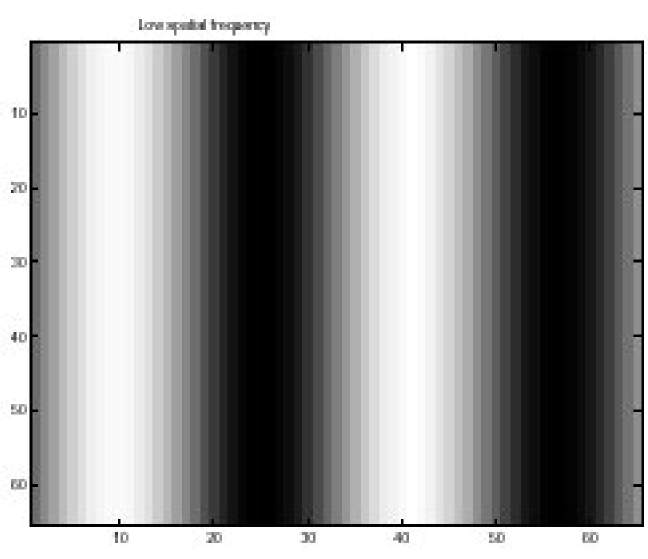
Psychological approaches to the study of vision

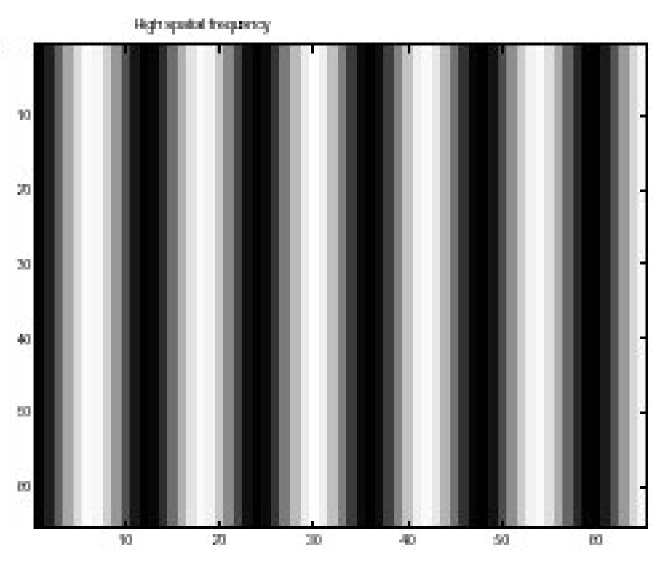
The spatial frequency approach

- Like regular (temporal) frequency
- BUT, concerns how many cycles a visual pattern makes per unit of area

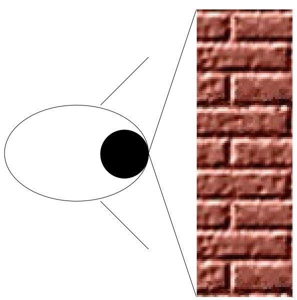
Low spatial frequency pattern:



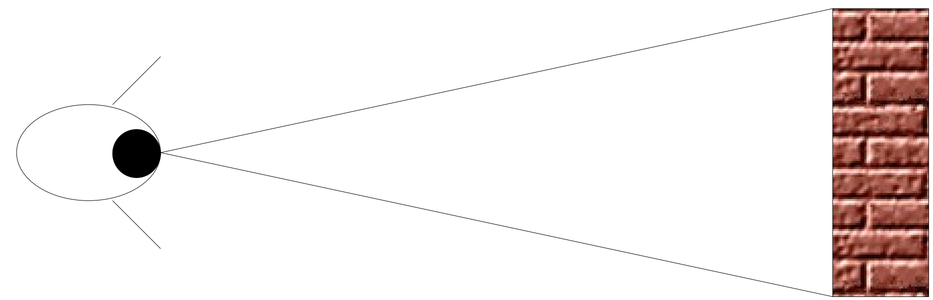
High spatial frequency pattern:



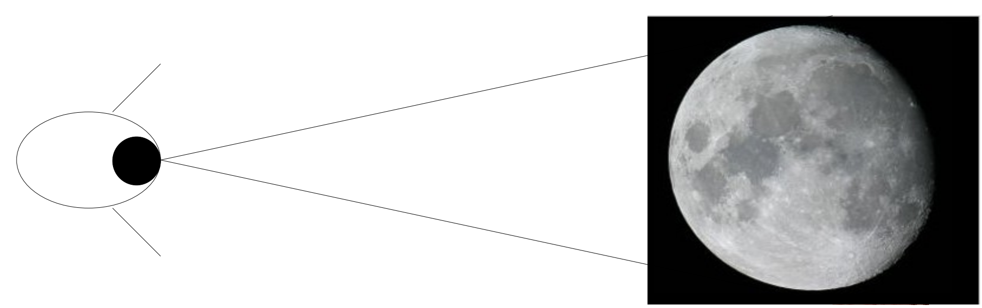
- The spatial frequency approach (cont.)
  - Usually, we don't talk about “cycles per inch”, or “cycles per meter”, but cycles per *degree of visual angle*



Large visual angle (objects are either close or large – or both) - so the image makes 9 cycles per (say) 150 degrees = .06 cycles/degree



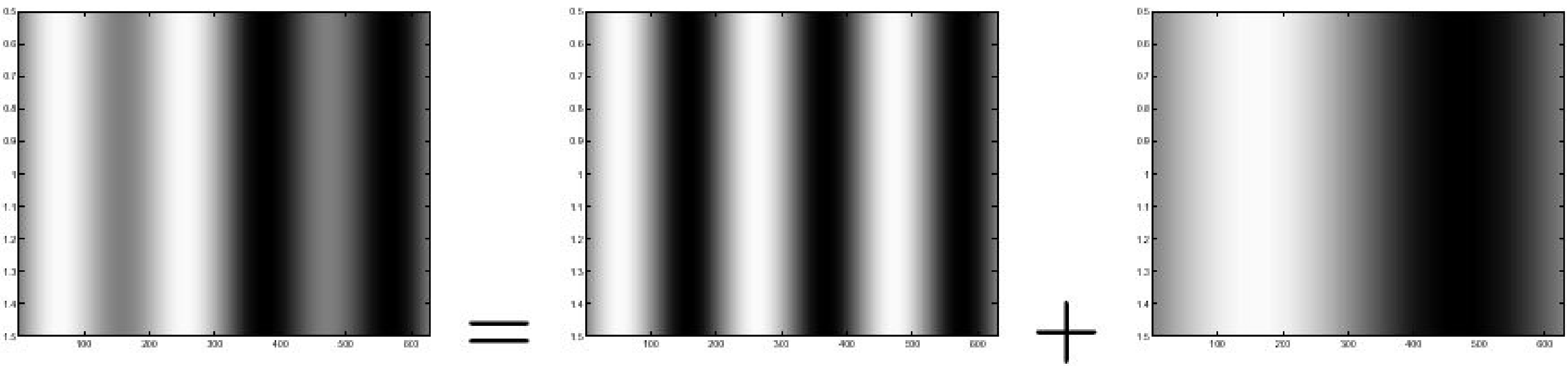
Small visual angle (objects are either far or small – or both) – so the image makes 9 cycles per (say) 20 degrees = .45 cycles/degree



(not to scale)

