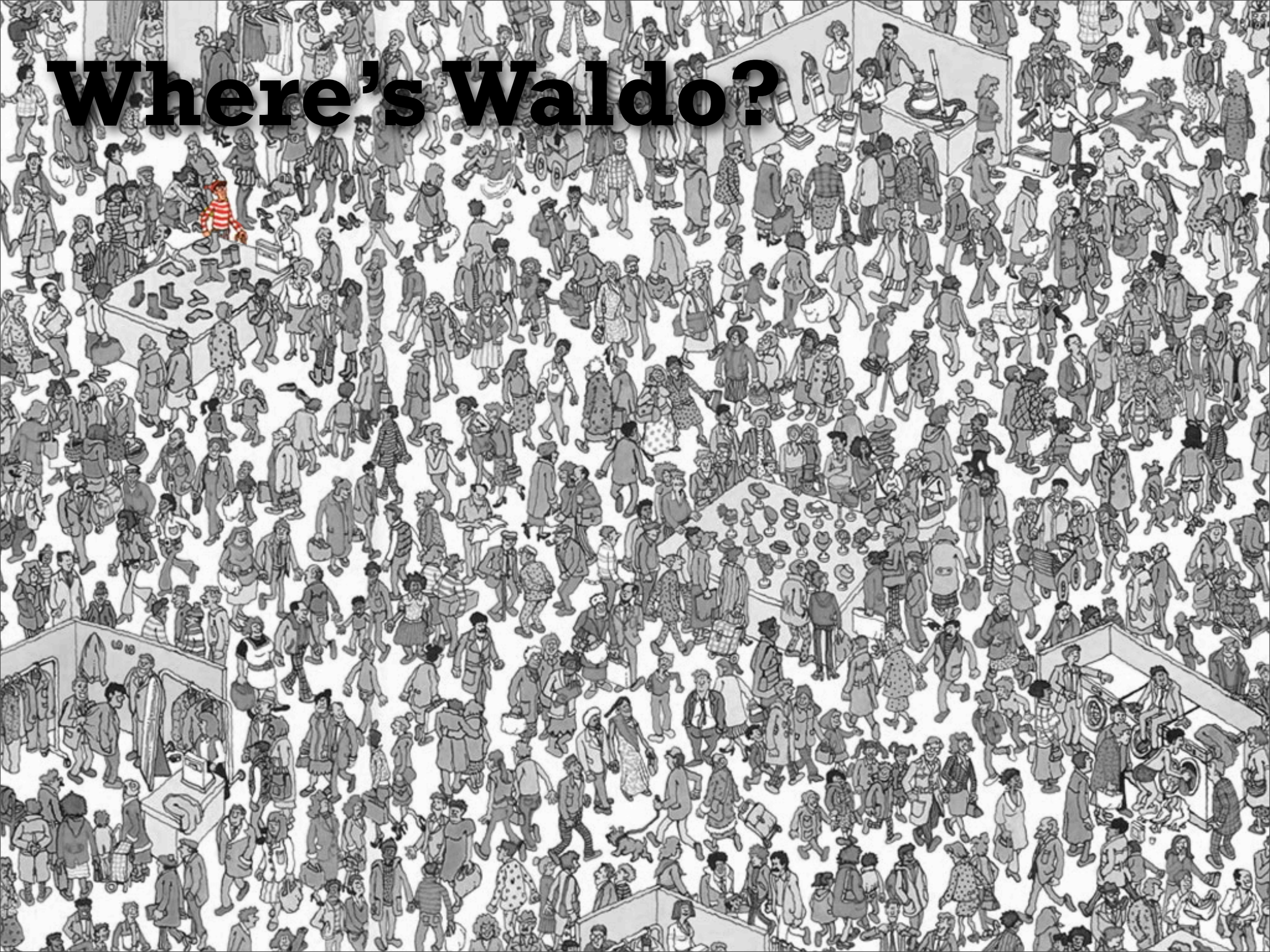


Ware, 2004

Where's Waldo?



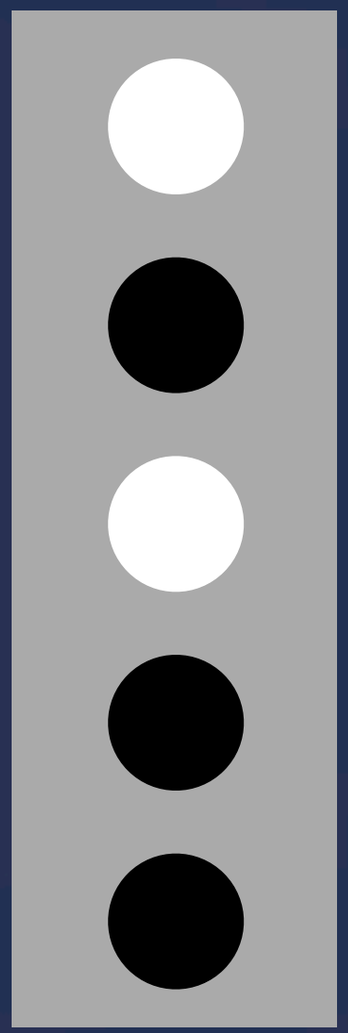
Where's Waldo?



Multiple Attributes Conjunctions

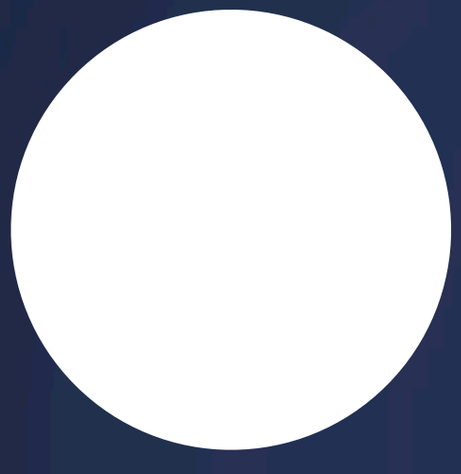
One-Dimensional

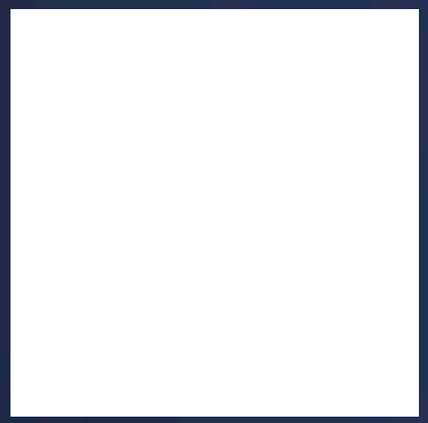
Lightness

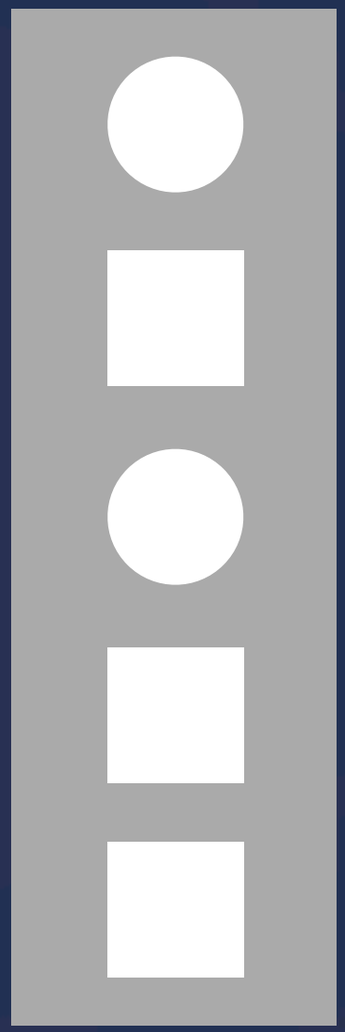


One-Dimensional

Shape







Circle

Square

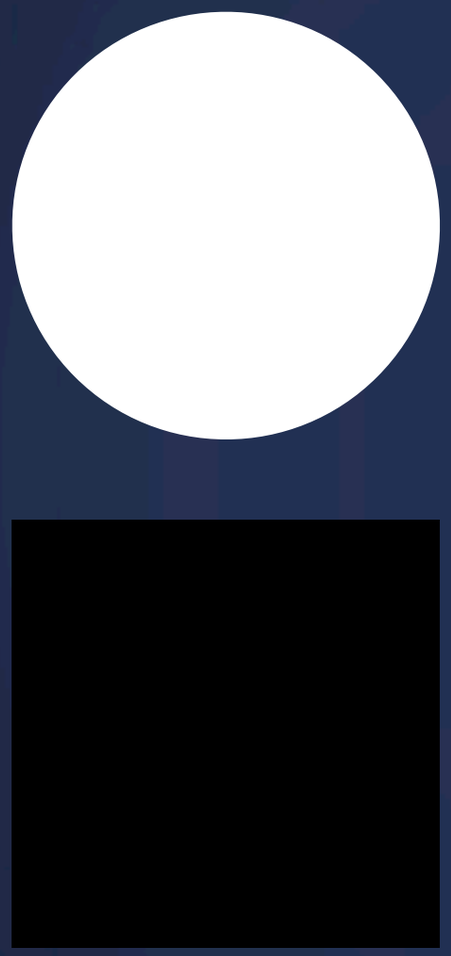
Circle

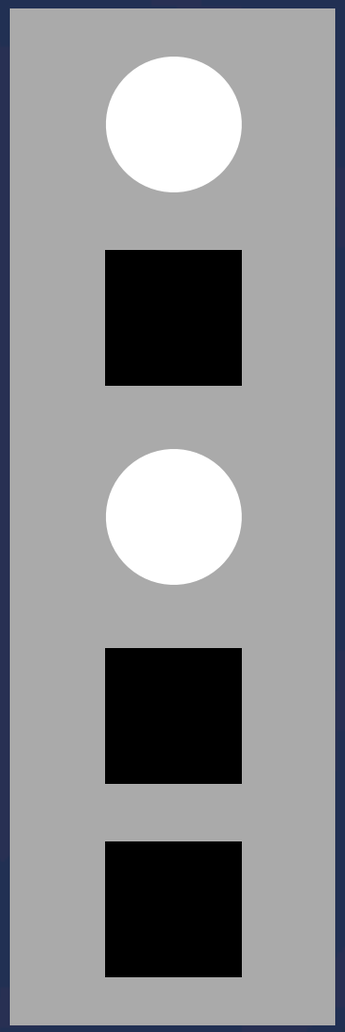
Square

Square

Correlated Dimensions

Shape or lightness (Redundant encoding)





