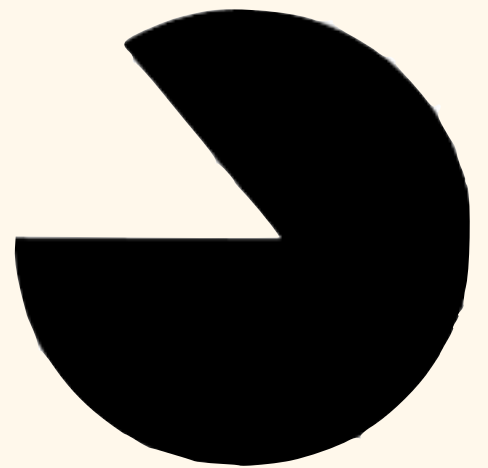
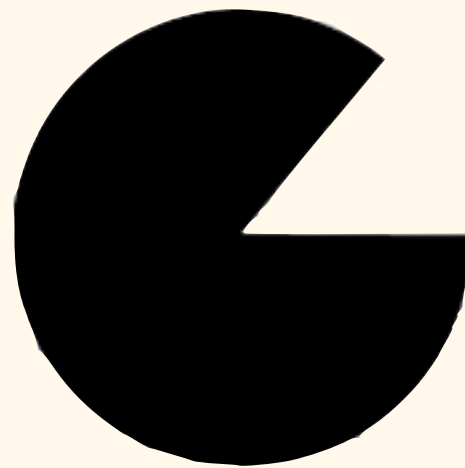
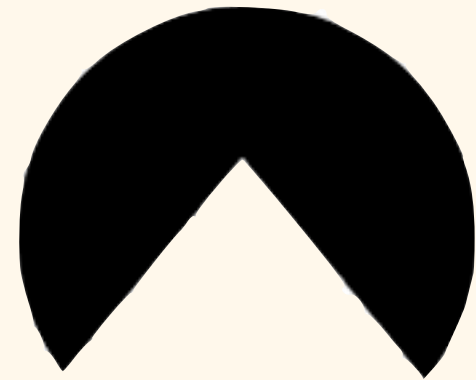
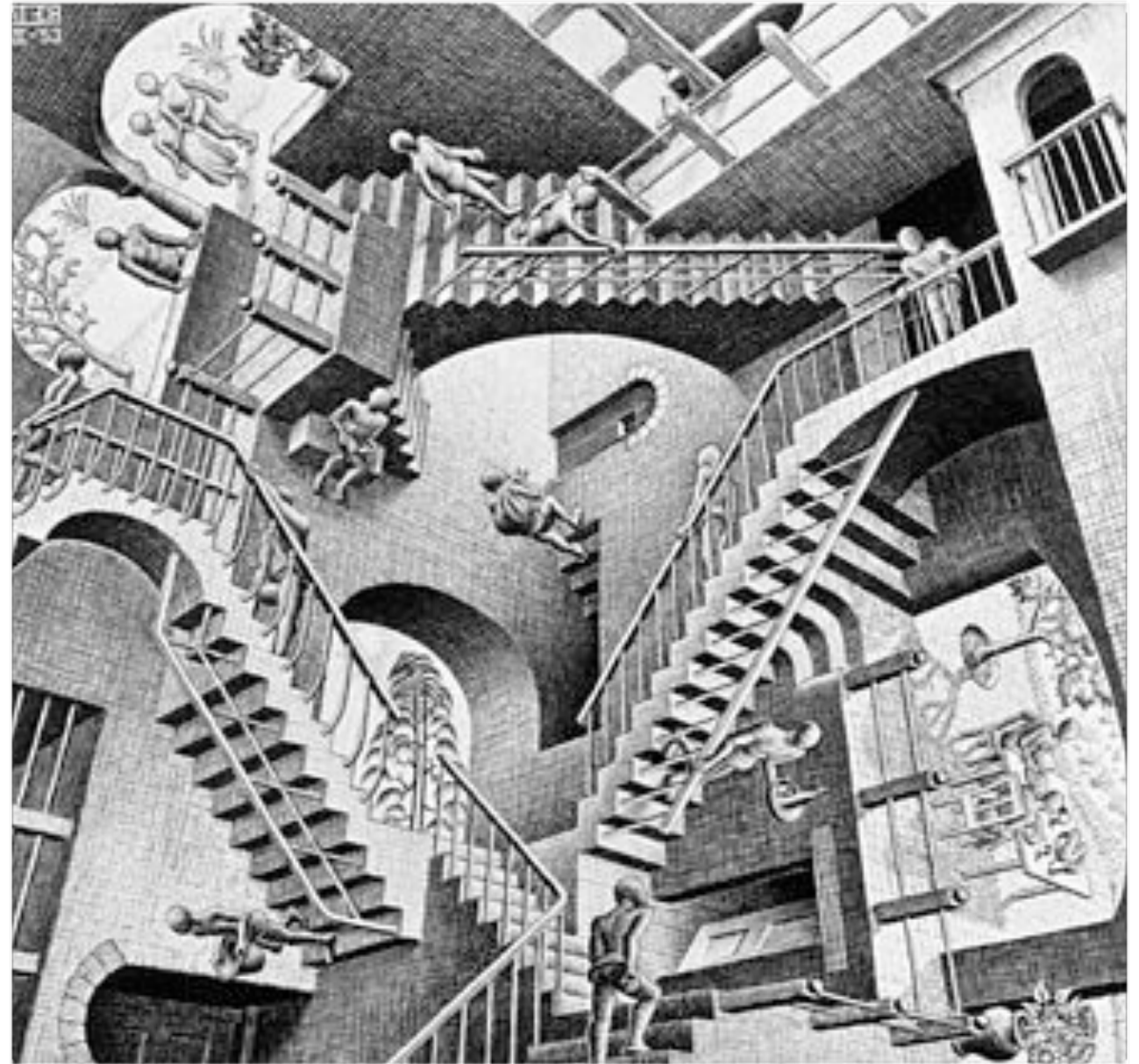


# Preattentive properties & Gestalt perception

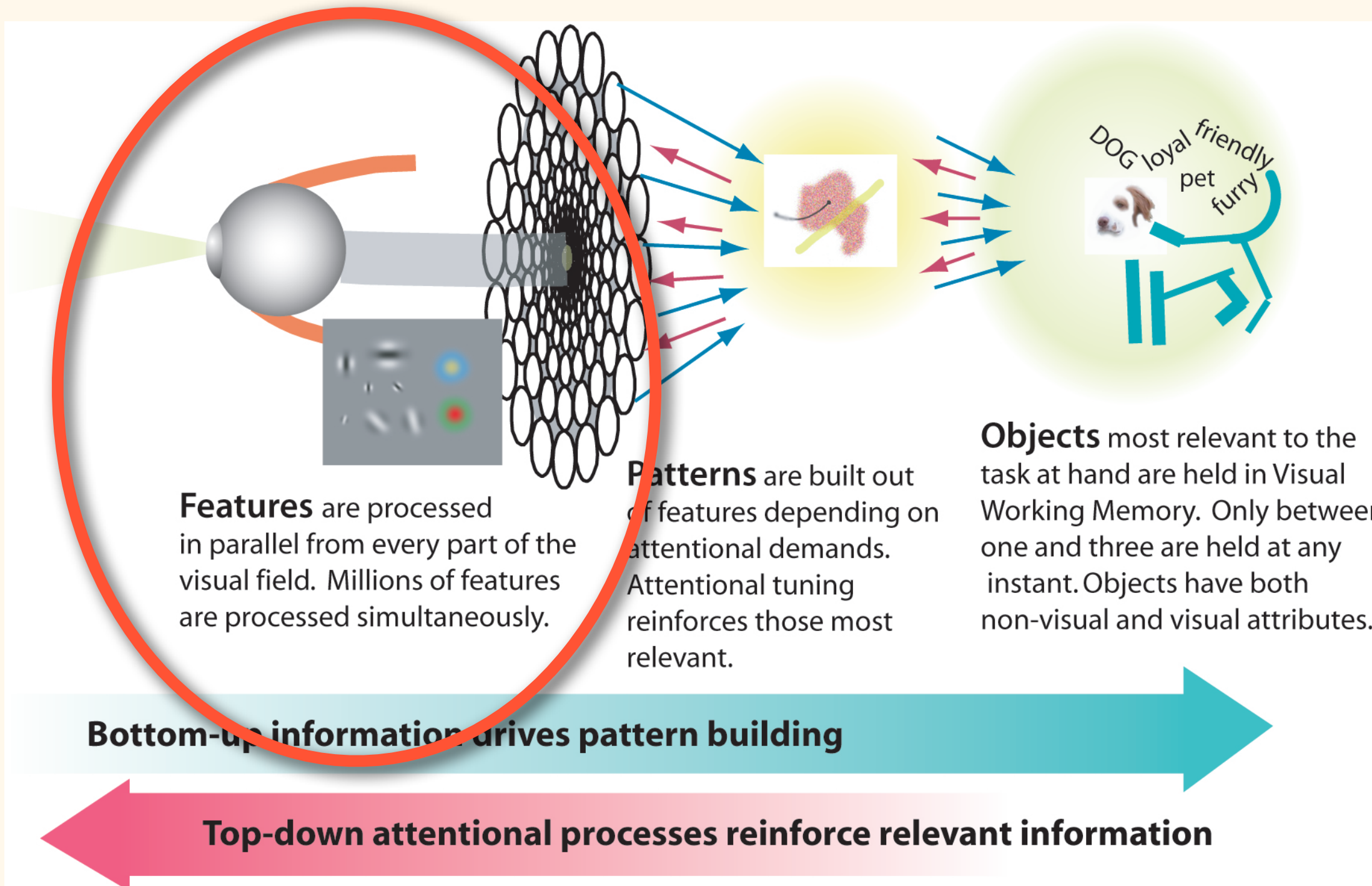




M.C. Escher, "Waterfall" [https://en.wikipedia.org/wiki/File:Escher\\_Waterfall.jpg](https://en.wikipedia.org/wiki/File:Escher_Waterfall.jpg)

M.C. Escher, "Relativity" [https://en.wikipedia.org/wiki/File:Escher%27s\\_Relativity.jpg](https://en.wikipedia.org/wiki/File:Escher%27s_Relativity.jpg)





**Features** are processed in parallel from every part of the visual field. Millions of features are processed simultaneously.

