University of Dayton

Perception and Color in Data Visualization

CPS 563 – Data Visualization

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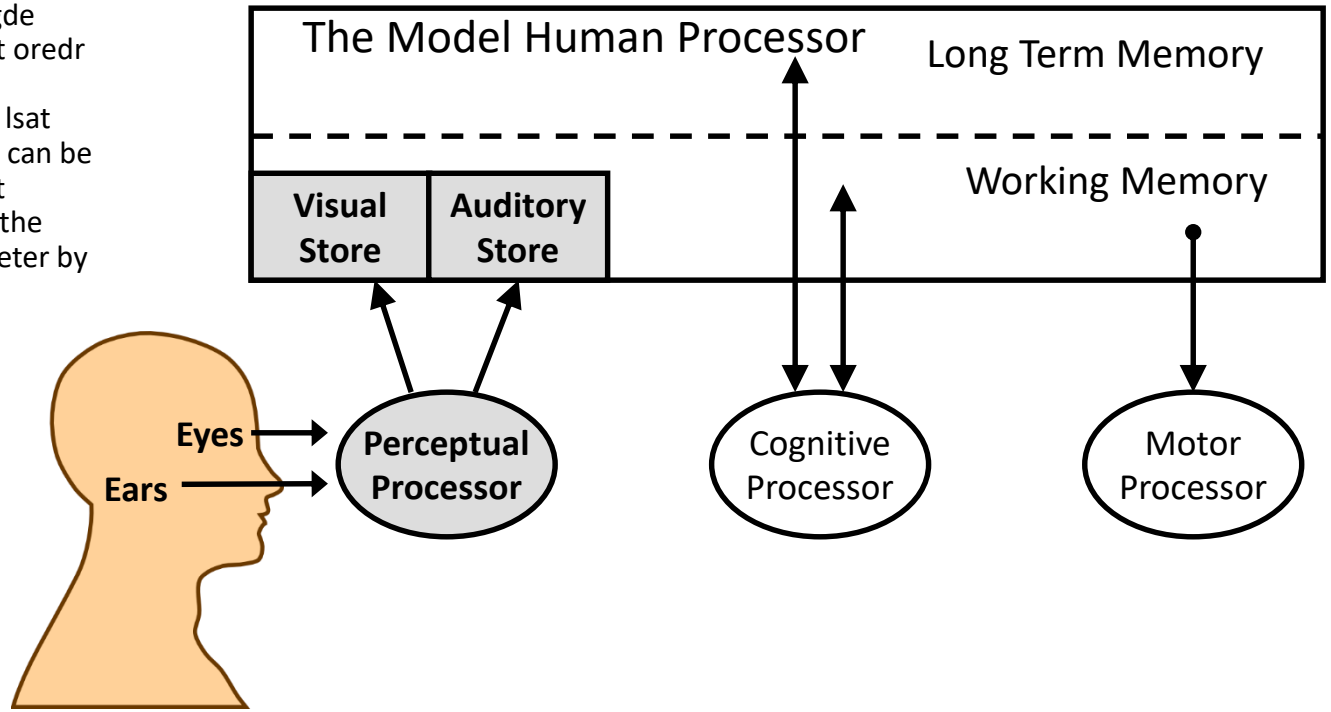
Outline

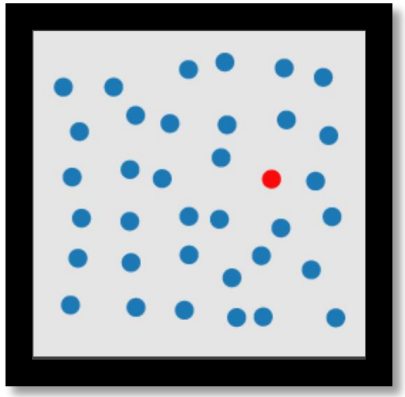
- Human Perceptual System
- Pre-Attentive Processing
- Color in Data Visualization

Perceptual System

- Responsible for transforming external environment into a form that cognitive system can process
- Composed of *perceptual memory* and *processor*

Aoccdrnig to rscheearch at Cmabrigde Uinervtisy, it deosn't mttaer in waht oredr the ltteers in a wrod are, the olny iprmoetnt tihng is taht the frist and lsat ltteer be at the rghit pclae. The rset can be a toatl mses and you can sitll raed it wouthit a porbelm. Tihs is bcuseae the huamn mnid deos not raed ervey lteter by istlef, but the wrod as a wlohe.





Visual Processing

- Aoccdrnig to rscheearch at Cmabrigde Uinervtisy, it deosn't mttaer in waht oredr the ltteers in a wrod are, the olny iprmoetnt tihng is taht the frist and lsat ltteer be at the rghit pclae. The rset can be a toatl mses and you can sitll raed it wouthit a porbelm. Tihs is bcuseae the huamn mnid deos not raed ervey lteter by istlef, but the wrod as a wlohe.

Visual Processing

1281768756138976546984506985604982826762
9809858458224509856458945098450980943585
9091030209905959595772564675050678904567
8845789809821677654876364908560912949686

How many 3s?

Visual Processing

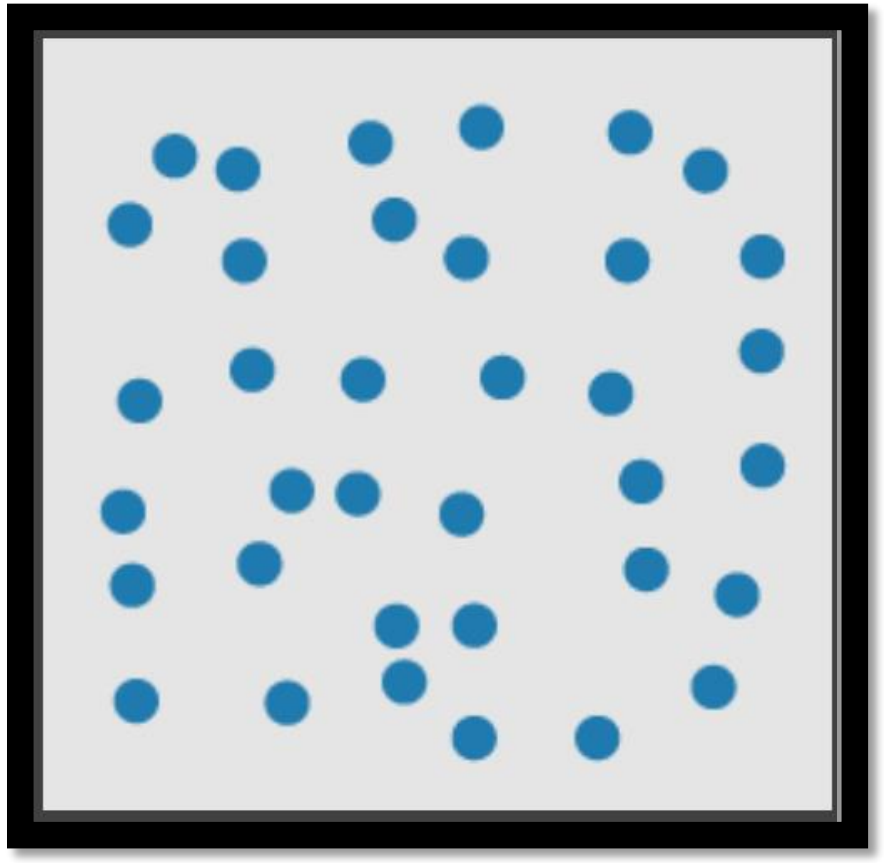
128176875613897654698450698560498282676 2

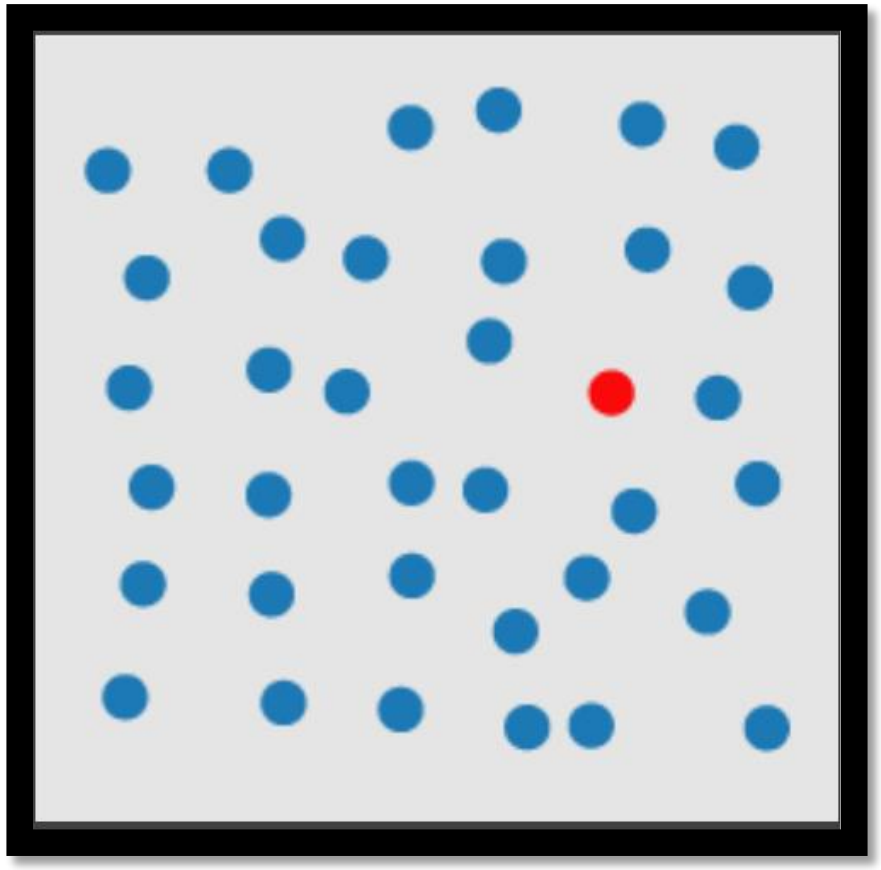
98098584582245098564589450984509809435 85

90910302099059595957725646750506789045 67

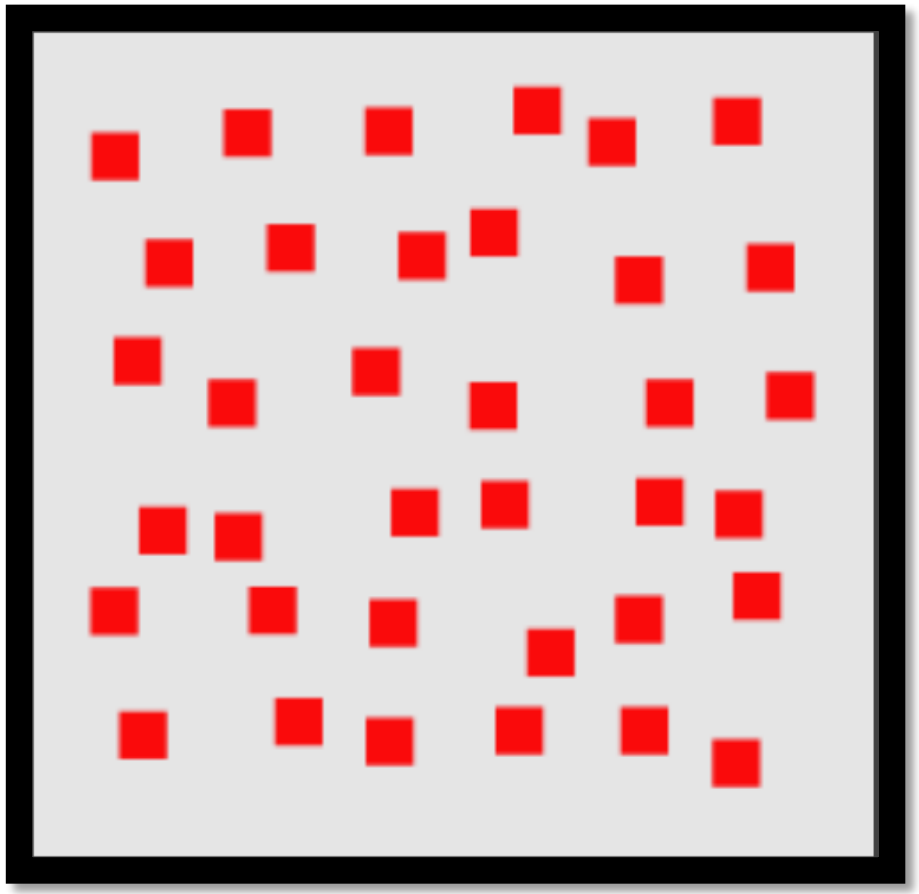
88457898098216776548763649085609129496 86