Circle

Square

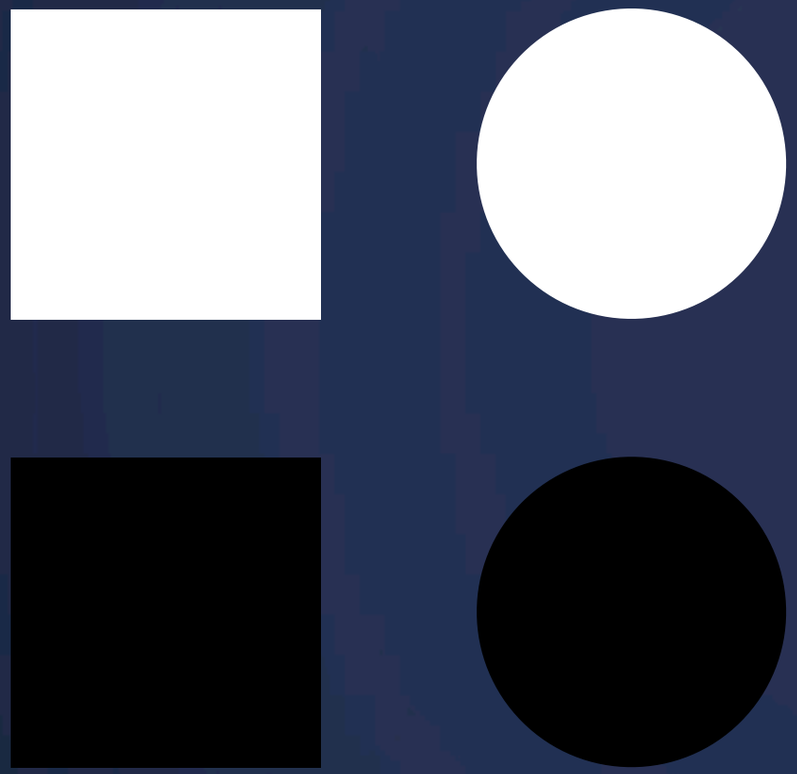
Circle

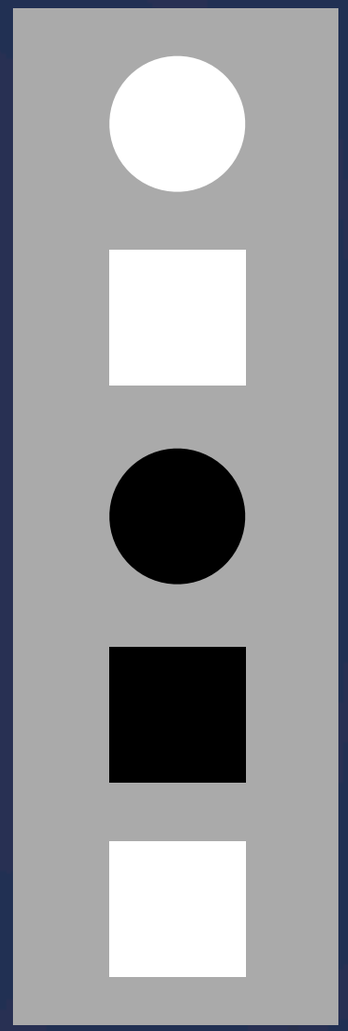
Square

Square

Orthogonal Dimensions

Shape **and** lightness





Circle

Square

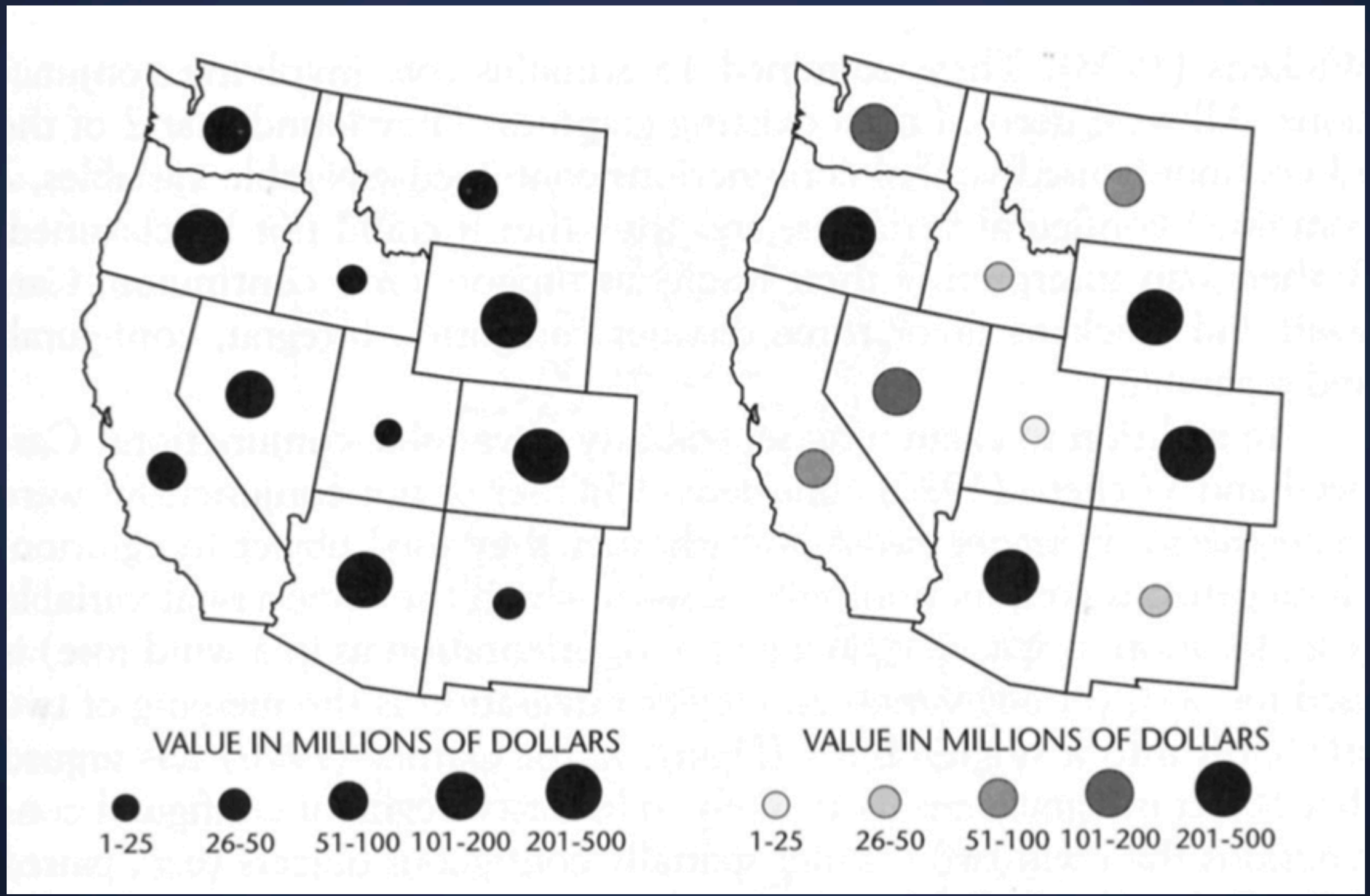
Circle

Square

Square

Correlated Dimensions

Size and Value



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

Orthogonal Dimensions

Aspect Ratio: Size and Size

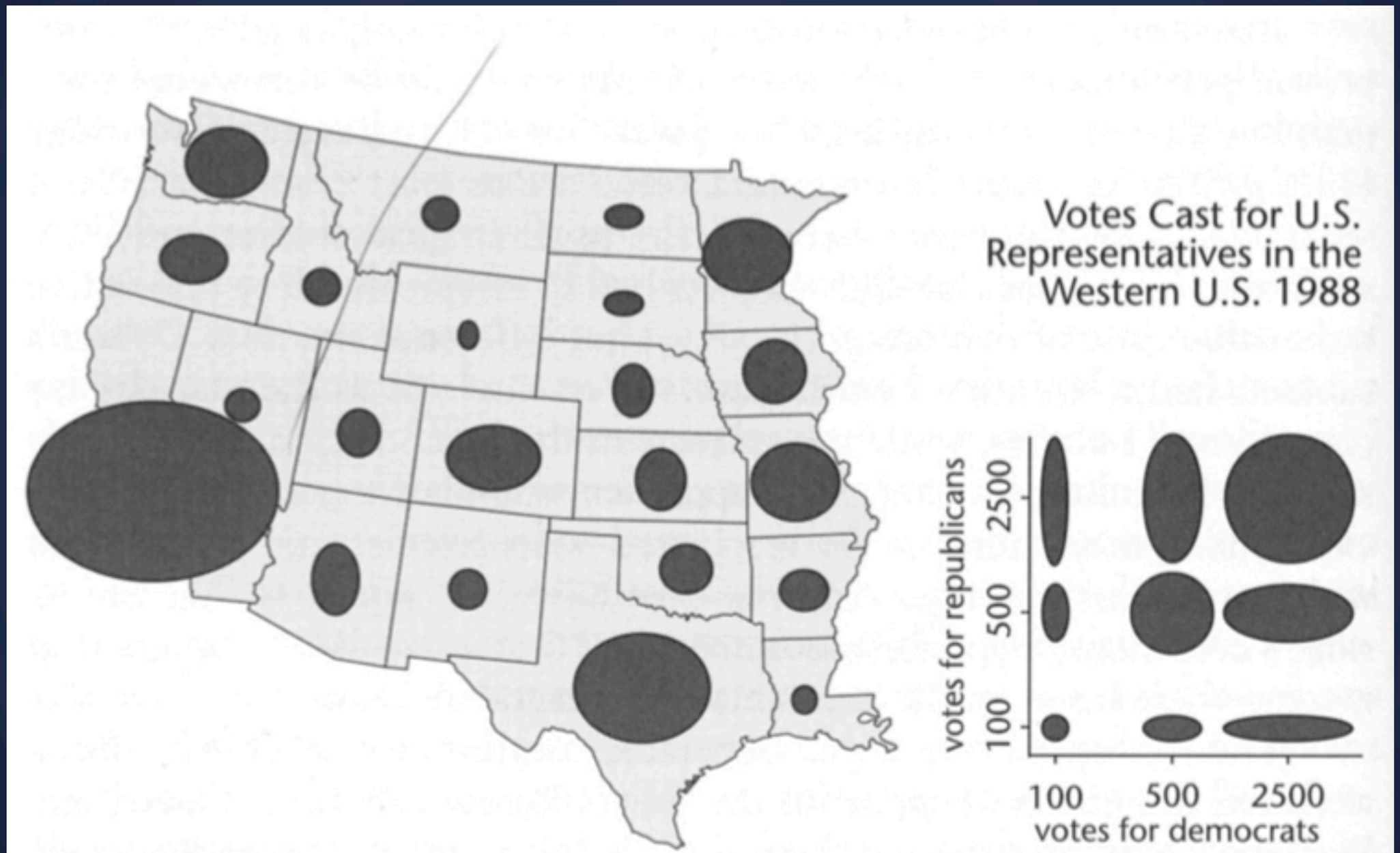
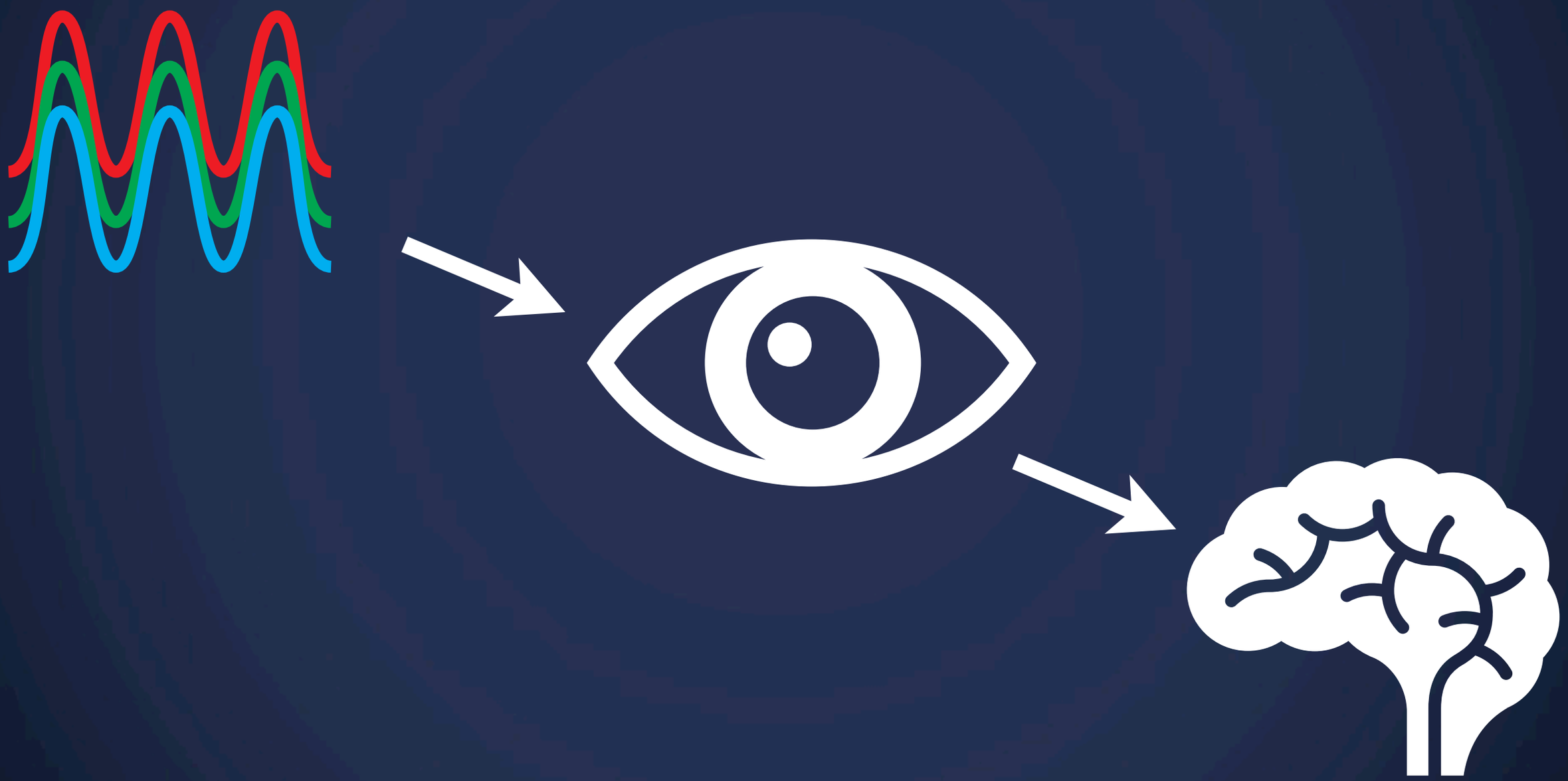


FIGURE 3.38. An example of the use of an ellipse as a map symbol in which the horizontal and vertical axes represent different (but presumably related) variables.

MacEachren, 1995

From Light to Visualization

Interpretations and Interpolations



Signal Detection

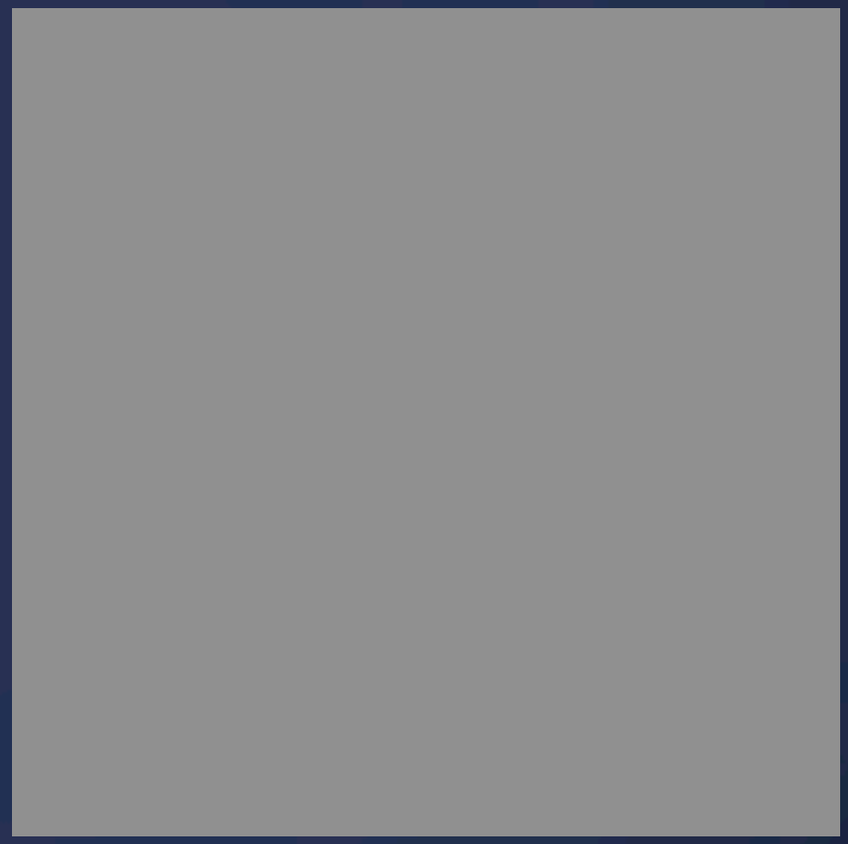
Which one is brighter?

Signal Detection

Which one is brighter?

[128,128,128]

[144,144,144]



Signal Detection

Which one is brighter?

Signal Detection

Which one is brighter?

Signal Detection

Which one is brighter?

[136,136,136]

[128,128,128]

Just noticeable difference

Weber's Law

$$JND = \frac{\Delta I}{I}$$

JND : constant

I : intensity

http://makingmaps.net/2007/08/28/perceptual-scaling-of-map-symbols/

Just noticeable difference

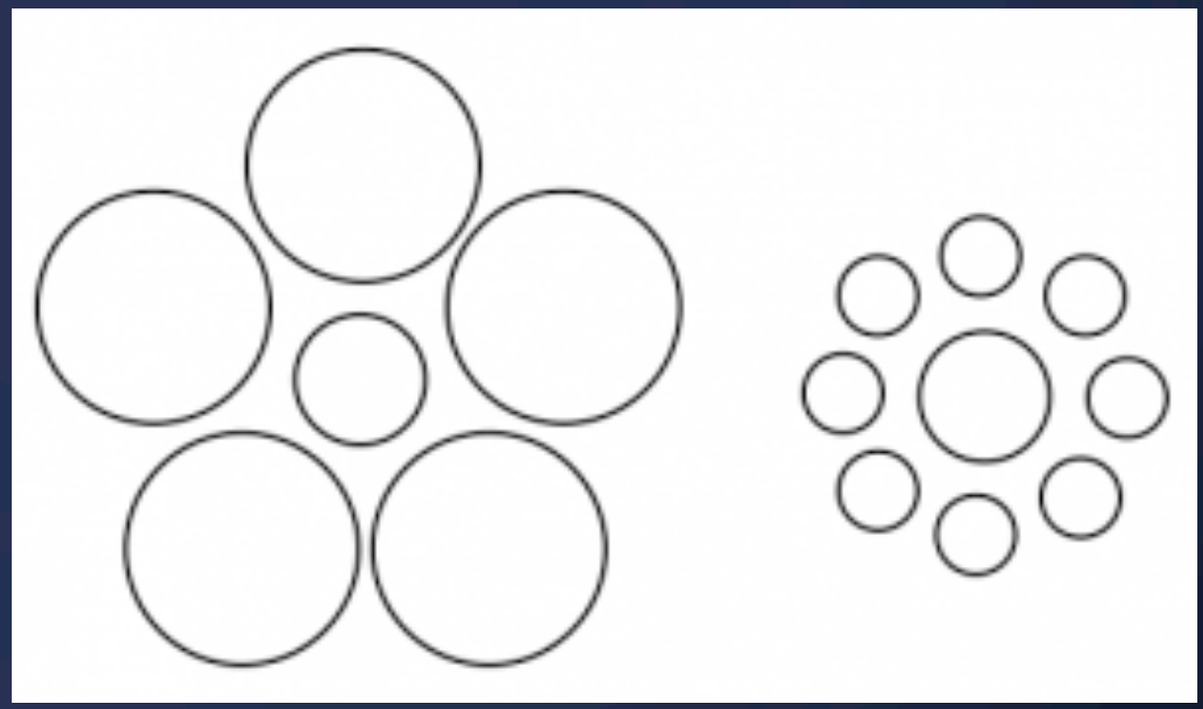
Weber's Law

$$JND = \frac{\Delta I}{I}$$

Ratio is much more important than magnitude

JND : constant

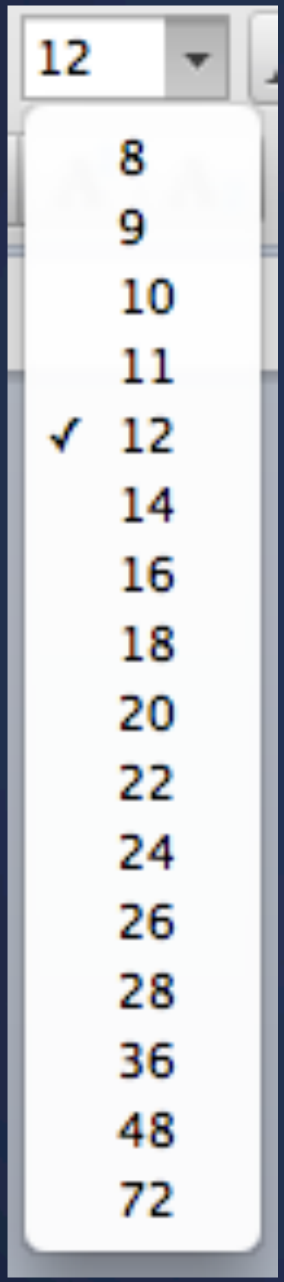
I : intensity



http://makingmaps.net/2007/08/28/perceptual-scaling-of-map-symbols/

Steps in font size

Sizes standardized in 16th century



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Magnitude Estimation

How much bigger is the lower bar?

