Lecture 08 – Finding Information

Today's Learning Objectives:

1. Describe the way that visual elements are processed.

2. Discuss how the brain finds elements easily findable and important.

3. List elements of visual distinctiveness for glyph and symbol design.

4. Describe pre-attentive processing and how it aids in rapid visual processing.

5. List the element combinations that can be used in conjunction while maintaining pre-attentive processing.

Pre-Attentive Visual Elements We've Learned So Far

List them here:

Searching Behavior

Saccadic movements – eye moves rapidly from fixation to fixation, relatively low-sweep (5 degrees of scanning a scene, 2 degrees for reading). Ballistic.

Smooth-pursuit – Locking on and tracking an object in motion.

Convergent movements –object moving closer causes eyes to converge (cross) and diverge when it moves away. Can be either saccadic or smooth.

How does the brain determine what is important?

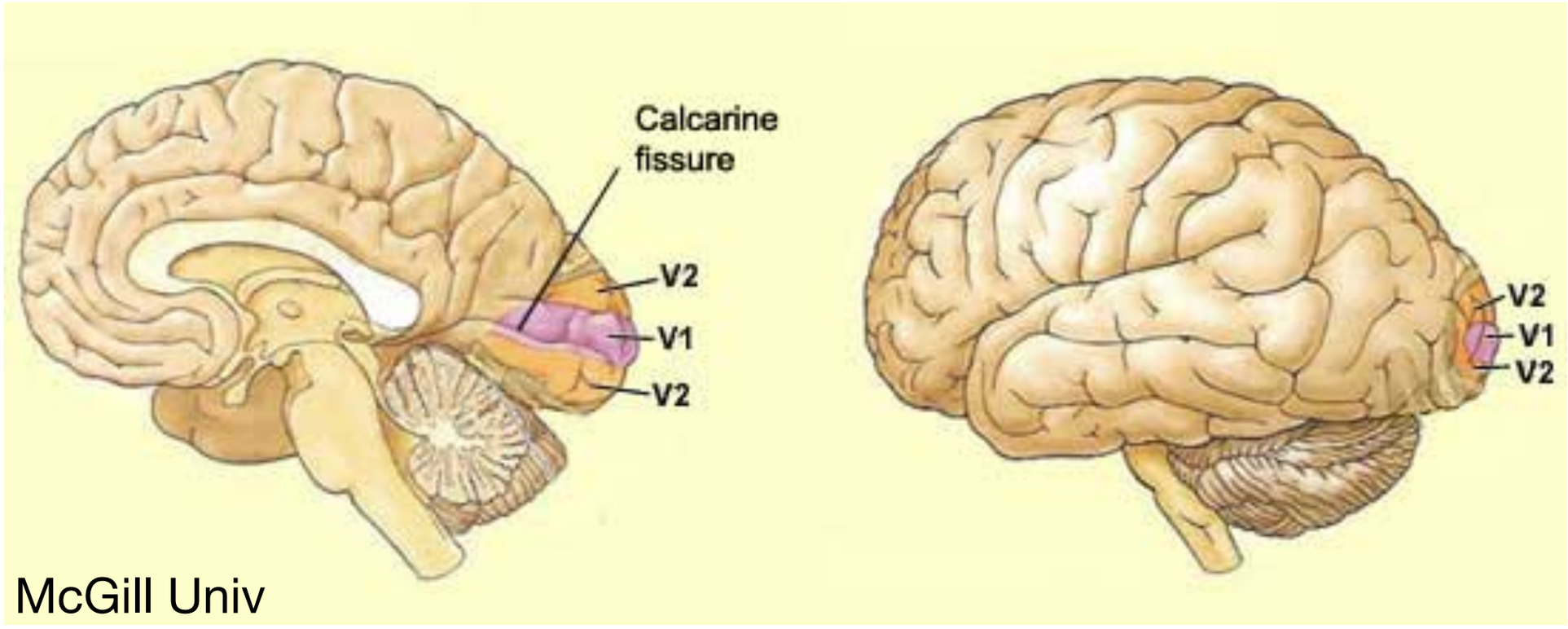
***A priori* salience** – some patterns excite more neural activity in the feature map than others.

Top-down salience – top-down mechanisms rerun the feature maps to increase sensitivity to features. “Search image” seeing a pattern before a search can help you find the pattern more quickly.