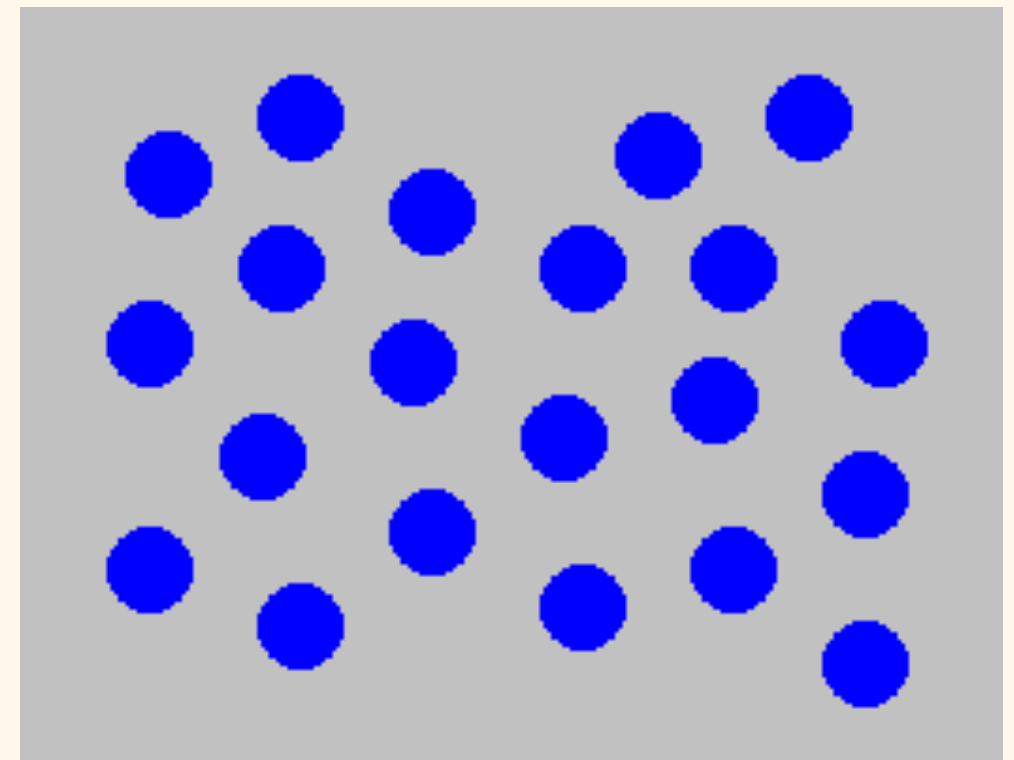
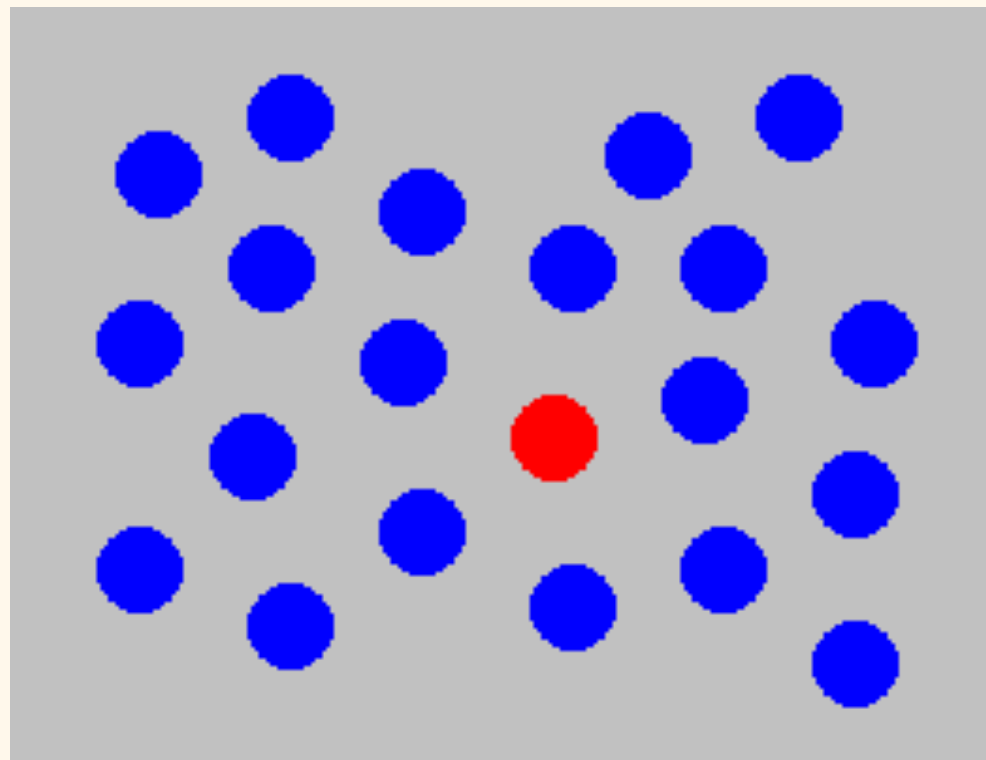
**Patterns** are built out of features depending on attentional demands. Attentional tuning reinforces those most relevant.

**Objects** most relevant to the task at hand are held in Visual Working Memory. Only between one and three are held at any instant. Objects have both non-visual and visual attributes.

**Bottom-up information drives pattern building**

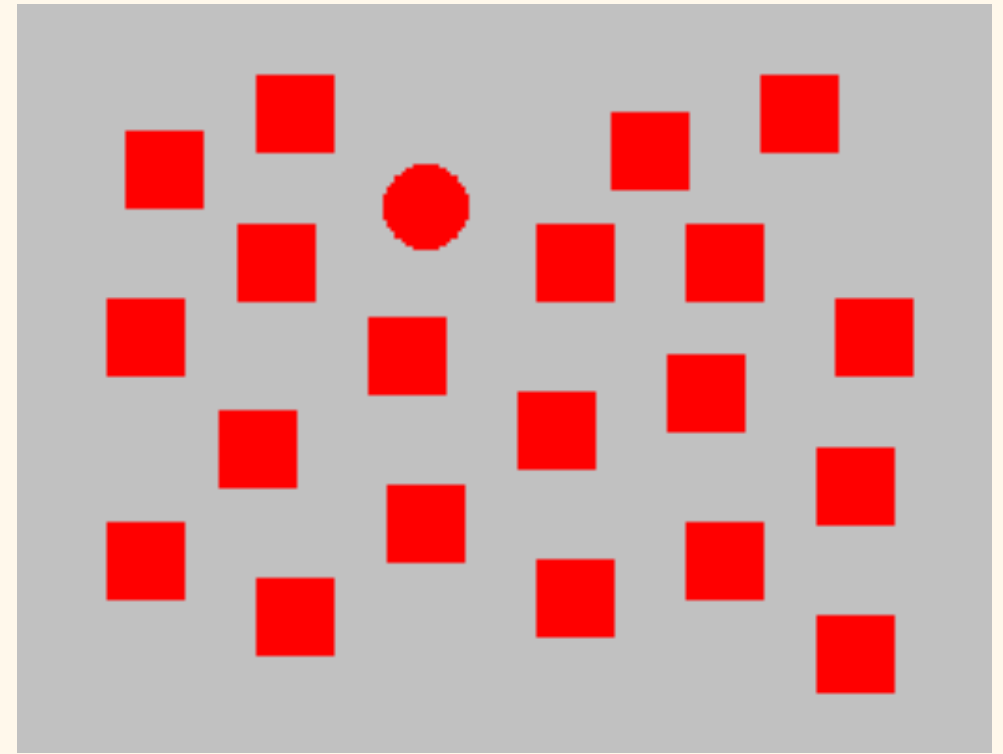
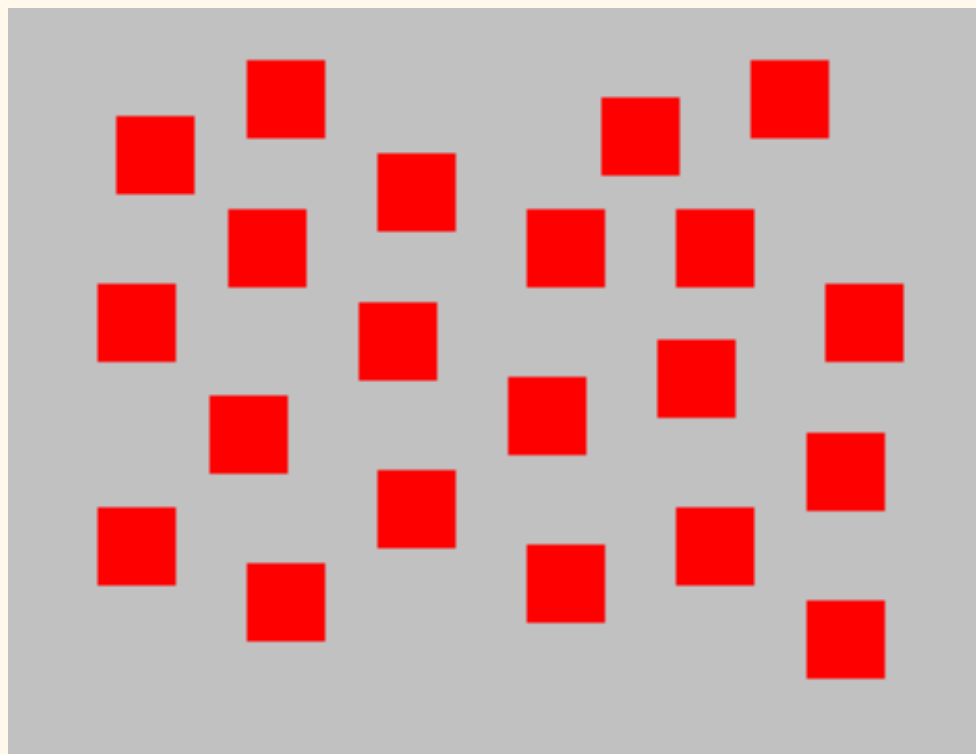
**Top-down attentional processes reinforce relevant information**

Certain visual inputs are processed almost instantaneously, and in parallel:



Is there a red circle present?