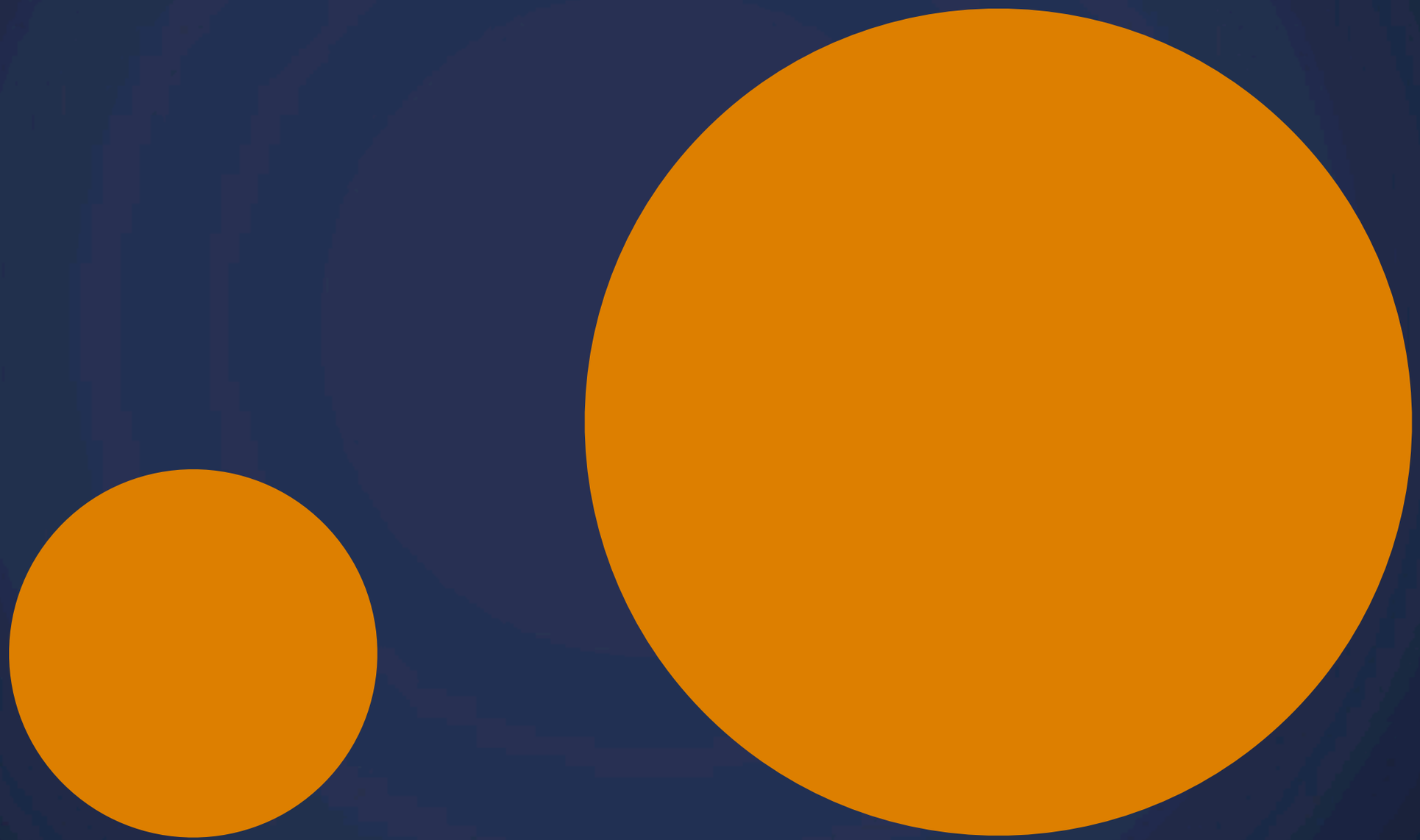
Magnitude Estimation

How much bigger is the lower bar?

×4

Magnitude Estimation

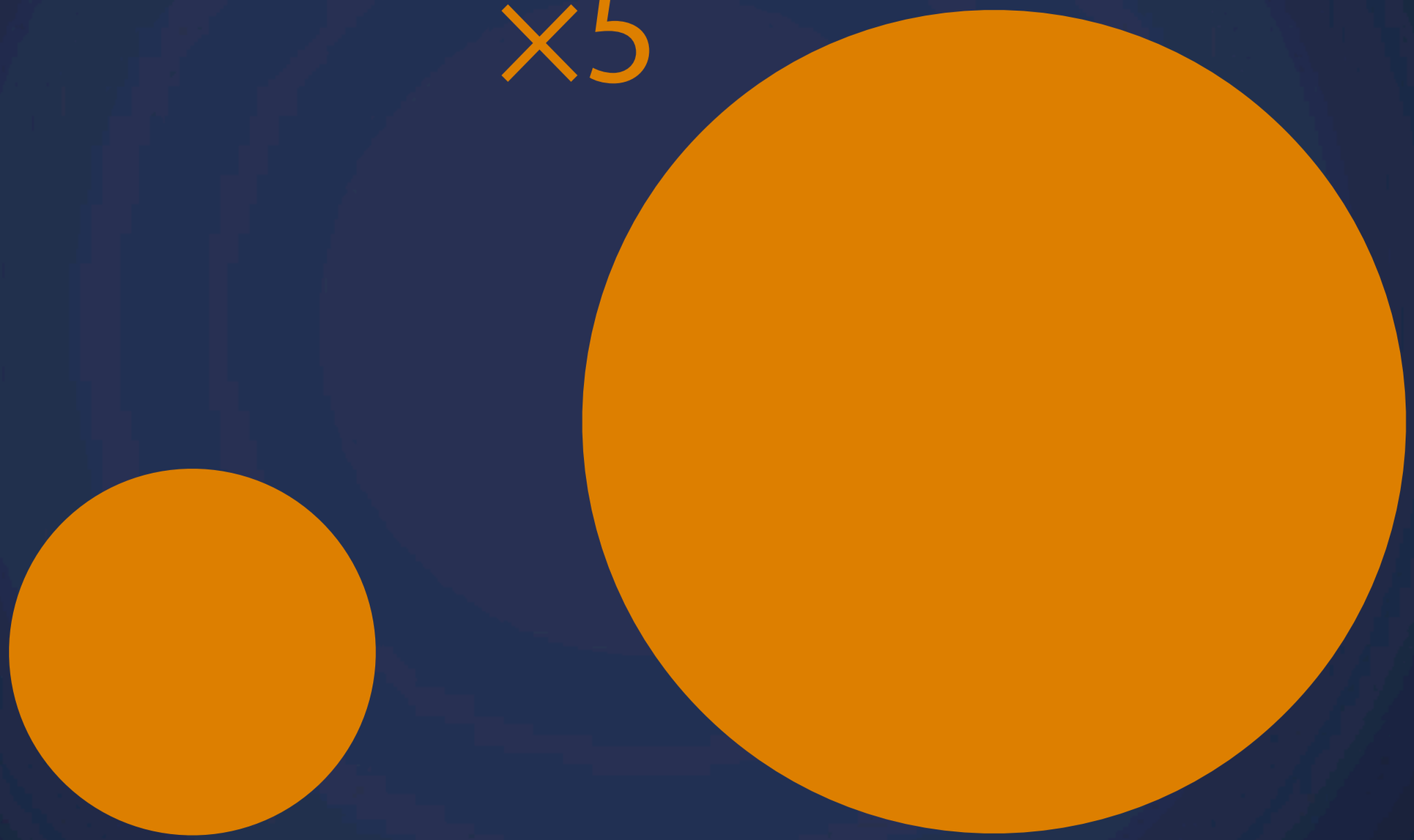
How much bigger is the right circle



Magnitude Estimation

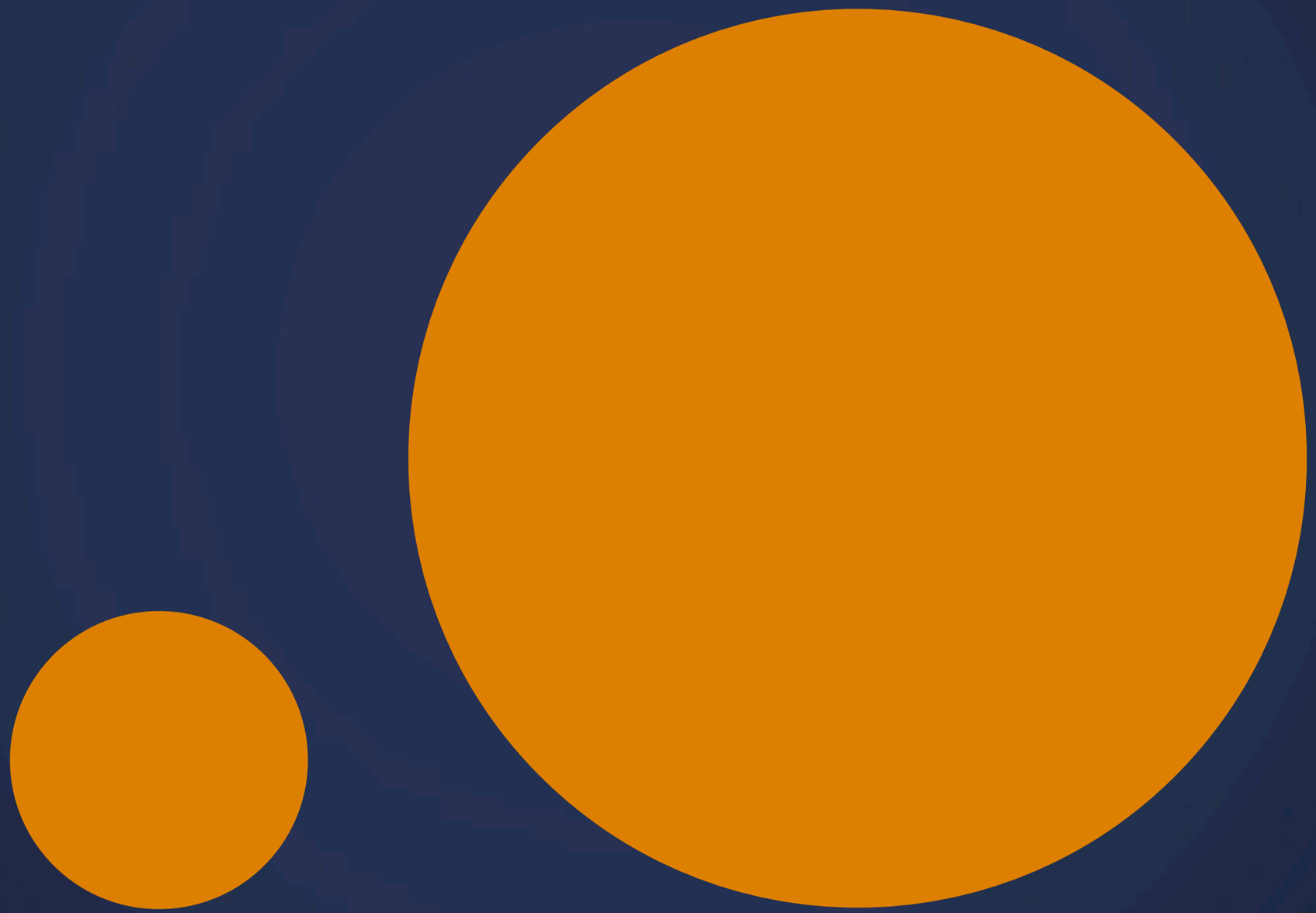
How much bigger is the right circle

×5



Magnitude Estimation

How much bigger is the right circle



Magnitude Estimation

How much bigger is the right circle

×9

Magnitude Estimation

How much darker is the right square?

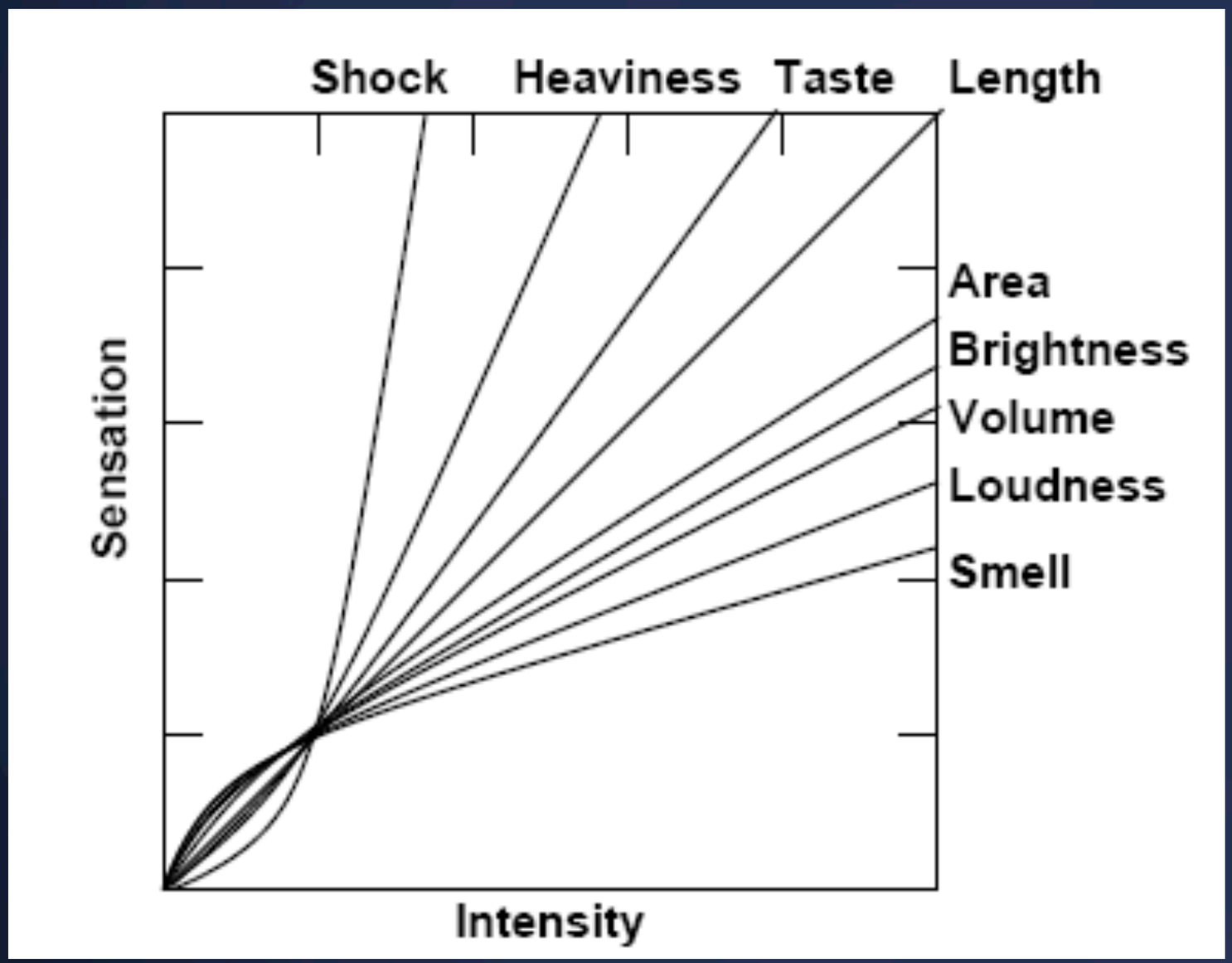
Magnitude Estimation

How much darker is the right square?