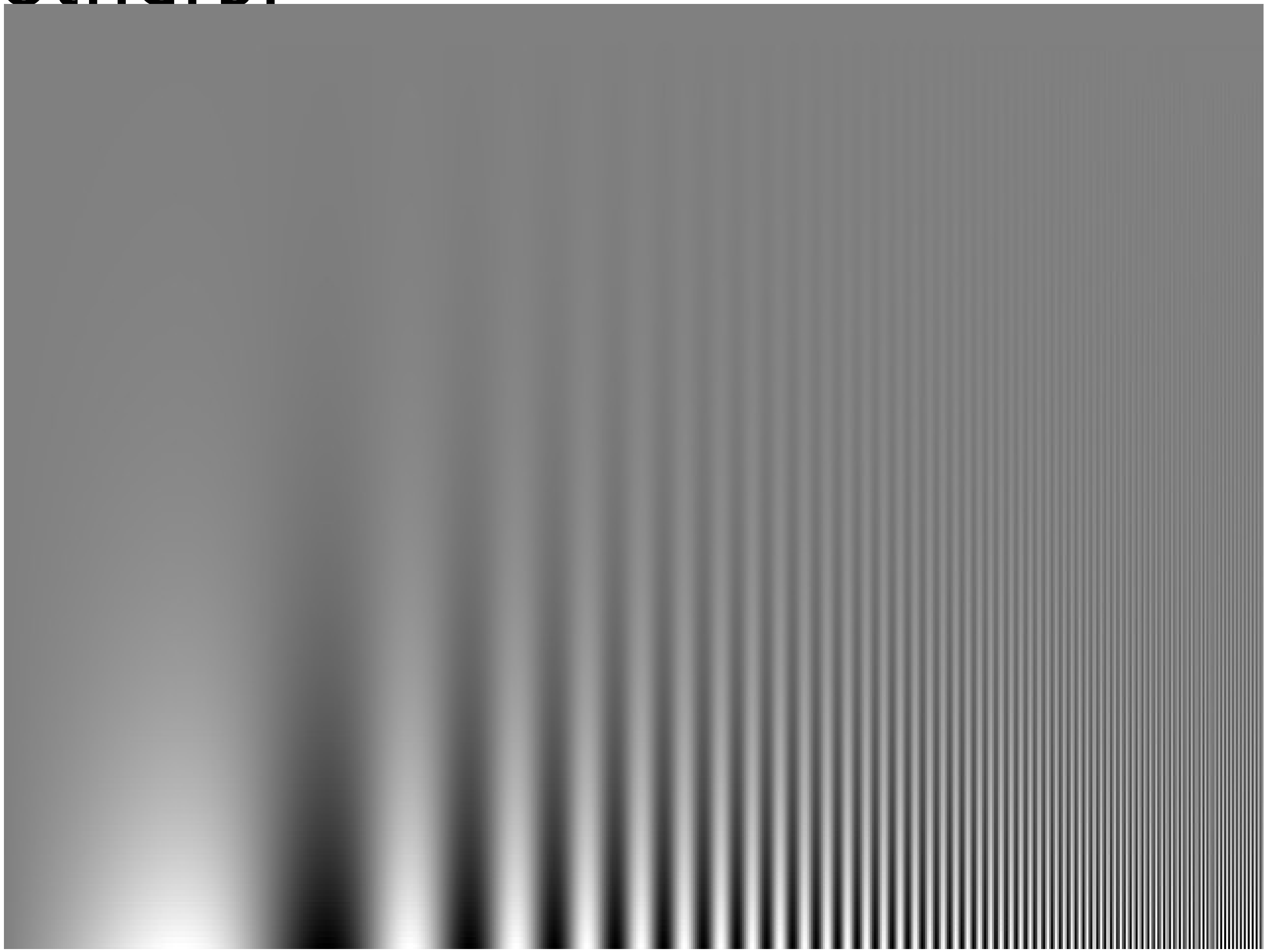
•The spatial frequency approach (cont.)

- Spatial patterns are like sound patterns; there are simple patterns and complex ones:



•Even very complex patterns, like a friend's face, or a photograph of your favorite vacation spot, can be decomposed into simple spacial frequency patterns.

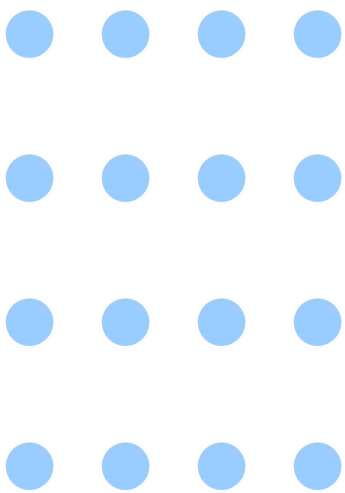
- The spatial frequency approach (cont.)
  - We're more sensitive to particular spatial frequencies than others:



  - This *contrast-sensitivity chart* has increasing *contrast* top-to-bottom, and increasing spatial frequency, left-to-right.