Certain visual inputs are processed almost instantaneously, and in parallel:



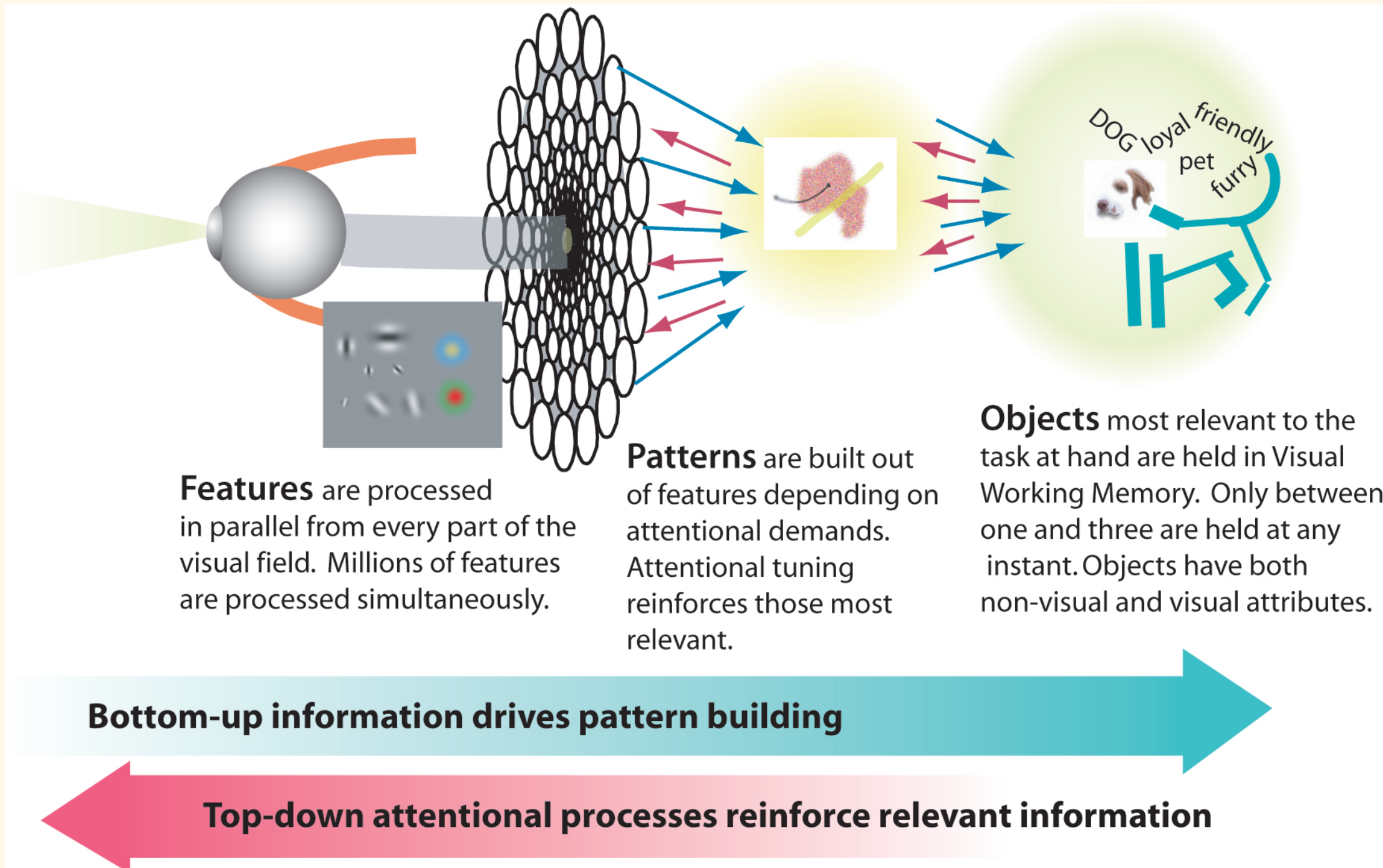
Is there a red circle present?

Certain visual inputs are processed almost instantaneously, and in parallel:

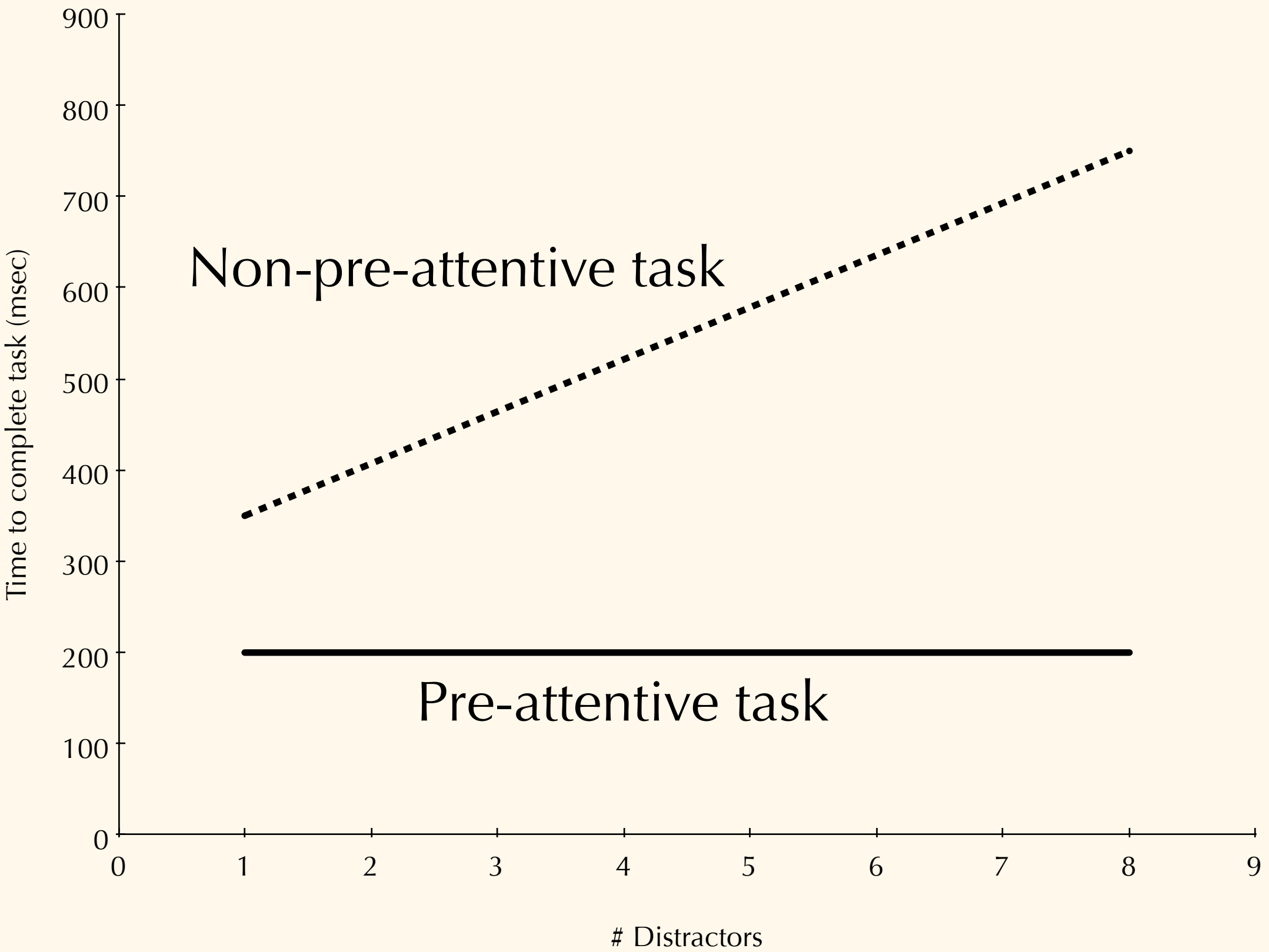


Is there a boundary?