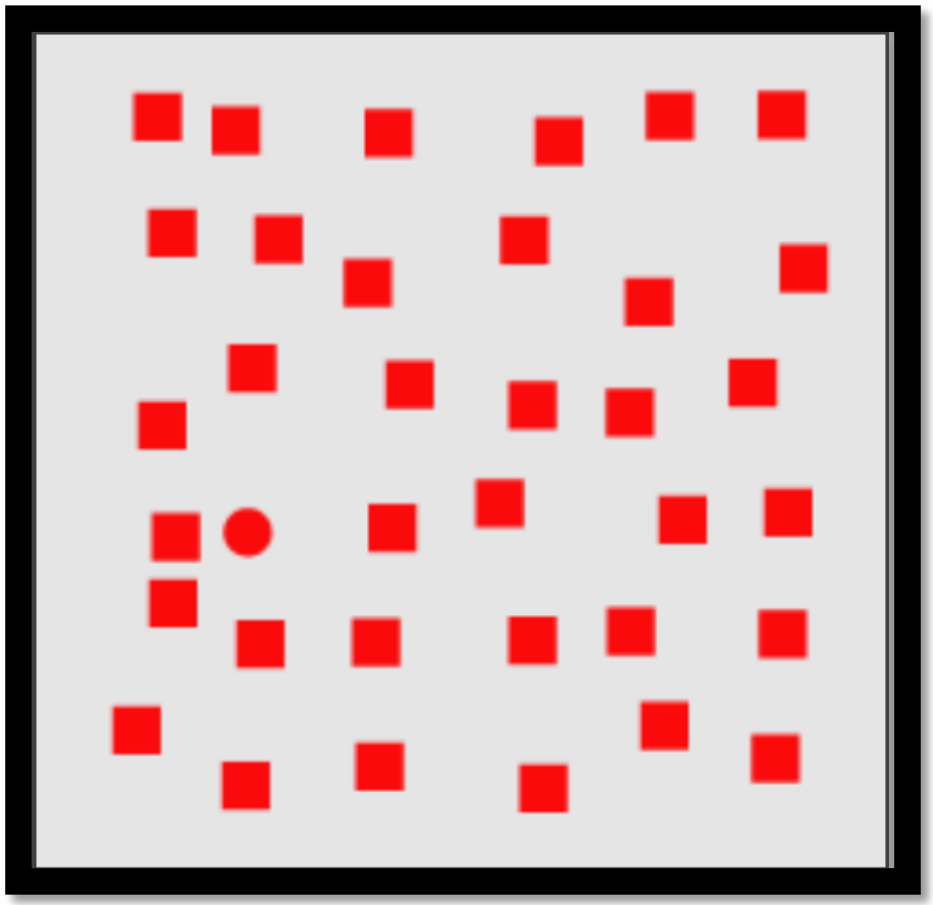
Visual Pop-Out: Color



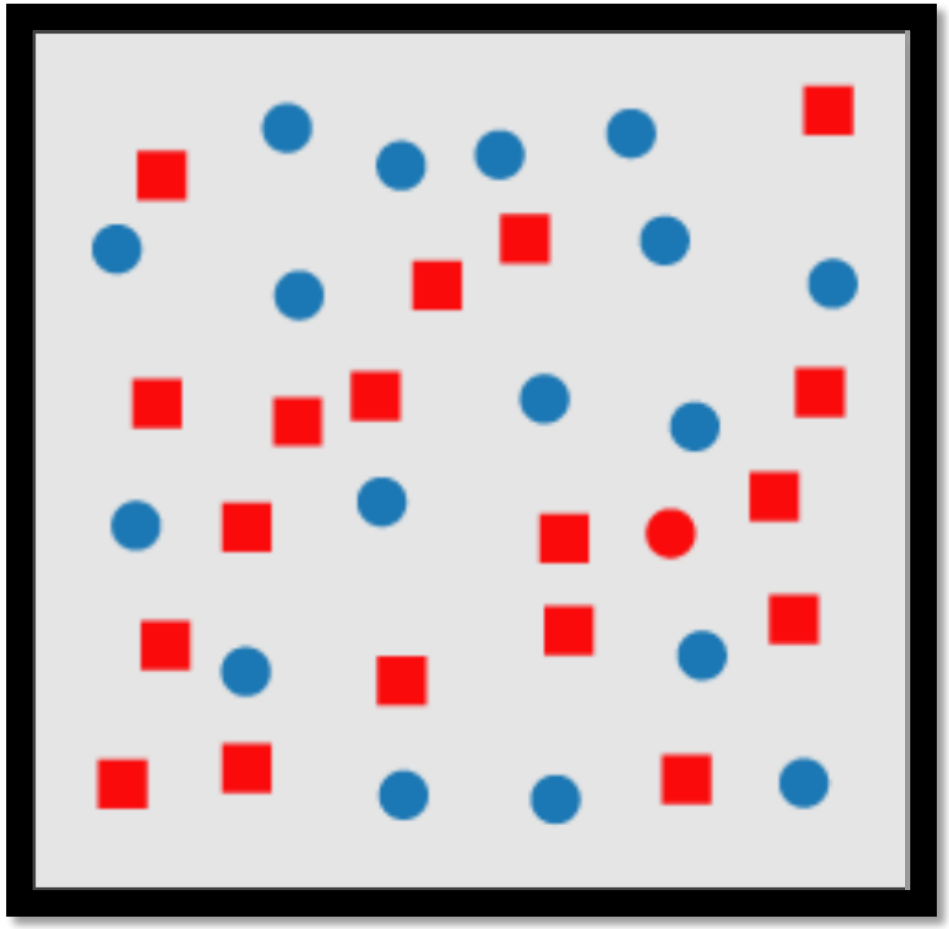


Visual Pop-Out: Shape



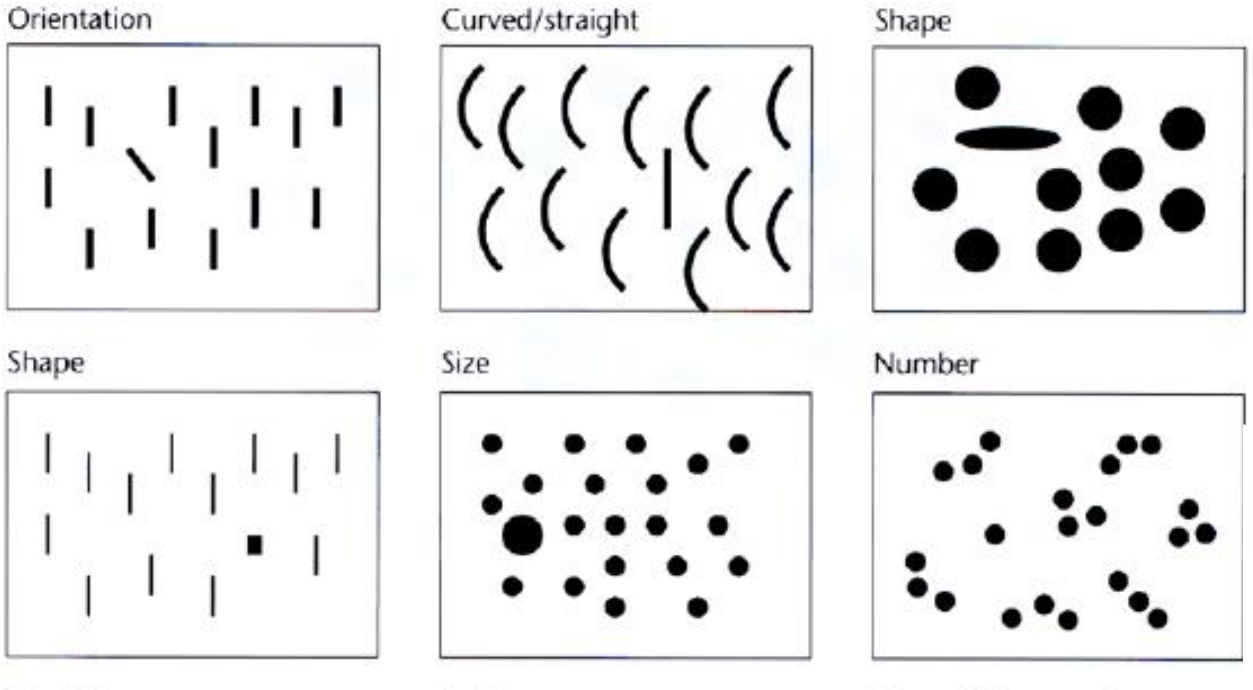


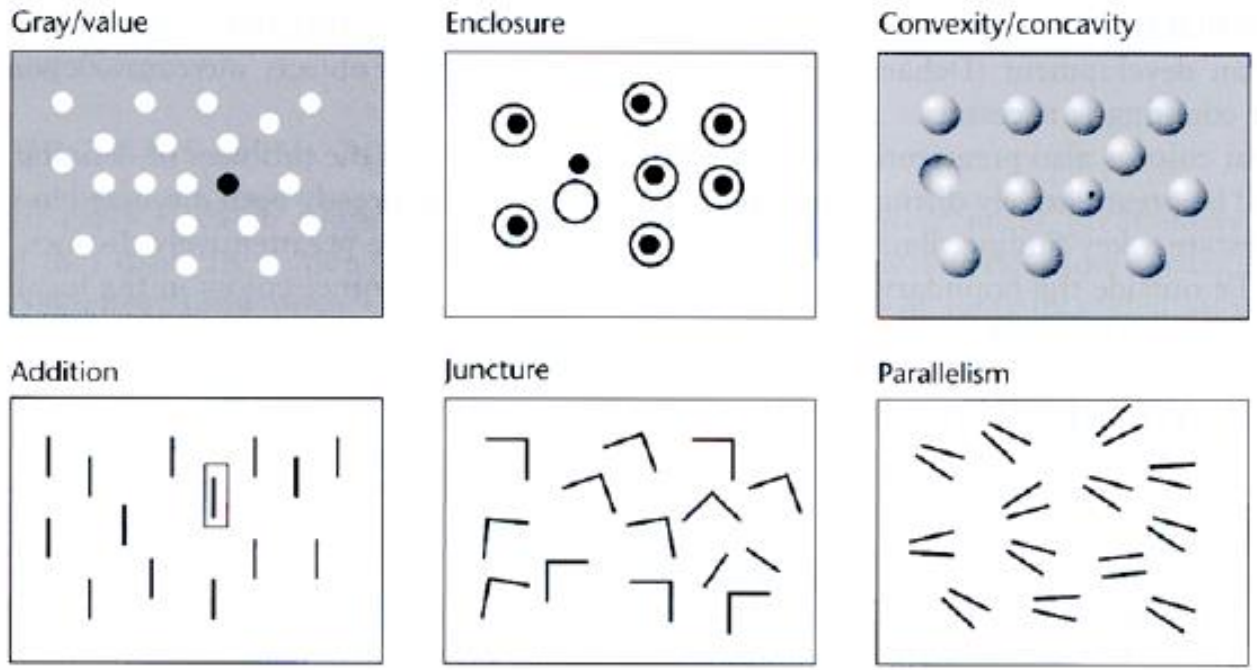
Feature Conjunctions



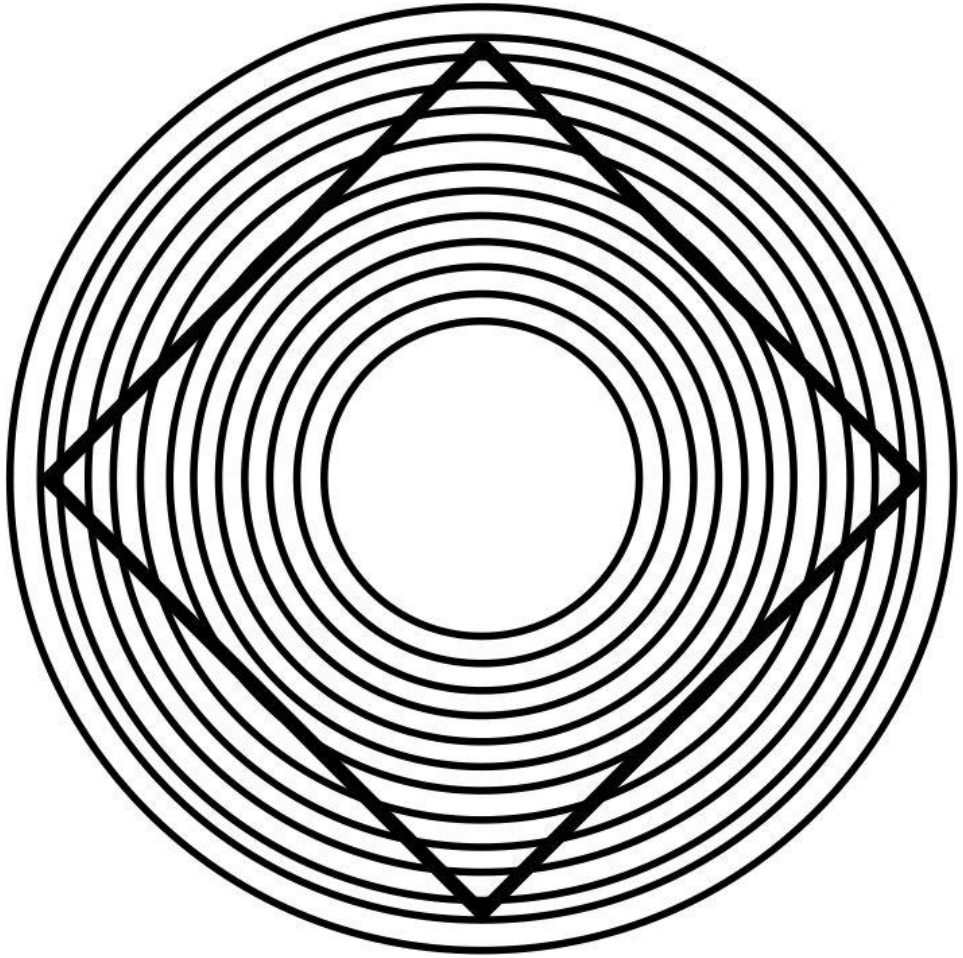
Paper: What is a pre-attentive feature?