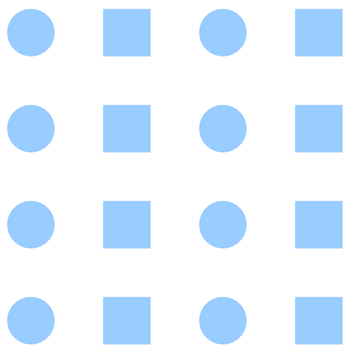
- The spatial frequency approach (cont.)
  - Why should we use the spatial frequency approach?
    - We know there are spatial-frequency "channels" in the brain: edge detectors that are sensitive to only particular spatial frequencies.
    - *Adaptation* studies – after you stare at one spatial frequency for a long time, you're less sensitive to that spatial frequency, but see no decline in you ability to perceive other spatial frequencies.

- The *Gestalt* approach
  - Cataloging biases to view objects or images in particular ways.
    - *Proximity* (we tend to believe nearby things "go together")



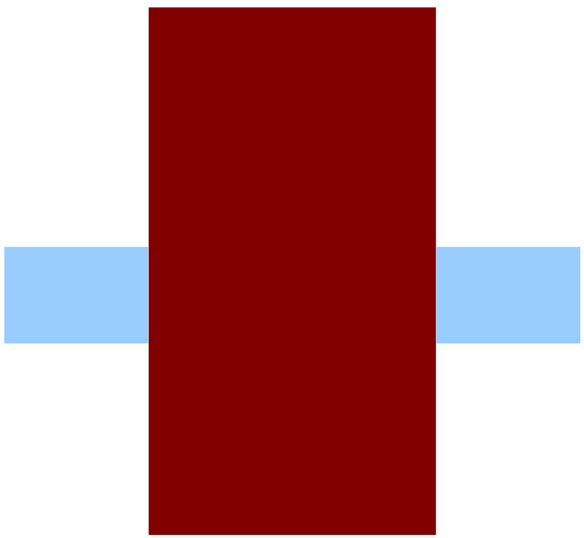
– tends to be perceived as rows rather than columns

- The Gestalt approach
  - *Similarity* (we tend to believe that similar looking things "go together")



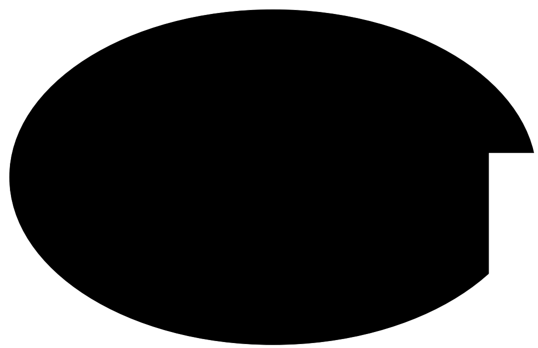
– tends to be perceived as columns rather than rows

- The Gestalt approach
  - *Good continuation* (we tend to believe things continue if interrupted by something)



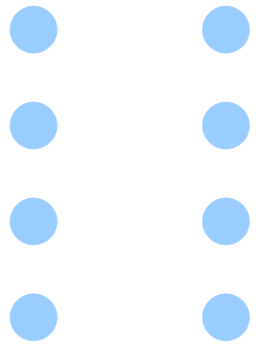
  - (we assume the blue bar continues behind the red one – not that there are two separate blue bars.)