# This “pre-attentive” perception happens very early in the vision pathway.

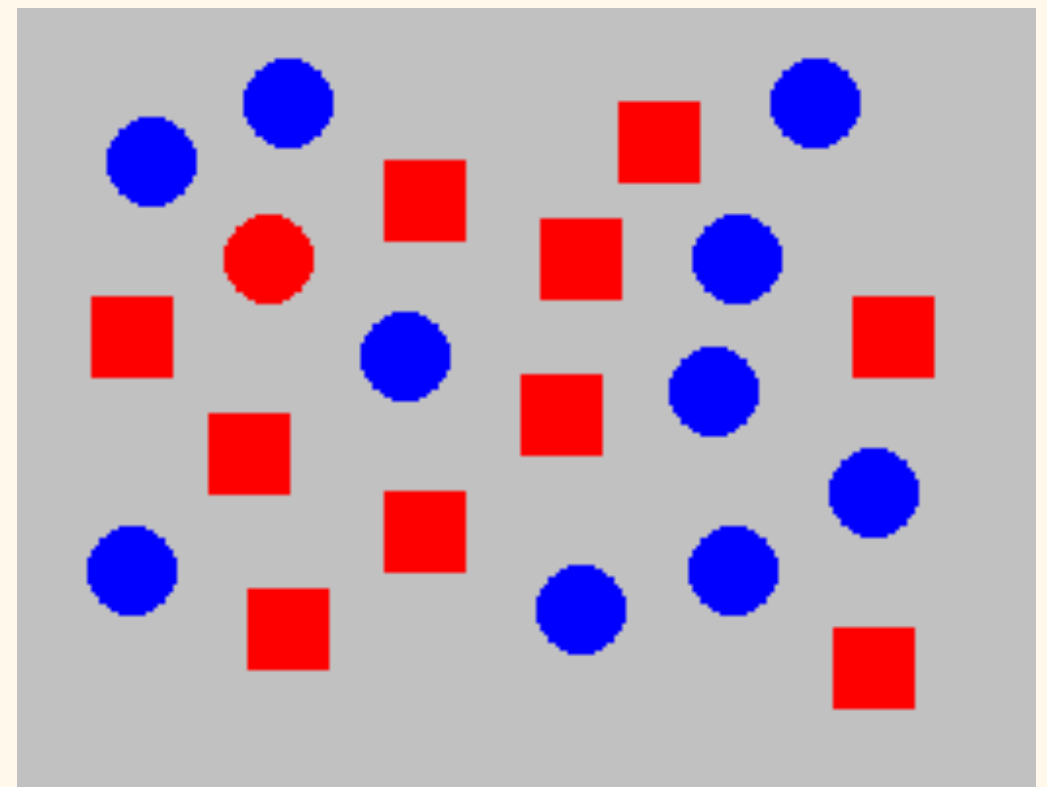
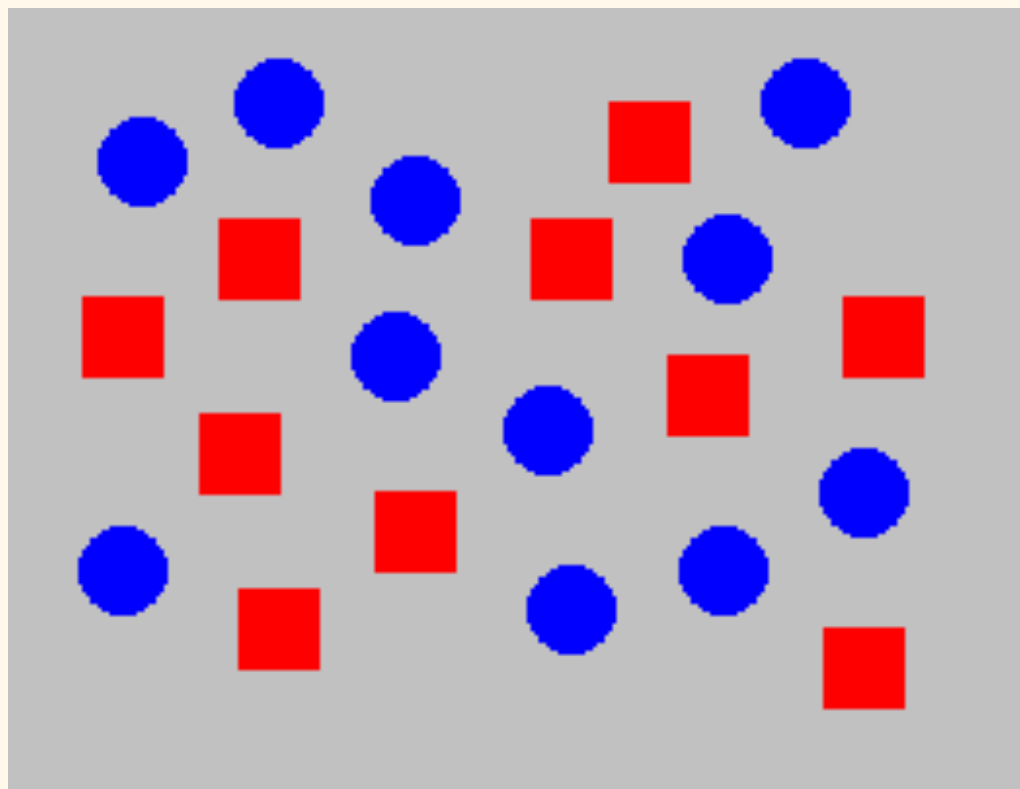


A pre-attentive task takes the same amount of time irrespective of the number of distractors.



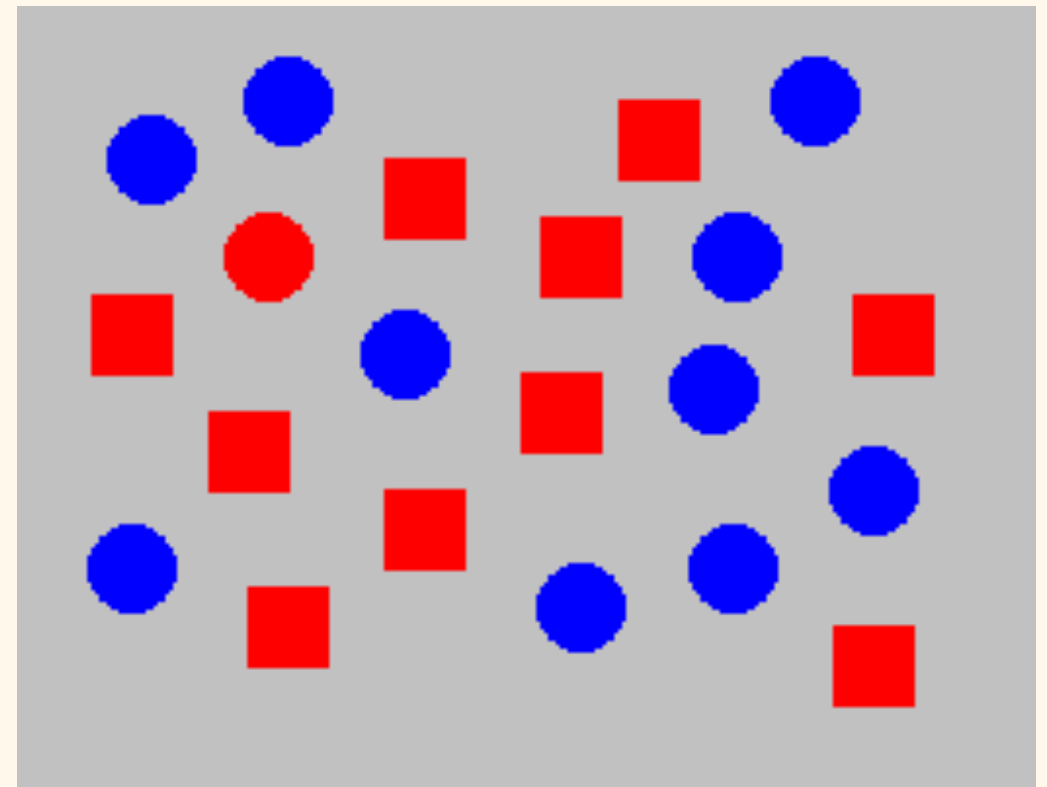
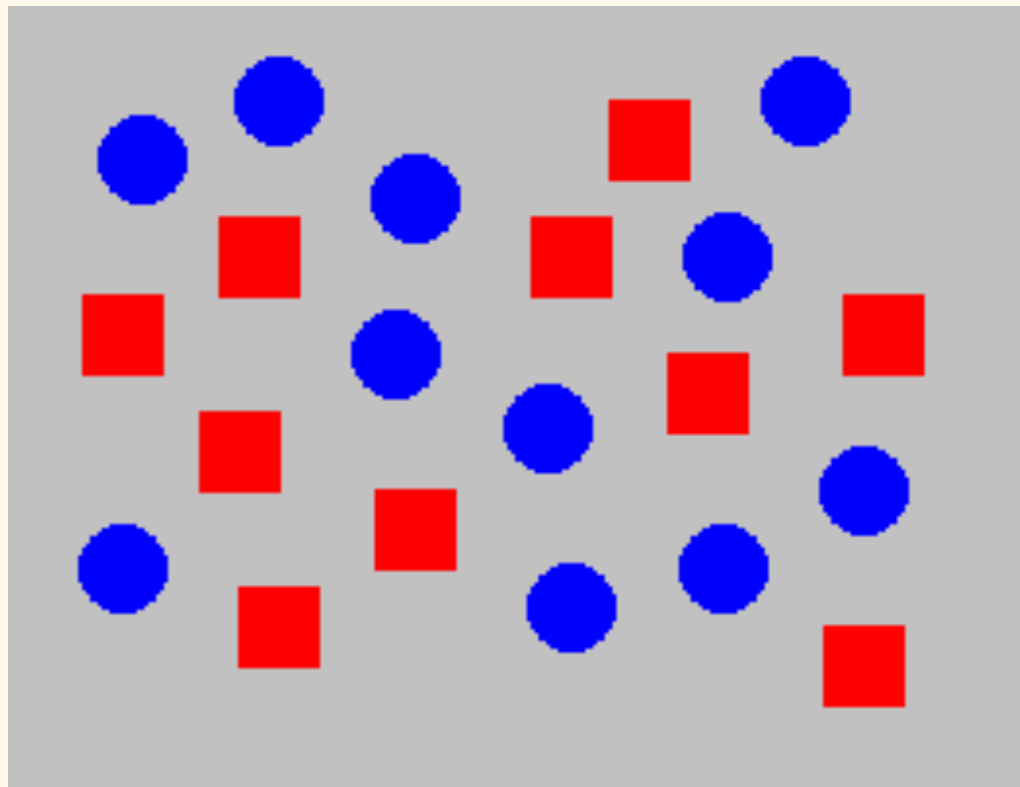