×4

Steven's Power Law

Under- and overestimation of magnitudes



$$S = I^{p}$$

$p < 1$

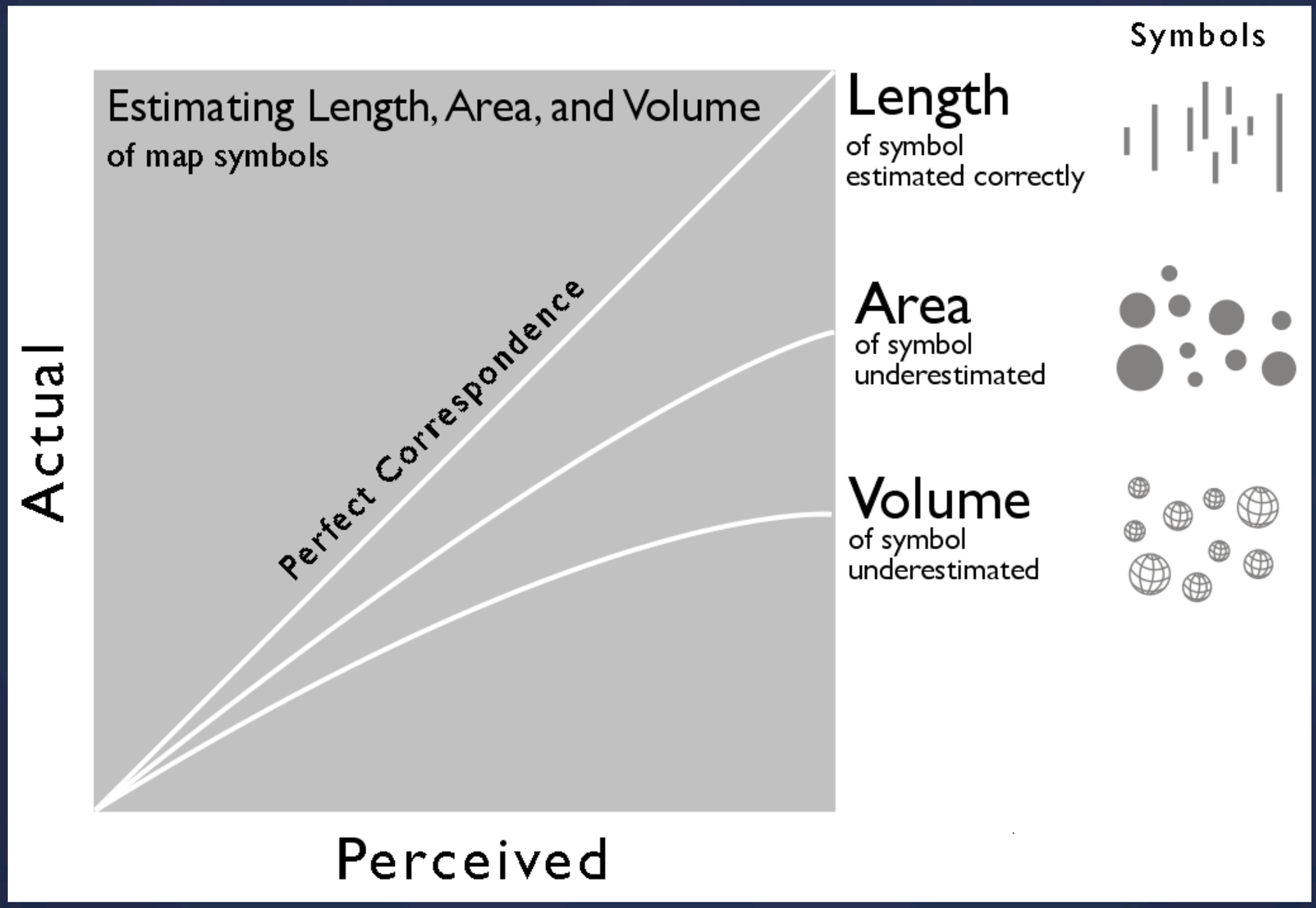
under-estimate

$p > 1$

over-estimate

Steven's Power Law

Under- and overestimation of magnitudes



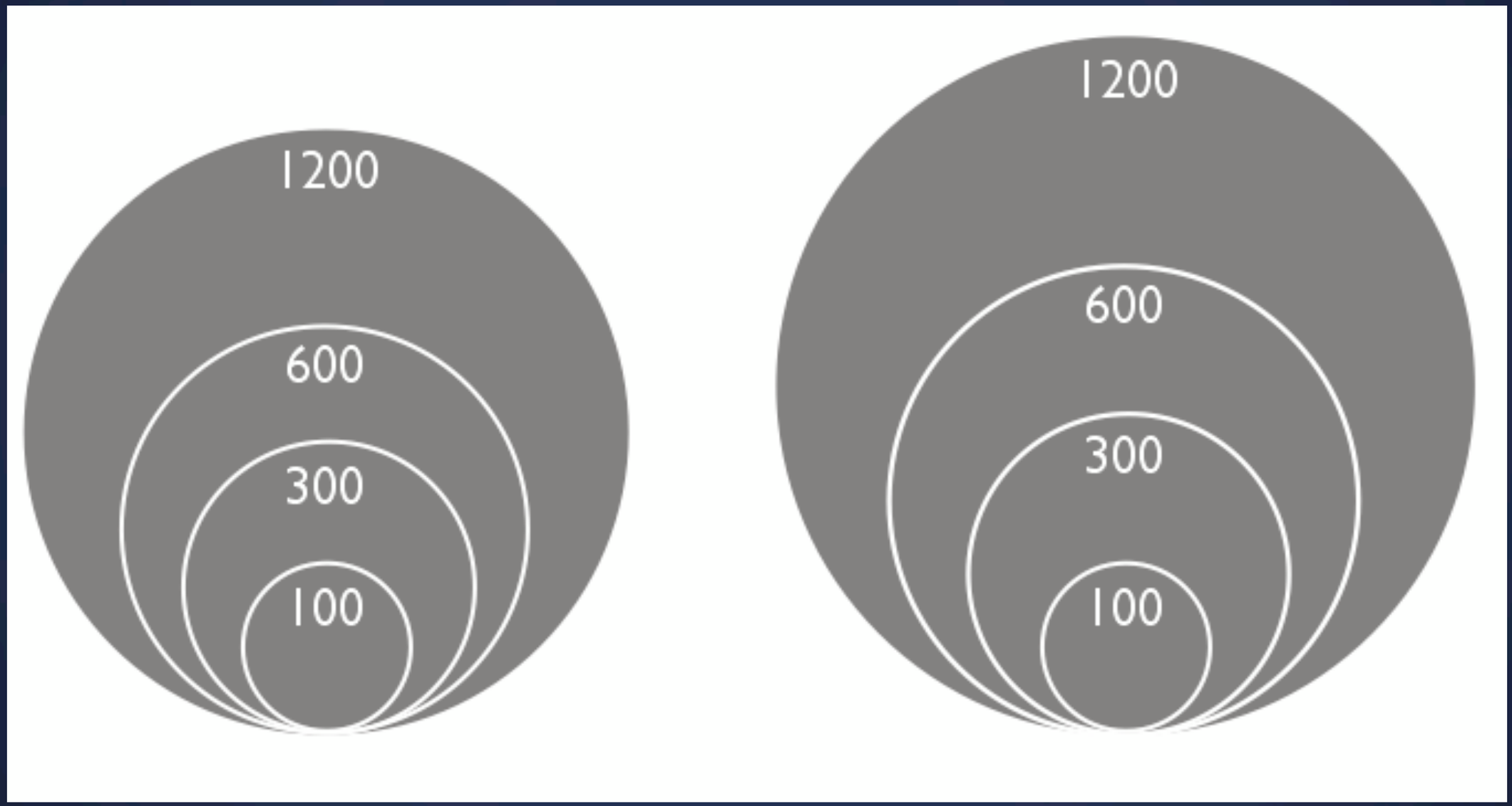
http://makingmaps.net/2007/08/28/perceptual-scaling-of-map-symbols/

Steven's Power Law

Examples of power law exponents p

Sensation	Exponent
Loudness	0.6
Brightness	0.33
Smell	0.55 (Coffee) - 0.6 (Heptane)
Taste	0.6 (Saccharine) -1.3 (Salt)
Temperature	1.0 (Cold) – 1.6 (Warm)
Vibration	0.6 (250 Hz) – 0.95 (60 Hz)
Duration	1.1
Pressure	1.1
Heaviness	1.45
Electic Shock	3.5

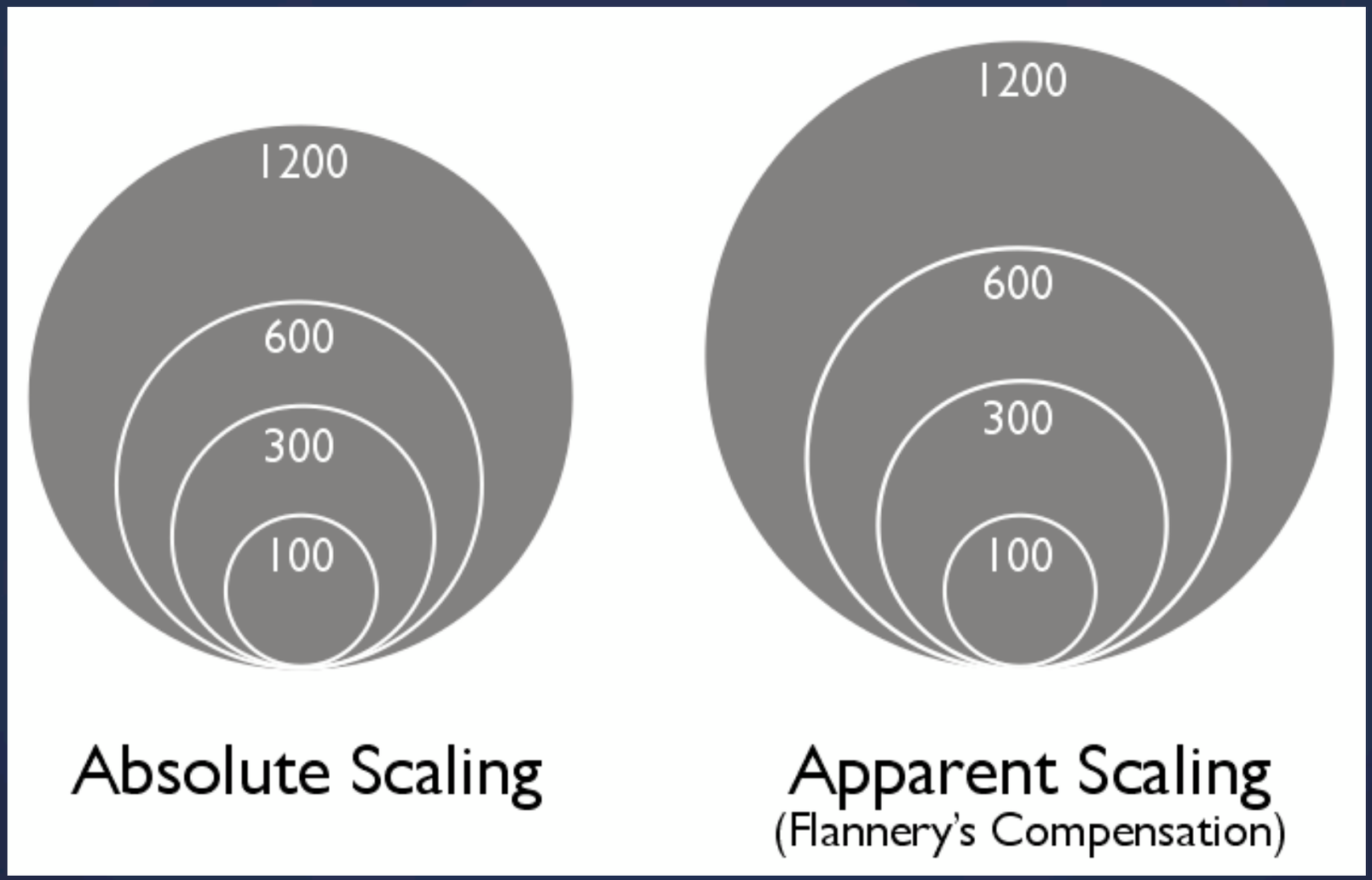
Which one is more accurate?



http://makingmaps.net/2007/08/28/perceptual-scaling-of-map-symbols/

Apparent magnitude scaling

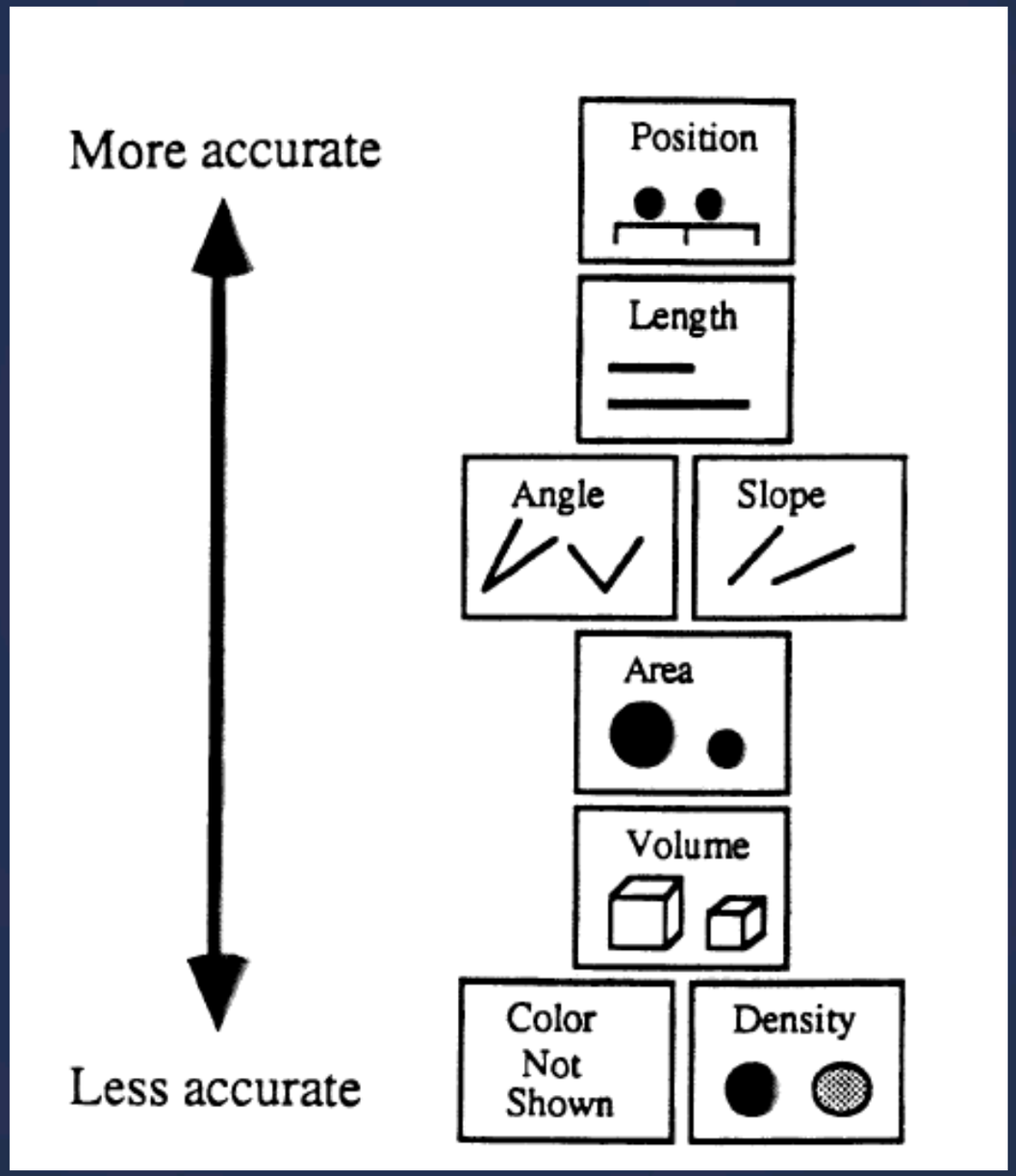
Compensating magnitude to match perception



http://makingmaps.net/2007/08/28/perceptual-scaling-of-map-symbols/

Encodings

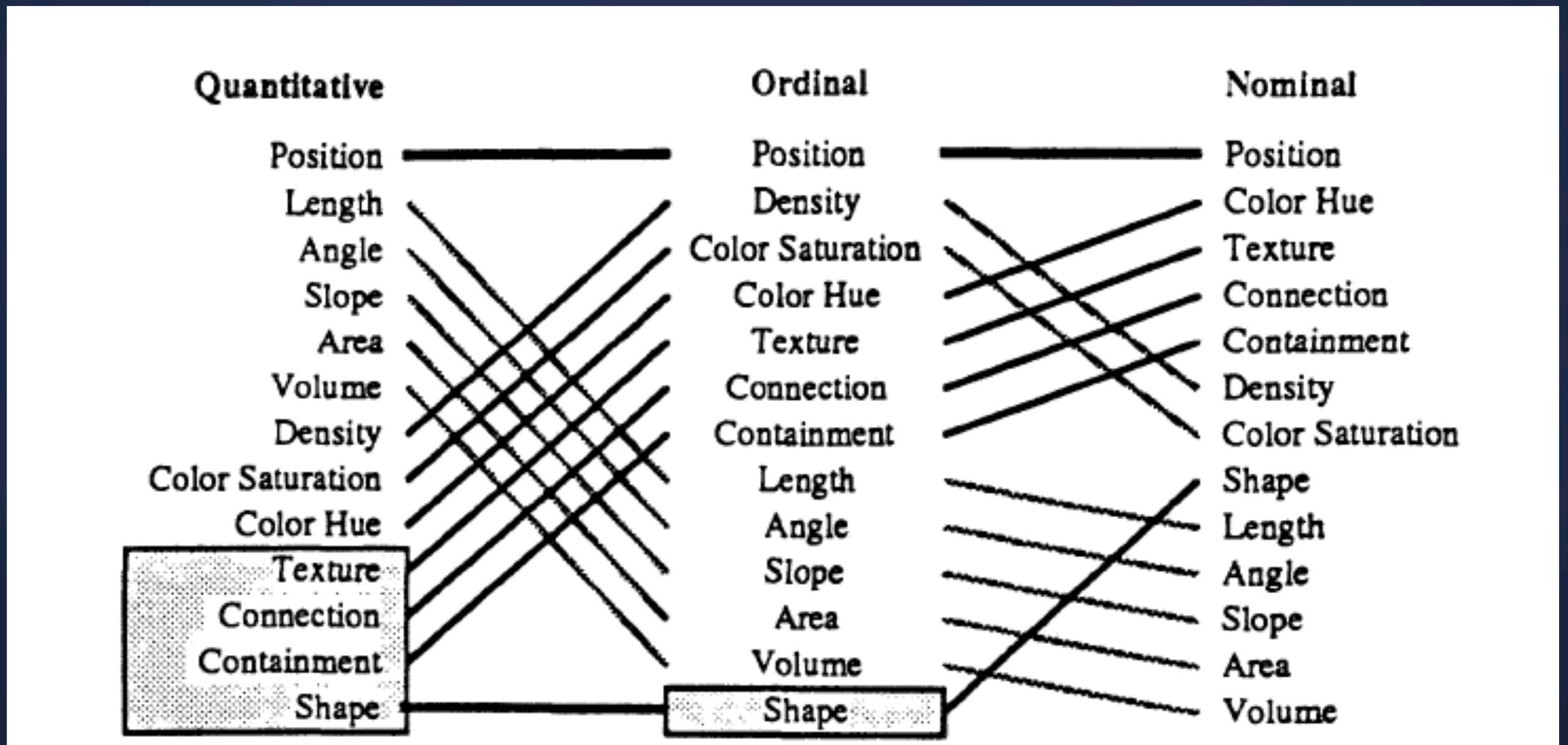
Hierarchy of accuracy



Mackinlay, Automating the Design of Graphical Presentations of Relational Information