Pre-attentive features

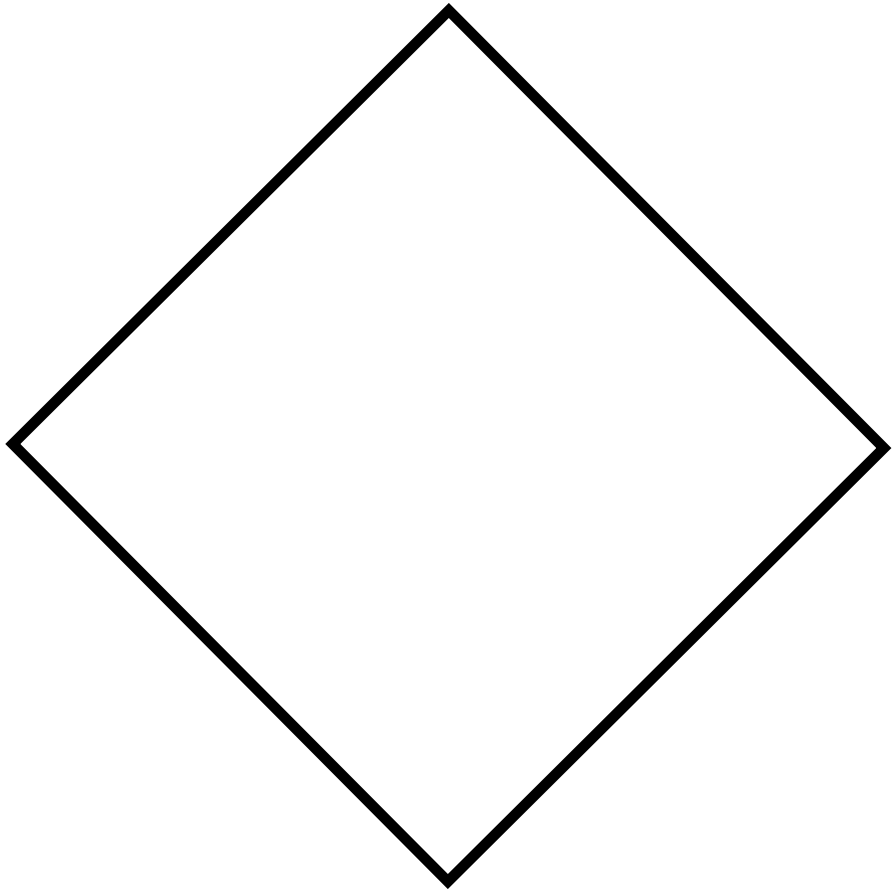




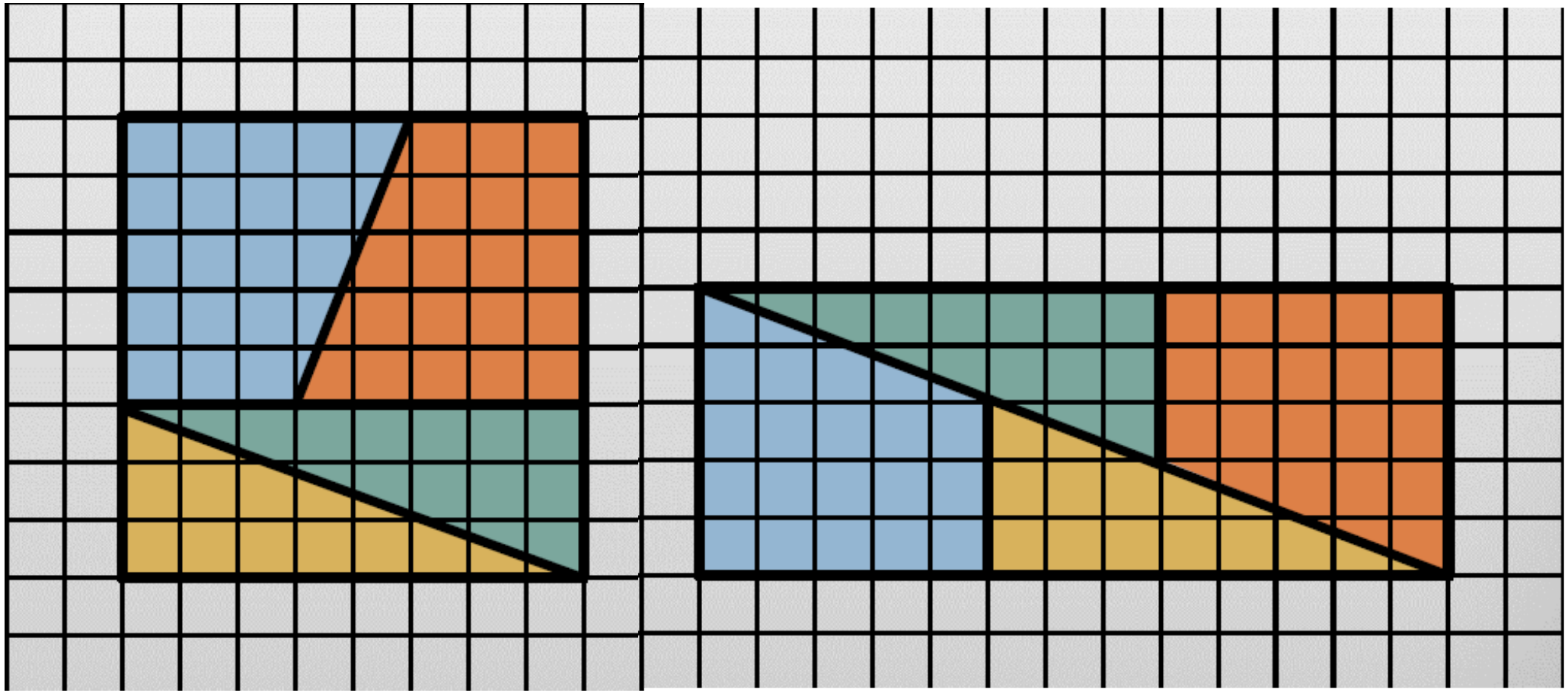
Human perception: Is what we see what we get?



Is what we see what we get?

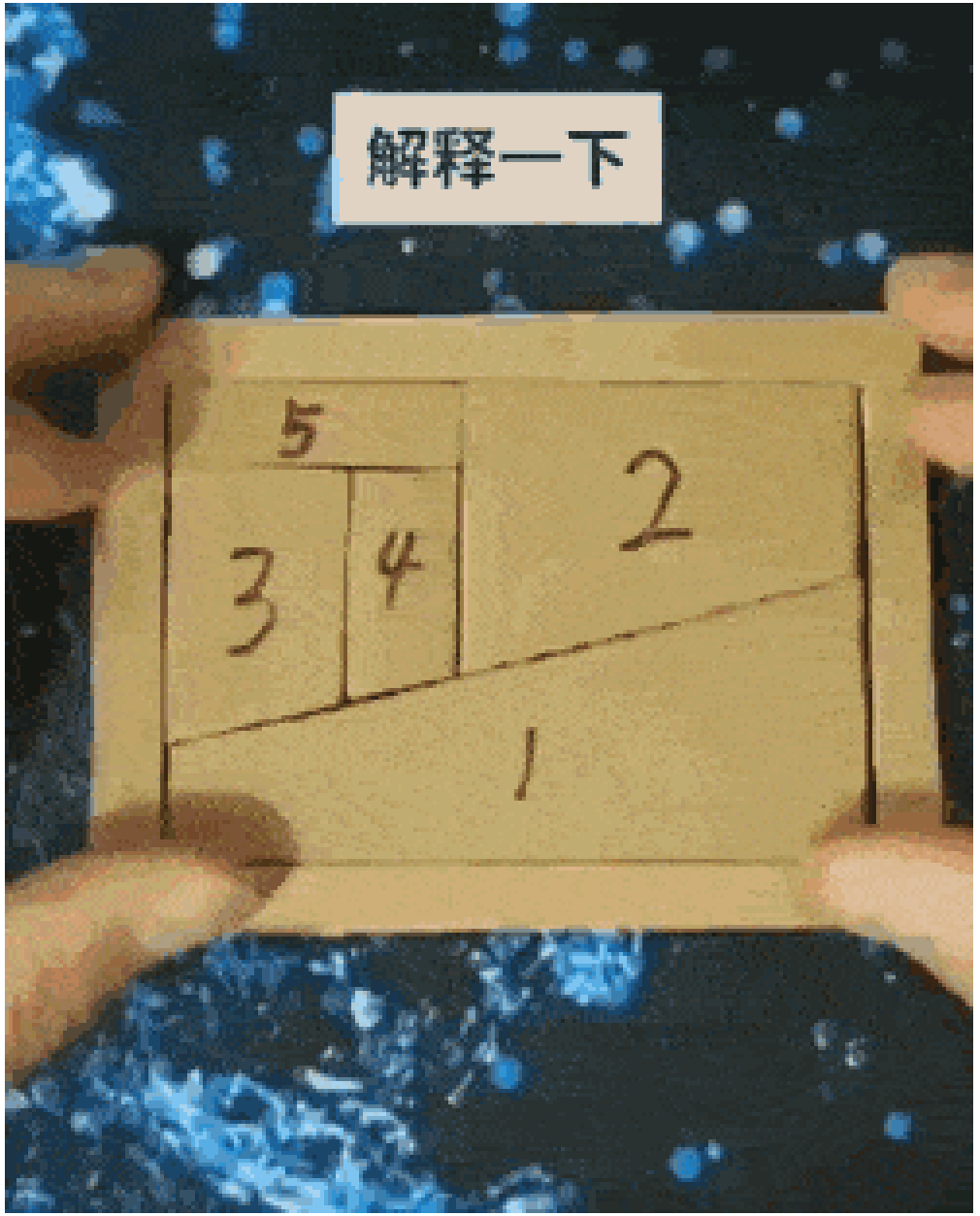


Is what we see what we get?



Which one is larger?

Visualization



Magnitude Estimation

Which one is brighter?

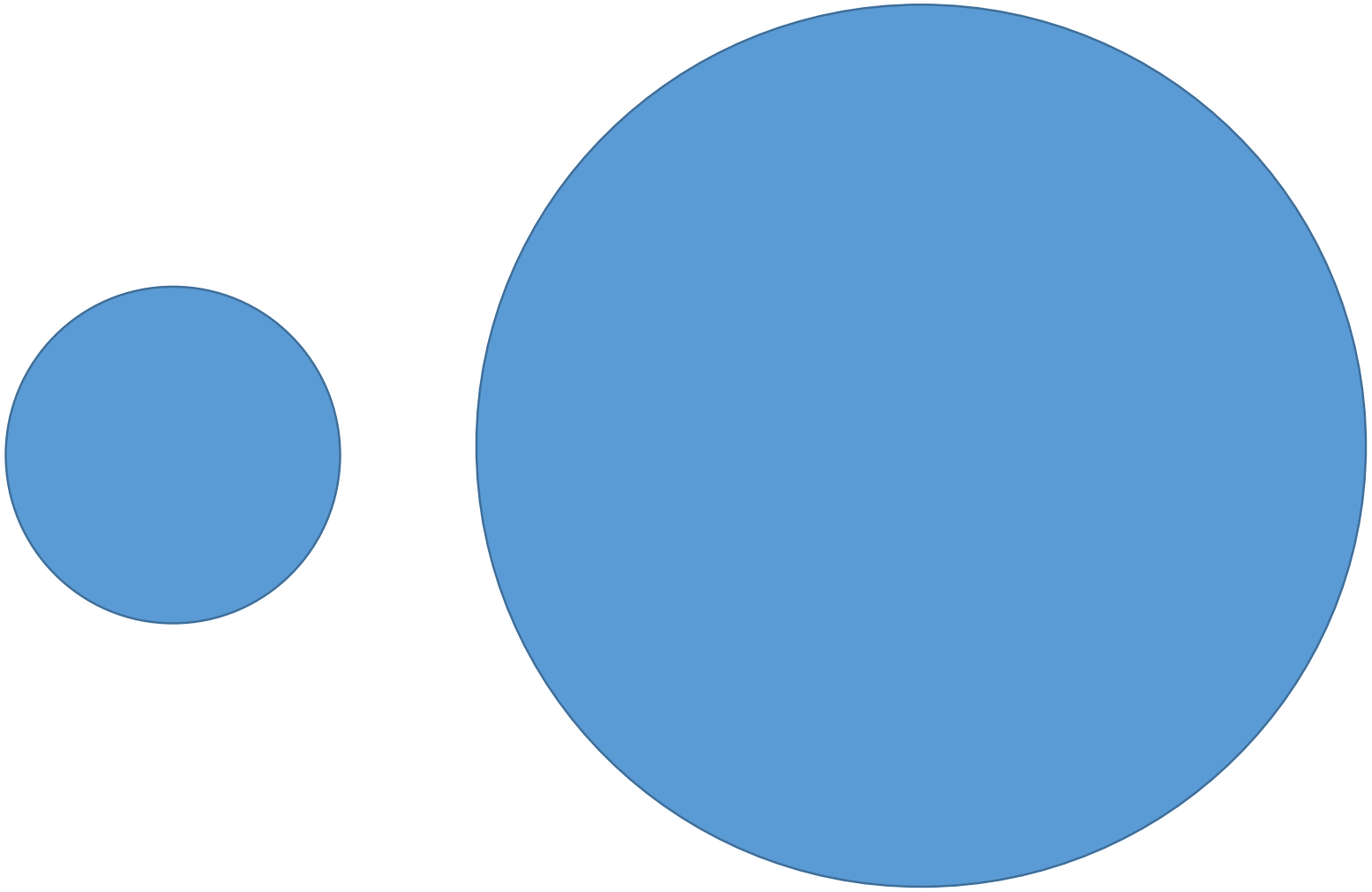
Magnitude Estimation

(128, 128, 128)