Interestingly, this only works when the distractors differ on the same feature:



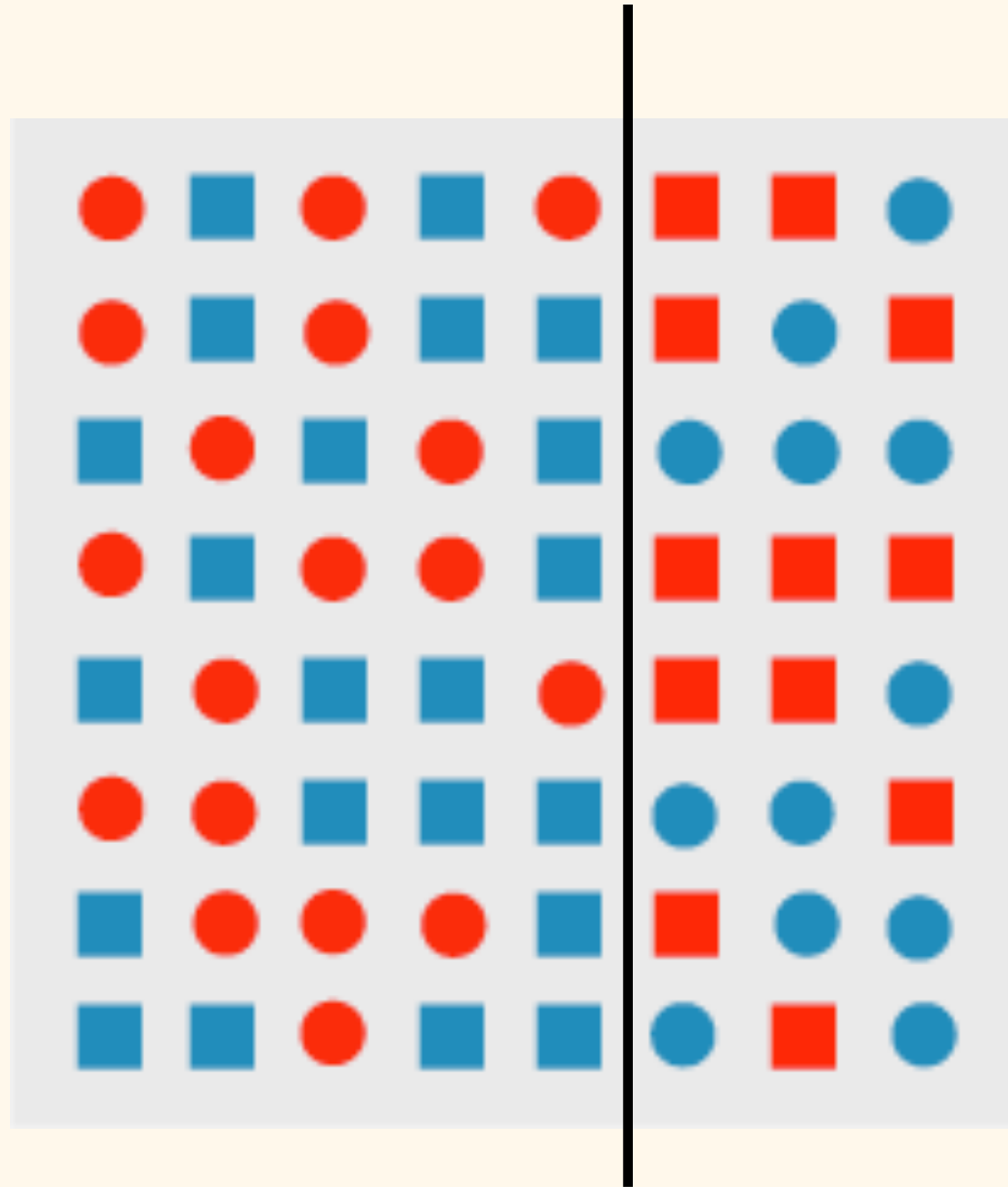
Is there a red circle present?

Interestingly, this only works when the distractors differ on the same feature:



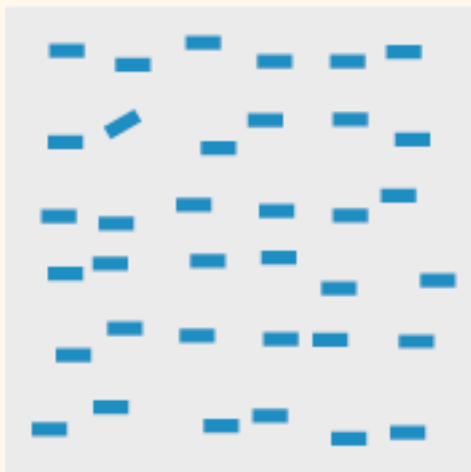
We must fall back on linear scanning when there is a “conjunction” of features.

Interestingly, this only works when the distractors differ on the same feature:

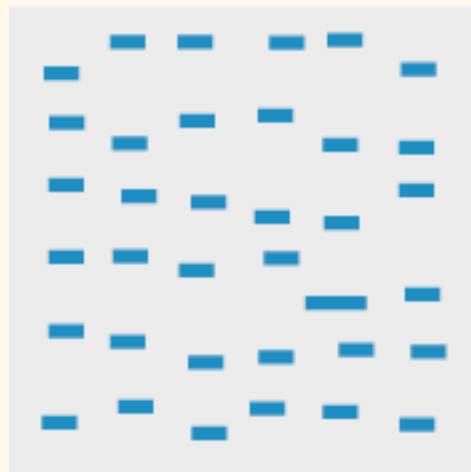


Is there a boundary? (hint: yes!)