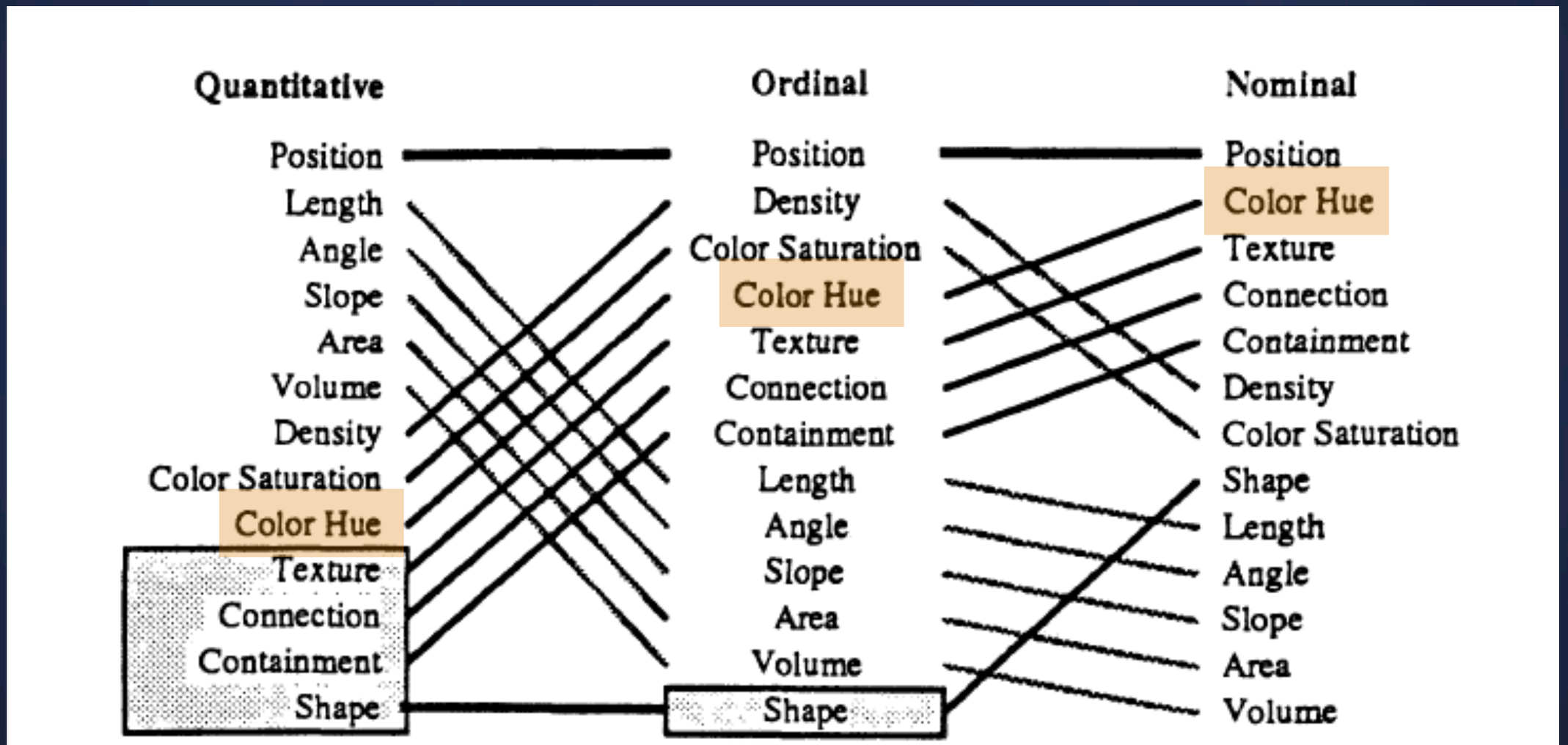
Encodings

Rankings of perceptual tasks



Encodings

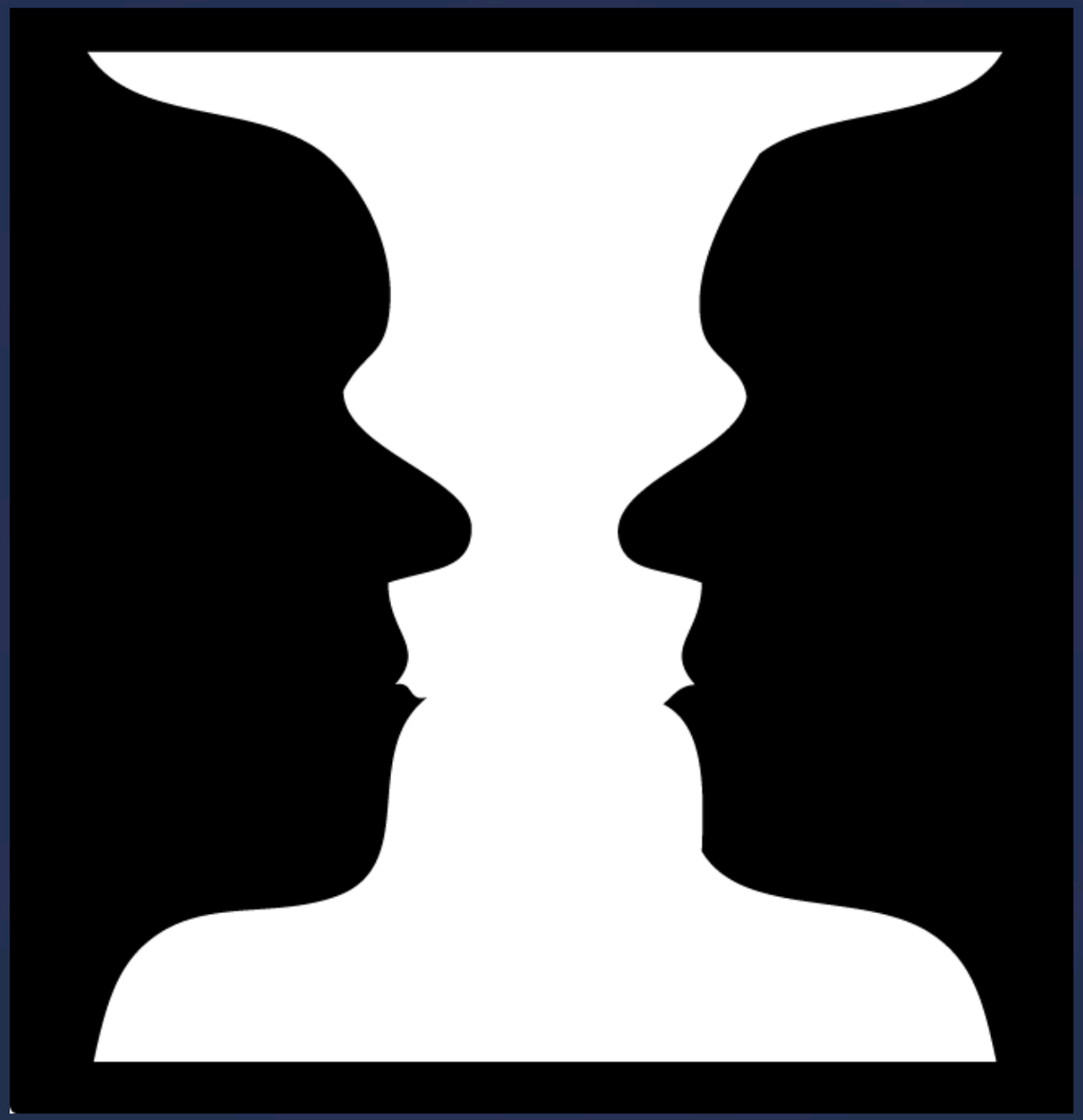
Rankings of perceptual tasks



Gestalt Grouping

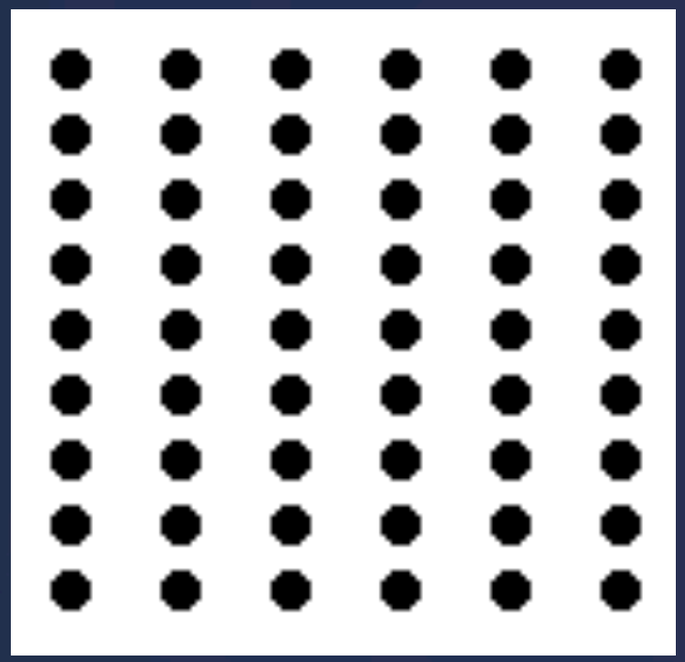
Principles

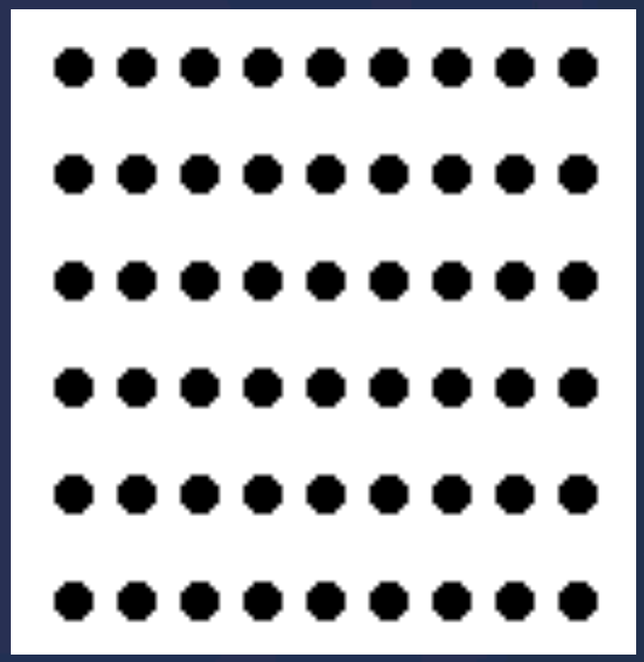
Figure & Ground



Principles

Proximity



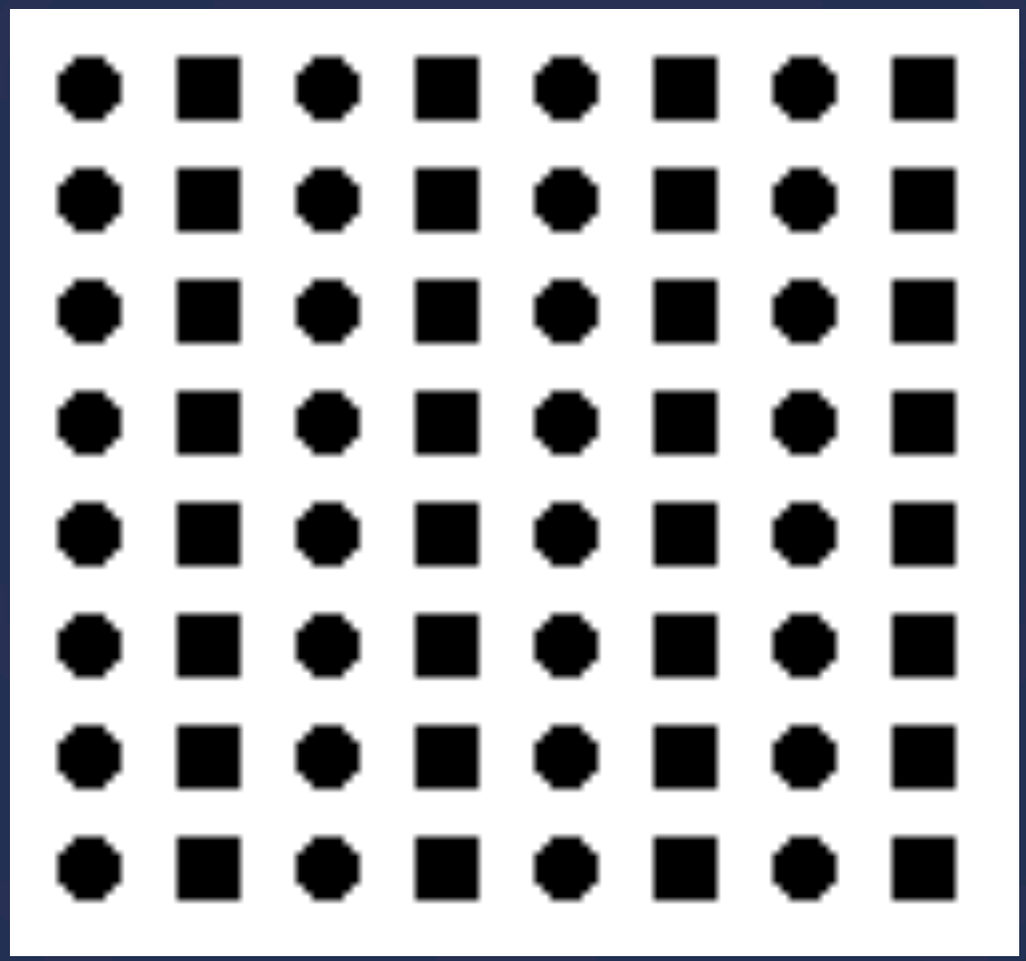


Principles

Proximity

Principles

Similarity

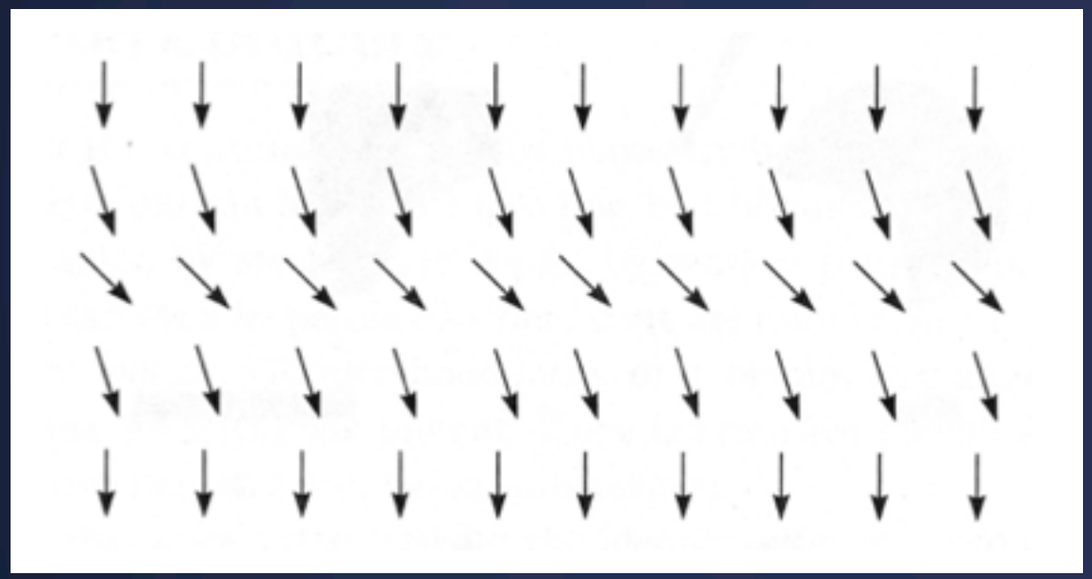


