Perception and Animation

Pre-attentive processing

How many 3’s?

1281768756138976546984506985604982826762
9809858458224509856458945098450980943585
9091030209905959595772564675050678904567
8845789809821677654876364908560912949686

Pre-attentive processing

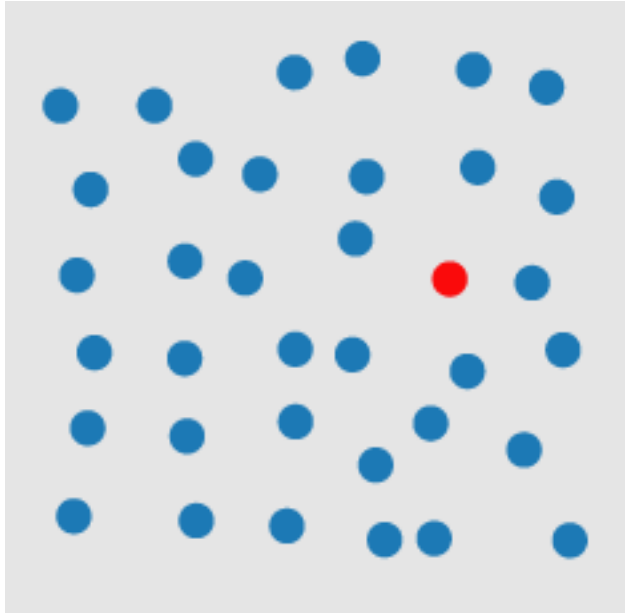
How many 3's?

1281768756138976546984506985604982826762
9809858458224509856458945098450980943585
9091030209905959595772564675050678904567
8845789809821677654876364908560912949686

Pre-attentive processing

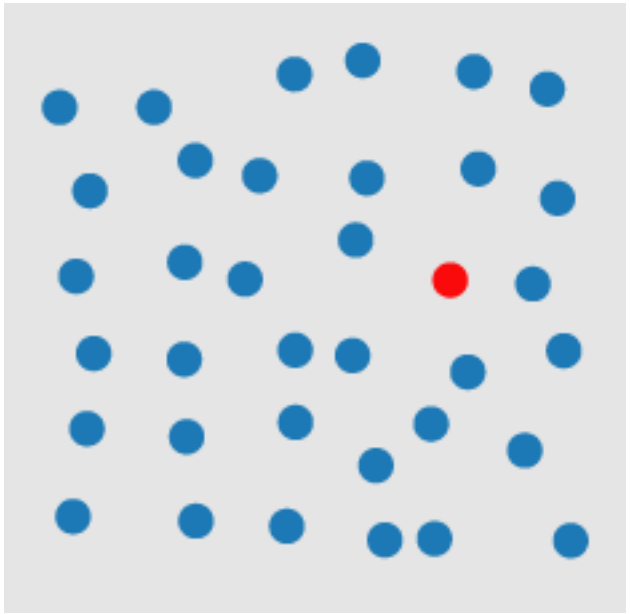
- Is there a red-circle in the following image?

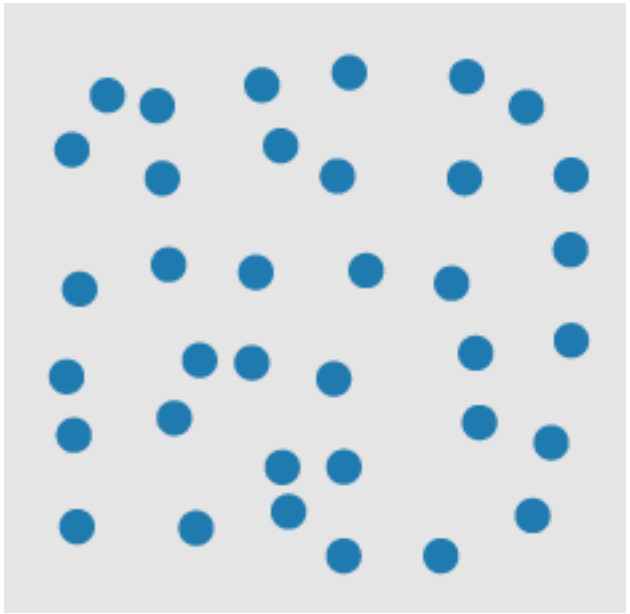
Pre-attentive processing



Pre-attentive processing

- Is there a red-circle in the following image?
  - YES!

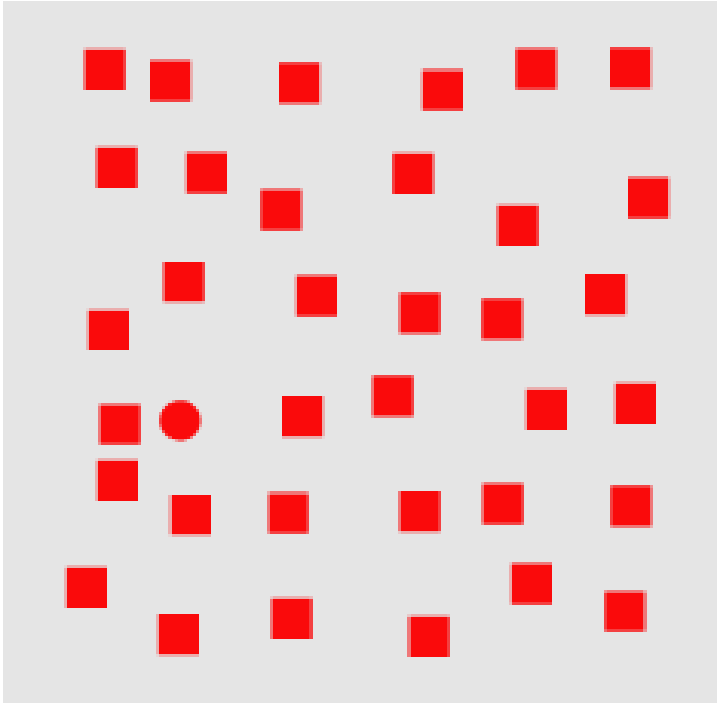




Pre-attentive processing

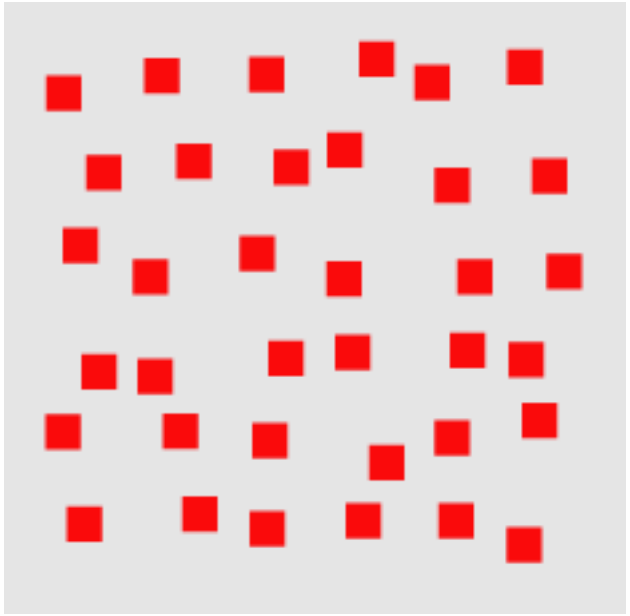
- Is there a red-circle in the following image?

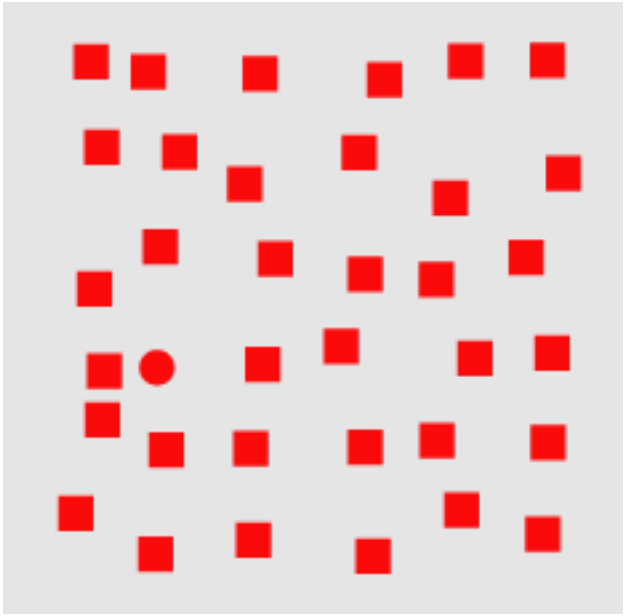
Pre-attentive processing



Pre-attentive processing

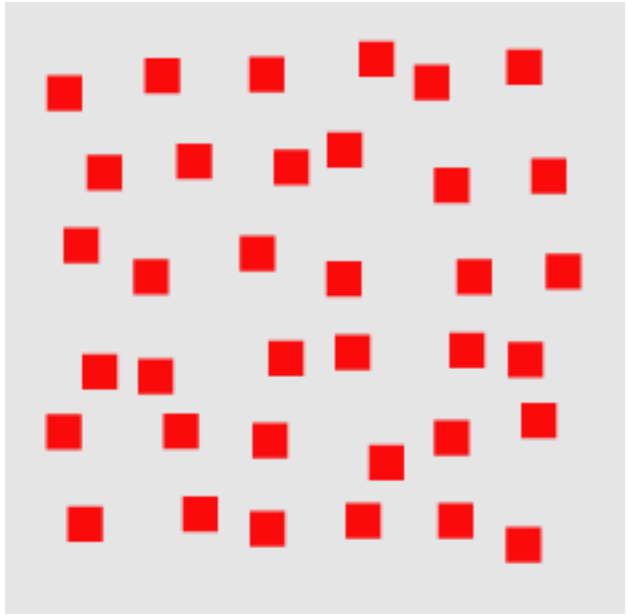
- Is there a red-circle in the following image?
  - YES!