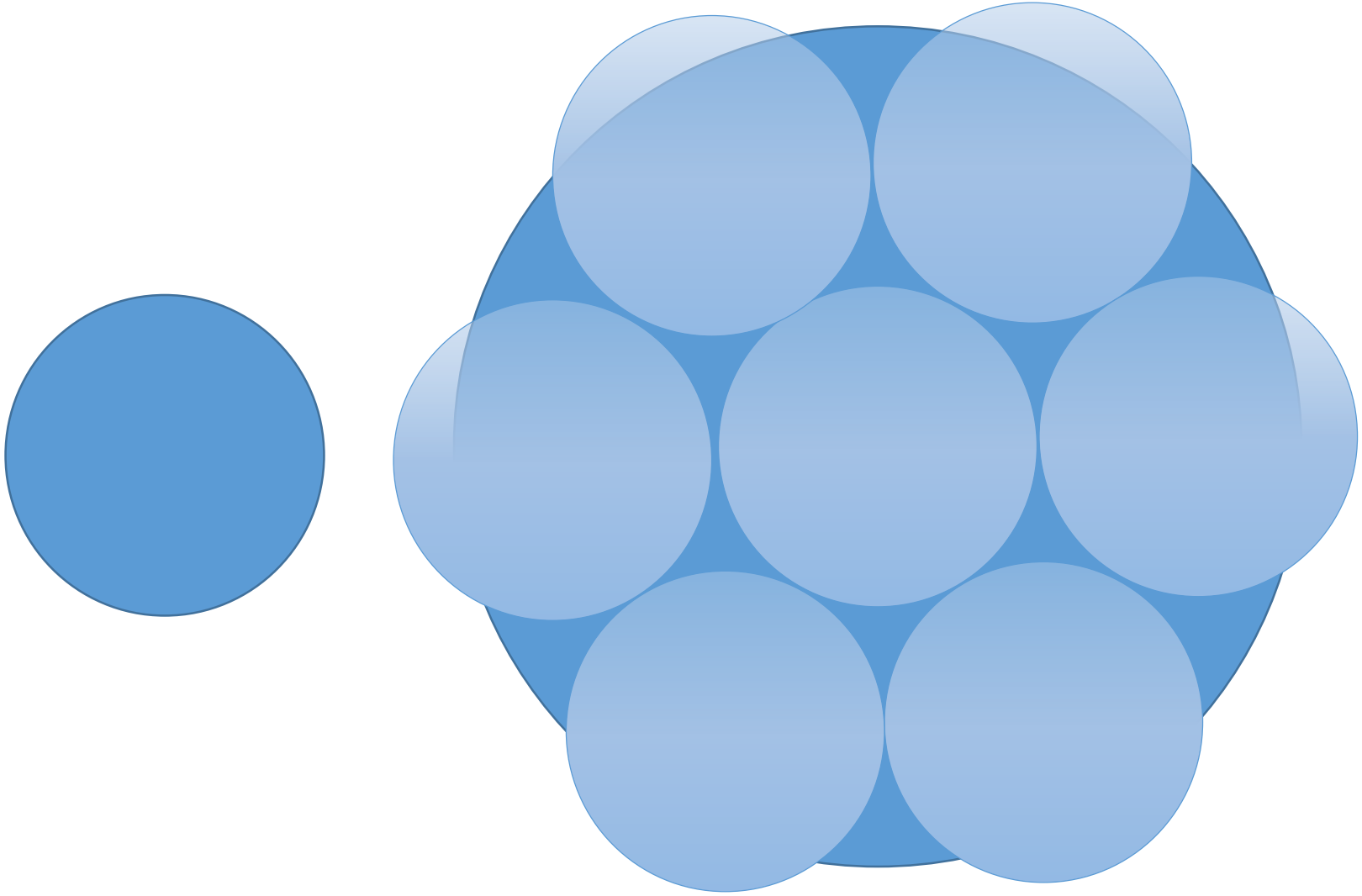
(144, 144, 144)

Which one is brighter?