Scene gist – scenes that are well-known and easily recognized will have easily accessible search patterns, learned through repeated use of a style of visualization.

How does the brain determine what is important?

***A priori* salience** – some patterns excite more neural activity in the feature map than others.



McGill Univ

Primary visual cortex

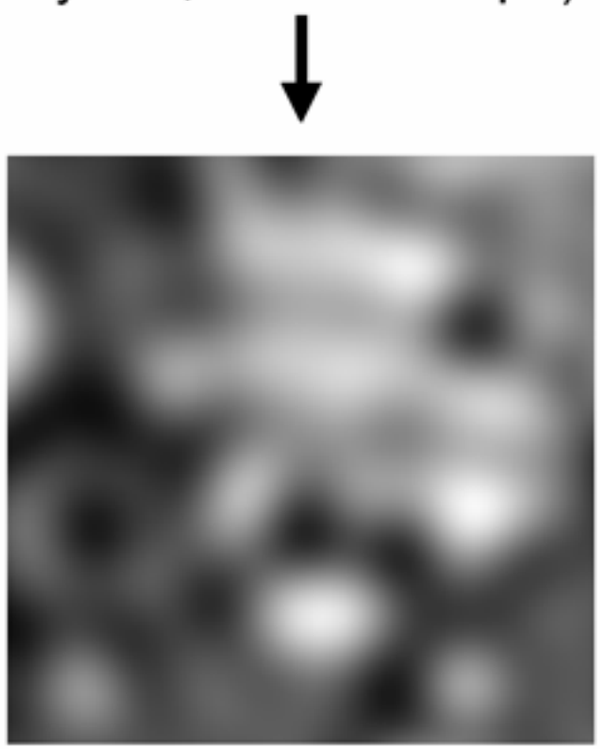
Visual Areas 1 & 2 (V1 & V2) – collections of neurons that respond selectively to different features of the scene that preserves spacial arrangement of signal.

- Special cells that respond to each: orientation, size, relative luminance, color, local stereoscopic depth, local motion.

- These signals are preferentially and rapidly processed in parallel!

Spatial Frequency Channels

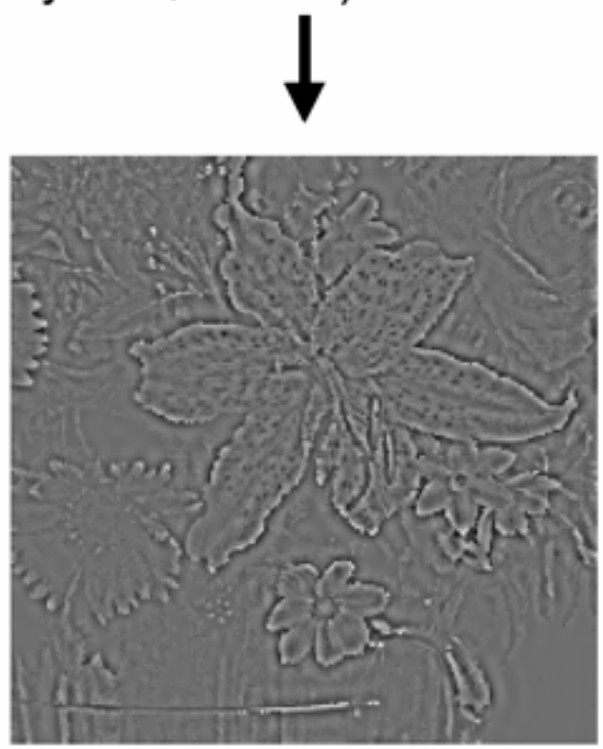
‘Low’ spatial frequency filters encode coarse luminance variations in the world (e.g. large objects, overall shape)