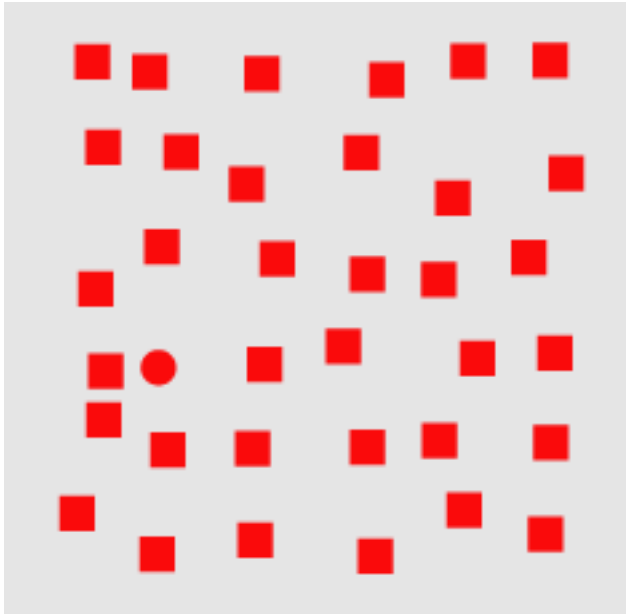




Pre-attentive processing

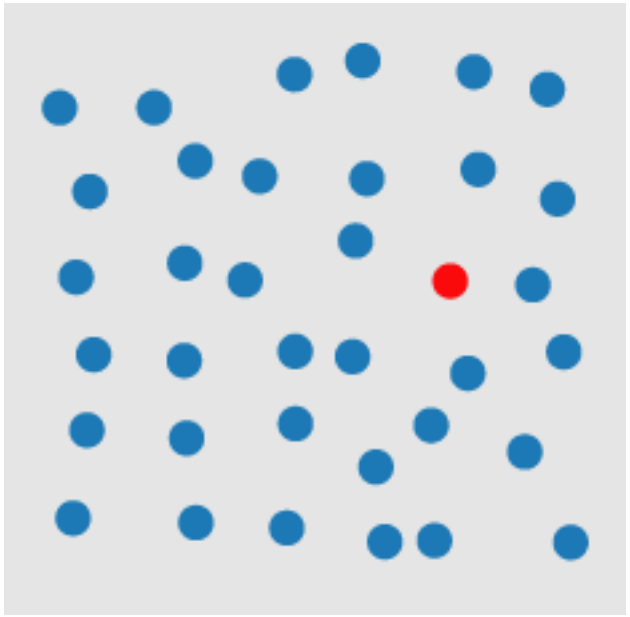
- Certain visual features can be processed *before* a viewer focuses attention
  - Usually defined as <250ms
  - Eye movements take >200ms to react



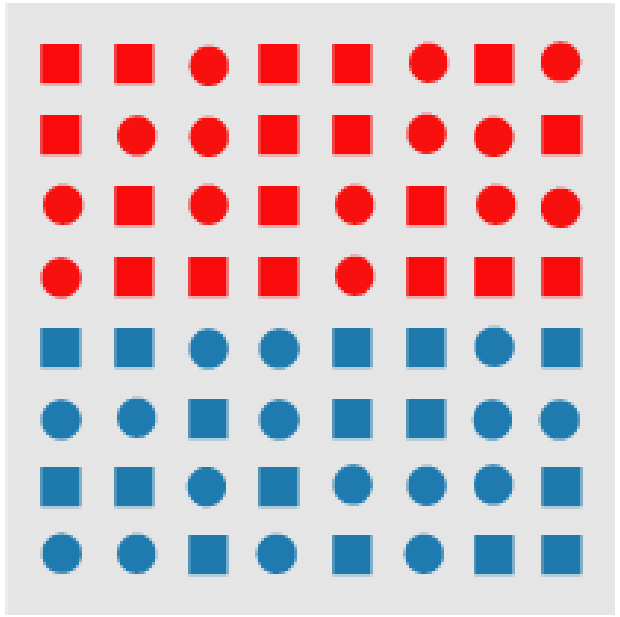


Pre-attentive processing

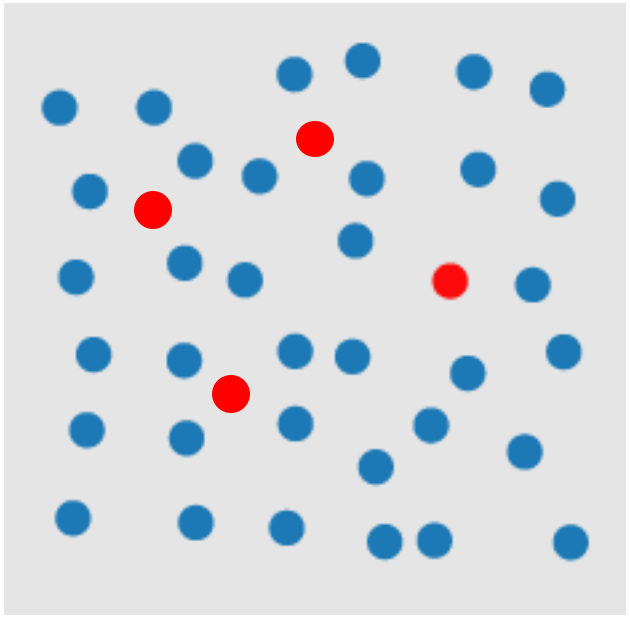
- Can be applied to different tasks:



Target identification



Boundary detection



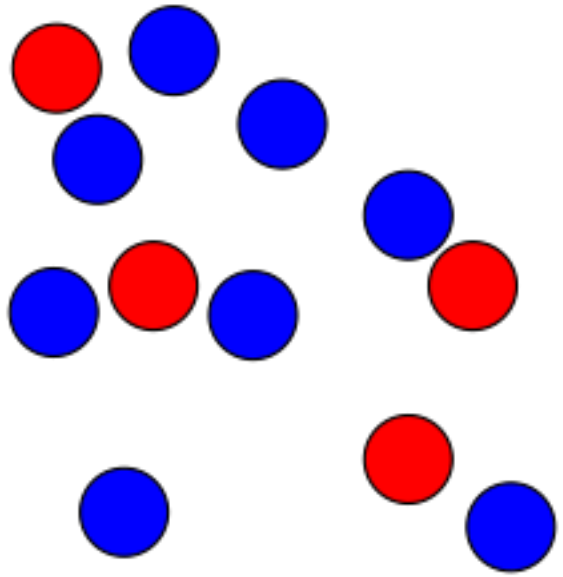
Counting

Pre-attentive processing

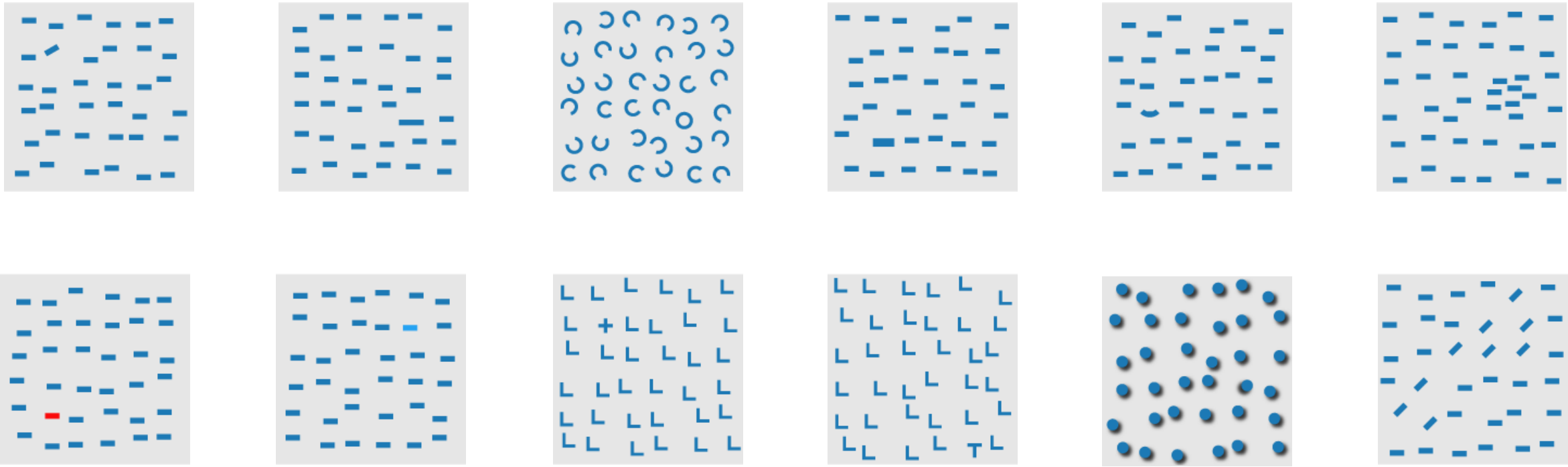
- Pre-attentive counting: *subtizing*
  - Humans can usually count up to 4-5 elements in parallel
  - Beyond that counting time increases dramatically

How many red circles?

How may blue circles?



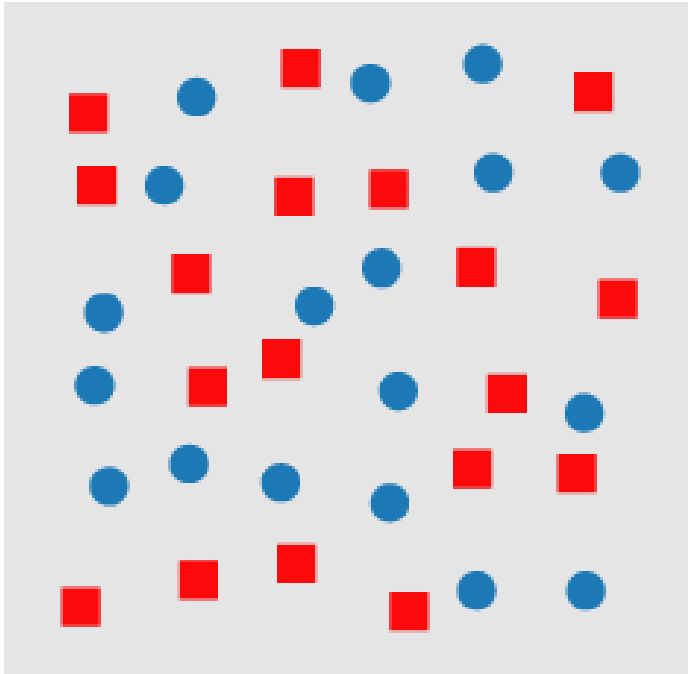
Pre-attentive processing



Pre-attentive processing

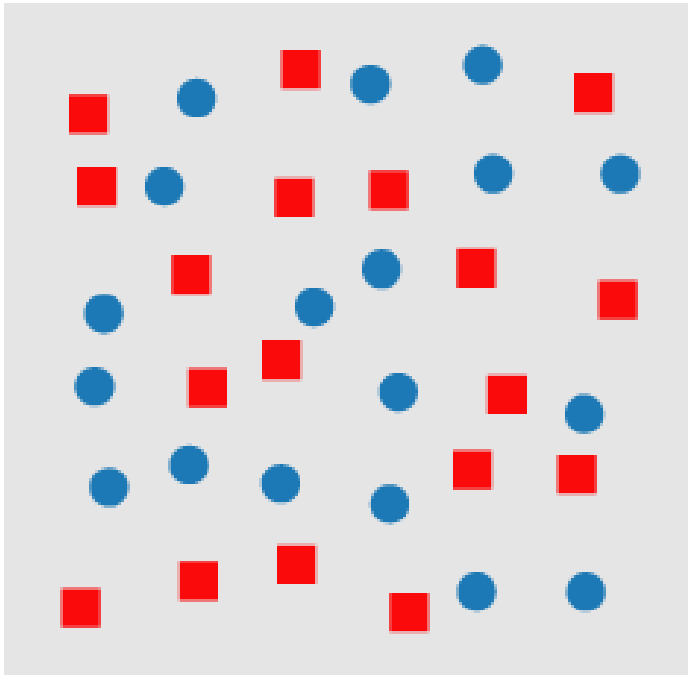
- Is there a red-circle in the following image?