Magnitude Estimation

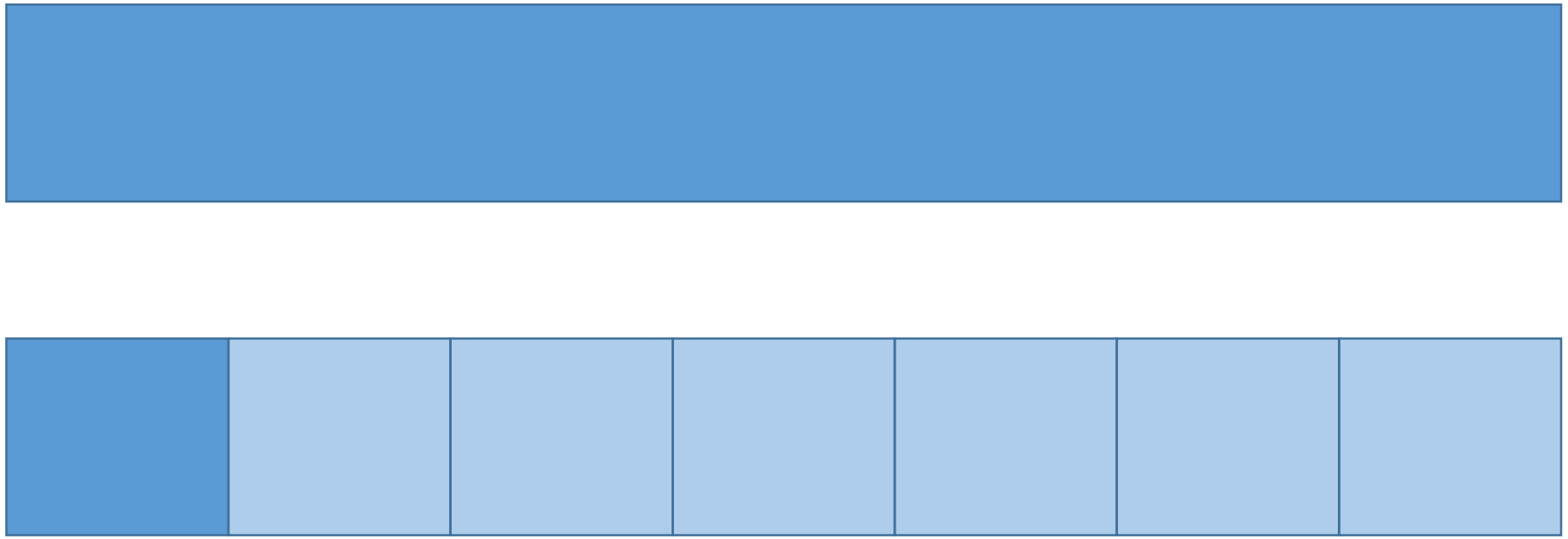


Magnitude Estimation



Magnitude Estimation

Magnitude Estimation



Magnitude Comparison

Most accurate

Least accurate

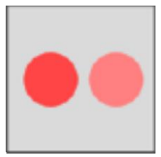
Length

Slope

Angle

Area

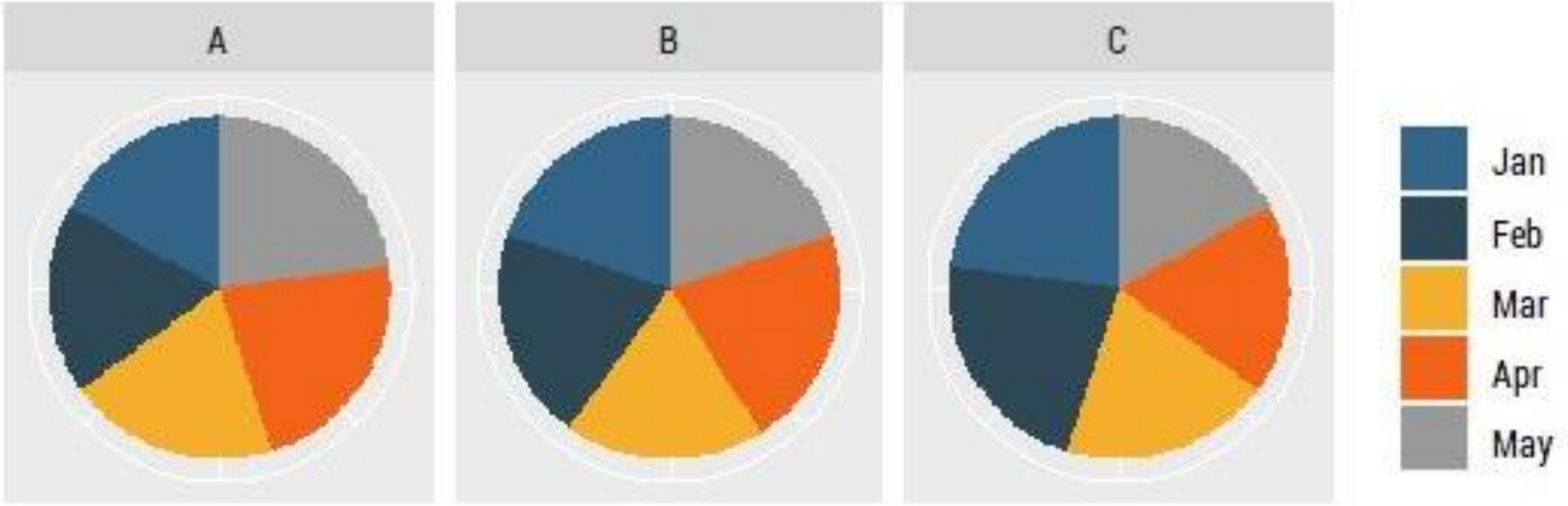
Volume



Color brightness

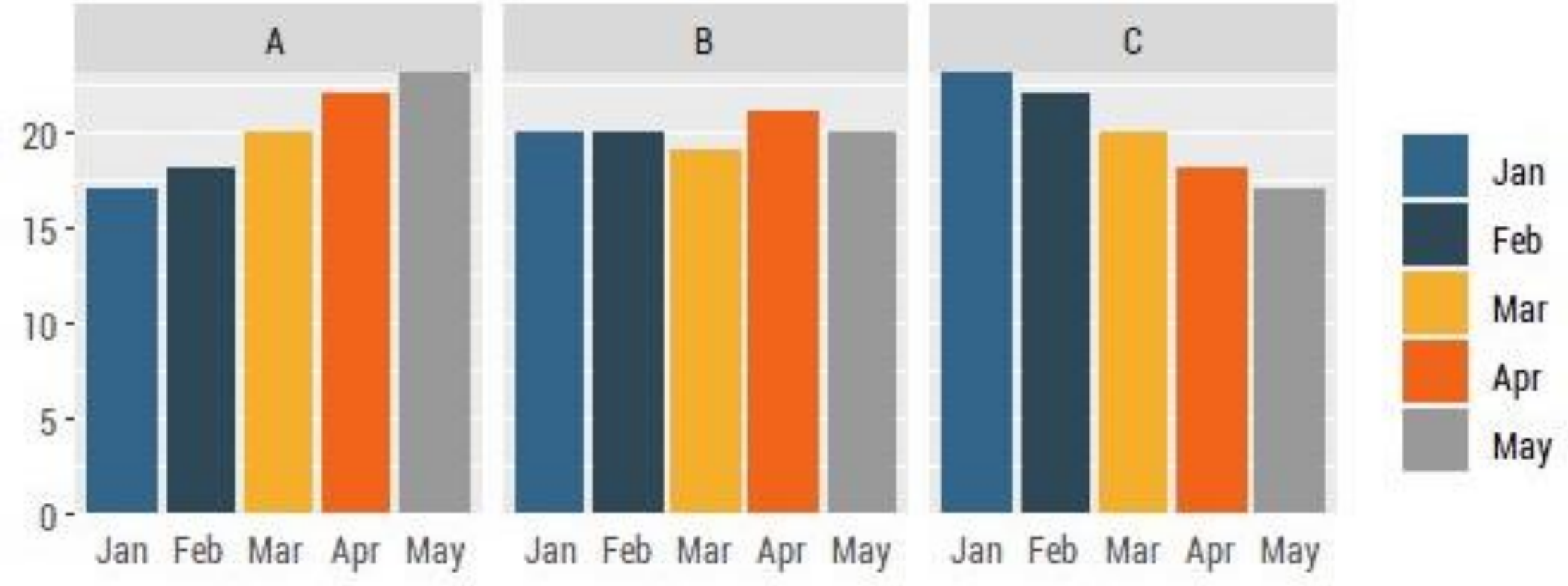
Remember this

- Pie Chart of Monthly Export by Country



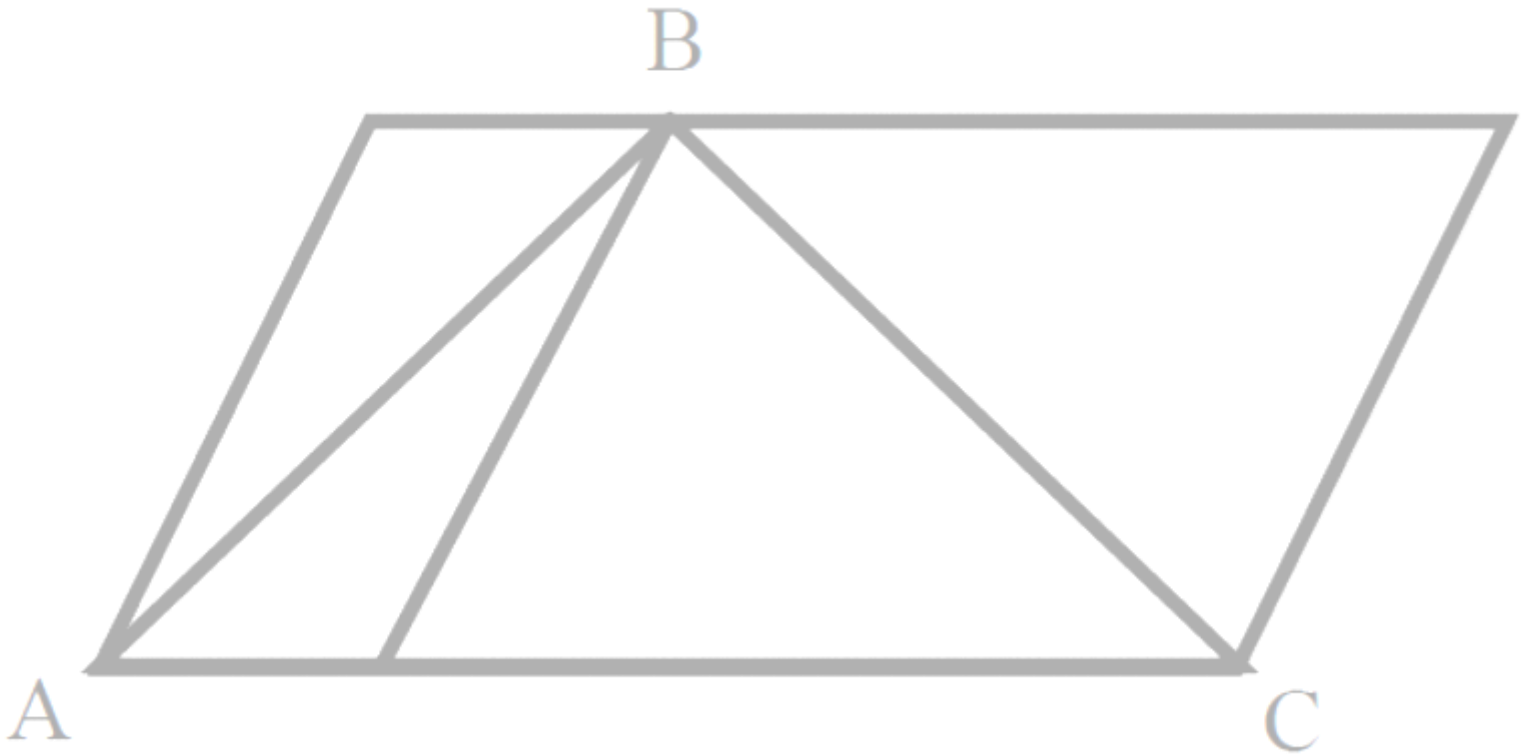
Remember this

- Bar Chart of Monthly Export by Country



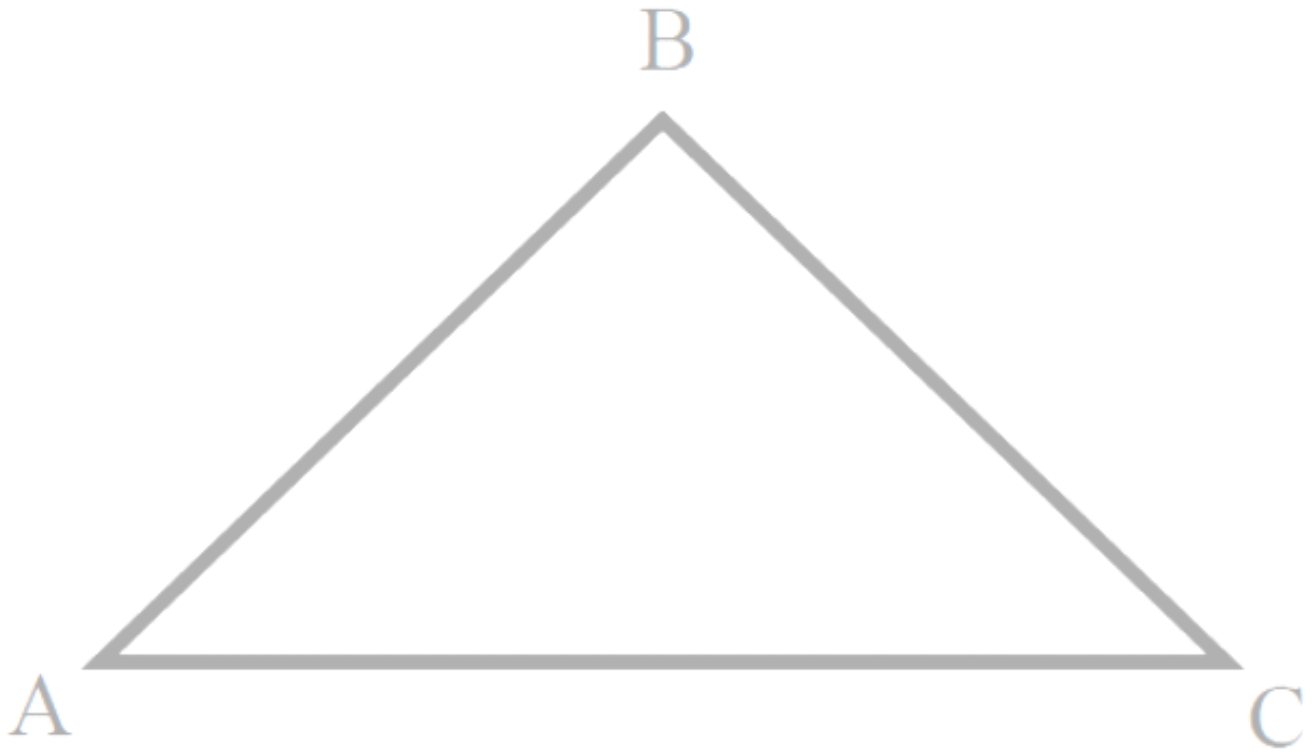
Size Context

- Which is longer, AB or BC?



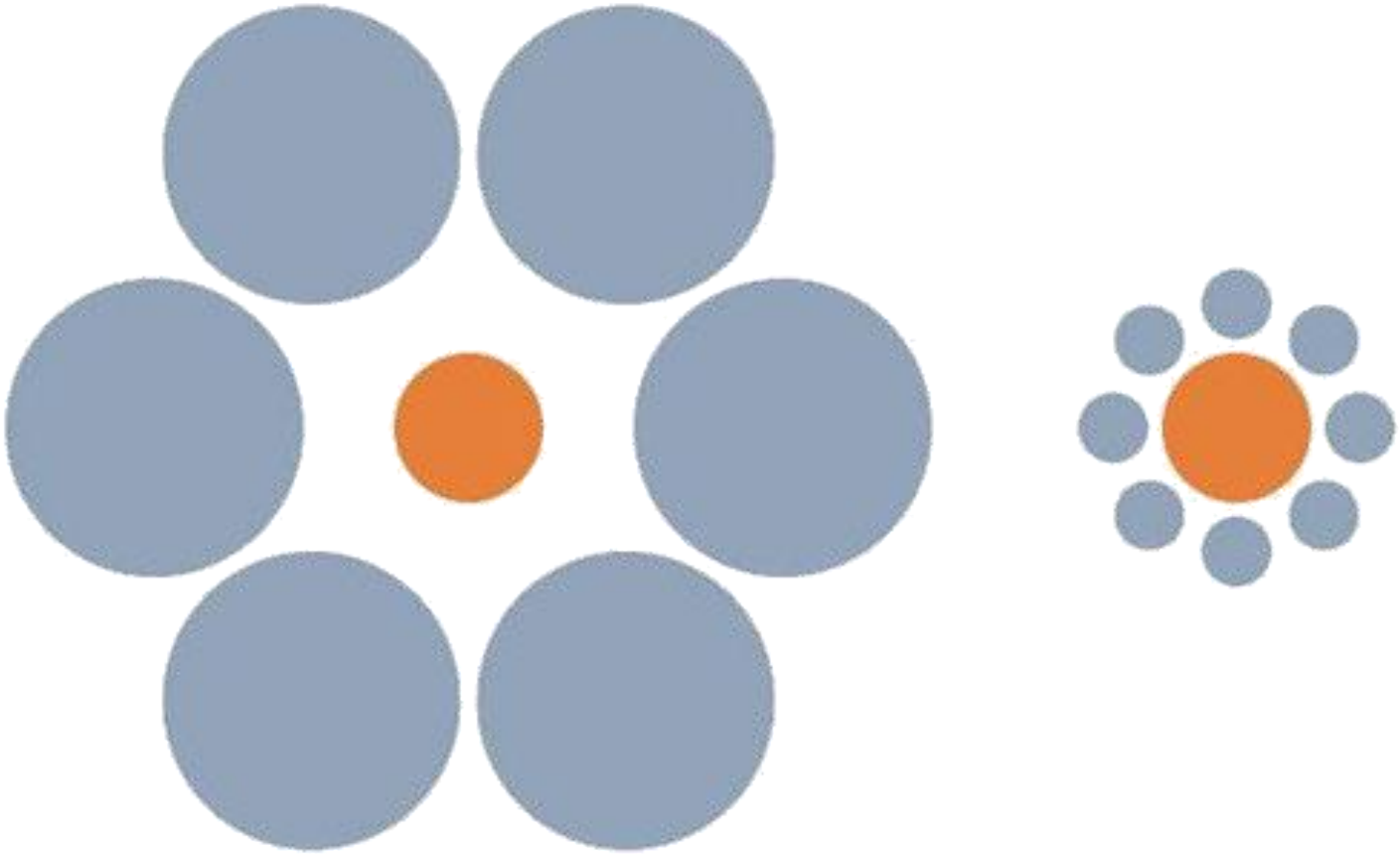
Size Context

- Which is longer, AB or BC?



Size Context

- Which orange circle is larger?

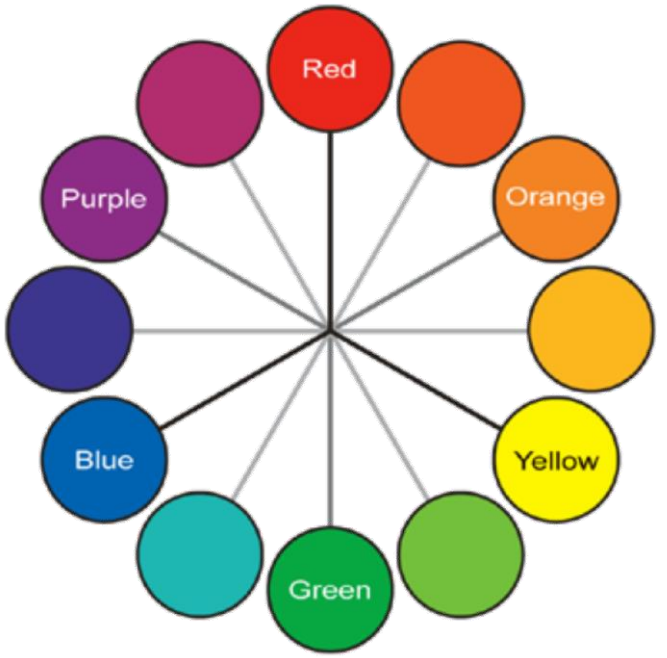


Size Context

=> always use consistent contexts for visual comparisons

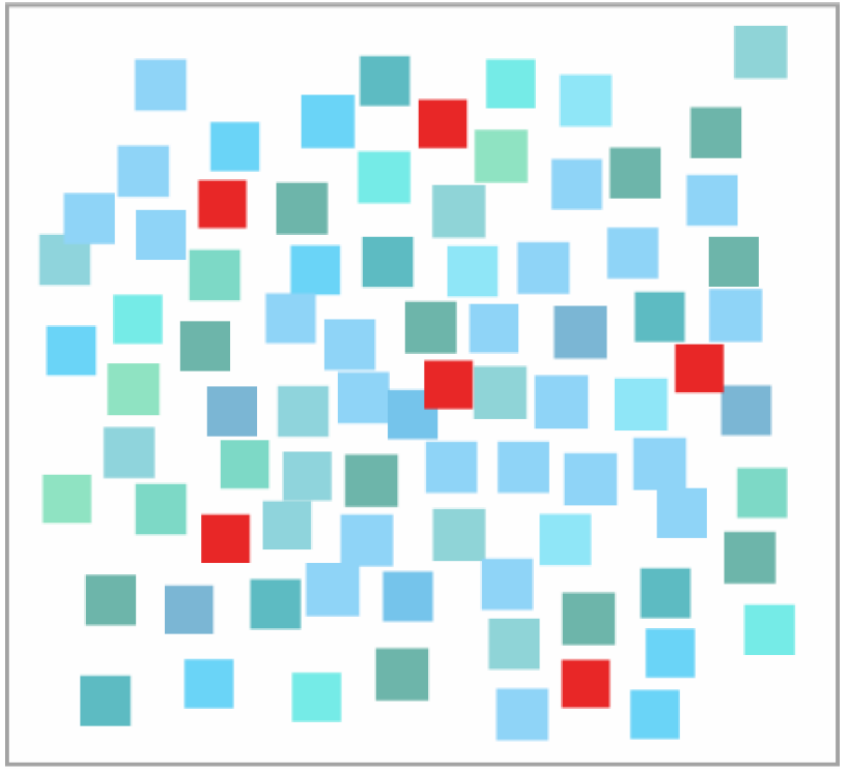
Principles of Color Design

- In color design, color is specified by three dimensions: hue, value, and chroma.
  - Hue is the color's name, such as red, green or orange.
  - Value is the perceived lightness or darkness of the color.
  - Chroma describes its colorfulness.