- The Gestalt approach
  - *Closure* (we tend to ignore gaps in an image to perceive it as “complete”)



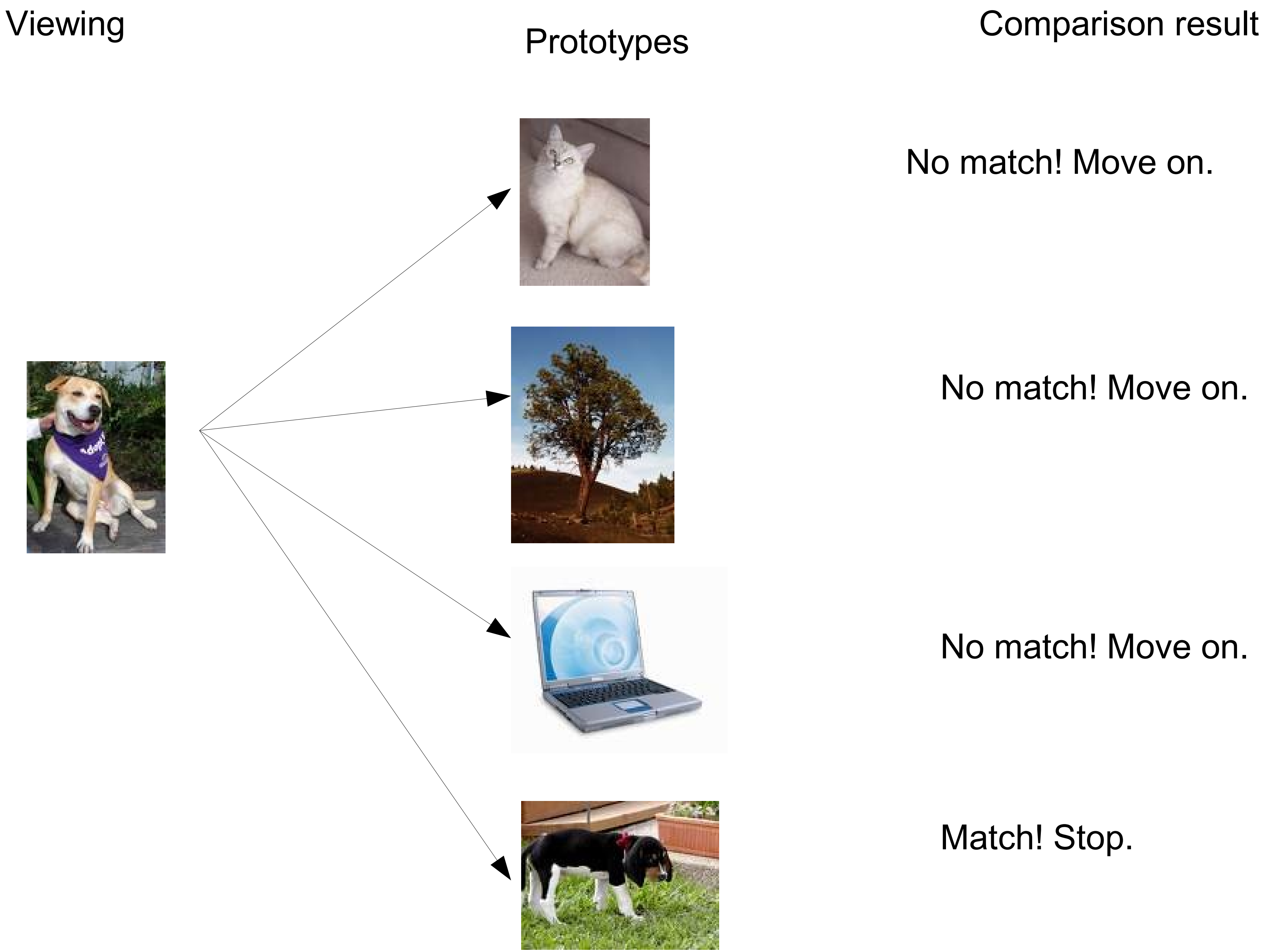
  - We tend to assume there's an ellipse there; not an odd c–shaped thing.

- The Gestalt approach
  - *Common fate* – if the same thing happens to two objects over time, we tend to assume they're part of the same thing.