Principles

Connectedness

Principles

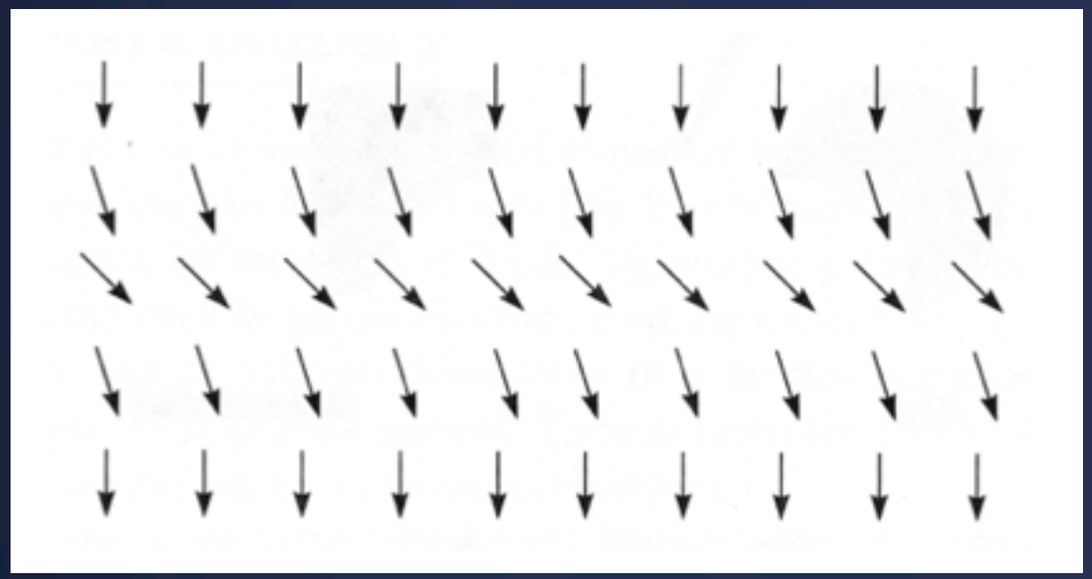
Continuity

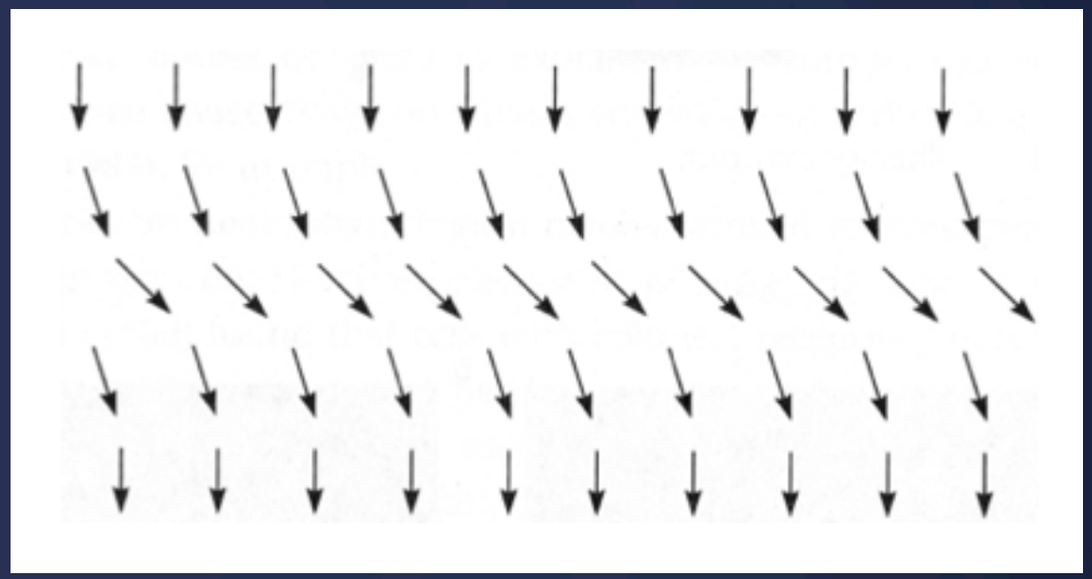


Ware 2004

Principles

Continuity





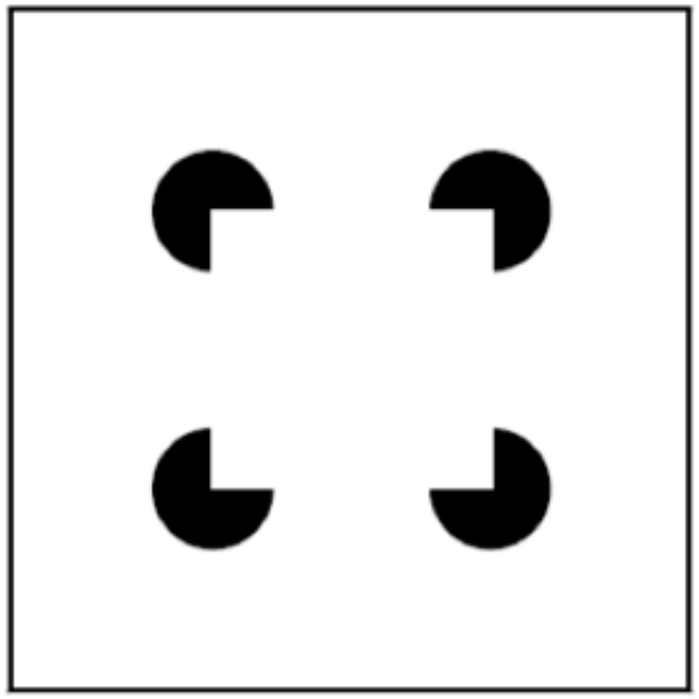
Ware 2004

Principles

Closure

Principles

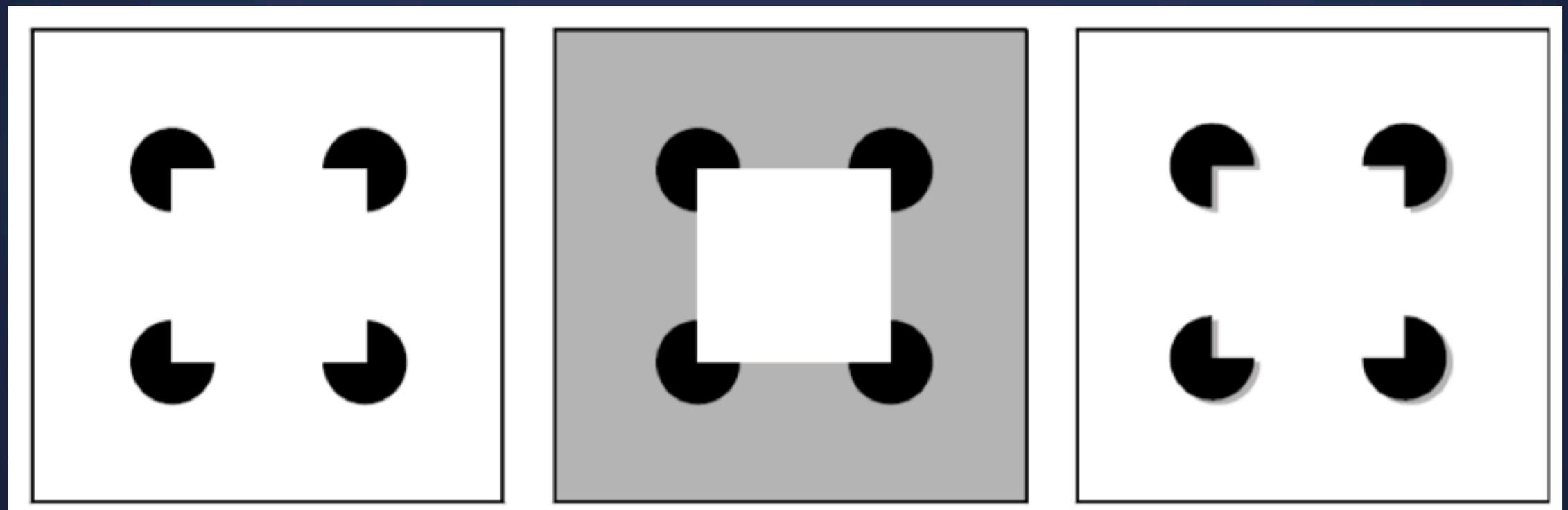
Closure



Illusory contours [from Durand 02]

Principles

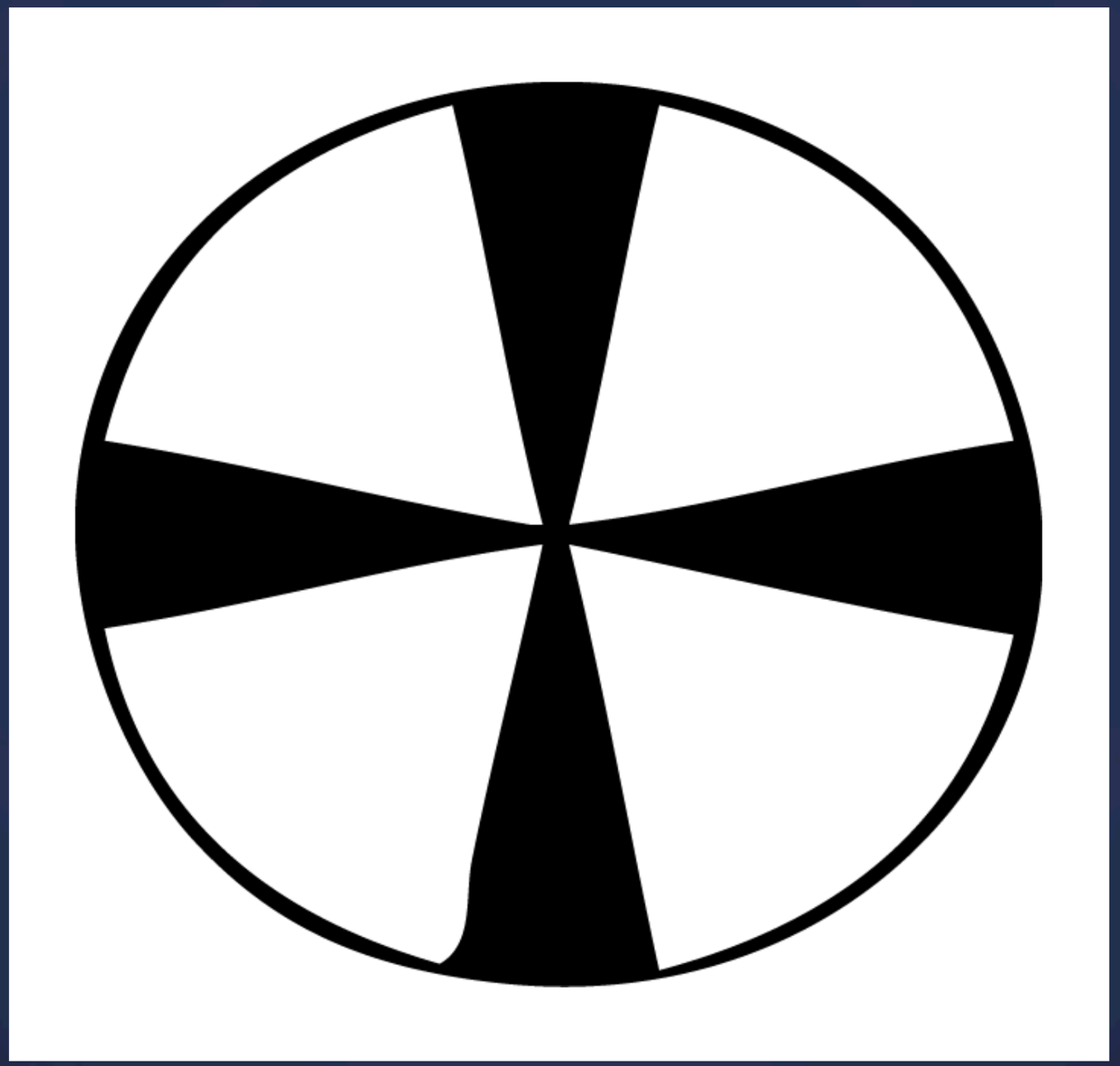
Closure



Illusory contours [from Durand 02]