# Color and shape are only a few of the pre-attentive visual properties:



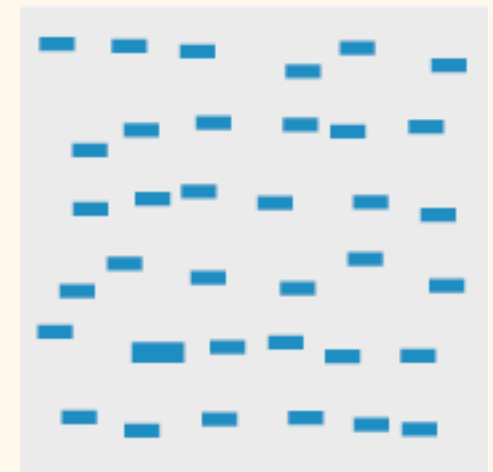
Orientation



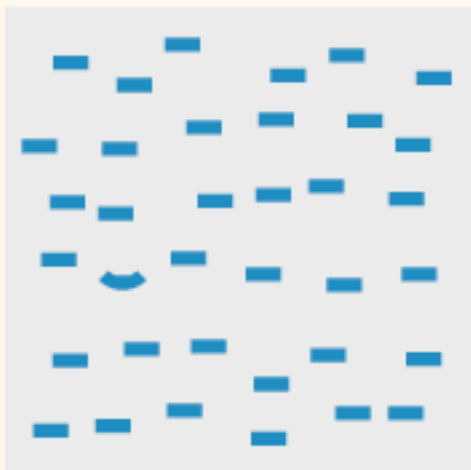
Length



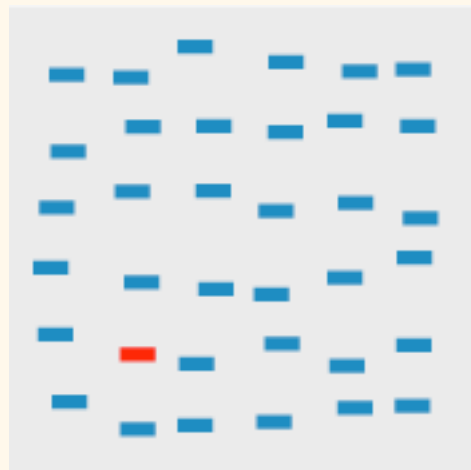
Closure



Size

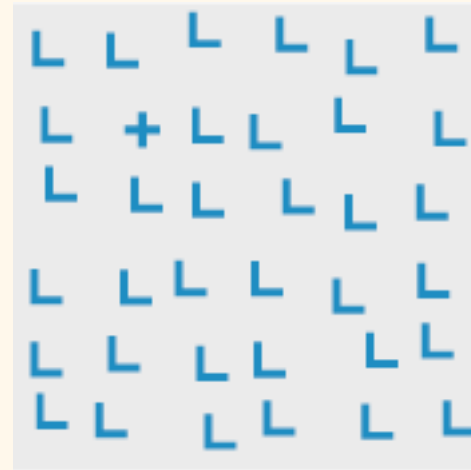


Curvature

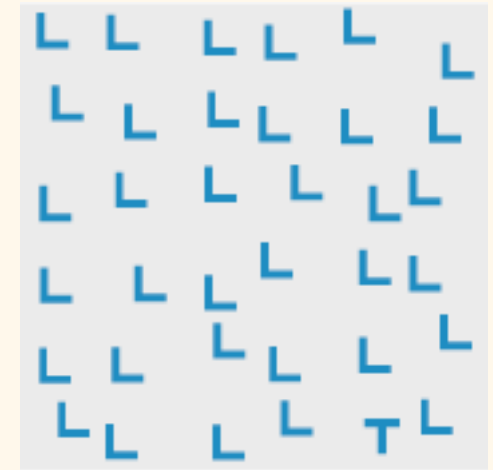


Color

*(hue & intensity  
operate independently)*



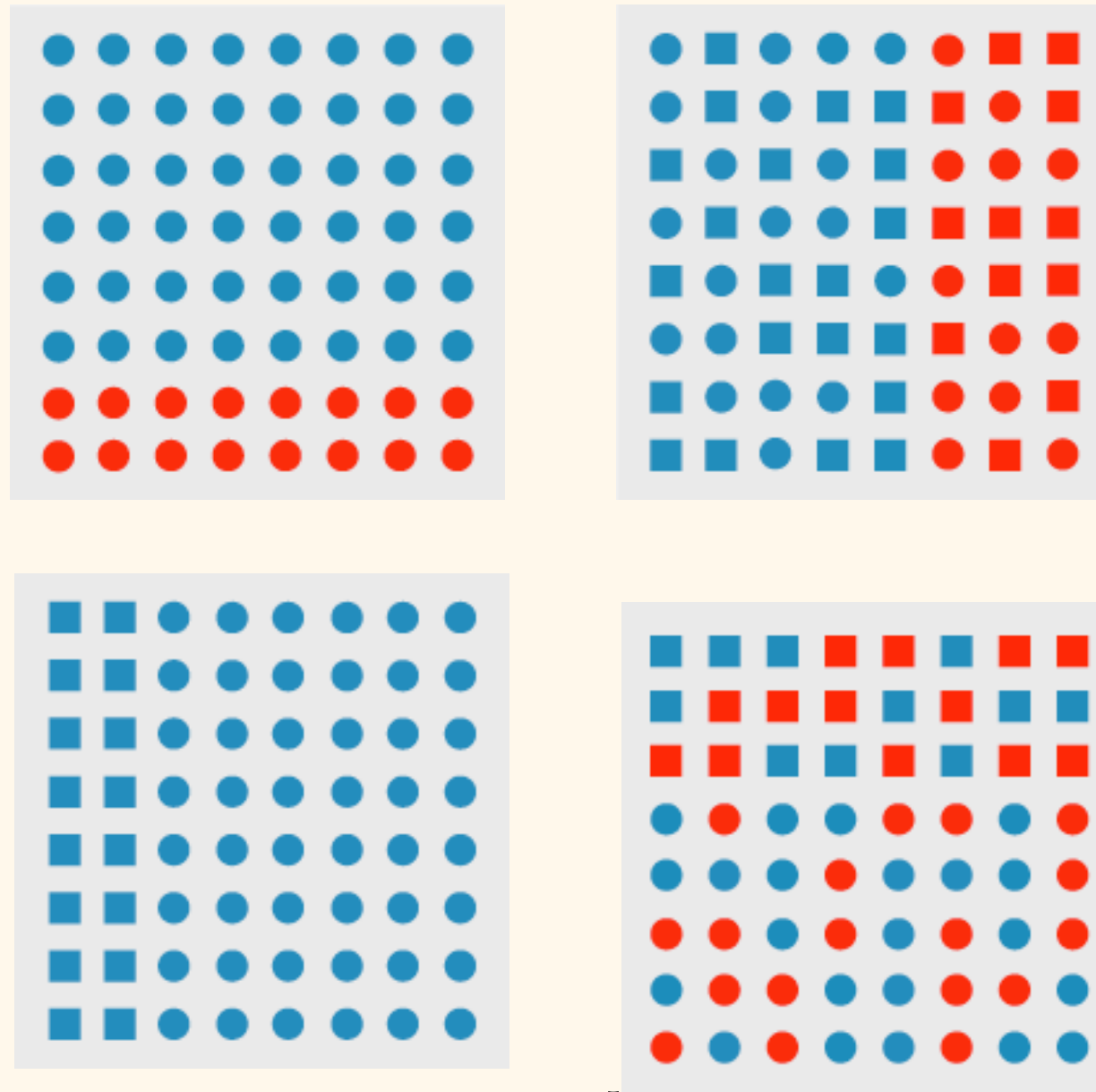
Terminators



Intersection



Note that these various features are not created equal!



We seem to have a strong bias towards color perception over shape perception, etc..

What does all of this mean?

1. Certain tasks that depend on pre-attentive features can sometimes be done “for free” by our brains:

*Target detection*

*Boundary detection*

*Region tracking*

*Counting (estimation)*

2. The more of our story we can tell using pre-attentive features, the faster and better our viewer will “get it.”

3. We can easily mess up our viewer's ability to interpret our visualization by "triggering" pre-attentive perception inappropriately!

*Many of the things that make a bad visualization "bad" can be traced back to problems in this area!*



# Another perspective: Gestalt perception

“Gestalt”:

*“An organized whole that is perceived as more than the sum of its parts.”* (Ox. Am. Dict.)

Possibly a mis-translation?

*“The whole is other than the sum of its parts.”*

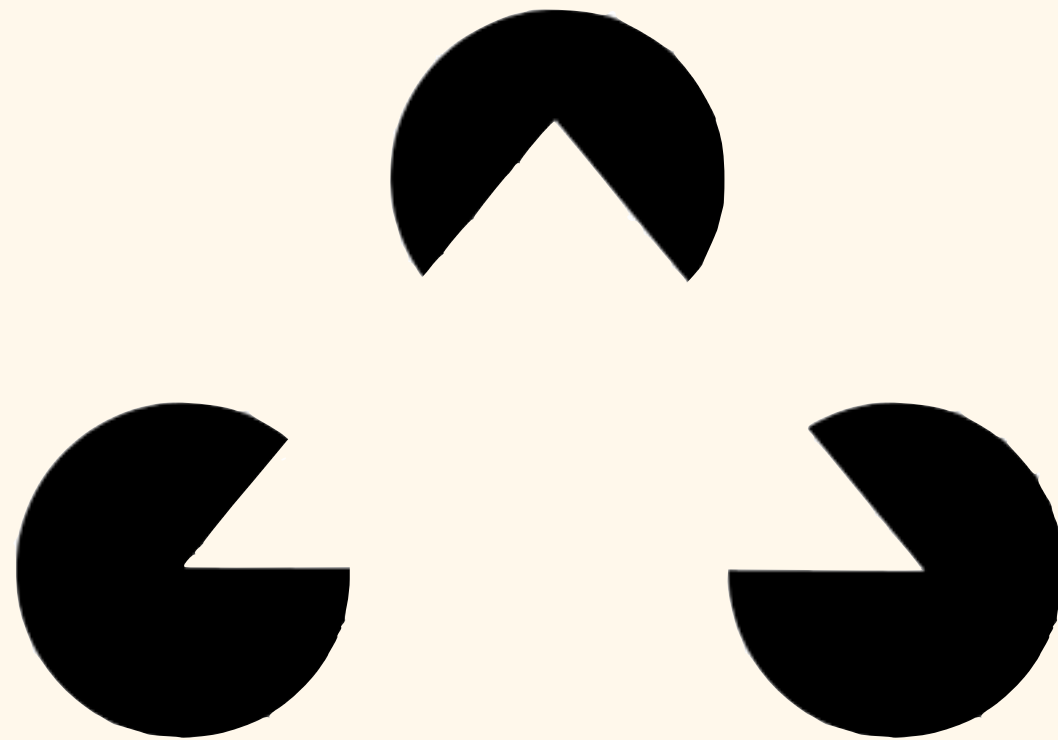
— Kurt Koffka (1886–1941)

The basic idea:

Our brains operate less on individual points, lines, etc....

... but rather on higher-level constructs...

... which is what our perceptual systems are optimized for.



We immediately see “triangle!”, not “circles with wedges removed...”



We don't see "leg", "ear", etc., but rather "entire dog".



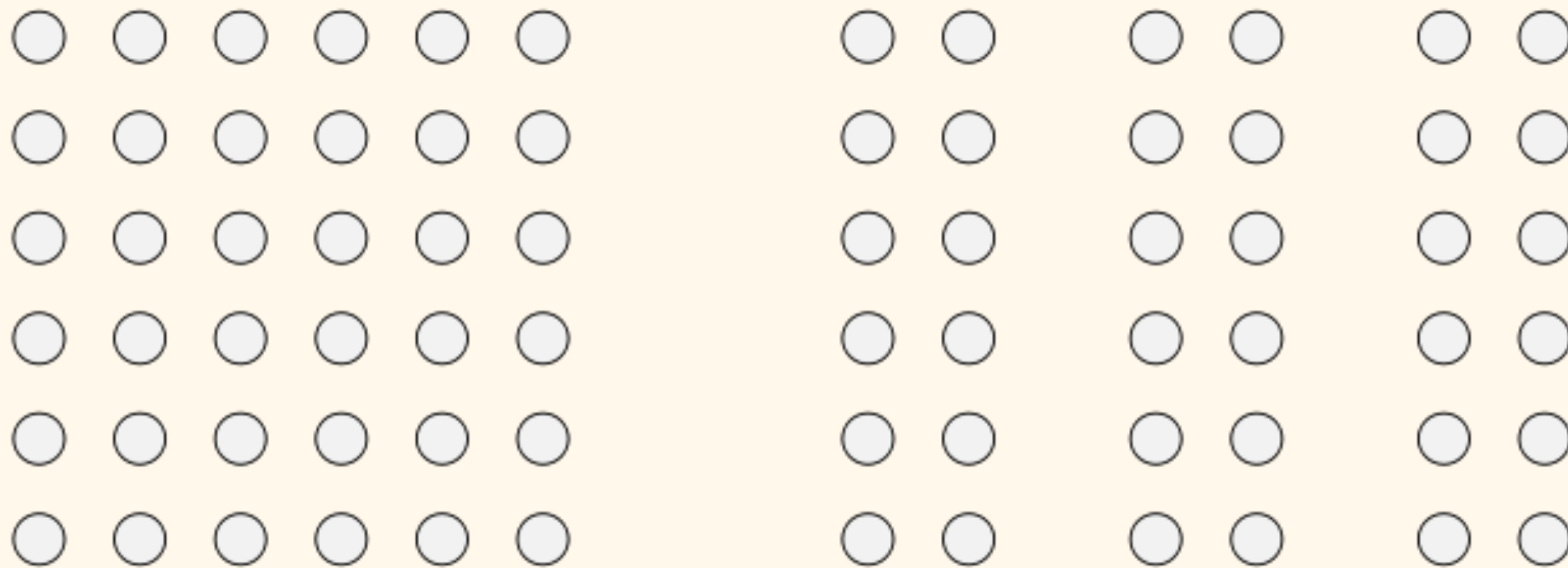
# “Gestalt Principles” (Prägnanz):