- The Gestalt approach
  - Overall gestalt idea: the *law of Pragnanz* (we choose the simplest percept of those available)
  - Similar to *Occam's razor* (the simplest explanation of a phenomenon is the preferred one)

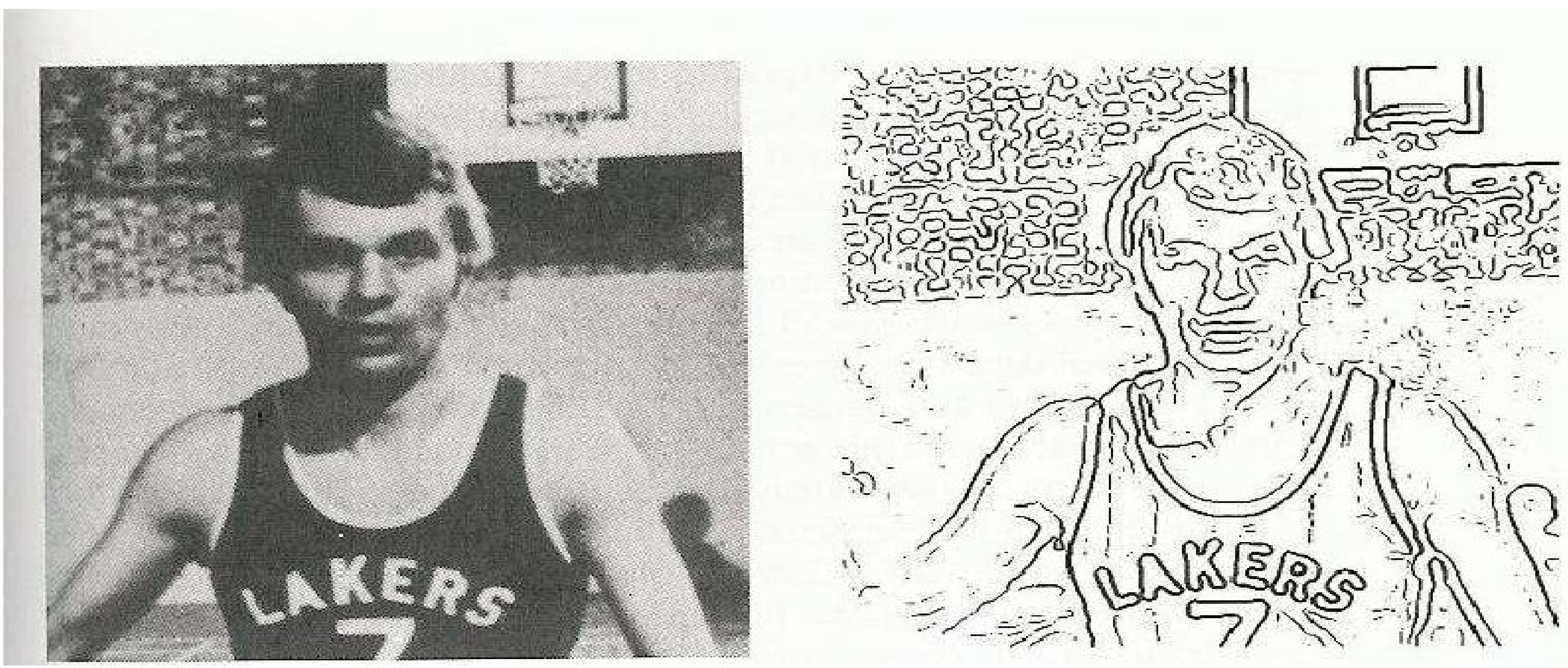
- The *prototype-matching* approach
  - Overarching question: how do we know what kind of thing an object is?
  - Compare visual image to a list of “prototypes” stored in memory.
    - If there's a match, call it that (ie, this object matched my “cat” prototype, so it's a cat.); if no match, move on to the next prototype.