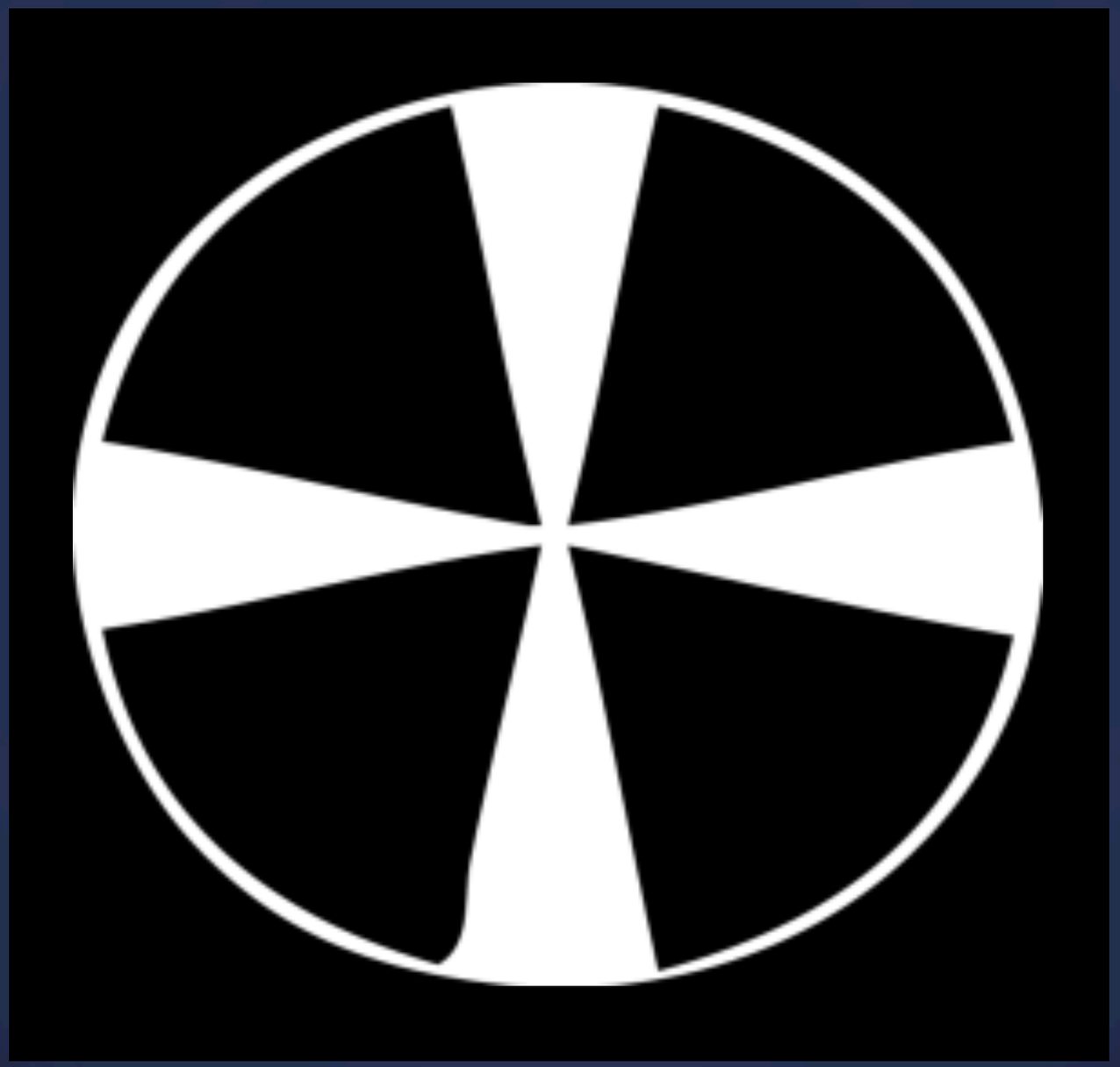
Principles

Smallness



Principles

Smallness



Principles

Surroundedness

Principles

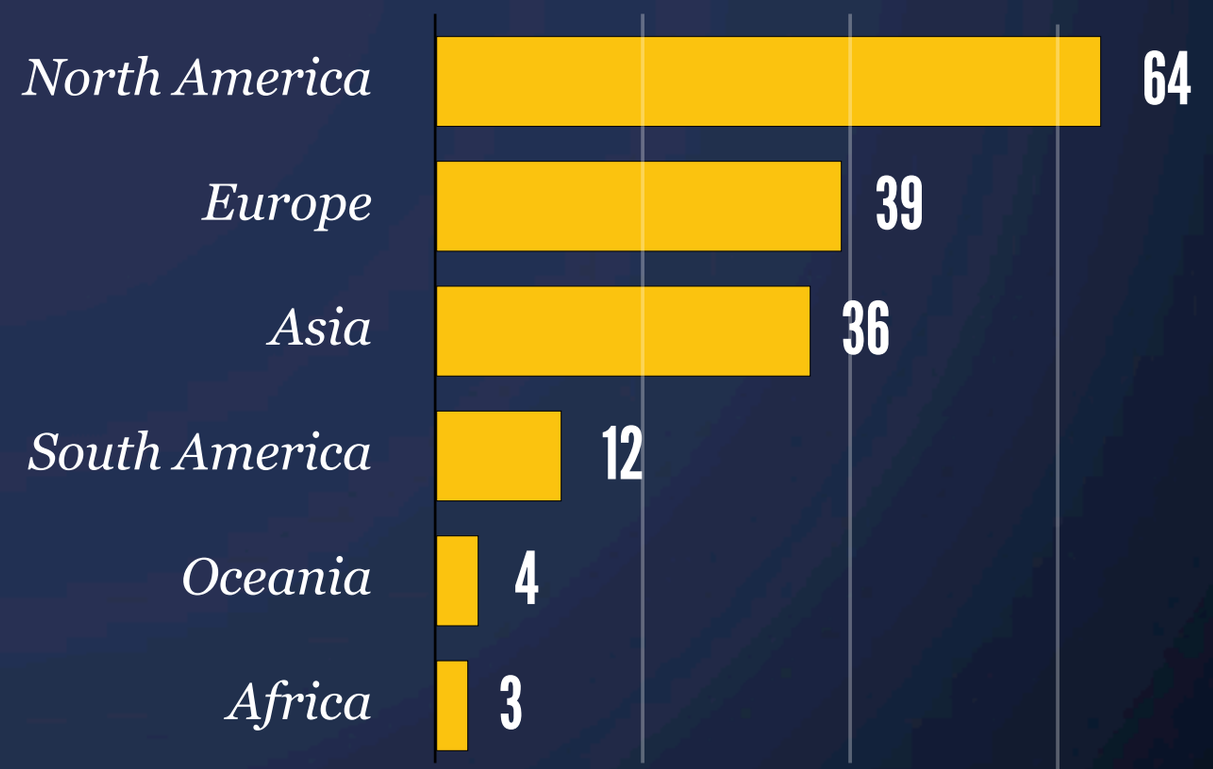
Surroundedness

TIE

Recap

Feedback Assignment 2

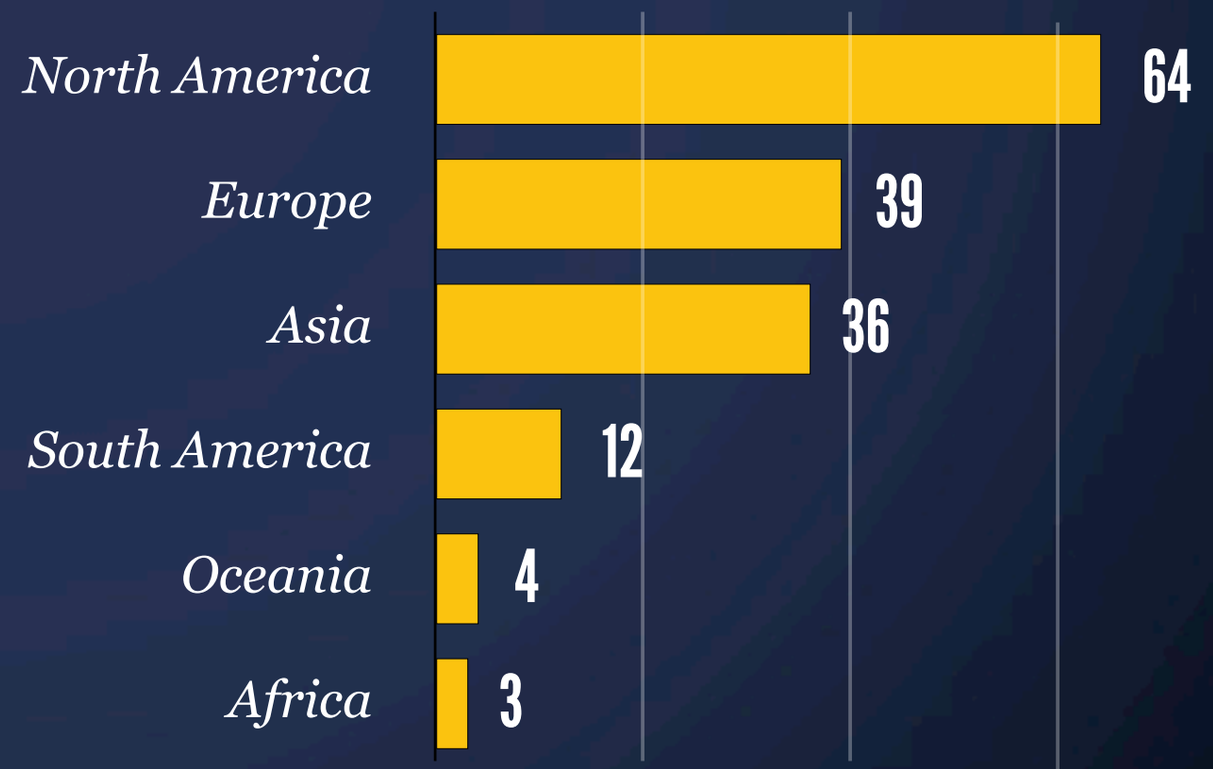
What's in the data?



Feedback Assignment 2

What's in the data?

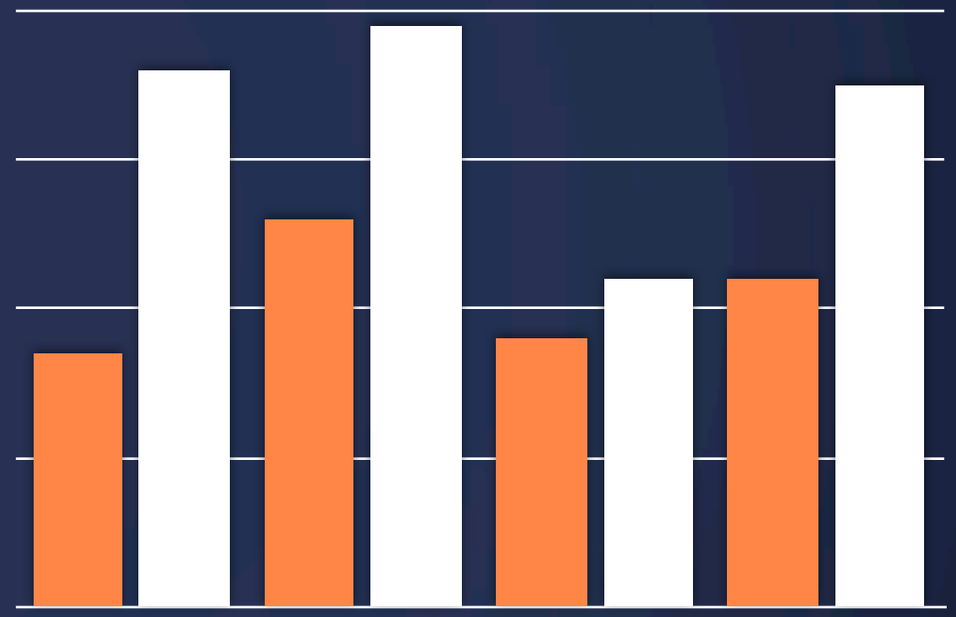
Geographic data can – but doesn't need to be – on a map



Feedback Assignment 2

Common Pitfalls

- No Labels
- No Axis
- No Title
- Too many elements
- Color Choice
- Distracting decorations



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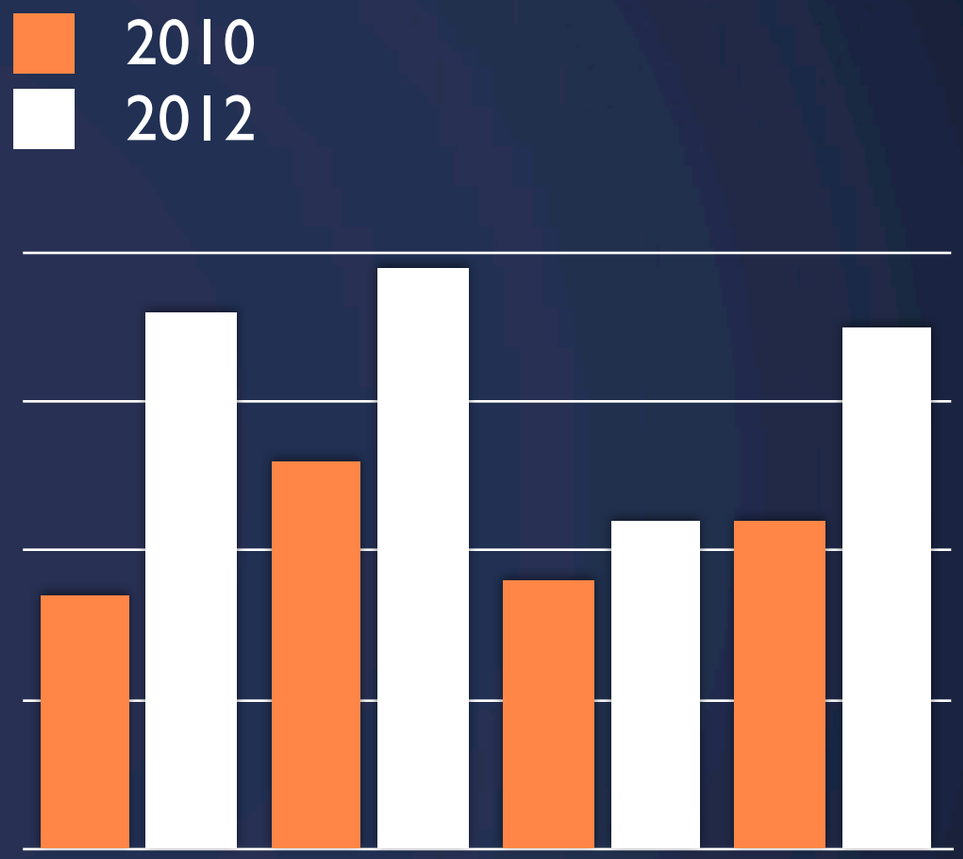

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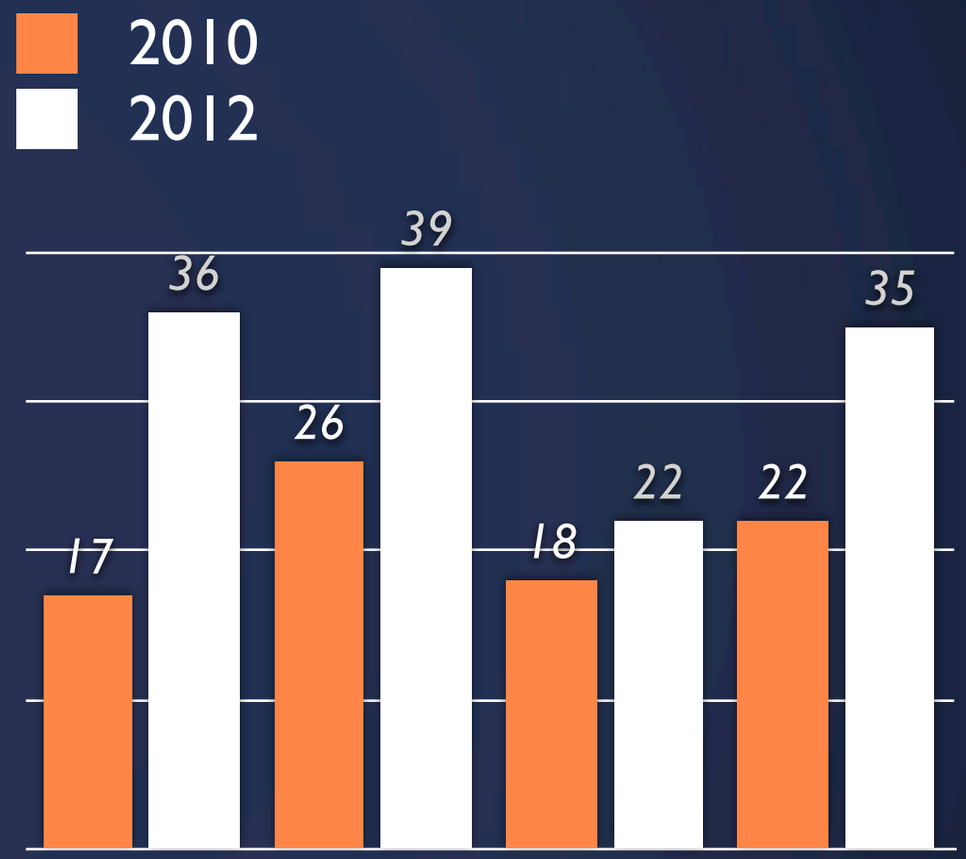

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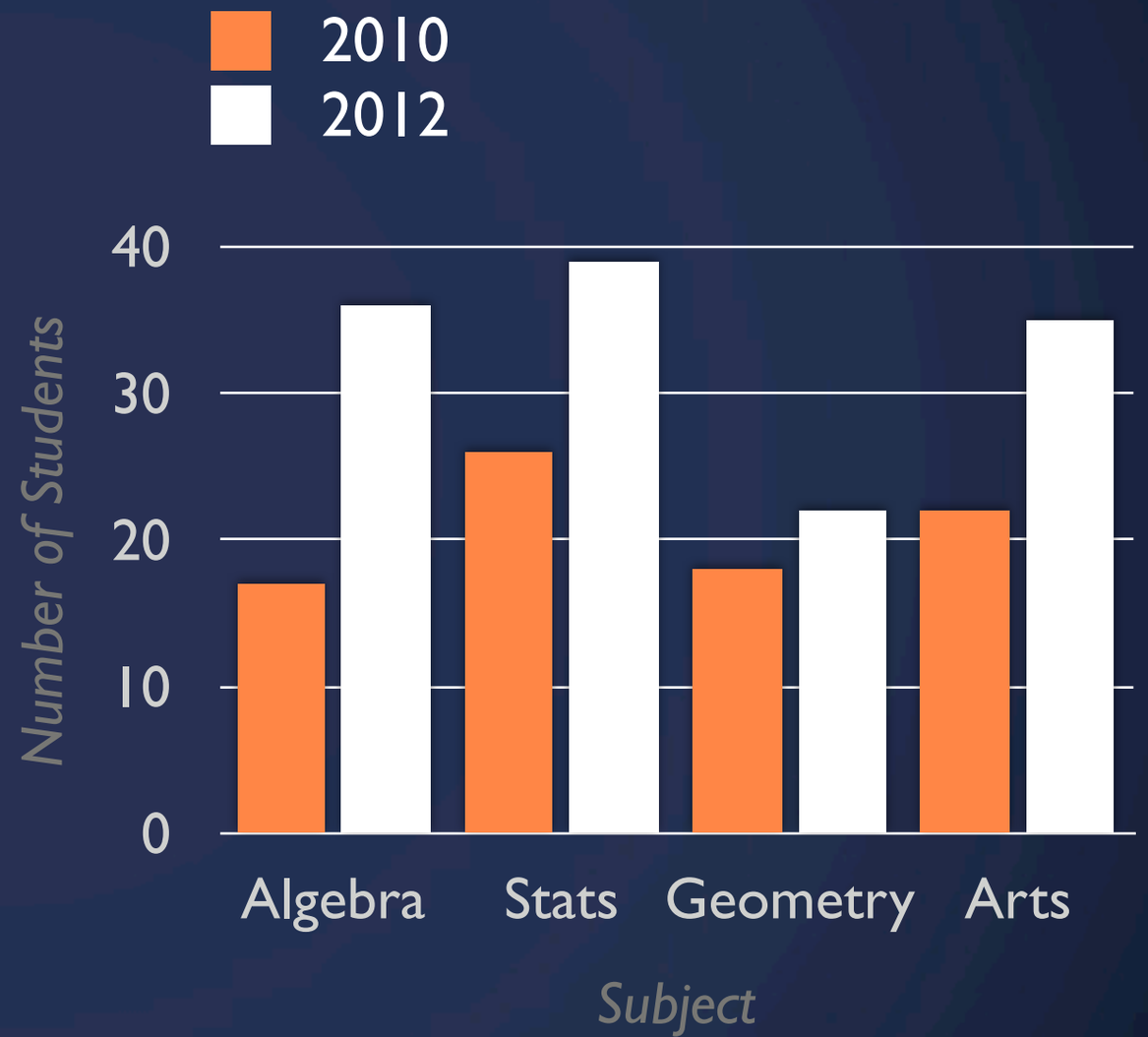