To make sense of the world around us, our brains use several different heuristics:

1. Proximity
2. Similarity
3. Closure
4. Symmetry
5. Continuation
6. Figure & Ground

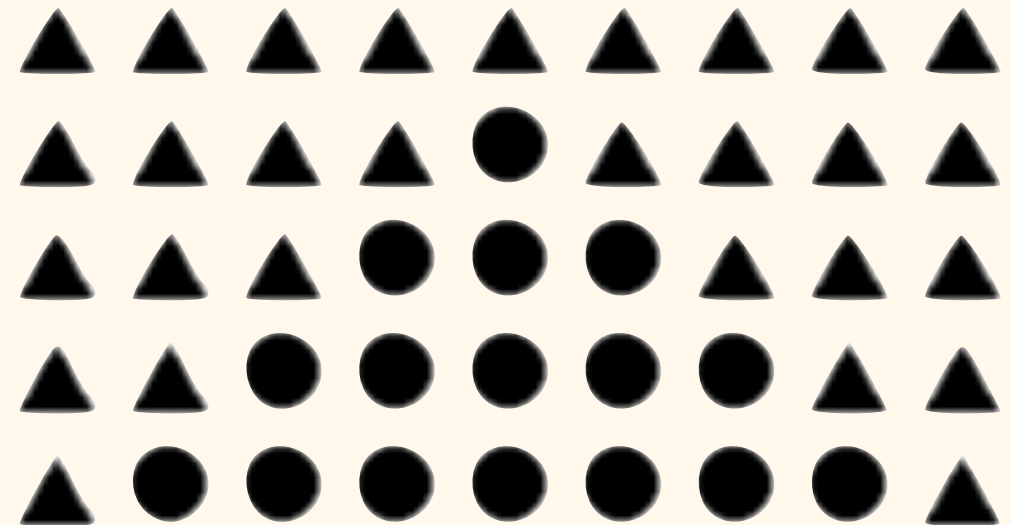
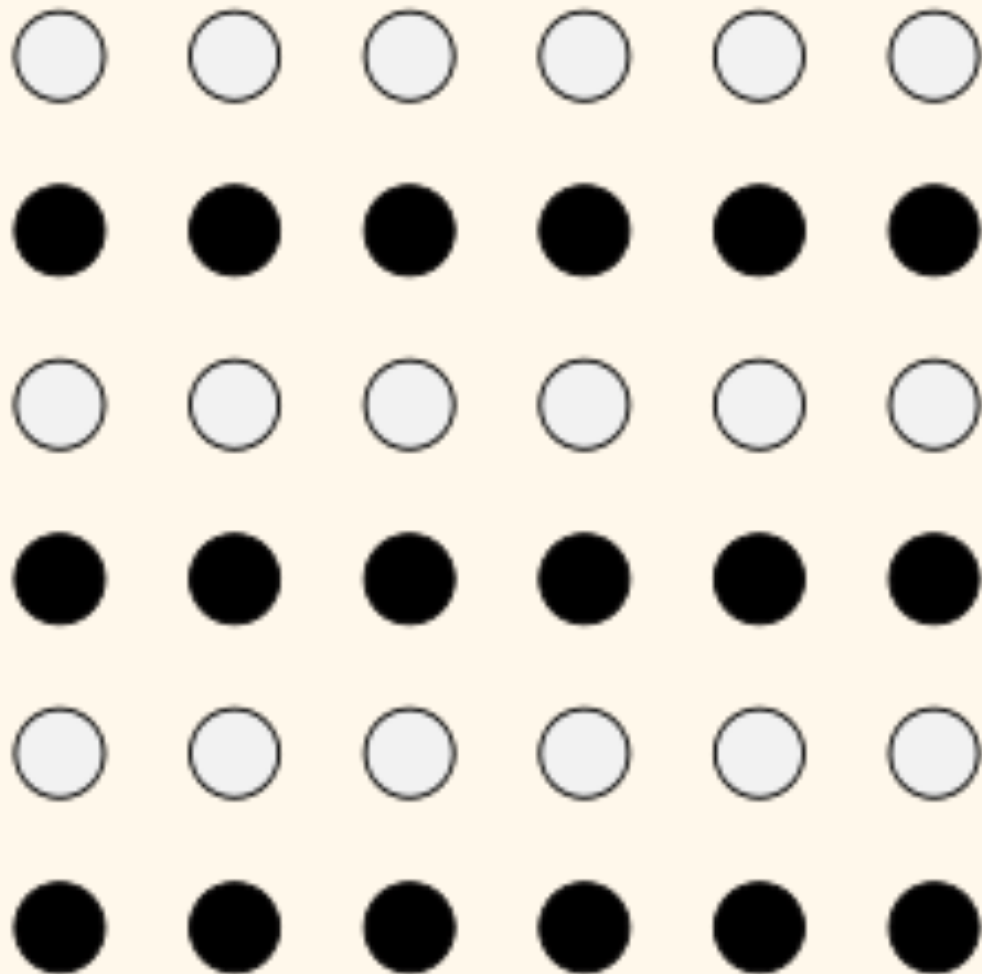
# Proximity:

Stimuli that are in proximity to one another are perceived to be grouped together.



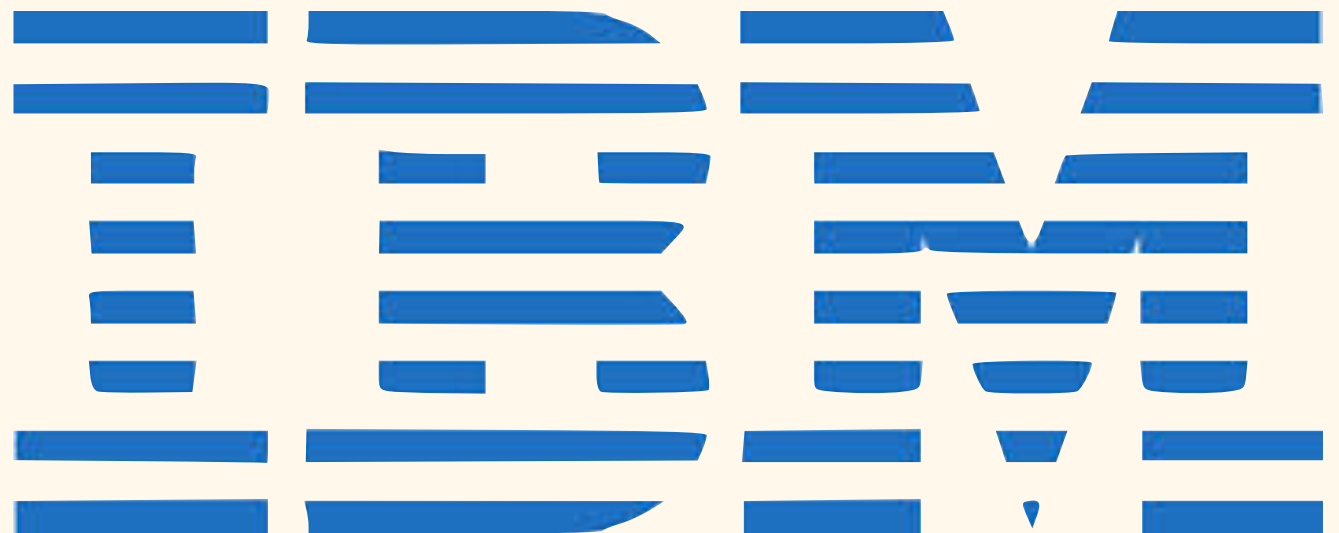
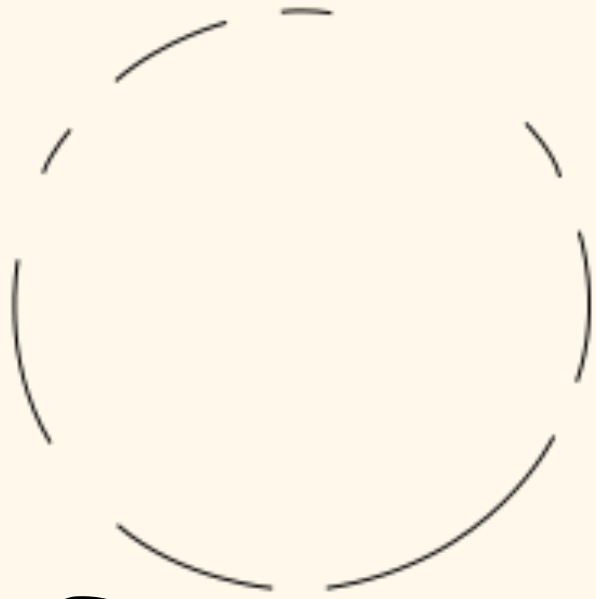
# Similarity:

Elements are grouped together if they are similar to one another.