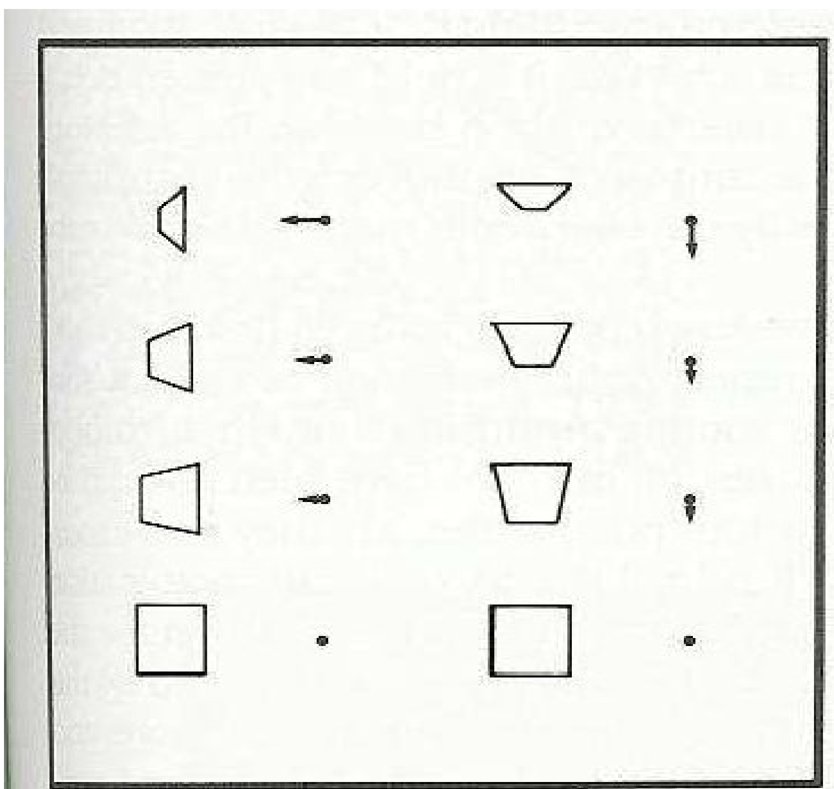
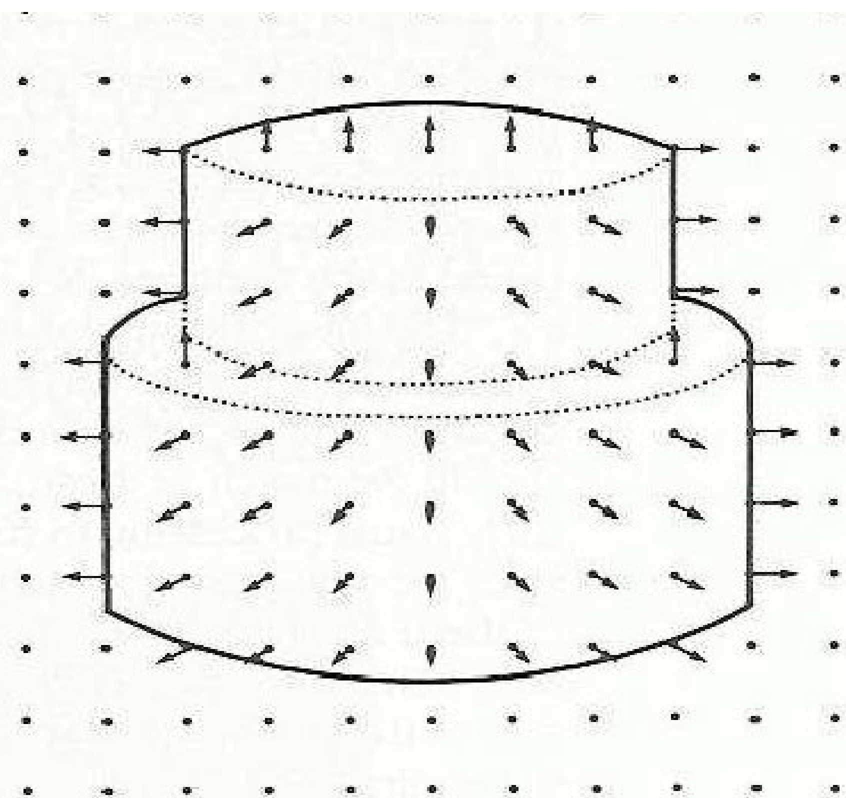
Viewing
Prototypes
Comparison result
No match! Move on.
No match! Move on.
No match! Move on.
Match! Stop.