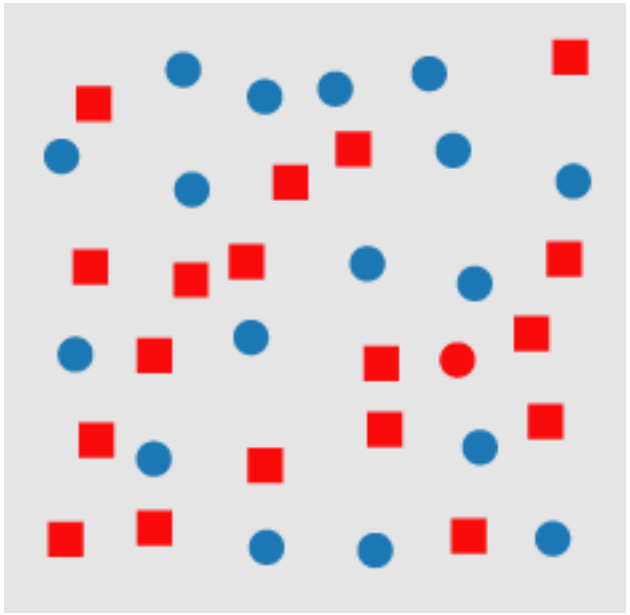
Pre-attentive processing



Pre-attentive processing

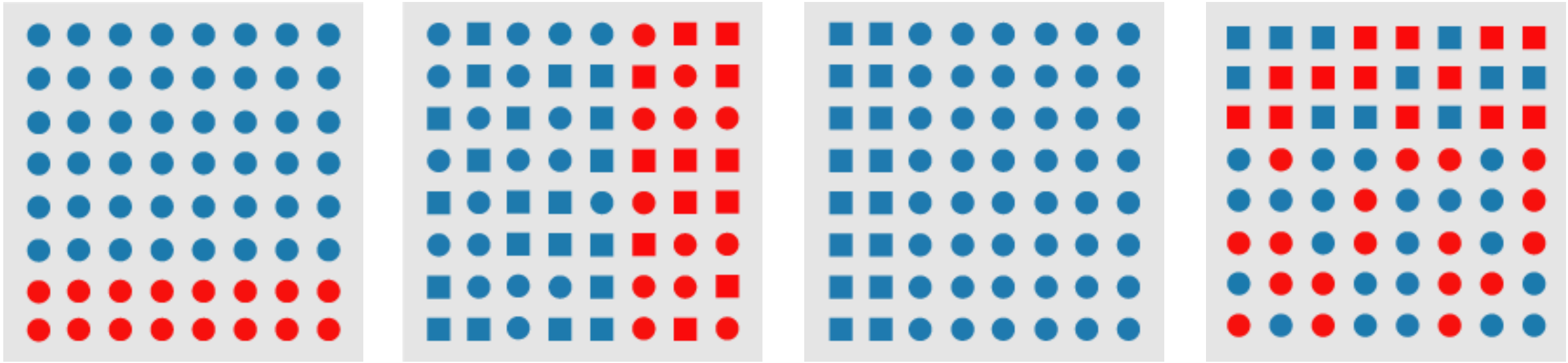
- Conjunctions of features are usually **not** pre-attentive





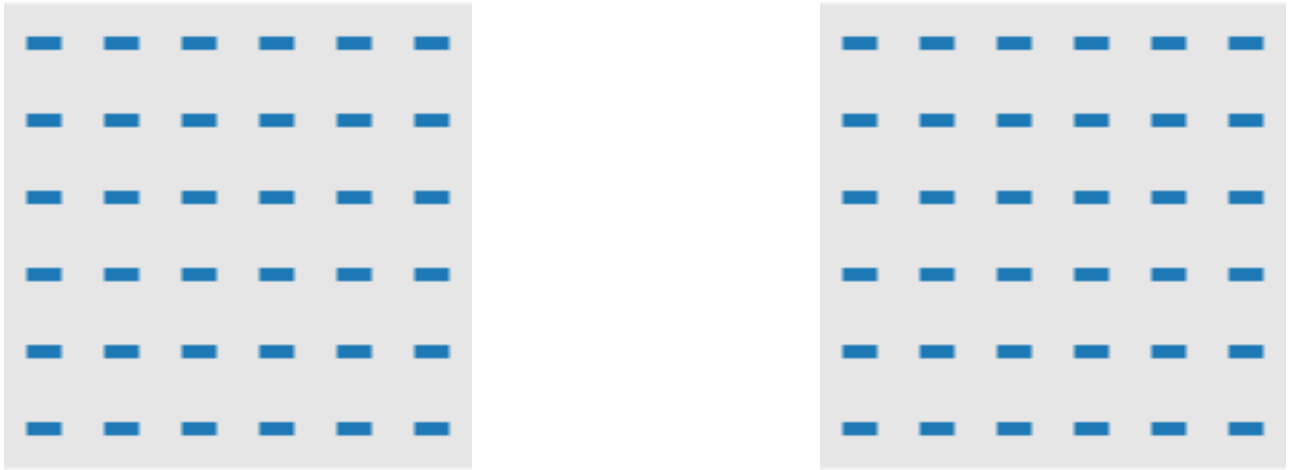
Pre-attentive feature hierarchies

- Color is generally prioritized over shape



What about animation?

- Motion generally **is** a pre-attentive feature!
  - We are highly sensitive to motion, stronger than color & shape!



Gestalt Principles

- Set of principles for how humans perceive images
  - Outlined by by the Gestalt Psychologists incl. Max Wertheimer (1880-1943), Wolfgang Köhler (1887-1967) and Kurt Koffka (1886-1941)
- Focus on how to we **group** elements in an image

Gestalt Principles: figure-ground

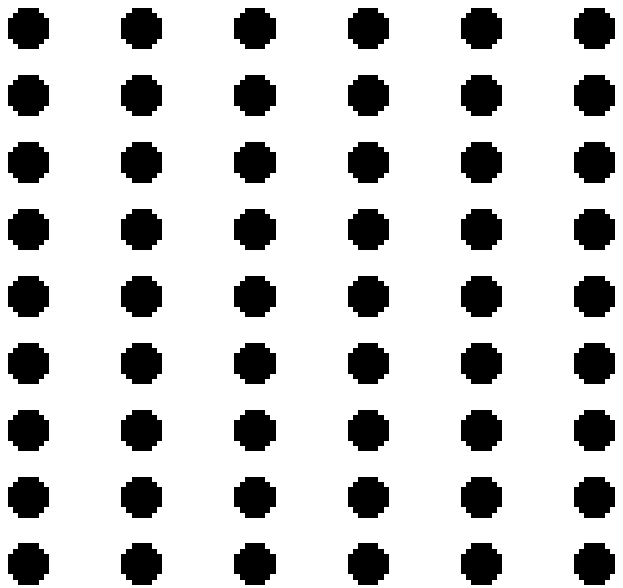
- We separate images into a *subject* (figure) and background
  - The figure is the dominant shape in the image
  - This can be ambiguous!

Gestalt Principles: proximity

- In the following picture are the dots organized in *columns* or *rows?*

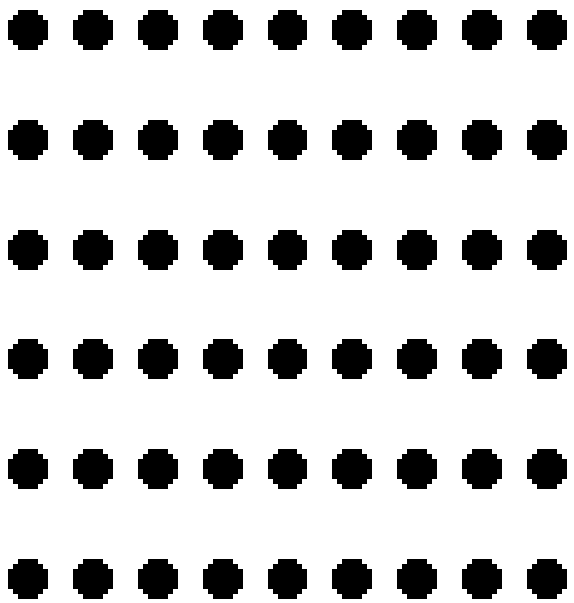
Gestalt Principles: proximity

- In the following picture are the dots organized in *columns* or *rows?*



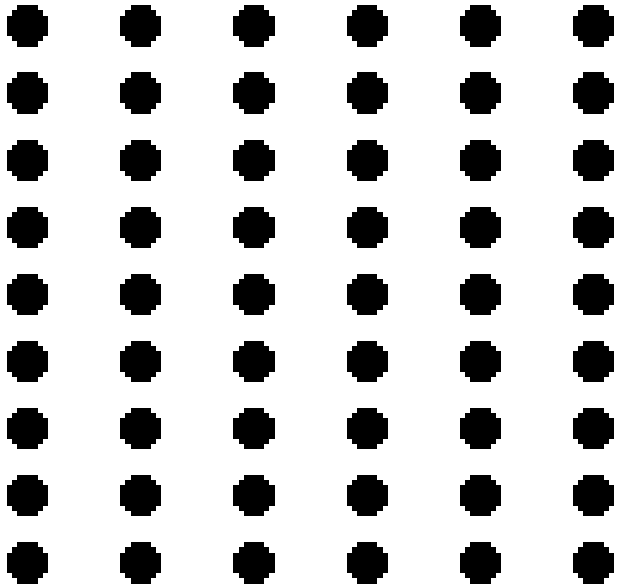
Gestalt Principles: proximity

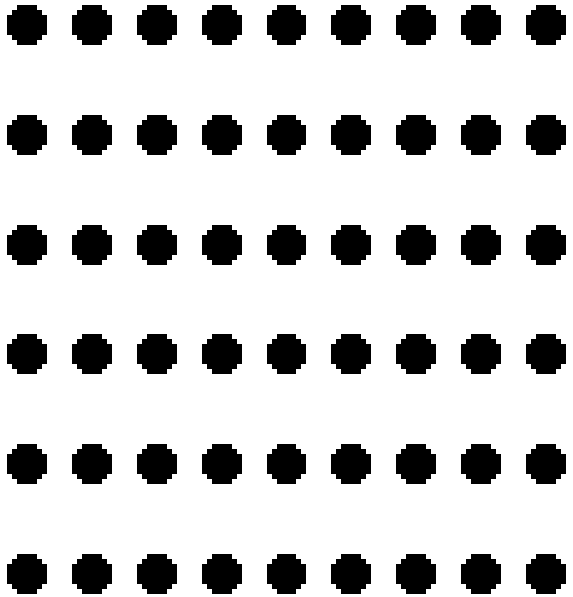
- In the following picture are the dots organized in *columns* or *rows?*