# Closure:

We see complete shapes in incomplete contexts.





Symmetry:

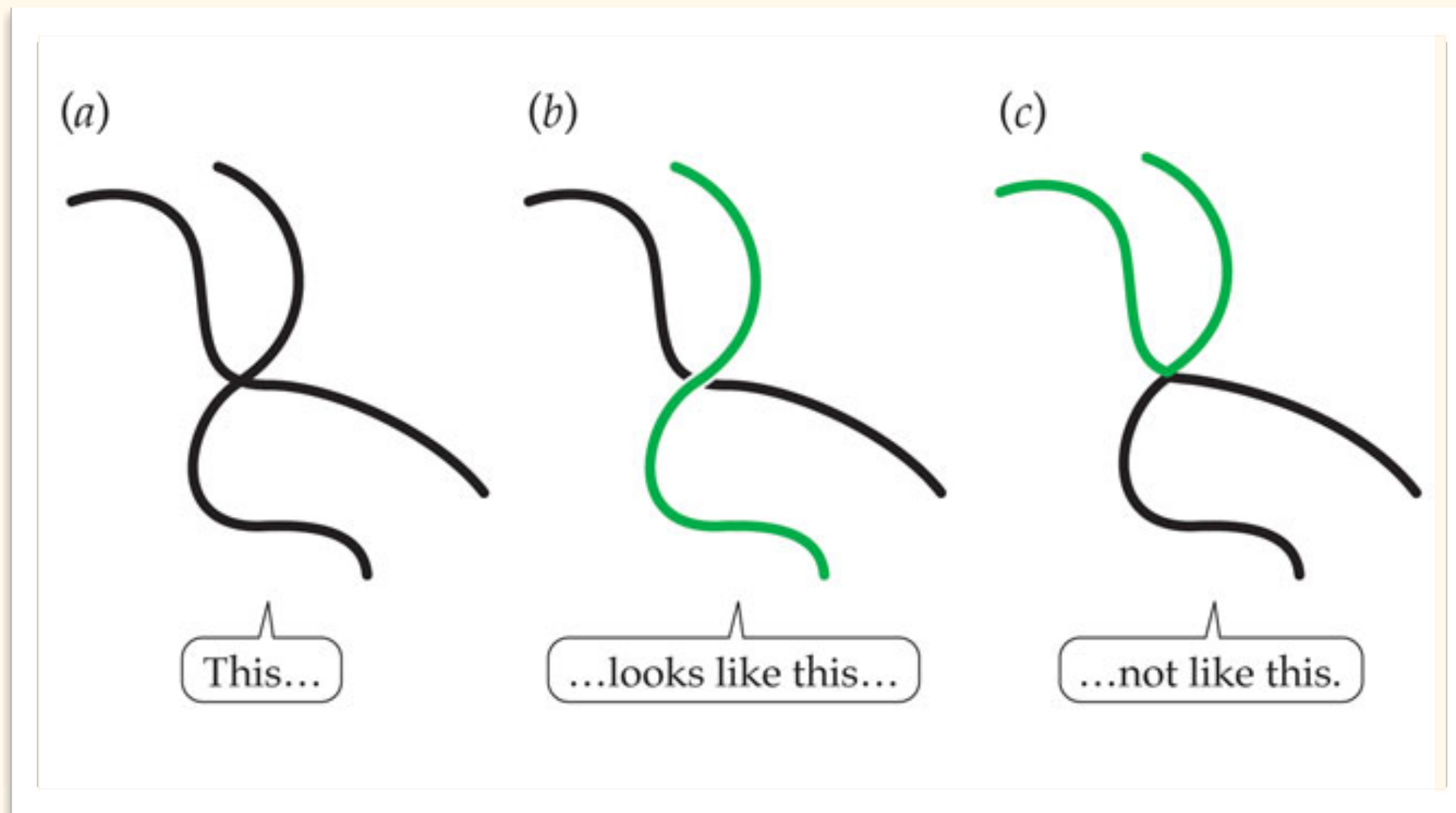
We naturally group things by central symmetry.

[ ] { } [ ]

How many groups of elements are there?

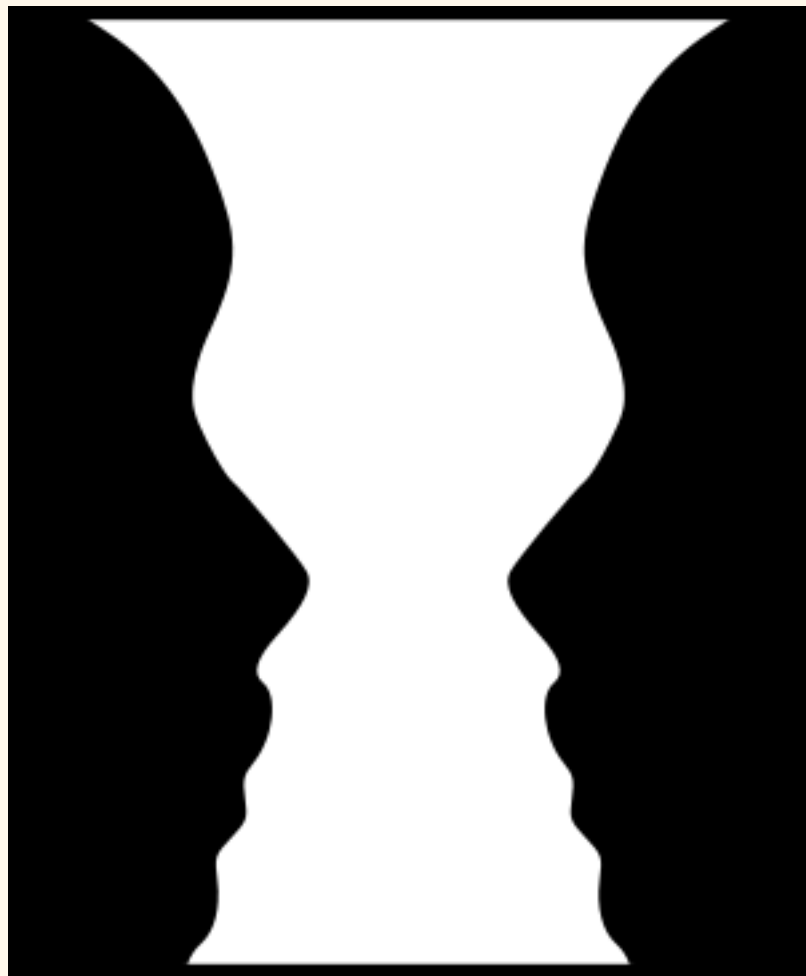
# Continuation

We try to follow the “simplest” path for connected/continuing elements:

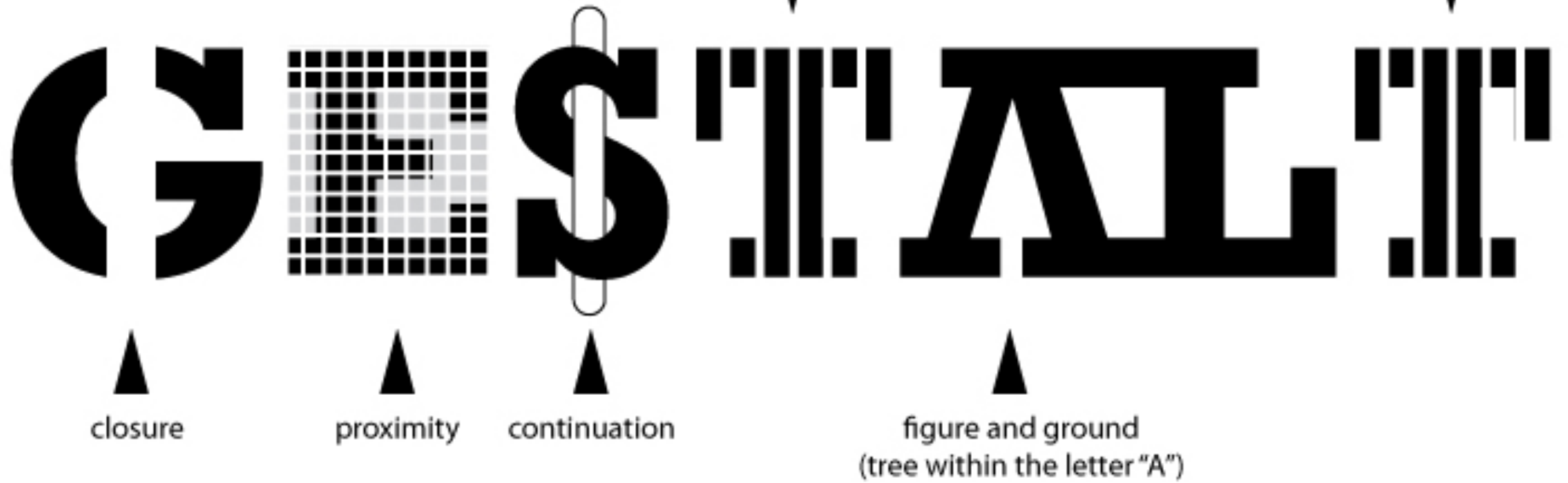


# Figure & Ground

We try and separate a *figure* from its *background*.



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In summary:

Our brains take lots of perceptual  
“shortcuts” ...

... which can either help or harm our  
visualizations!

**KNOWLEDGE IS POWER.**



Homework: find examples of both positive and negative preattentive/Gestalt behavior in a visualization.

Either find new ones, or re-evaluate your existing +/- examples.