Coarse

Medium

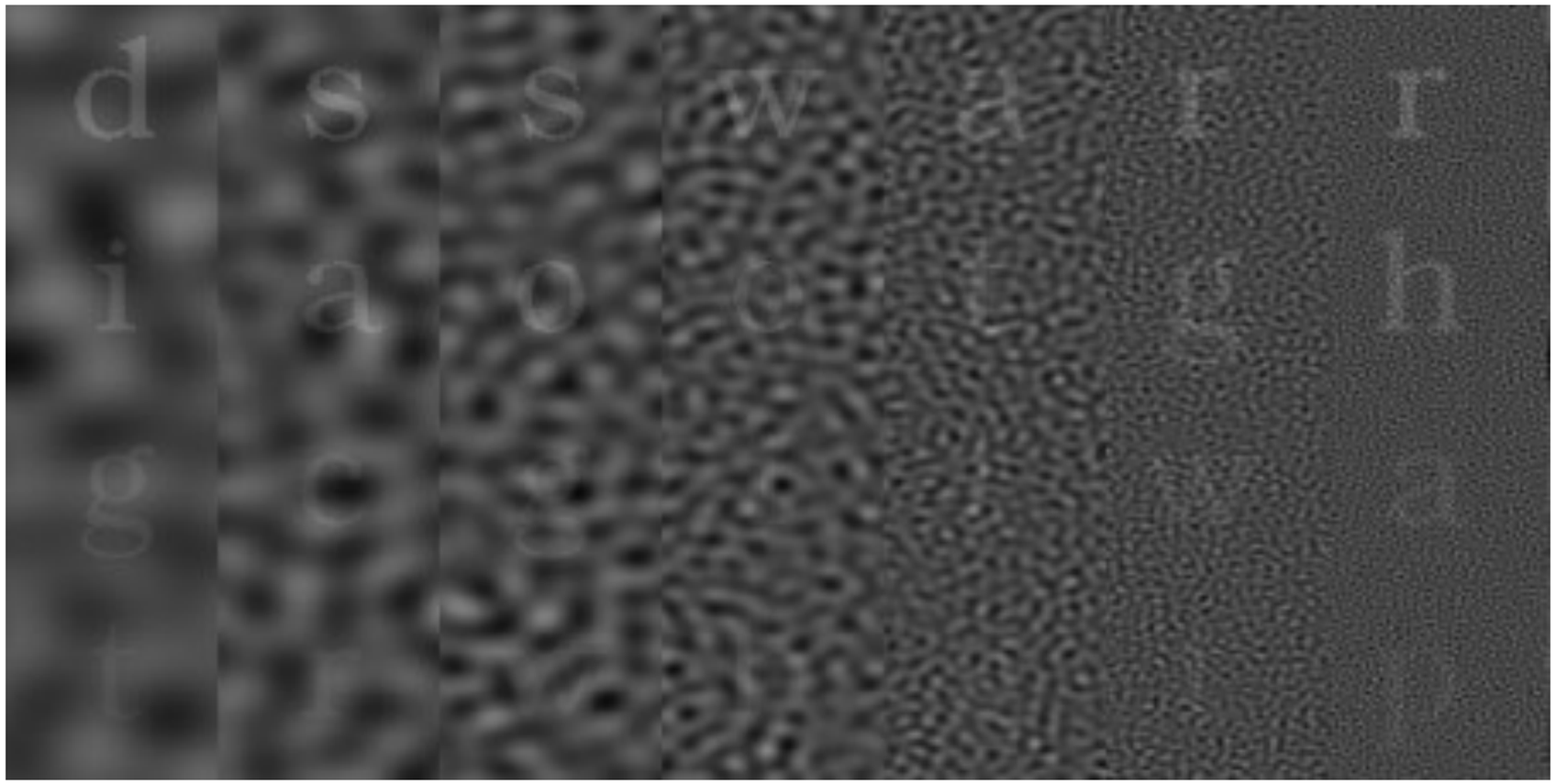
‘High’ spatial frequency filters respond to the fine spatial structure of the world (e.g. small objects, detail)