Gestalt Principles: proximity

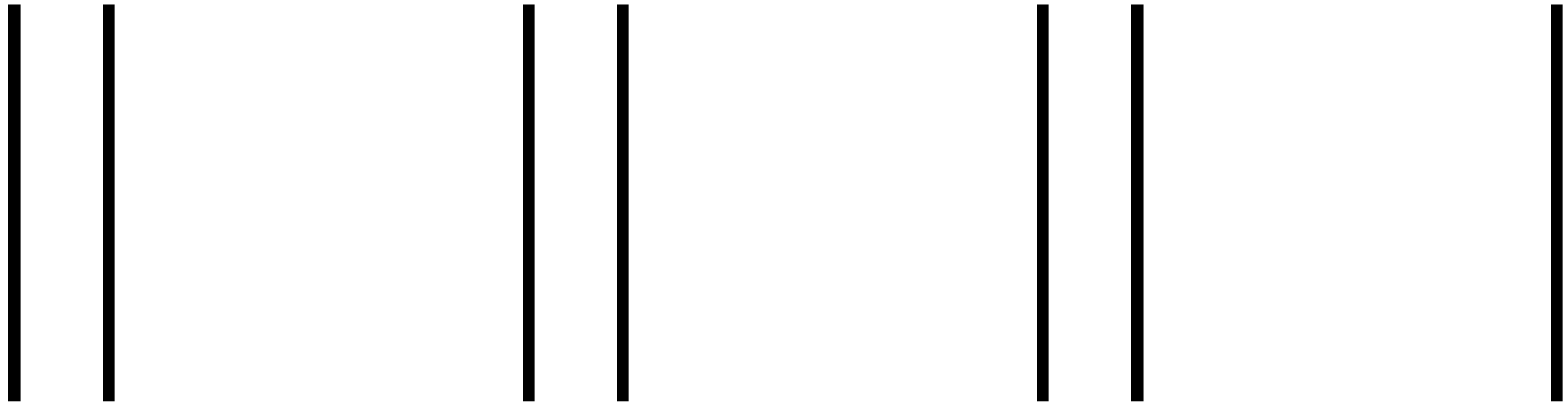
- Why?
  - Group objects based on their relative proximity





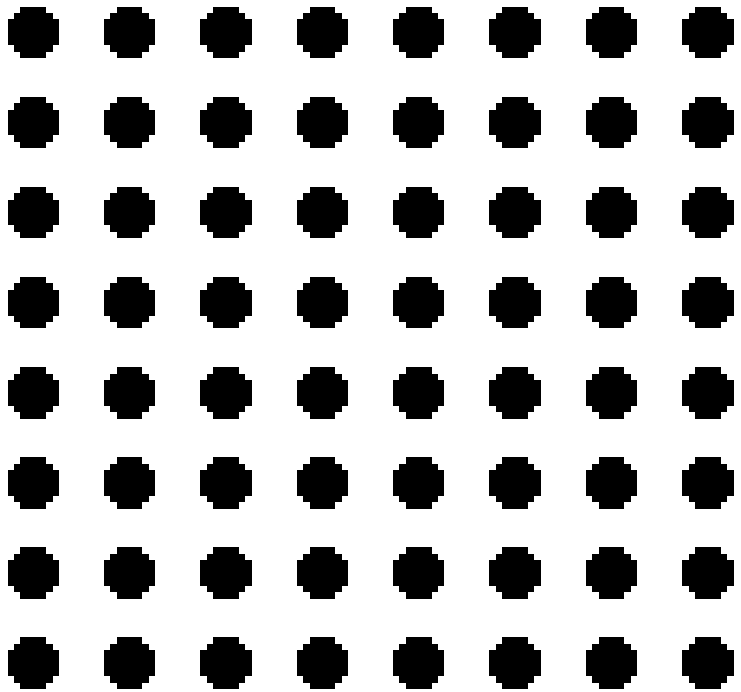
Gestalt Principles: proximity

- Why?
  - Group objects based on their relative proximity
  - Three groups of 2 and one lone line:



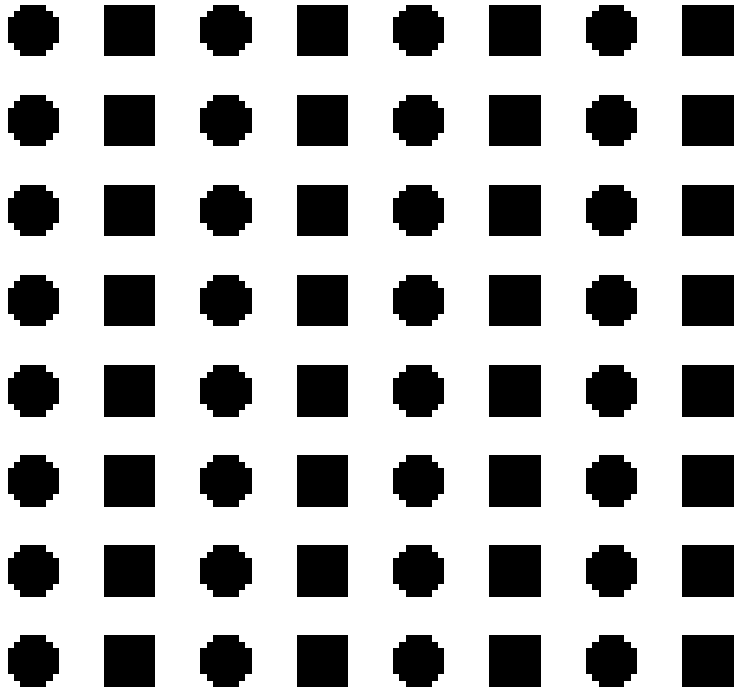
Gestalt Principles: proximity

- In the following picture are the dots organized in *columns* or *rows?*



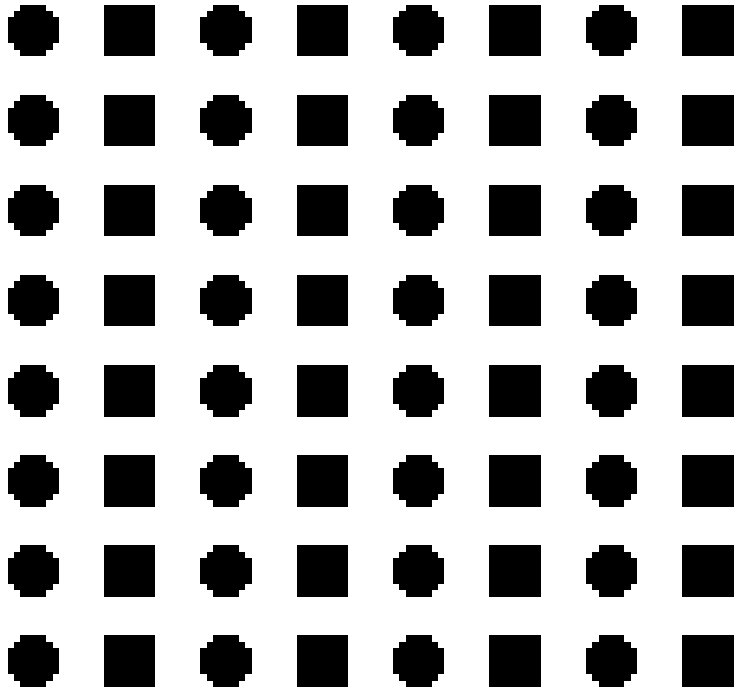
Gestalt Principles: similarity

- In the following picture are the shapes organized in *columns* or *rows?*



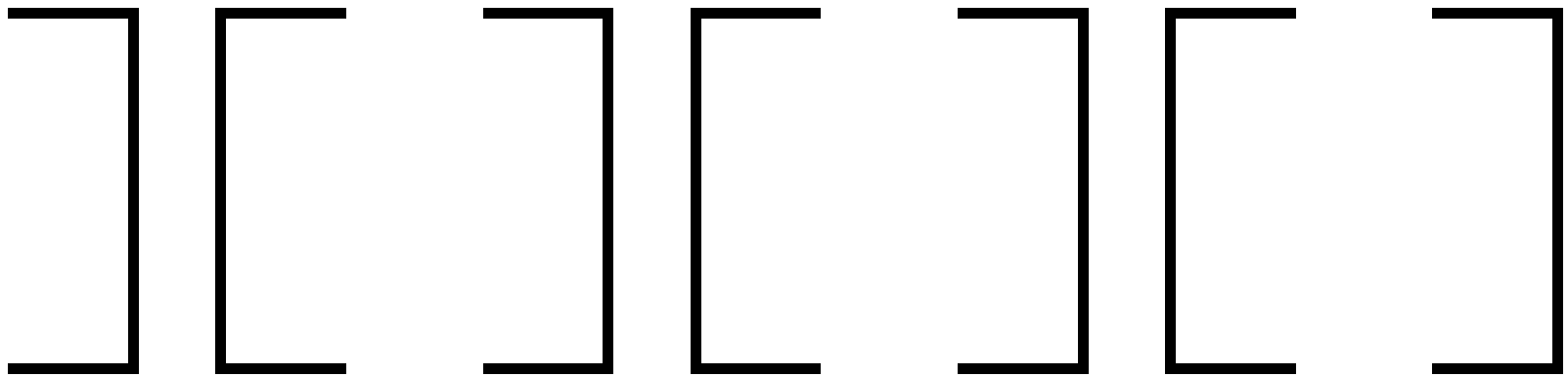
Gestalt Principles: similarity

- In the following picture are the shapes organized in *columns* or *rows?*



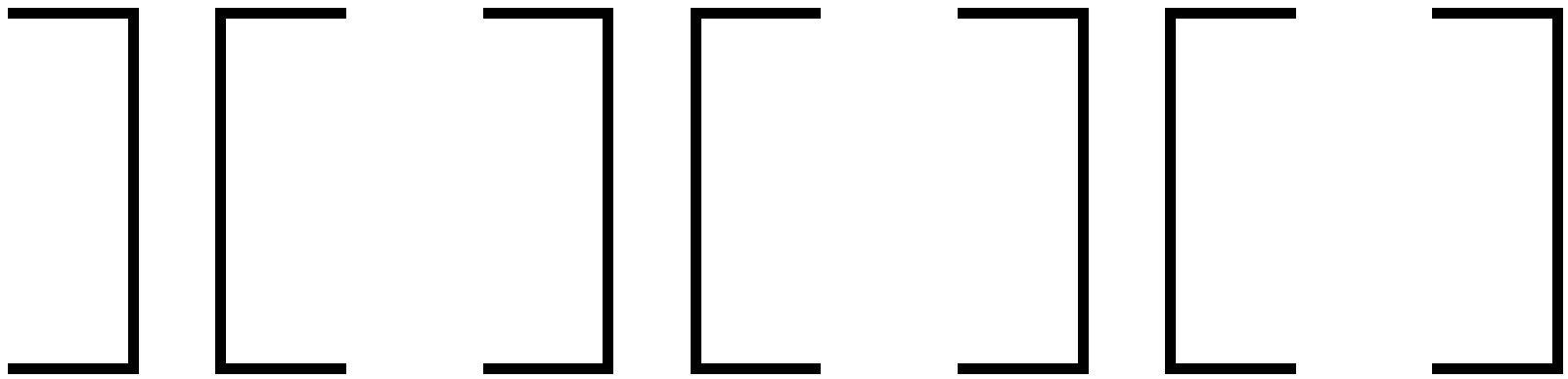
Gestalt Principles: closure

- Do you see 3.5 squares or 2.5 “I” shapes?