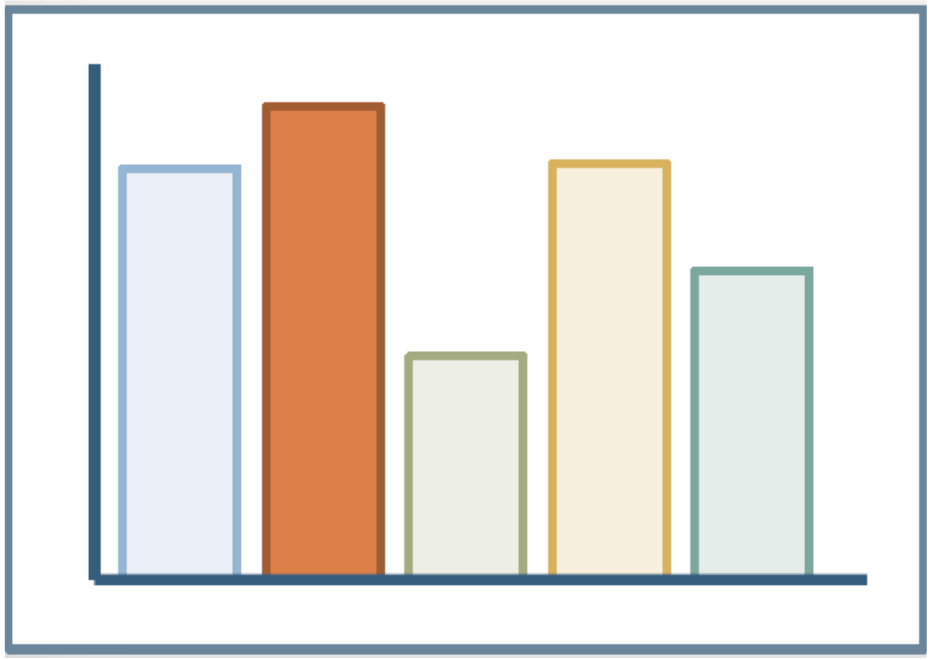
Principles of Color Design

- Contrast and analogy are the principles that define color design.
- Contrast draws attention, analogy groups