Fine

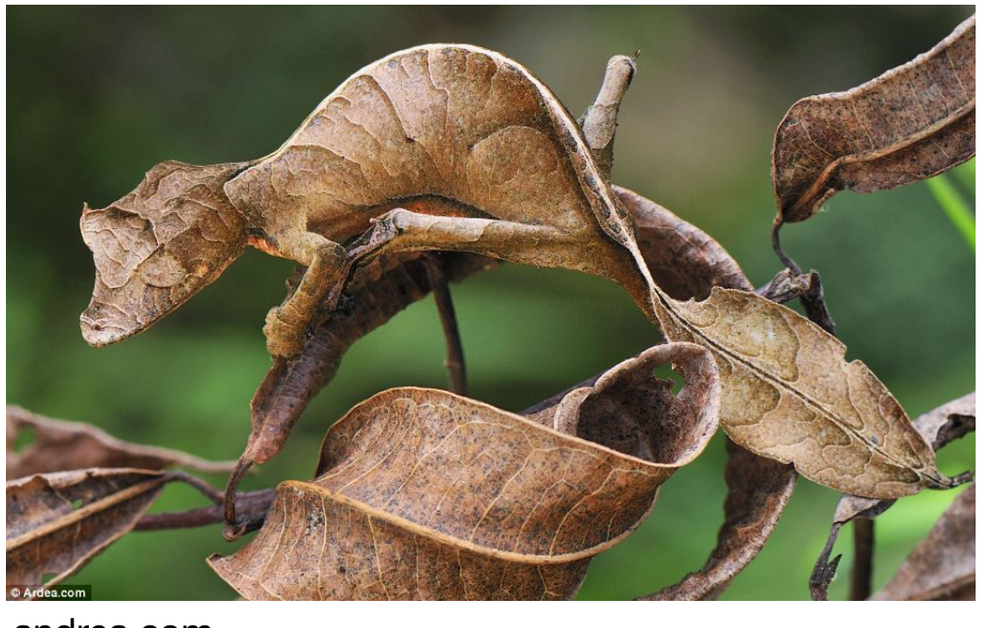
Image: M. Landy

Gabor model



What visual channels are these animals using to trick us?
(And what channels are you using to figure them out?)

Adam Skowronski/Flickr



andrea.com

Find the snake!

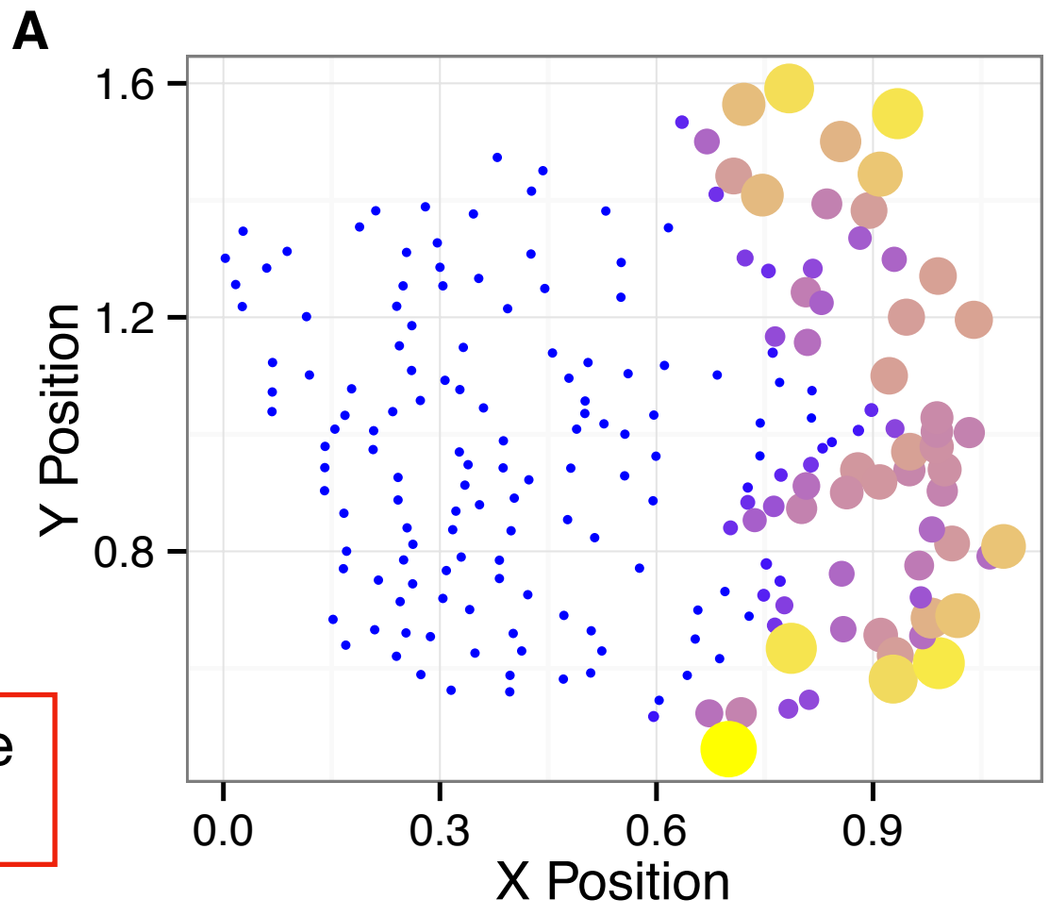
Don’t make visualizations like this.