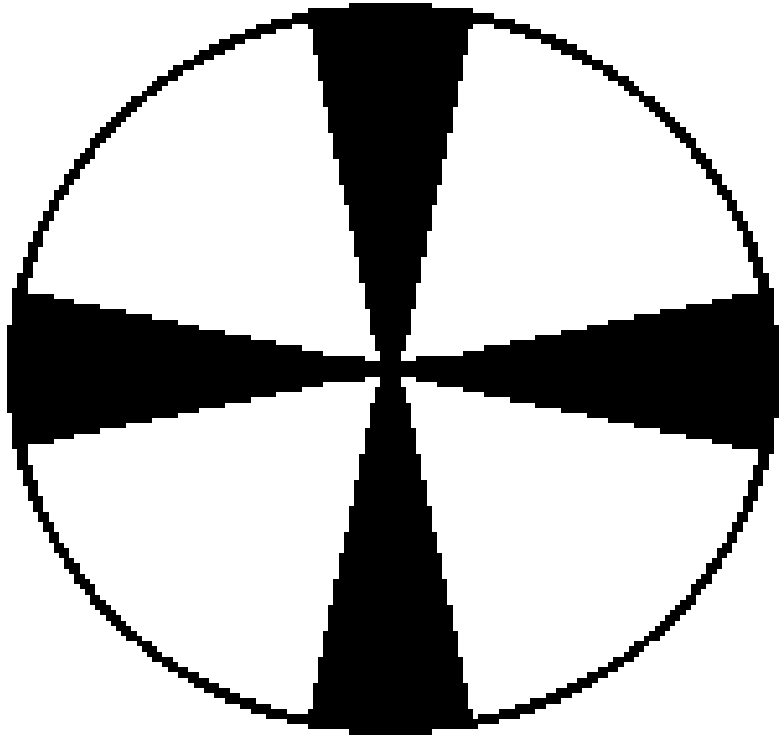
Gestalt Principles: closure

- Do you see 3.5 squares or 2.5 “I” shapes?
  - Probably squares!
- Tend to prefer “closed” shapes



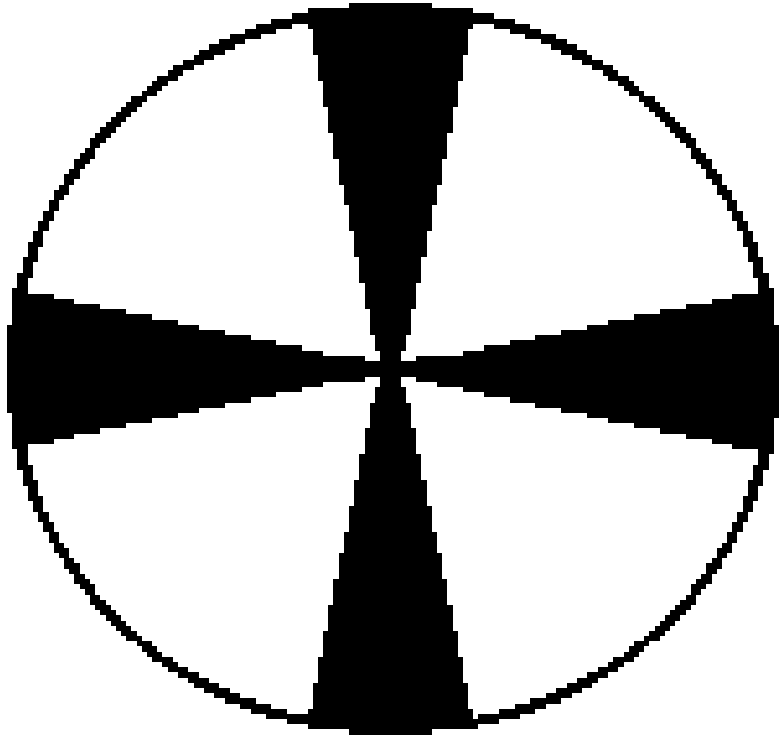
Gestalt Principles: smallness

- Do you see a black cross or a white cross?

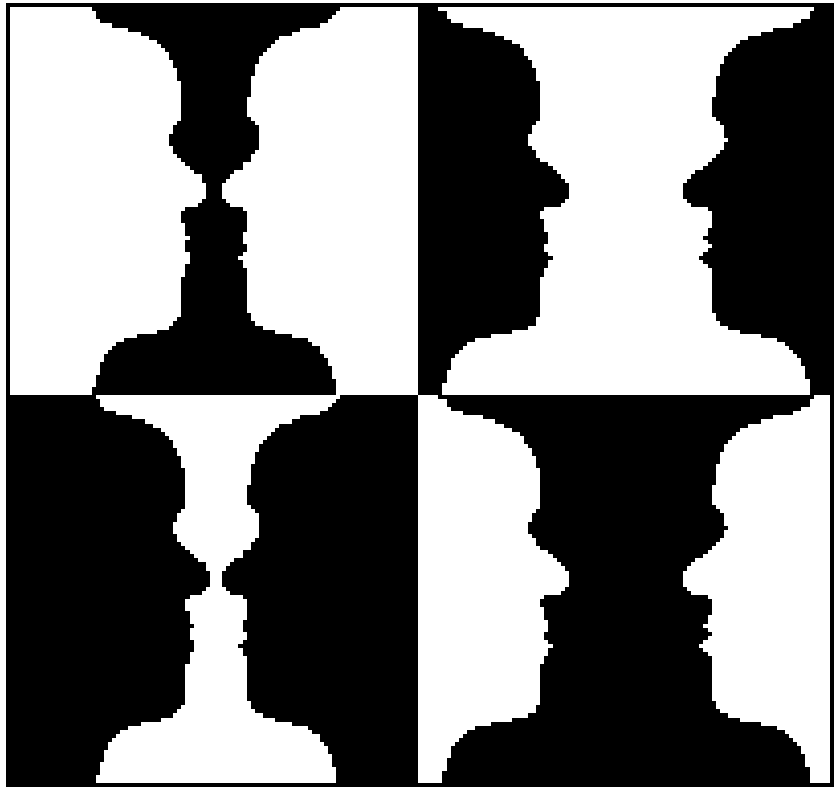


Gestalt Principles: smallness

- Smaller shapes are more likely to be seen as the “figure”

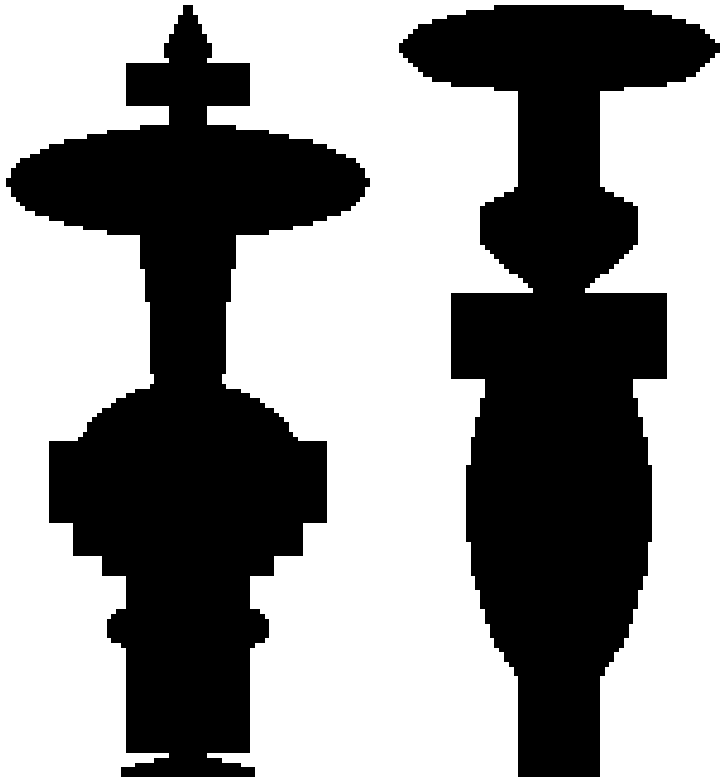


Gestalt Principles: smallness



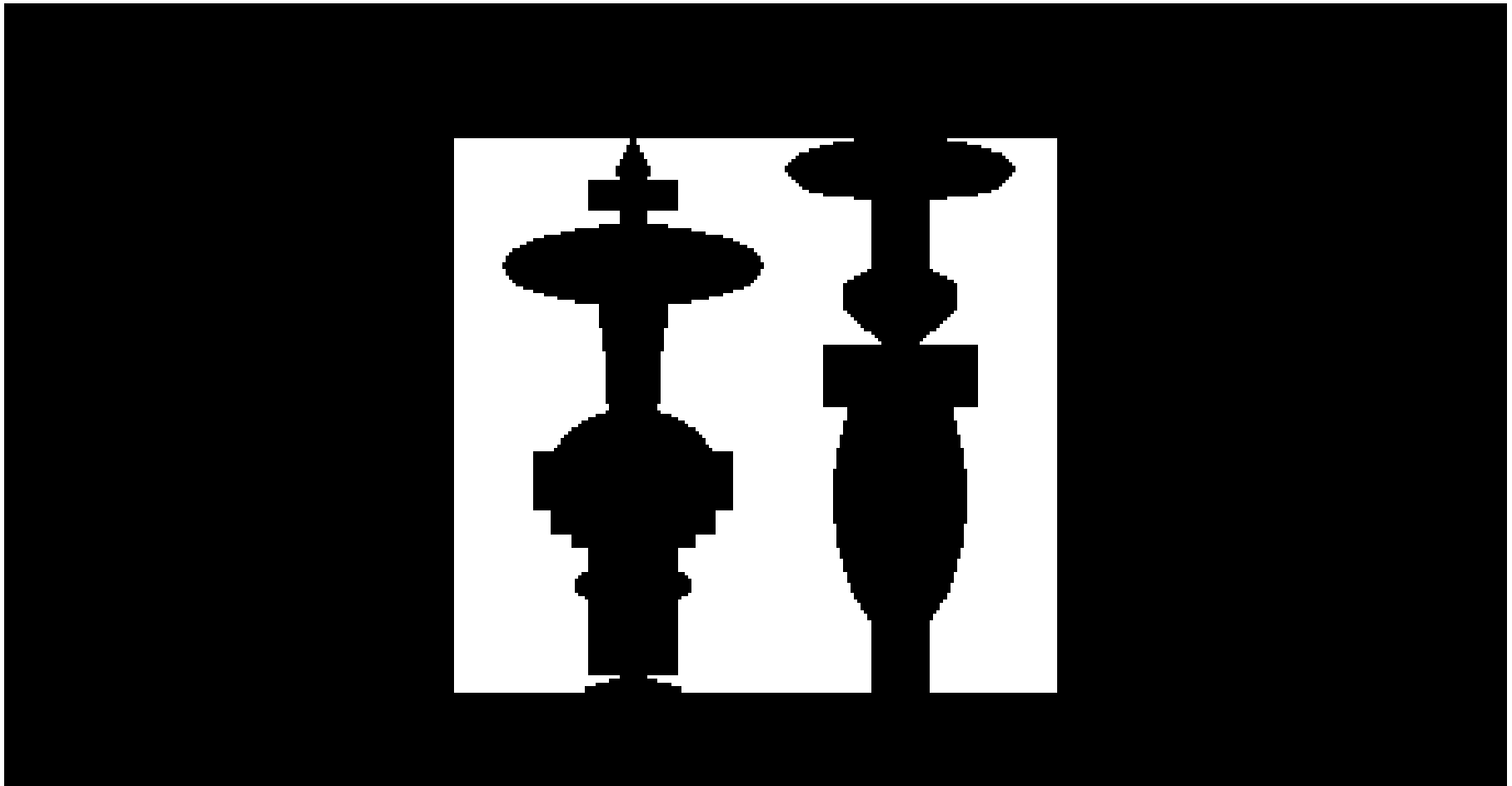
Gestalt Principles: Symmetry

- Symmetrical shapes are more likely to be seen as the “figure”



Gestalt Principles: Symmetry

- Even over the principle of smallness!