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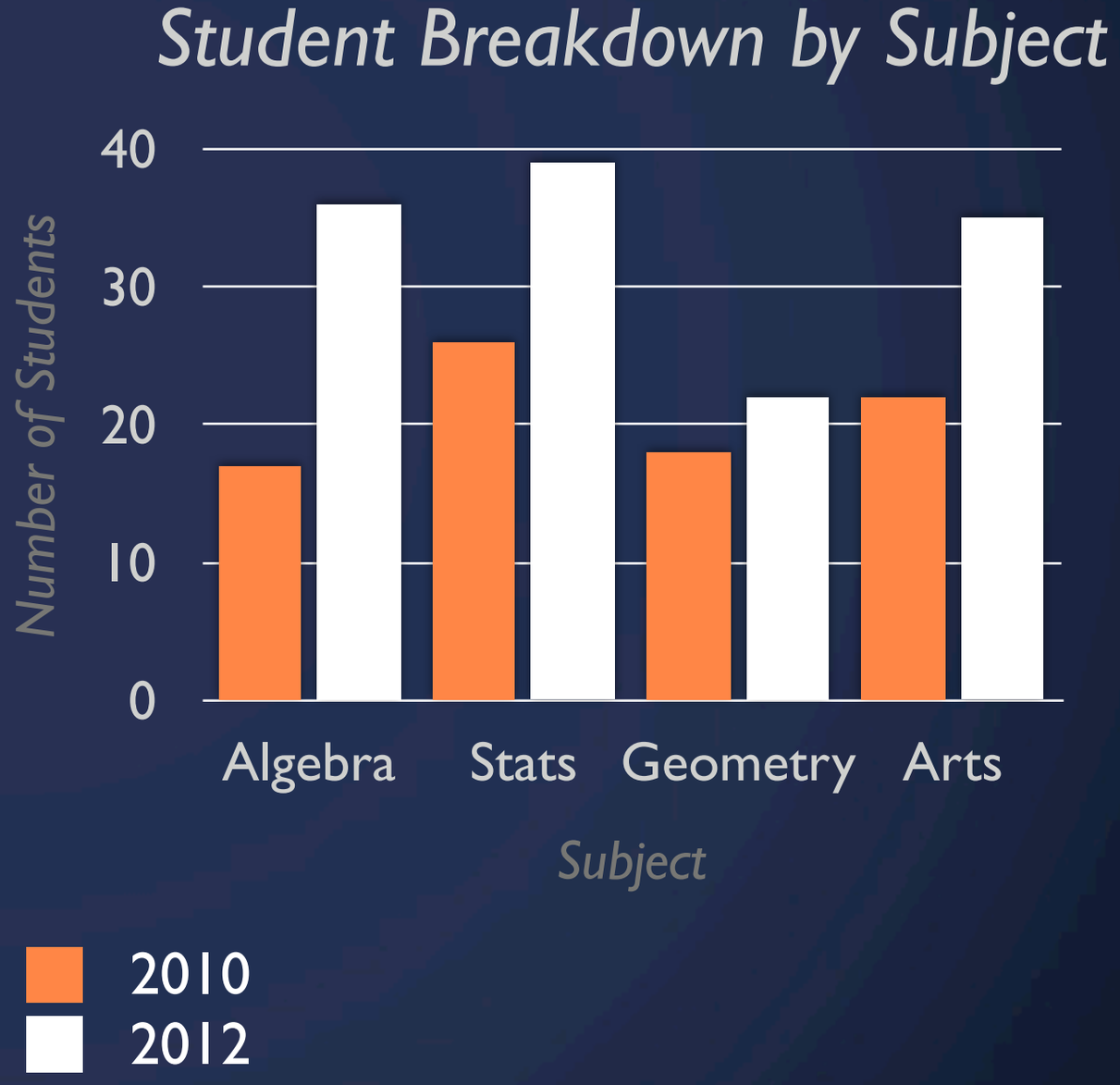

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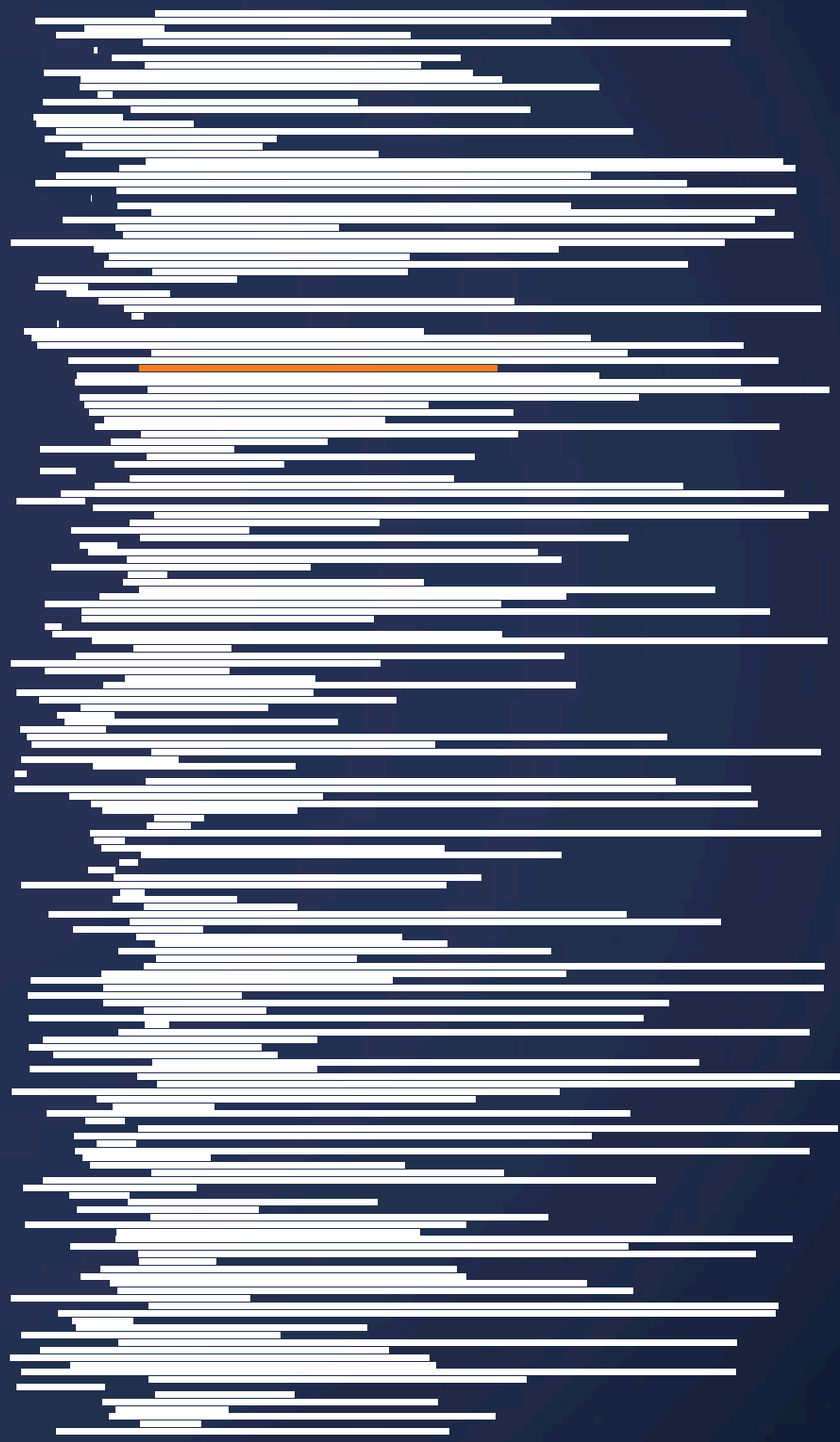

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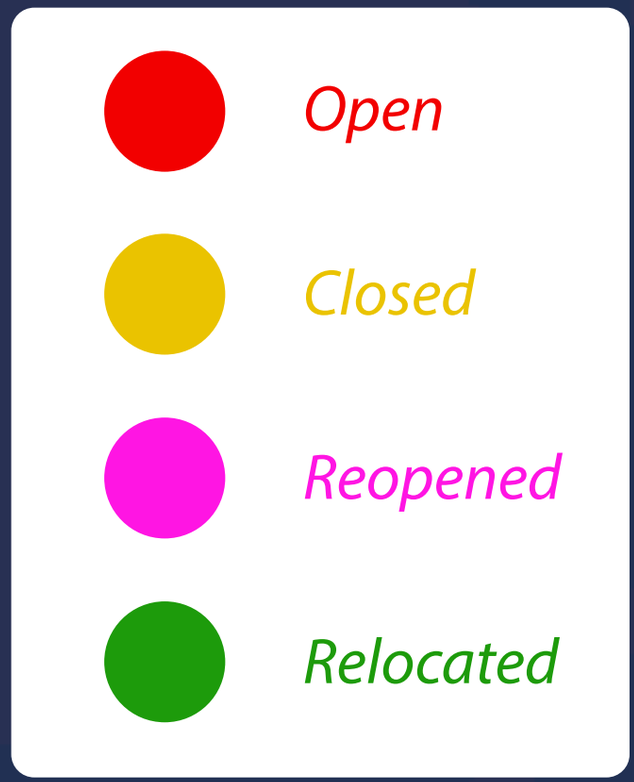

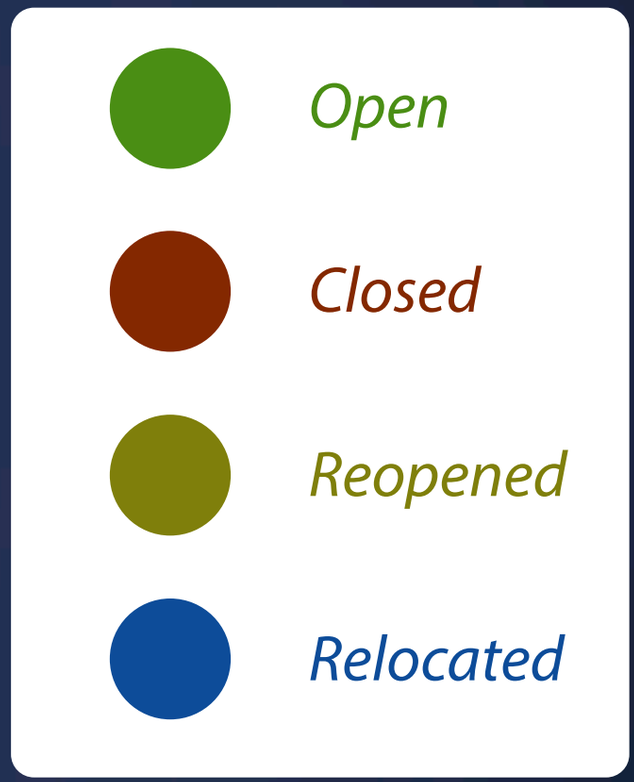

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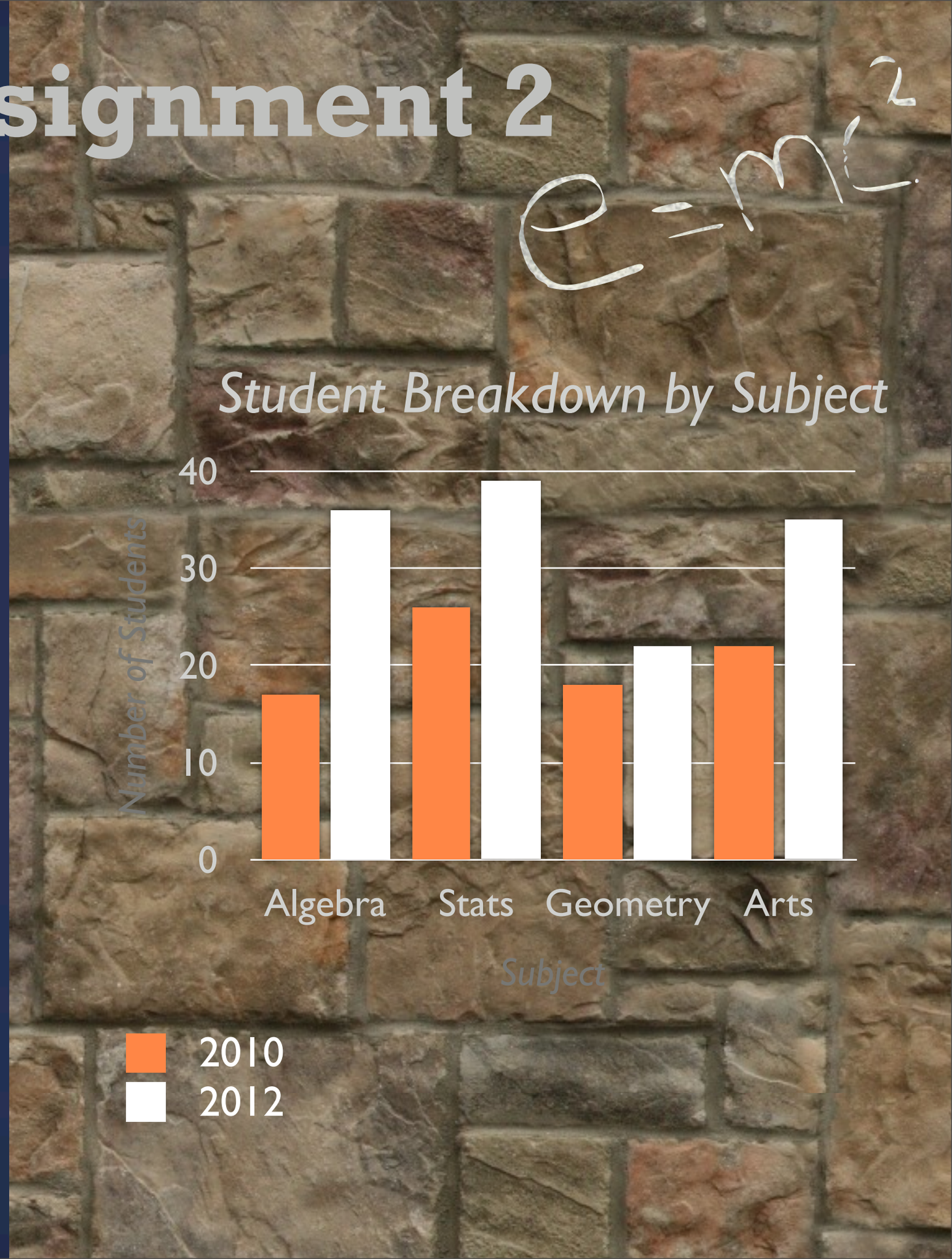
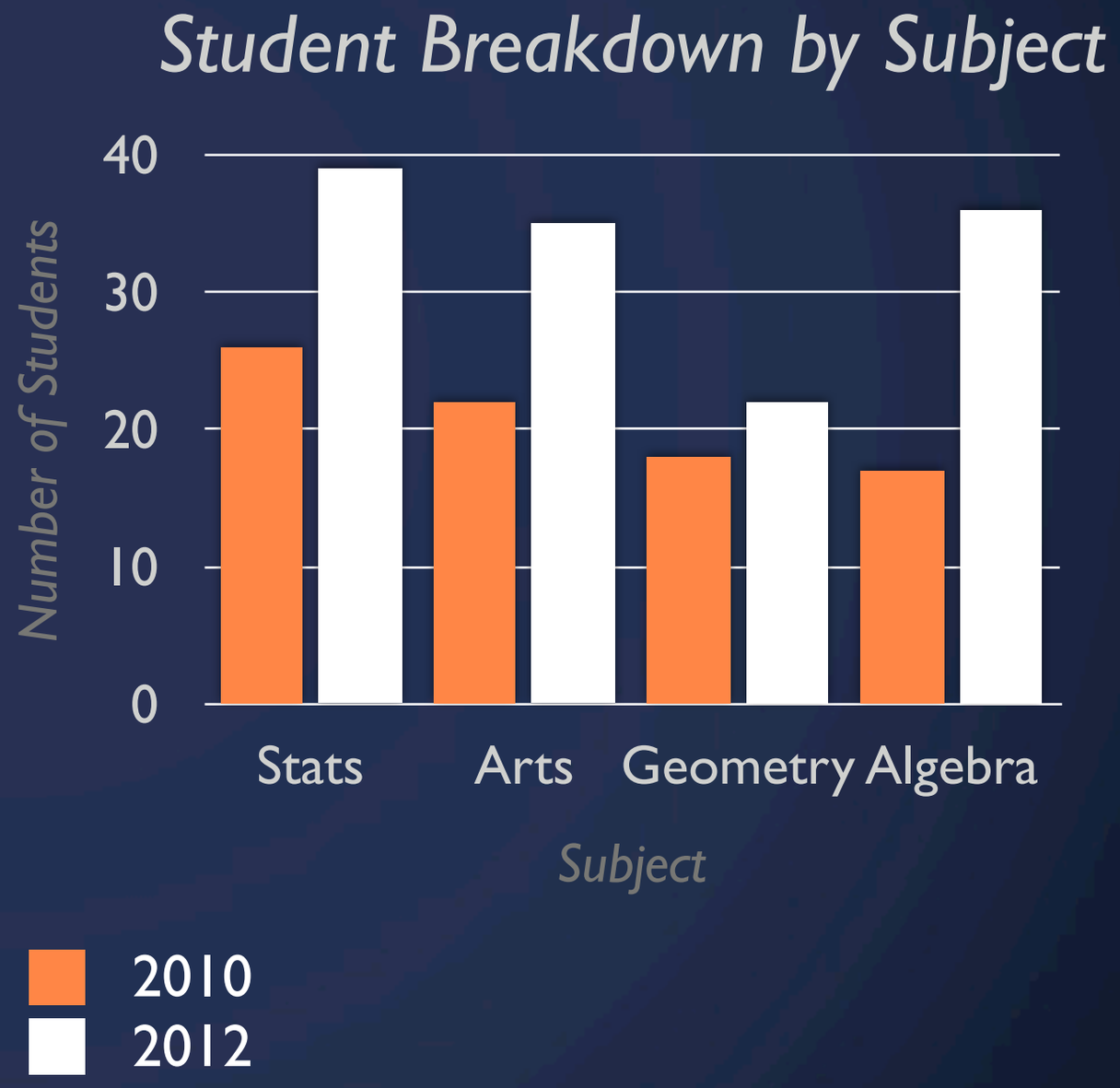


Feedback Assignment 2

Improvements

- Filter Data
- Arrange / Sort By Data
- Create new groupings (decade, continent)
- Ask For Feedback



Lab Thursday

Raphaël.js

Next Lecture

Color