Putting Neuroscience into Practice: Designing Visualizations

- Creating visualizations requires two elements:

  - **Symbols**: a visual stand-in for a specific nominal object or idea, an icon. "This thing stands for that."

  - **Glyphs**: a visual object that represents an object or idea an also passes numerical information/ attributes.



- **Important**: PAY ATTENTION to how you are ENCODING DATA for your viewers!

Putting Neuroscience into Practice: Designing Visualizations

- Elements of visual distinctness for symbols and graphs:

  - **Rely on V1 and V2 processing** – these take advantage of rapid processing.

    - Use **different visual channels** to display aspects of data so they are visually distinct.

    - More reliant on basic processing, the more they will stand out!

  - **Color –** make color vary on yellow-blue and red-green axes, use primary colors which are easy to identify.

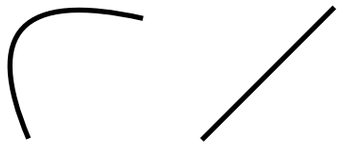
  - **Gabor –** make things easy to find by relying on different textures, orientation, and sizes, distinct from background in terms of spatial channels.

  - **Local depth cues and stereoscopicity –** shading and other depth cues are processed quickl.

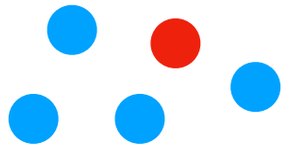
Putting Neuroscience into Practice: Designing Visualizations

- Specific examples of **pre-attentive processing**:

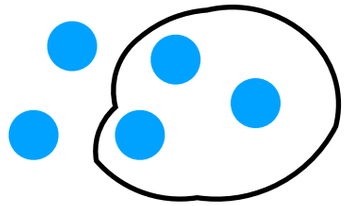
- **curved/straight**



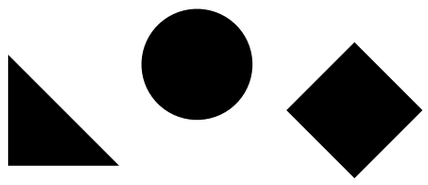
- **color**



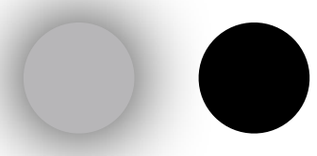
- **enclosure**



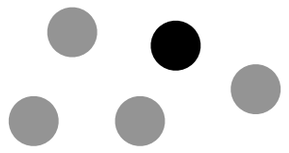
- **shape**



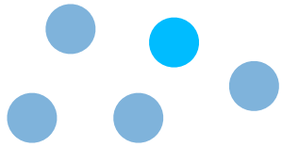
- **blur**



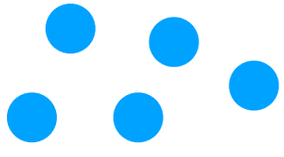
- **light/dark**



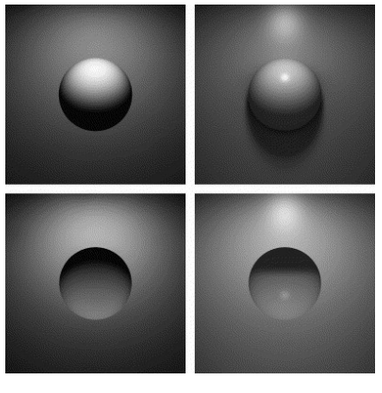
- **hue intensity**



- **motion**



- **convex/concave**

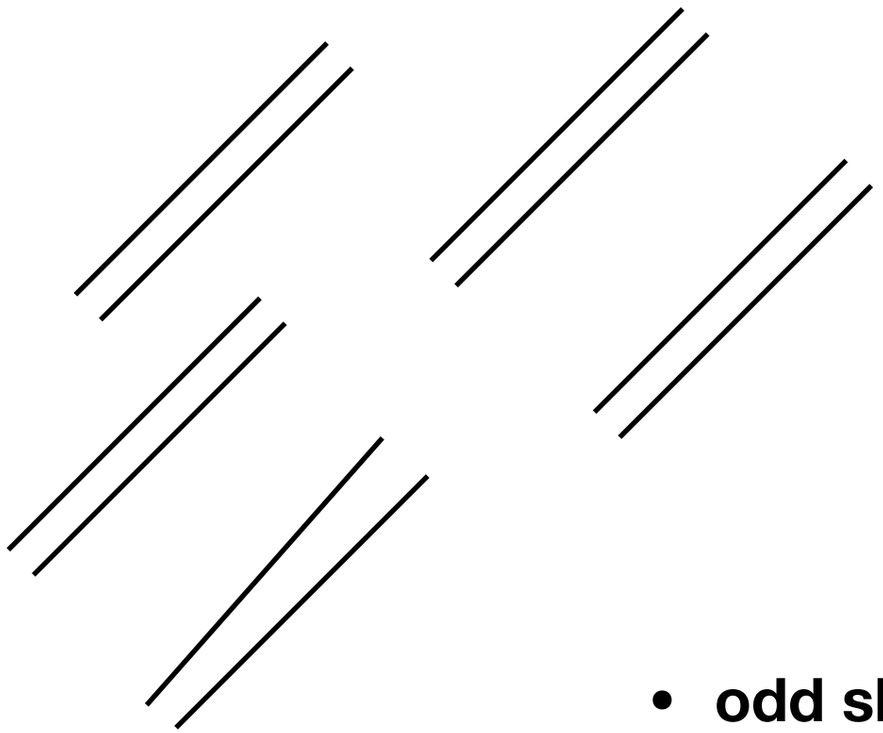


USE THESE

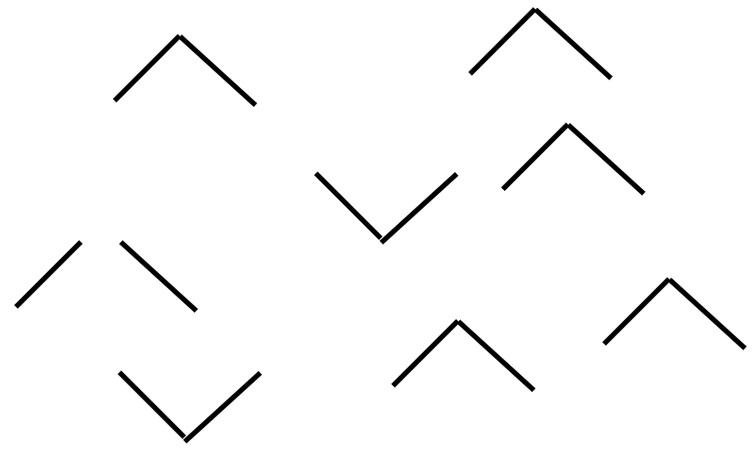
Putting Neuroscience into Practice: Designing Visualizations

- Specific examples of **non pre-attentive processing**:

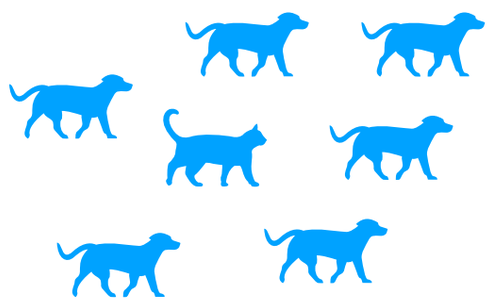
- **parallelism**



- **junctions**



- **odd shapes**



AVOID THESE

Group work:

1. Use the iris data set in R and create three graphs of Sepal.Length versus Sepal.Width. Each graph should highlight the *versicolor* species using a single pre-attentive process. Choose one process from each column.

Column 1	Column 2	Column 3
Orientation	Color	Texture/Blur
Curved/straight	Light/dark	Convex/concave
Shape	Enclosure	Added marks
Size	Hue	Stereoscopic depth

2. Create two additional graphs where two processes are used to indicate versicolor species in addition to the other two species.

Group work:

3. Create a visualization of the CO2 data set in R showing plant location (Type), Treatment, environmental concentration of CO2 (conc), and uptake of CO2 (uptake). Do not use a bar graph.

a) Which data are integral? separable?

b) How will you encode the integral variables? separable?

References

McGill University. “The Brain From Top to Bottom: The Eye.” https://thebrain.mcgill.ca/flash/d/d_02/d_02_cr/d_02_cr_vis/d_02_cr_vis.html