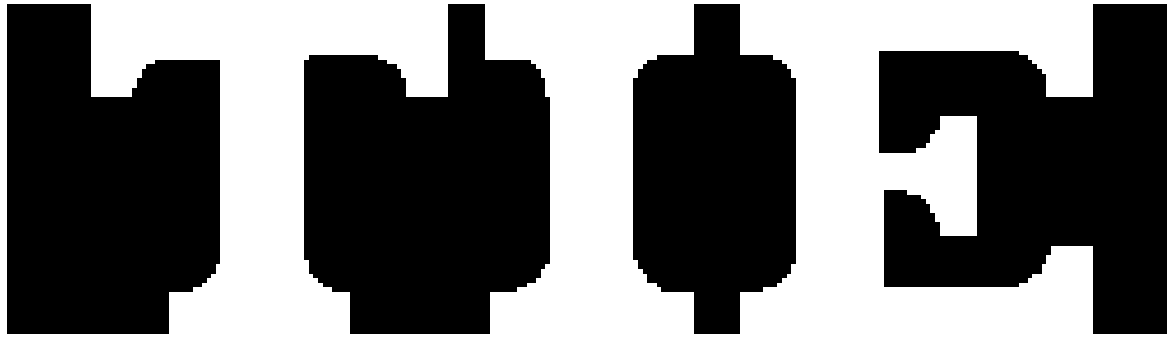


Gestalt Principles: Symmetry

- Did you see this shape?

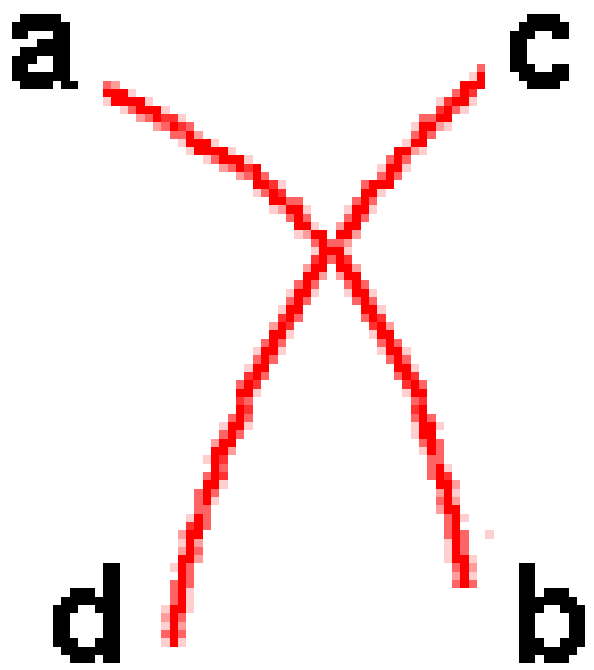
Gestalt Principles: Surroundedness

- Areas surrounded by another color a more likely to be seen as the figure



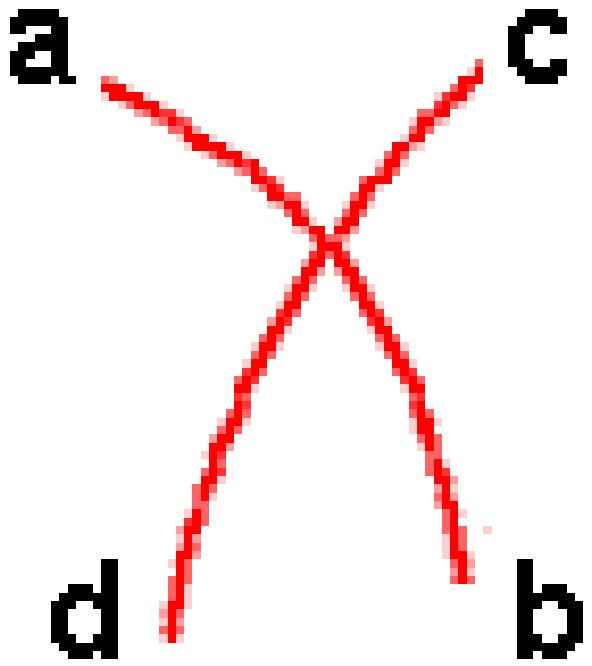
Gestalt Principles: Continuity

- Does a connect to b, c, or d?

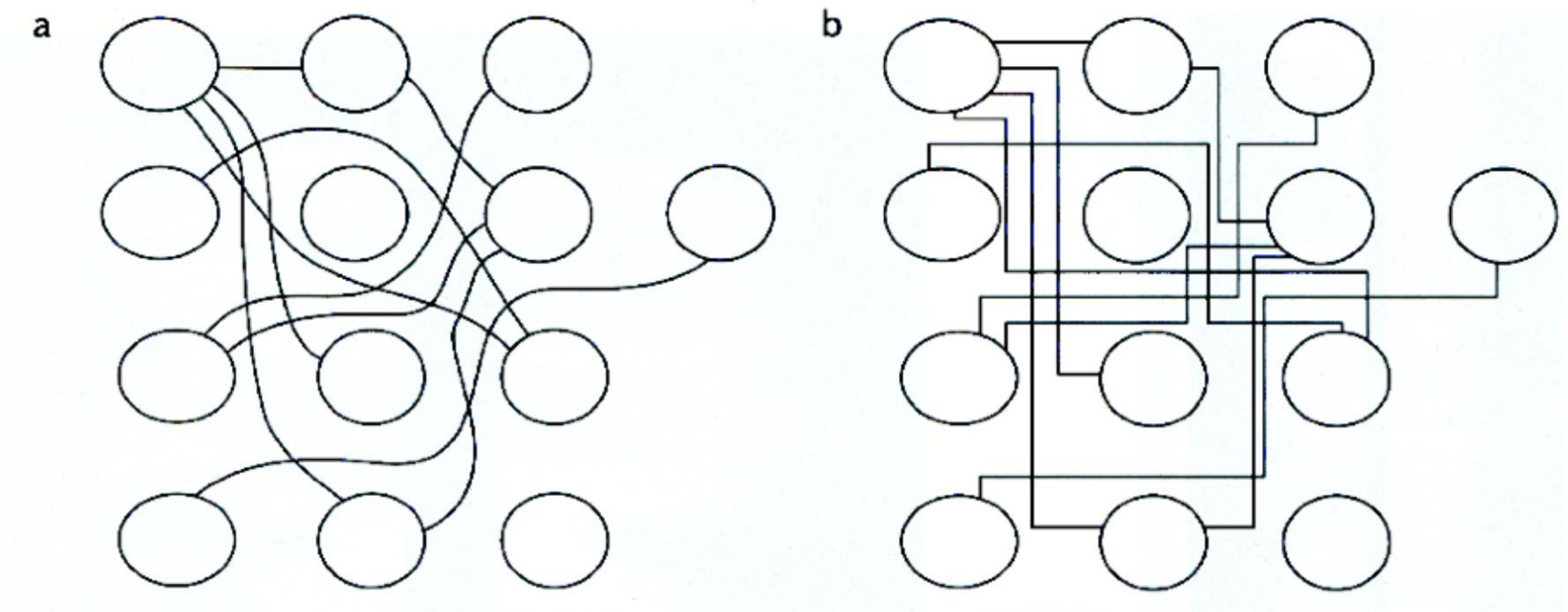


Gestalt Principles: Continuity

- Does a connect to b, c, or d?
  - Prefer **smooth** continuity

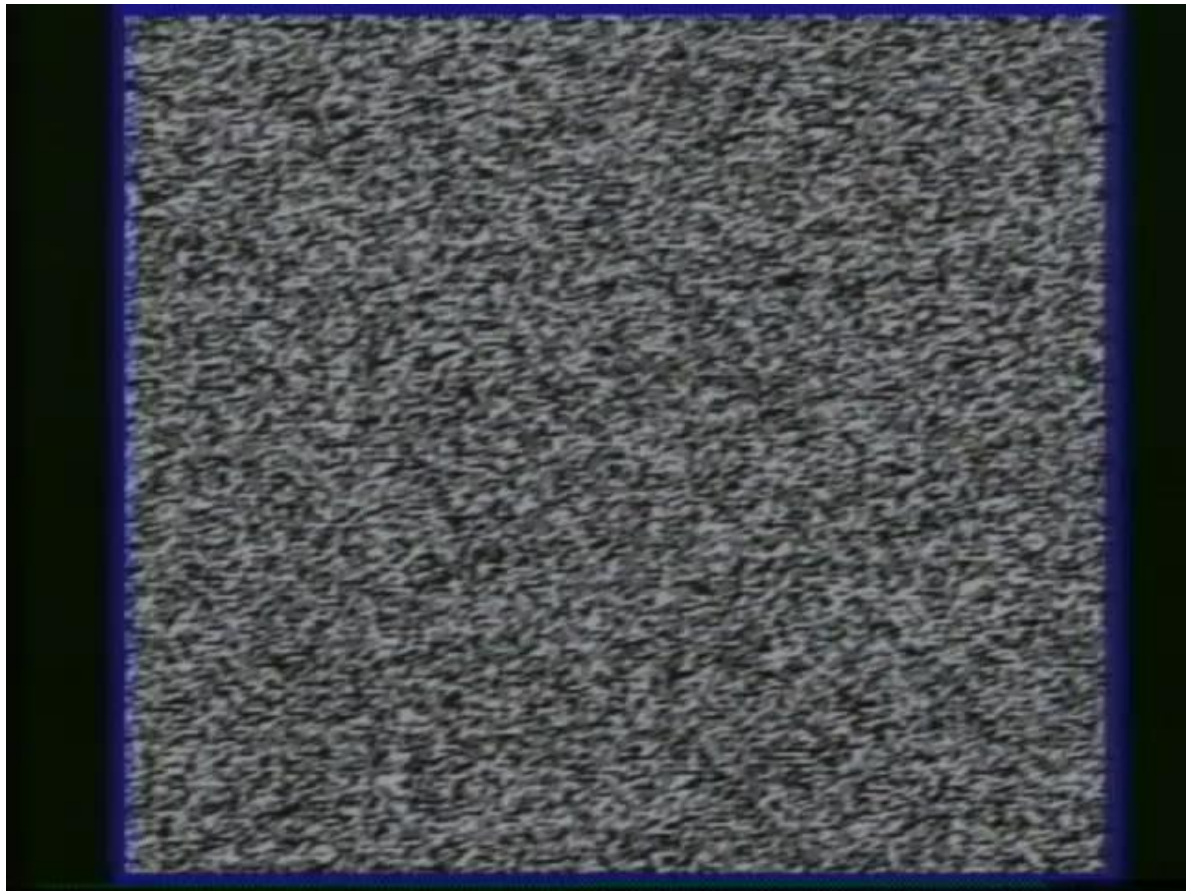


Gestalt Principles: Continuity



Gestalt Principles: animation

- Similar motions are perceived as a group!