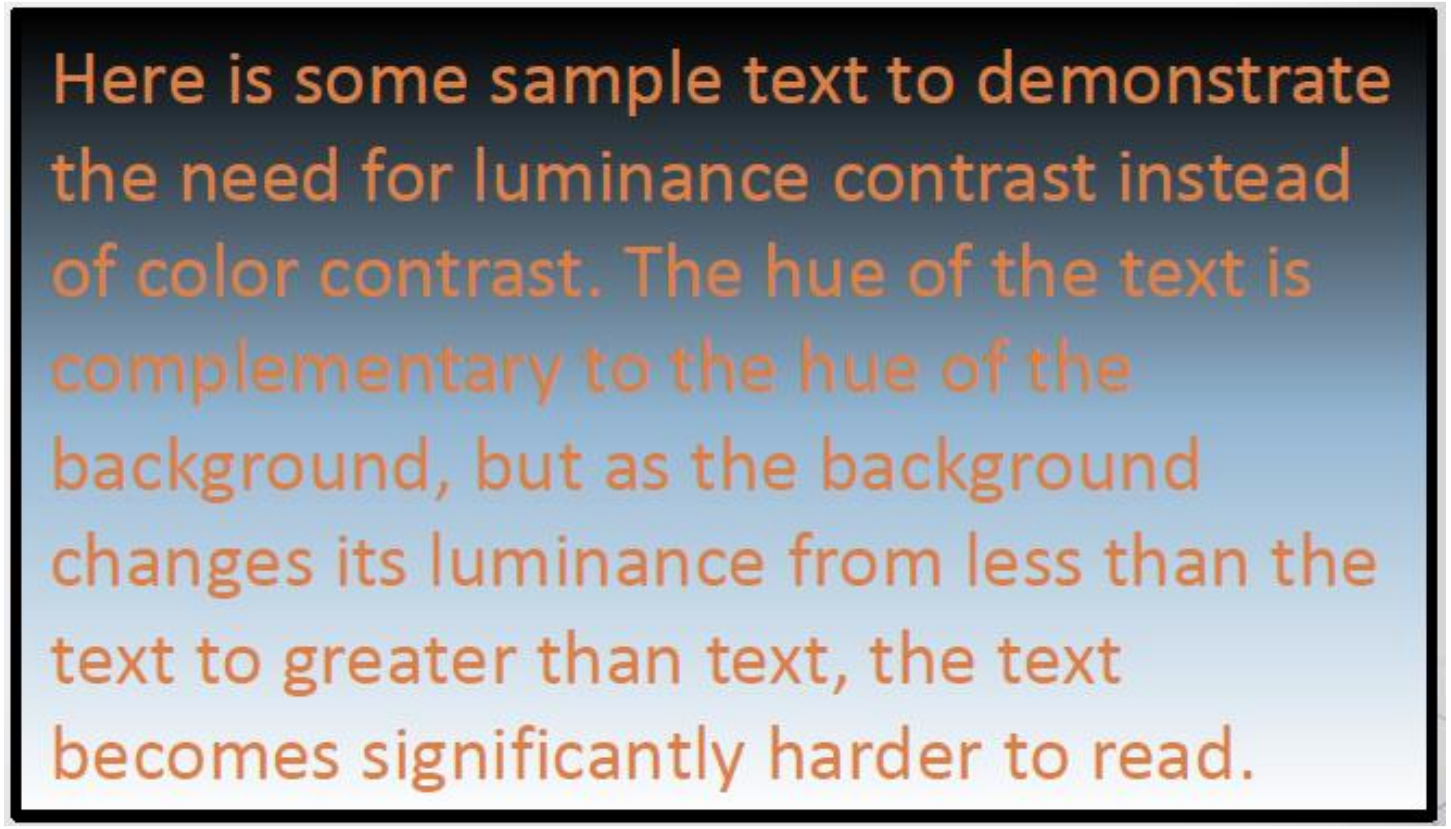
Contrast

- Use higher luminance contrast to gain attention



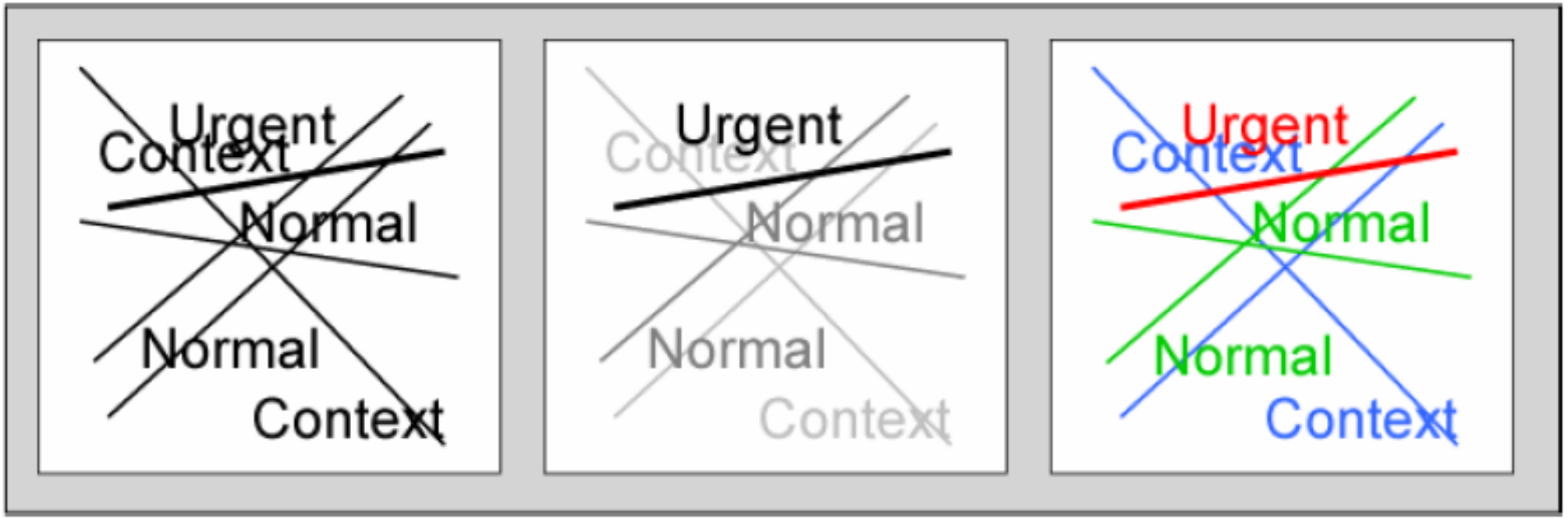
Legibility

- Make sure text has sufficient luminance contrast

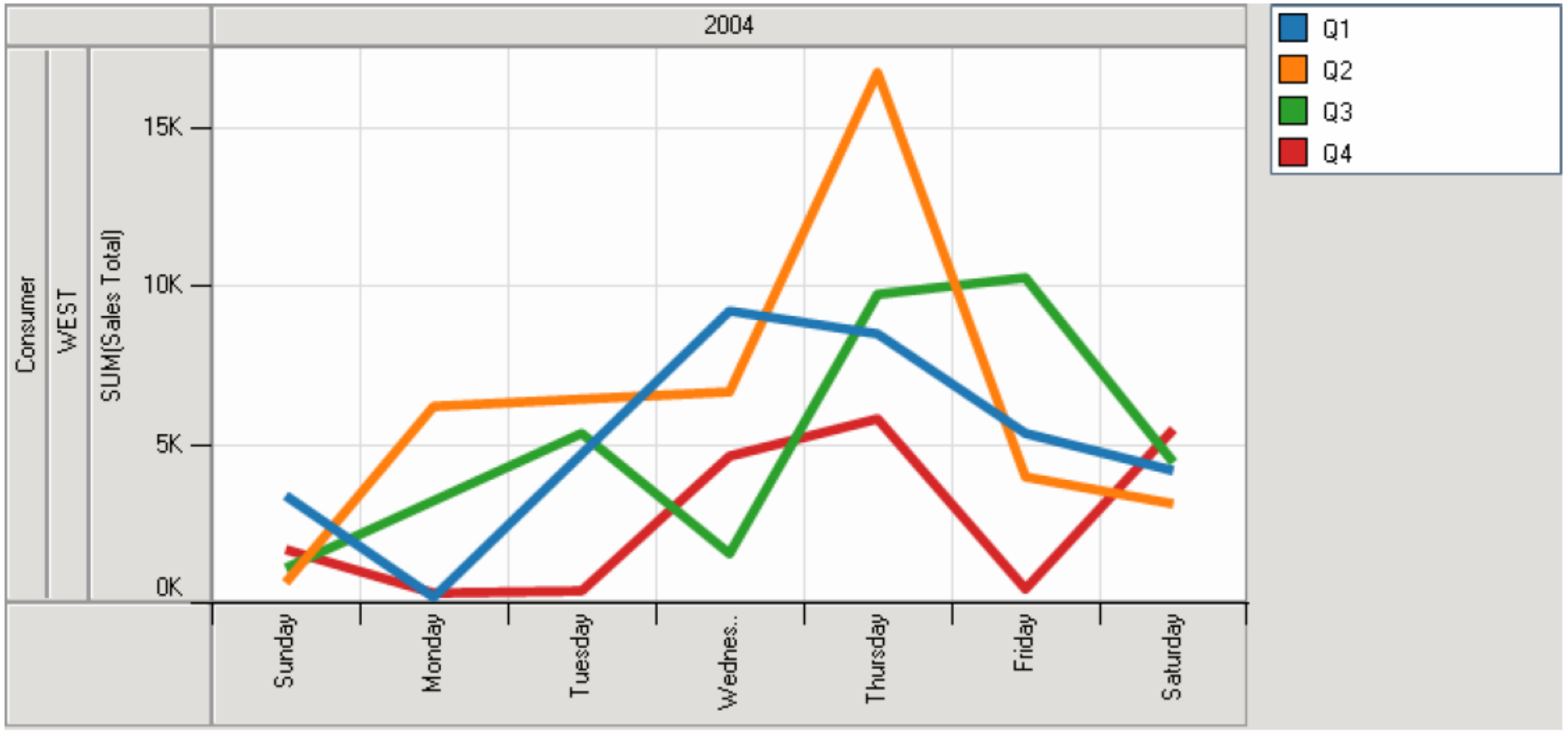


Legibility

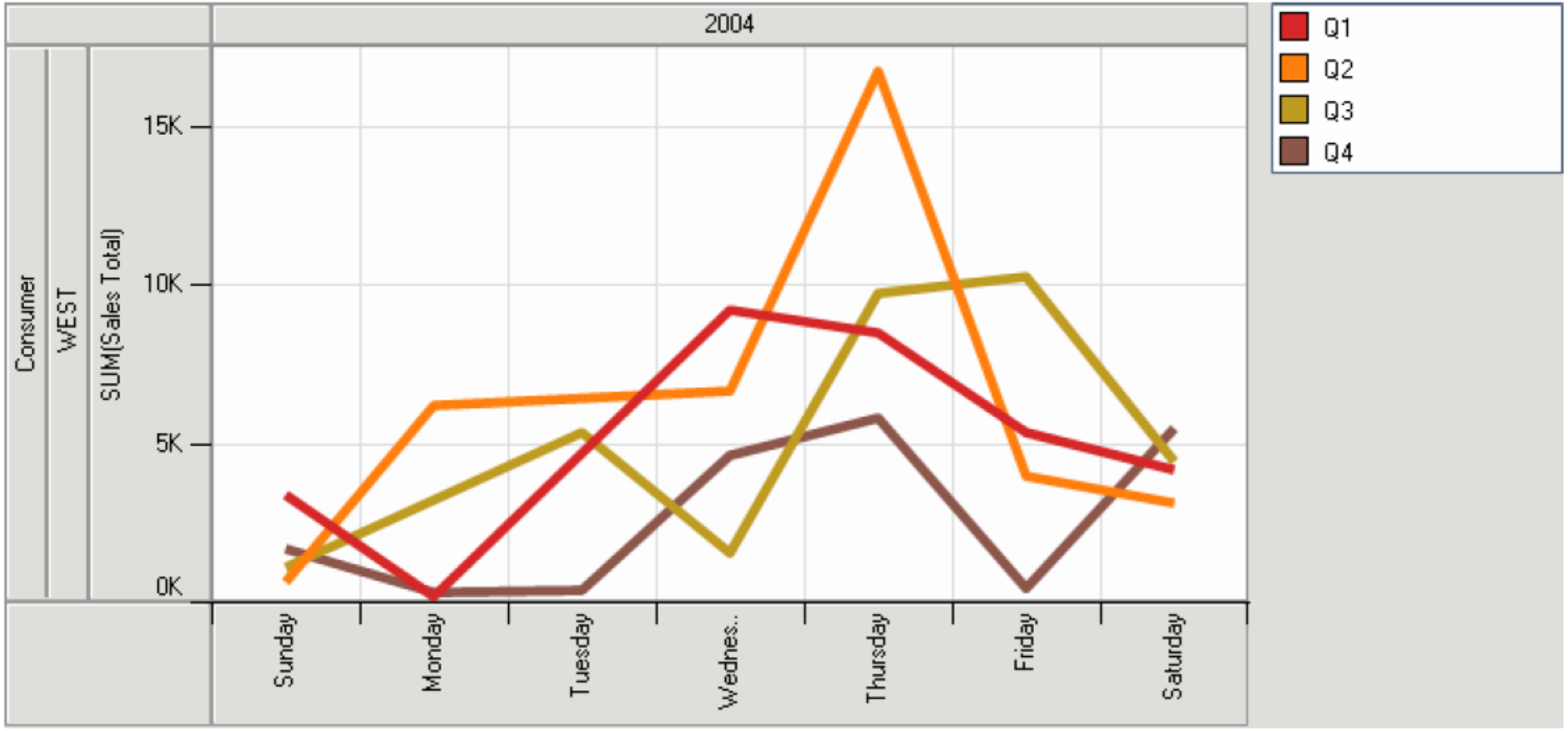
- Variation in luminance can also used to separate overlaid values into layers, where low contrast layers can sit behind high contrast ones without causing visual clutter.