Gestalt Principles: Continuity

- Continuity is very important for motion!

Lack of continuity

Presence of continuity

Perceiving animation

- Motion perceived at about 10 fps
  - Need at least 20-30 fps for *smoothness*

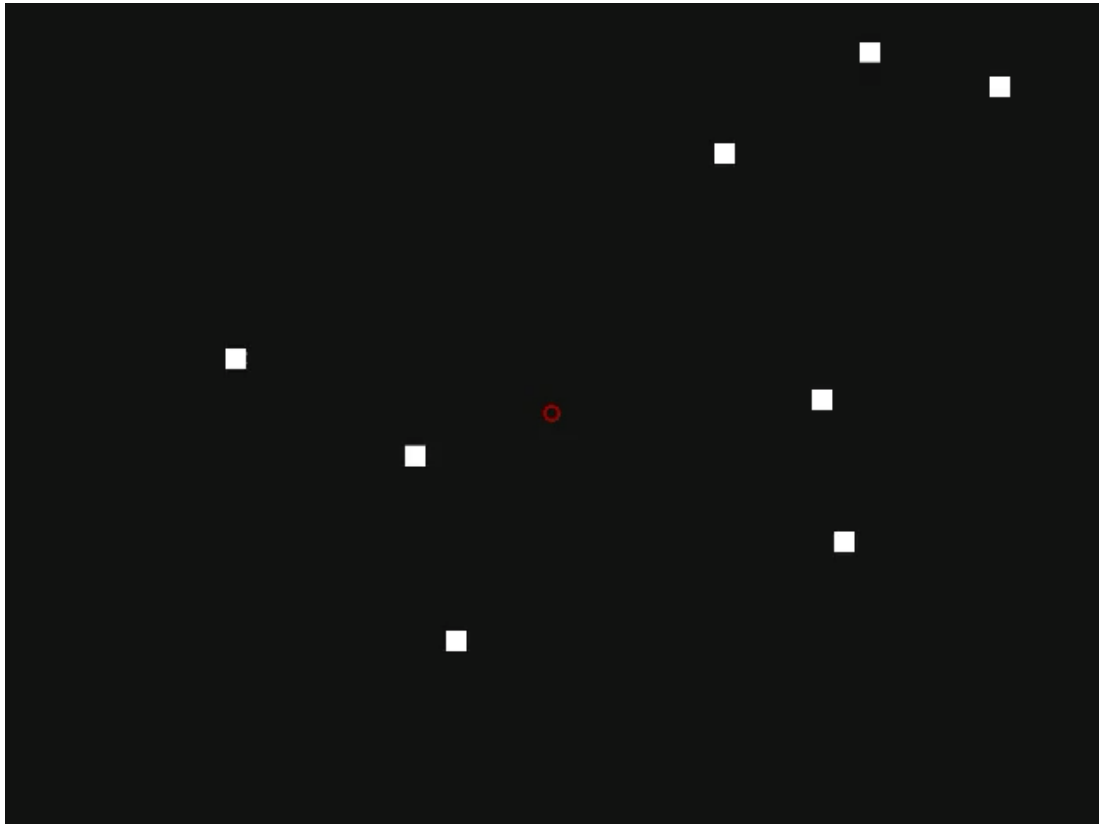
8fps (0.125... s)
0/8

12fps (0.083... s)
0/12

24fps (0.041... s)
0/24

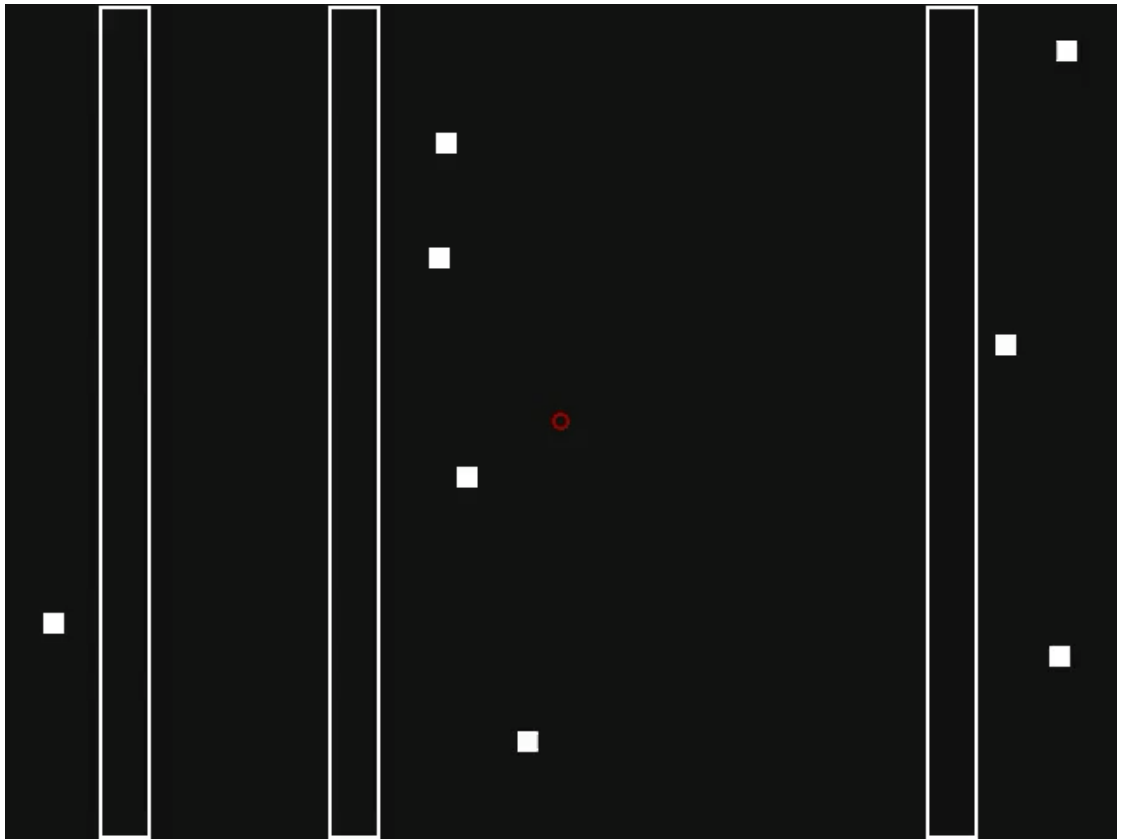
Tracking motion

- We are limited in our ability to track uncorrelated motion
  - About 4 objects is the limit



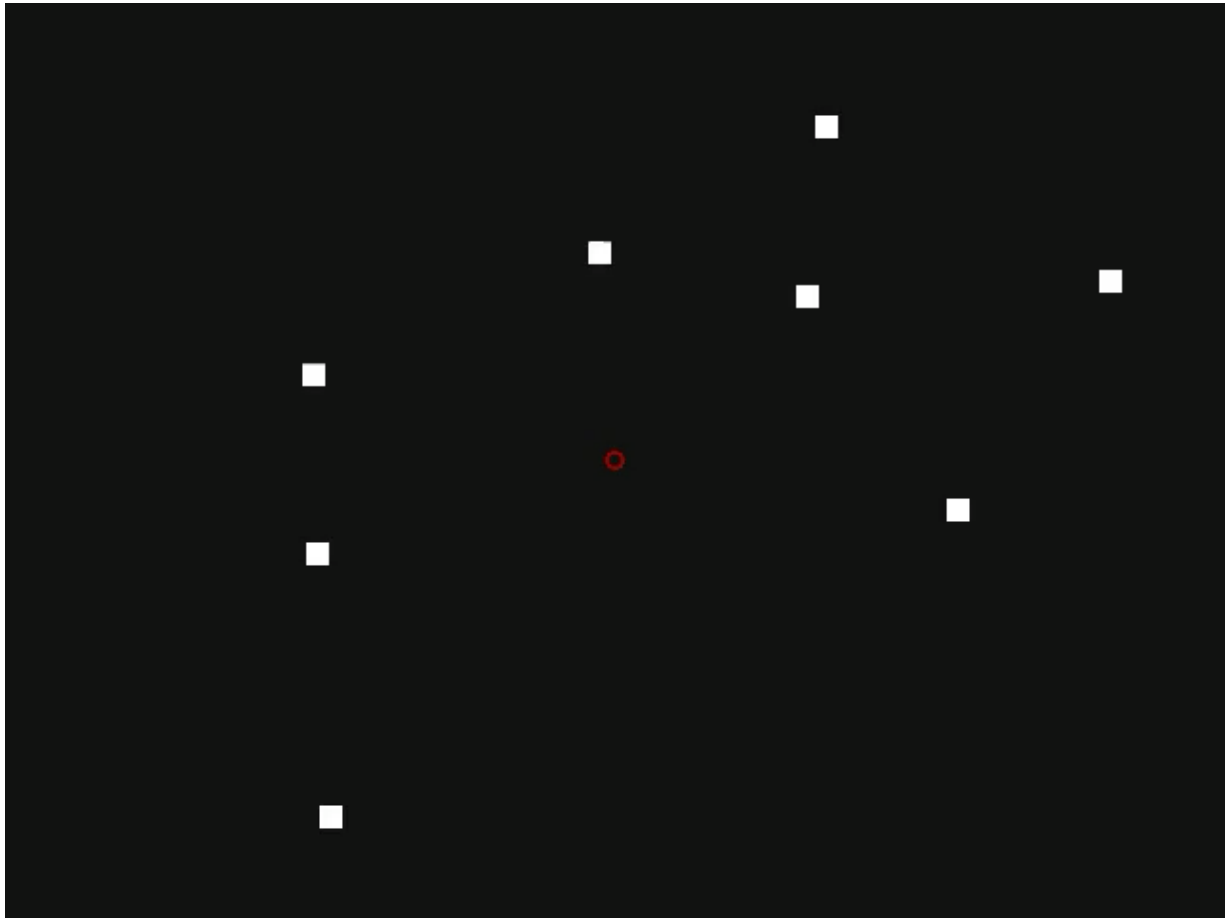
Tracking motion

- Can usually deal with occlusion



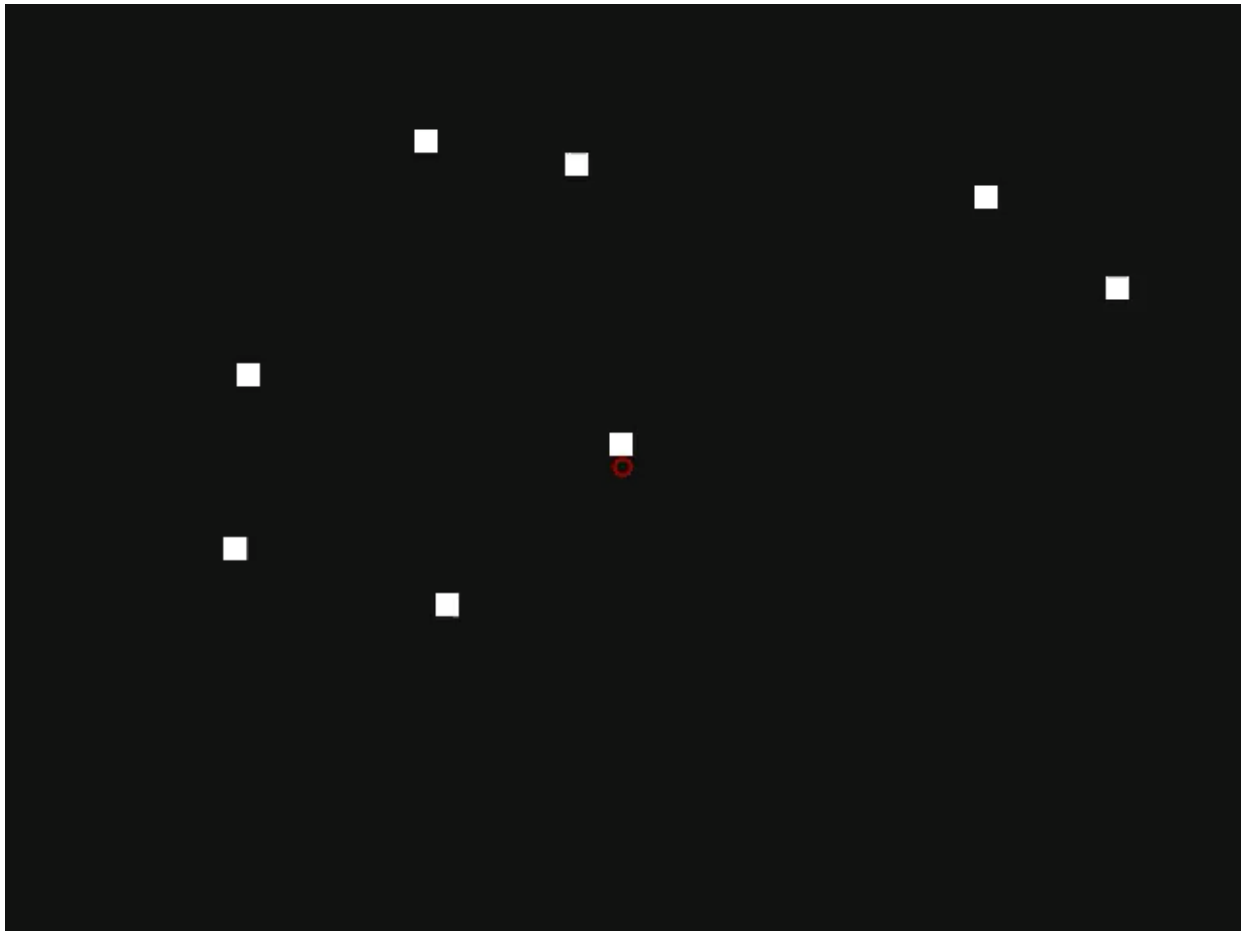
Tracking motion

- Even virtual occlusion



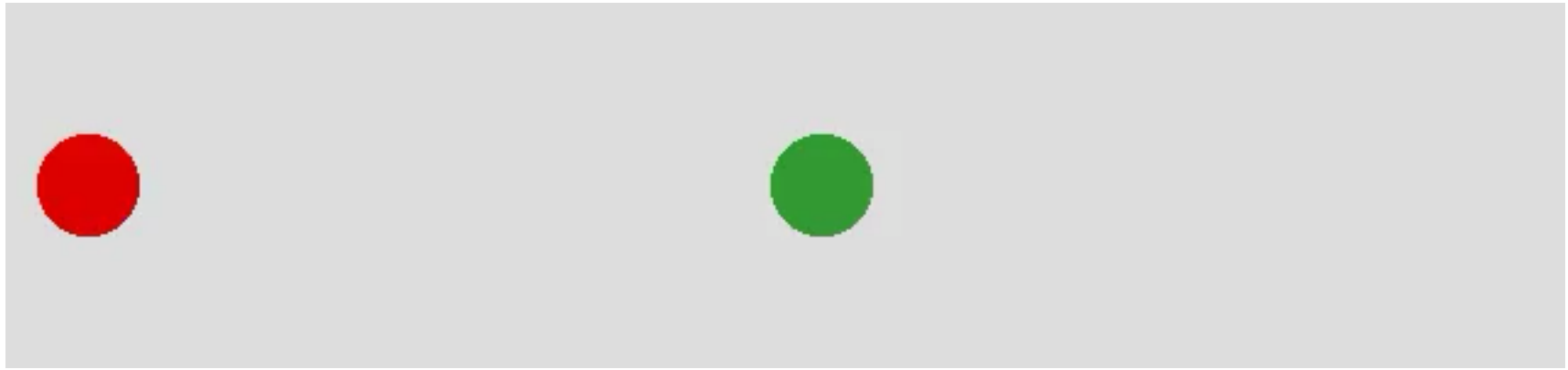
Tracking motion

- Other animations make this much harder



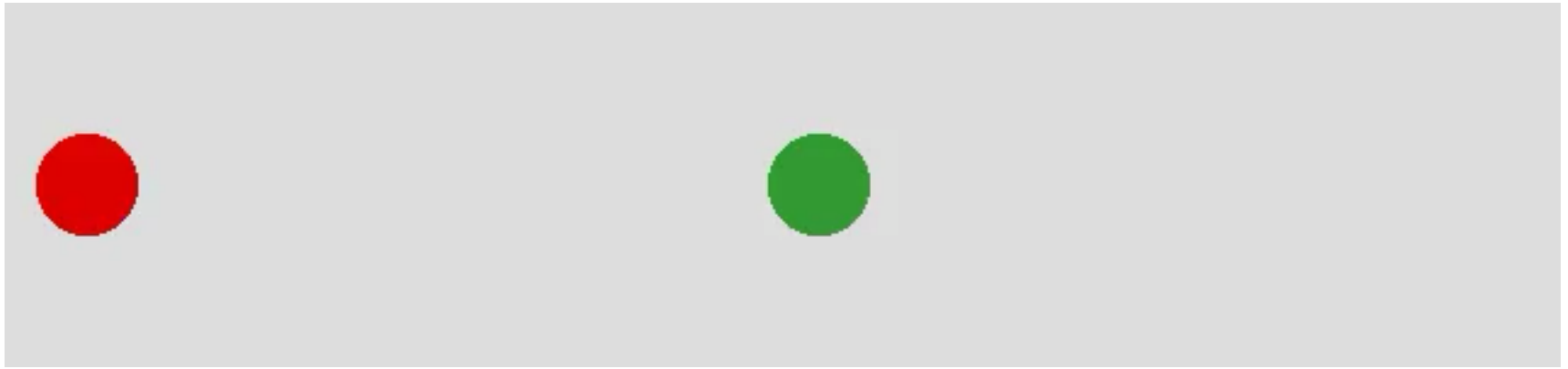
Causality

- Hard-wired to infer causality from motion

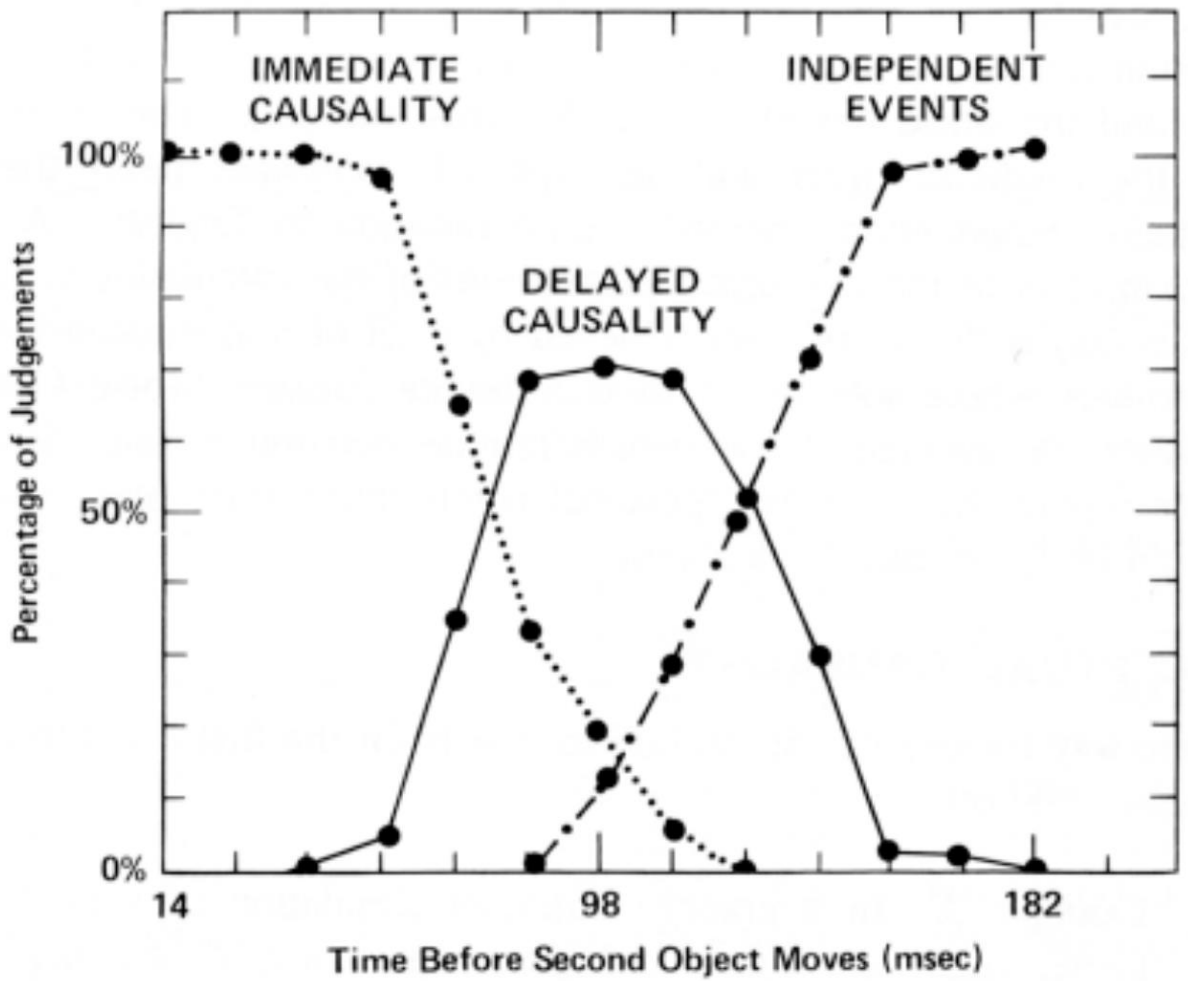


Causality

- Hard-wired to infer causality from motion



Causality


IMMEDIATE CAUSALITY
INDEPENDENT EVENTS
DELAYED CAUSALITY
100%
50%
0%
Percentage of Judgements
14
98
182
Time Before Second Object Moves (msec)

Storytelling

Animation	Helps?	Hurts?
Attention	direct attention	distraction
Constancy	change tracking	false relations
Causality	cause and effect	false agency
Engagement	increase interest	“chart junk”
Calibration		too slow: boring
		too fast: errors

Animation principles (Heer)

- Don’t change aesthetic mappings or scales if possible
- Respect correspondence, geometries should always represent the same observation
- Minimize occlusion
- Maintain vaild data graphics during transitions
- Use simple transitions
- Use staging for complex transitions
- Group similar transitions
- Different operators should have distinct animations