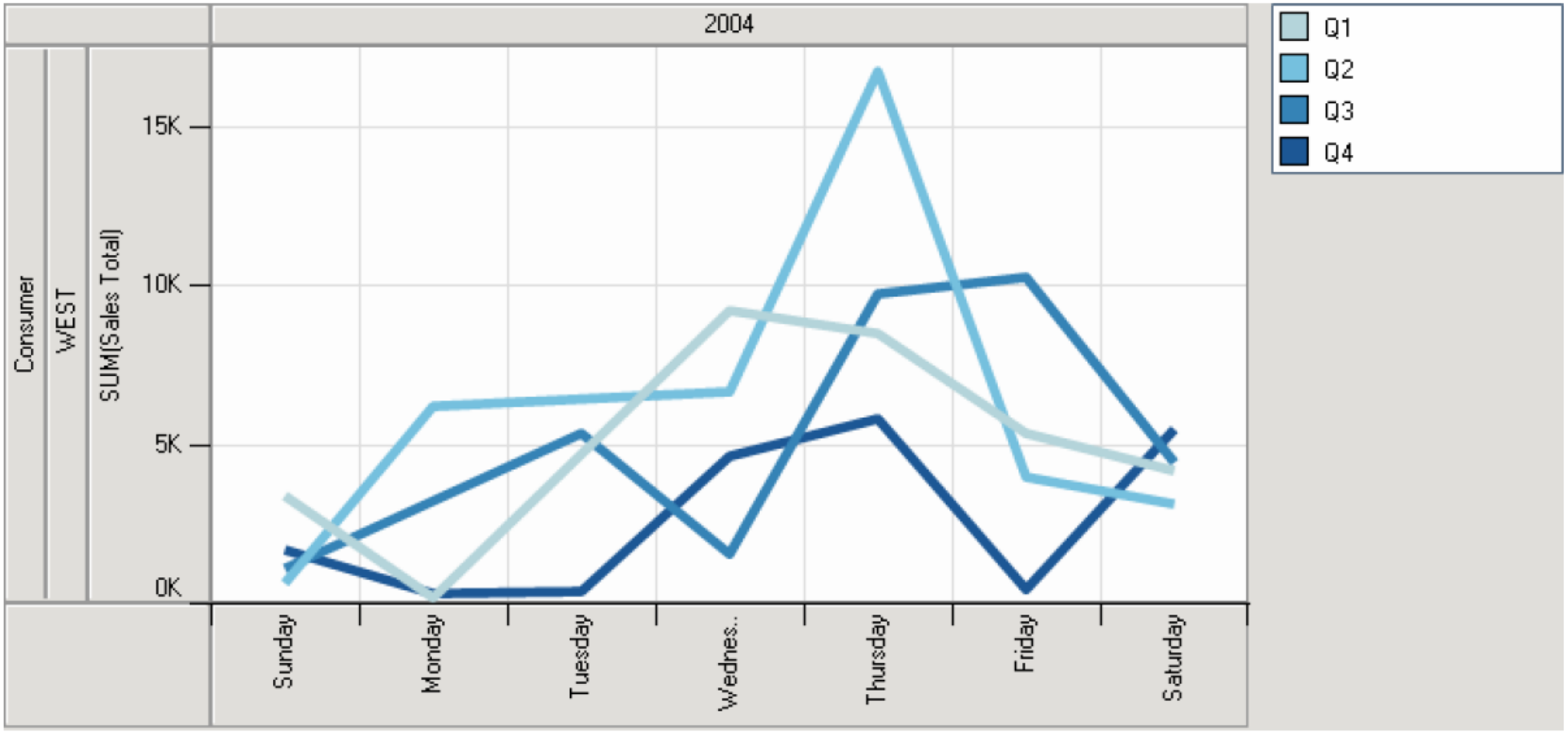
Example: Color changes human attention



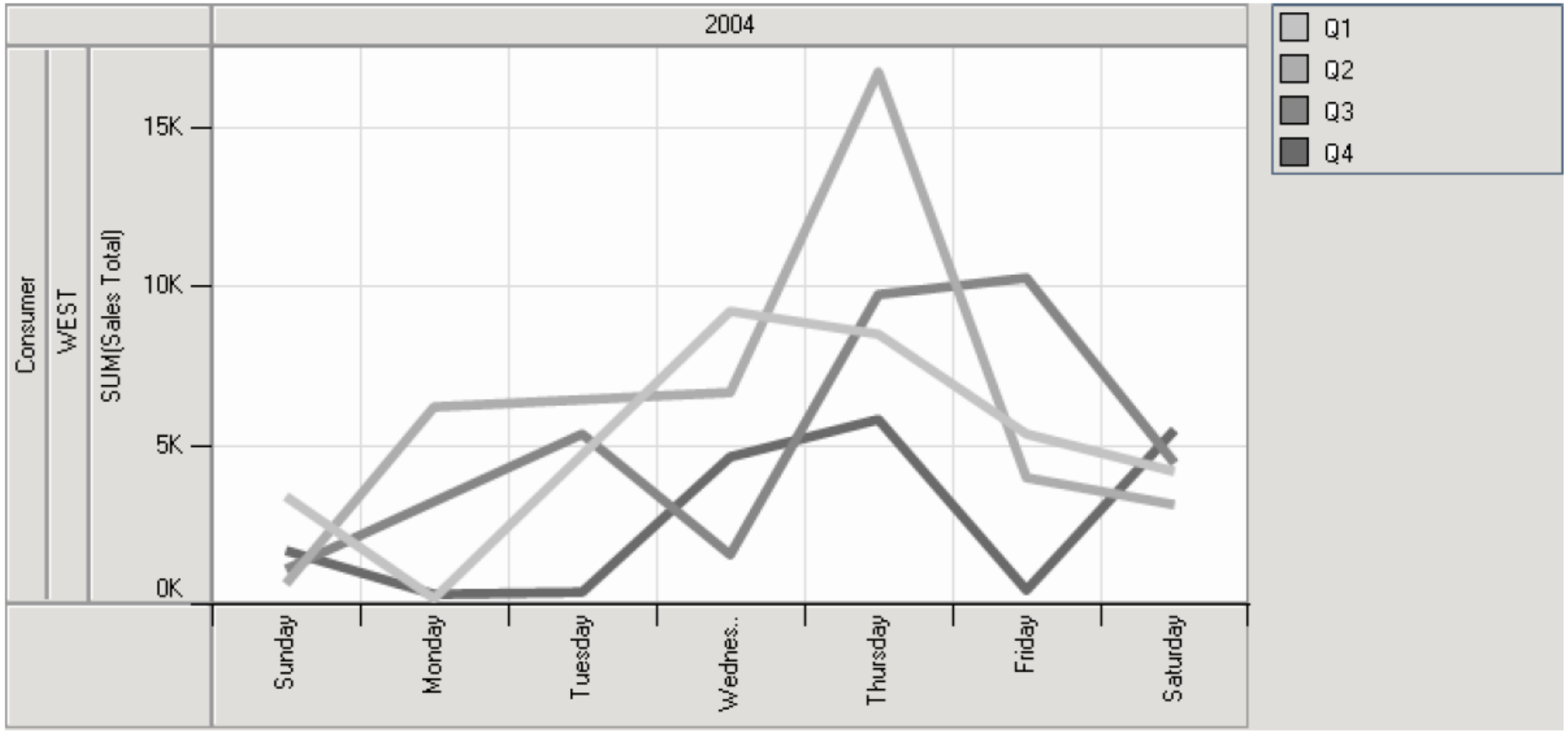
Color changes human attention



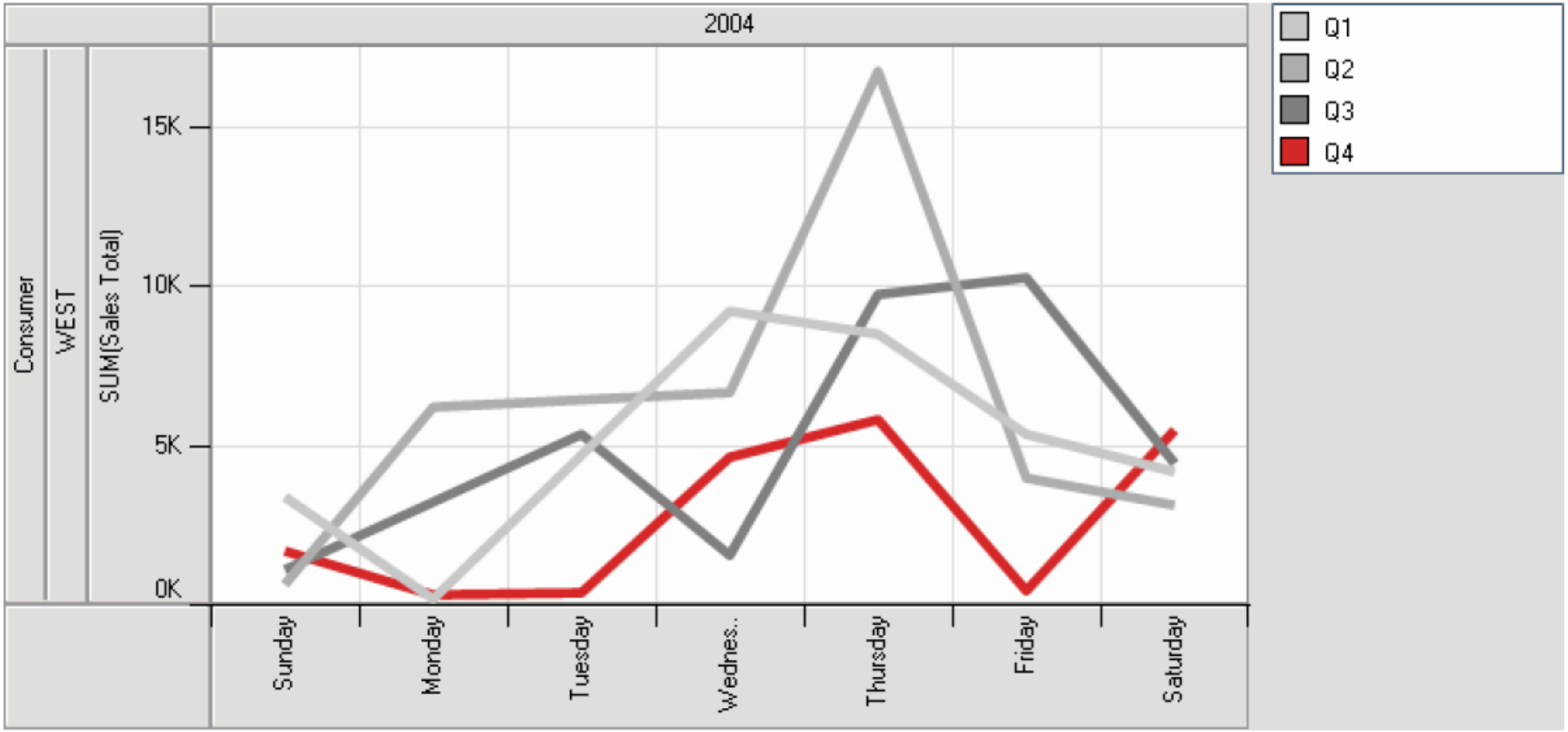
Color changes human attention



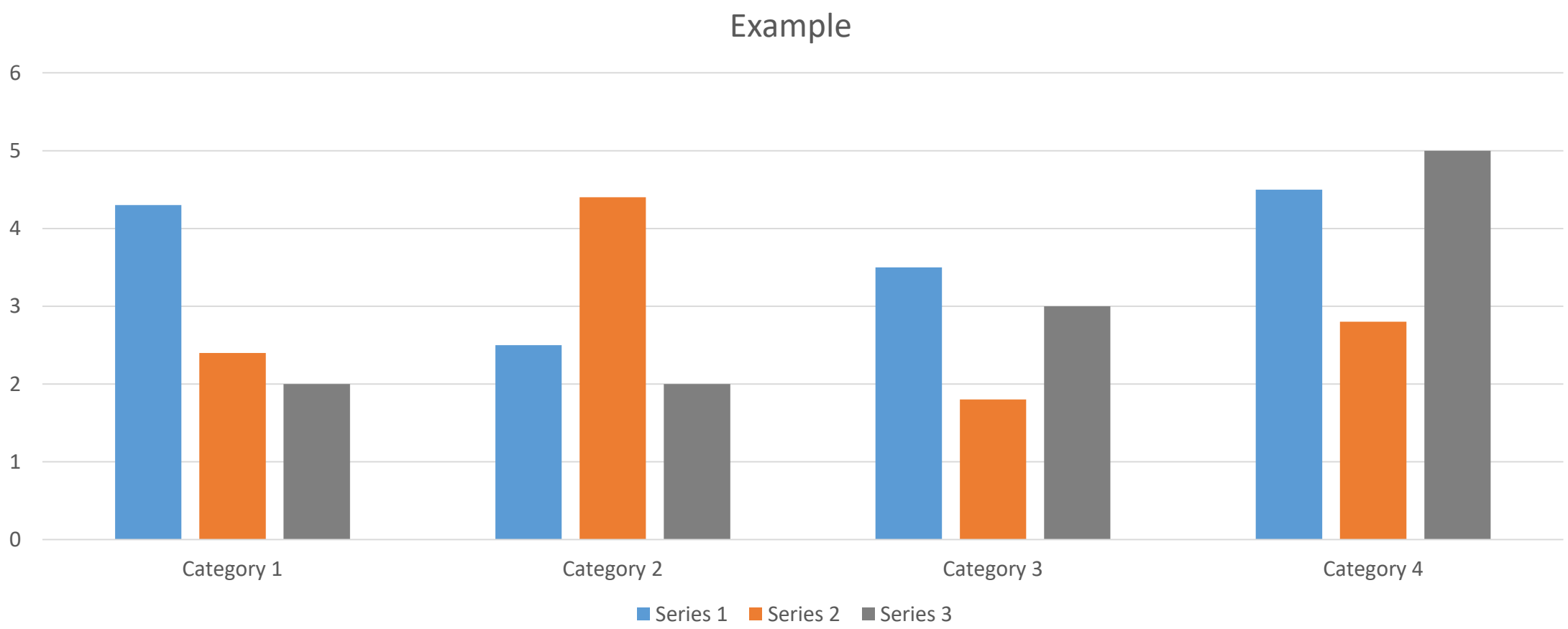
Color changes human attention



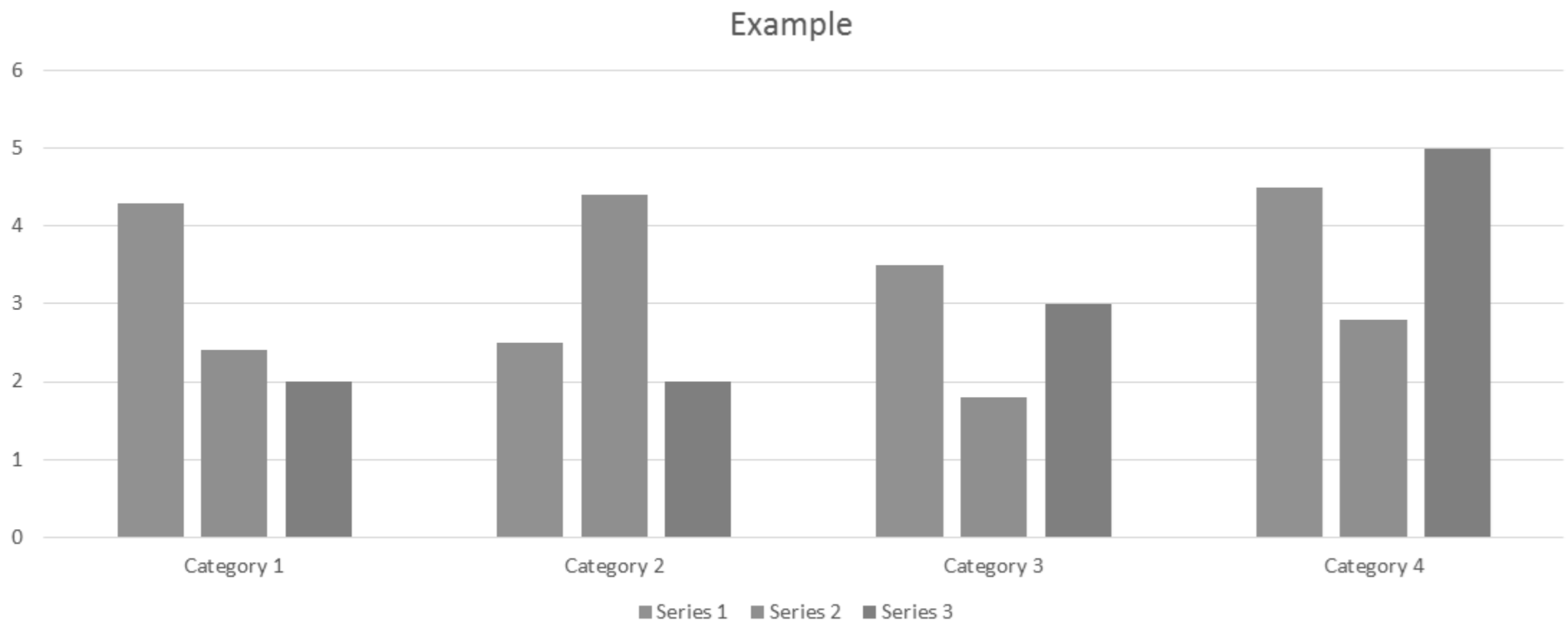
Color changes human attention



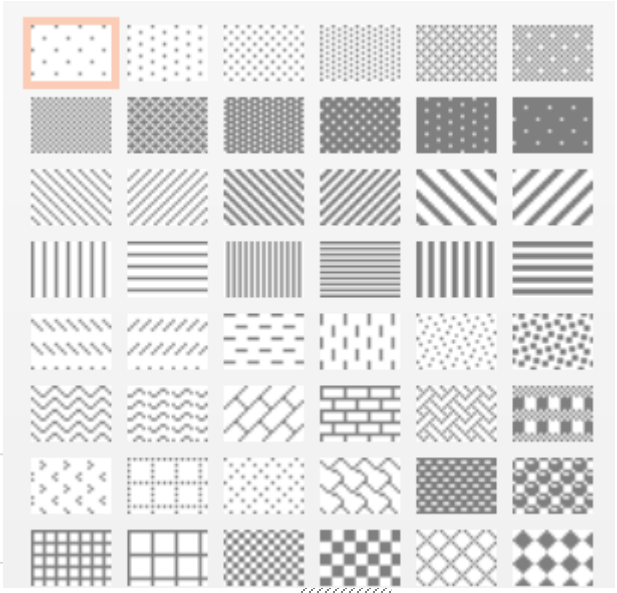
When color can’t differentiate anything at all

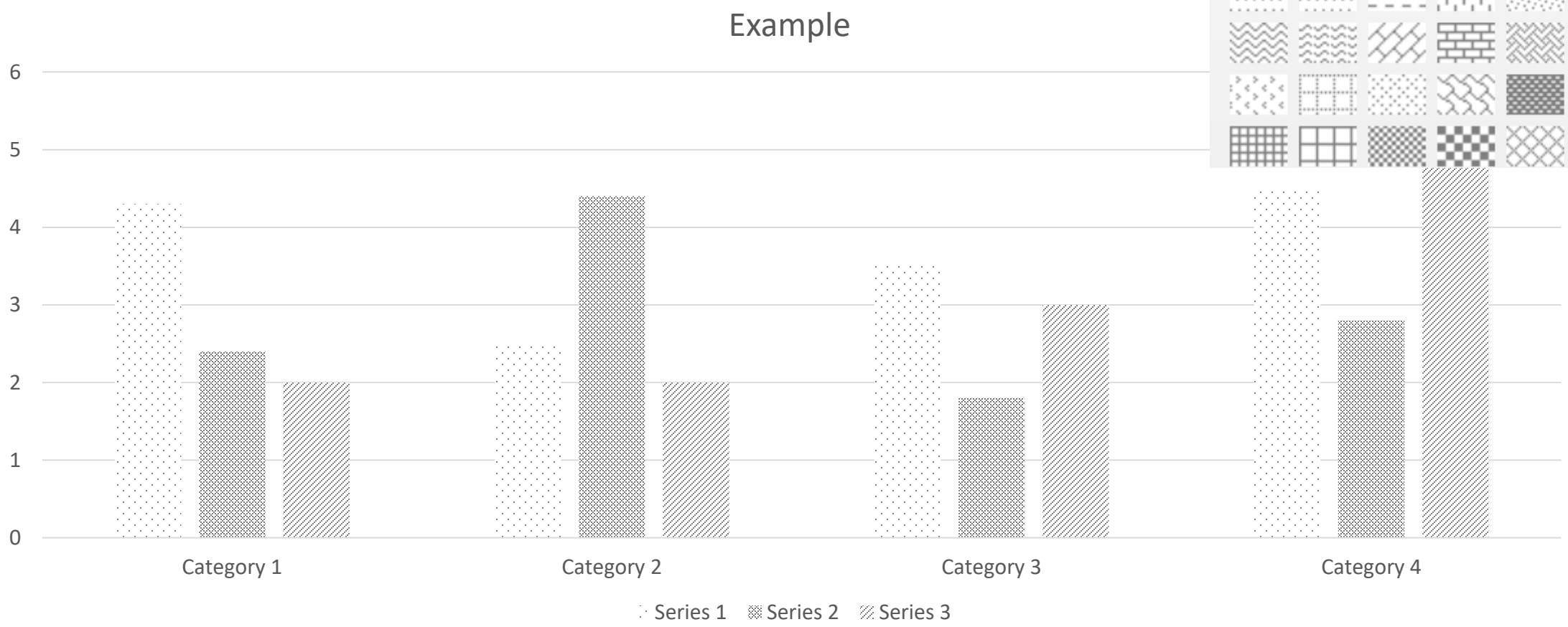


When color can’t differentiate anything at all

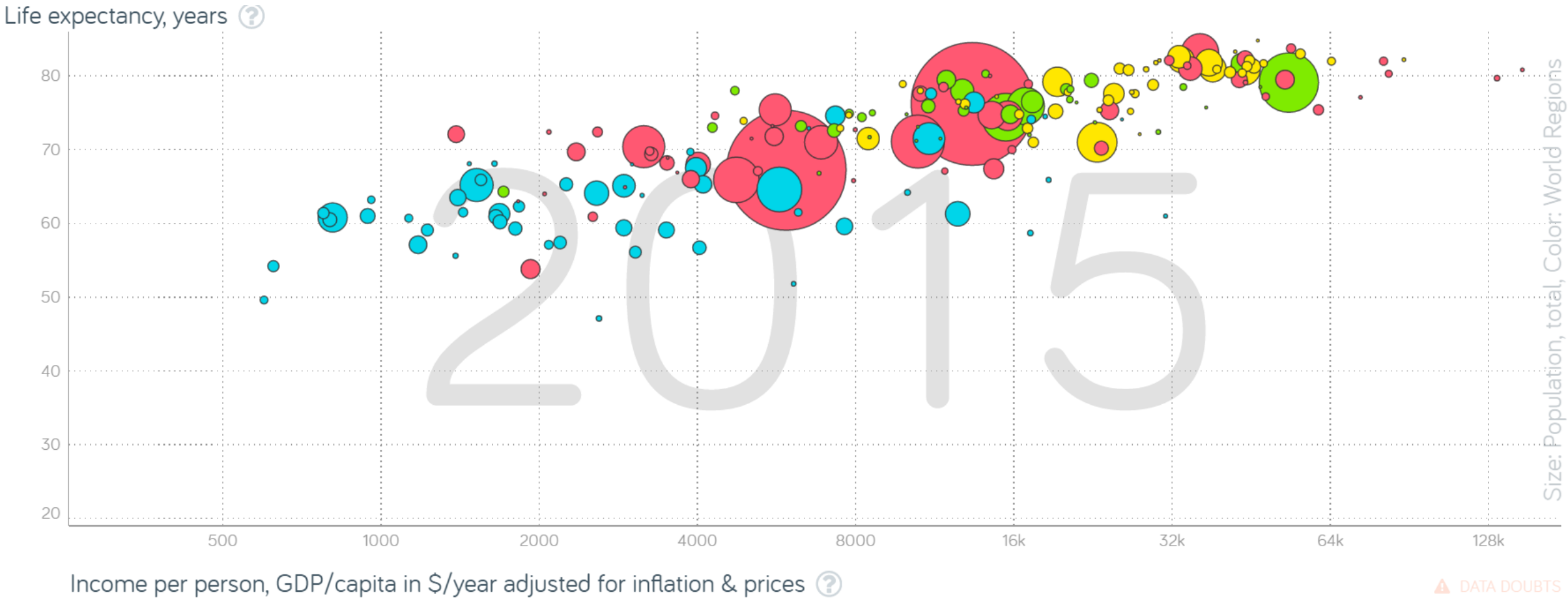


Using other fill, e.g., pattern fill





Hans Rosling Revisit



Q&A