- The prototype-matching approach
  - Evidence for prototypes?
    - *Posner & Keele* (1968) created several configurations of dots that were variations on a prototype. Trained people on the dots, but **never** on the prototype. Later, when tested on prototype, people were faster & more accurate to recognize p-type than anything they'd been trained on.

- *Computational approach*
  - building artificial visual systems
  - Marr (1982): start with a x×y picture - an intensity map, then
    - *primal sketch*: find “*zero crossings*”, locations of edges, local orientation.



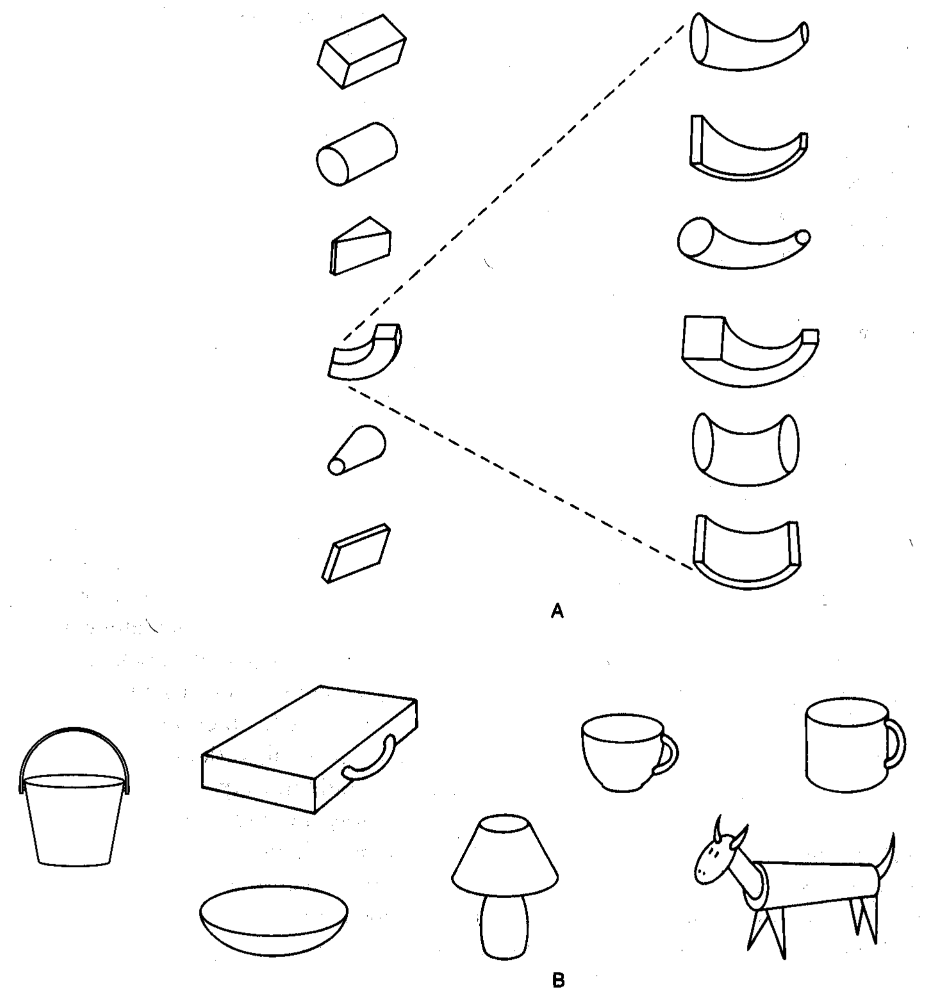
- Computational approach
  - Marr (1982): start with a x×y picture - an intensity map, then
    - build *2-and-a-half-d sketch*: *viewer-centered*, encodes 3-d information only abstractly

- Computational approach
  - Marr (1982)(cont.)
    - Build *3-d sketch*: object centered, encodes actual 3-d information directly
  - *Viewer-centered*: the Ψ representation of the object depends on your viewpoint; somebody else, looking at the same object from a different angle, would have a different representation.
  - *Object-centered*: the Ψ representation of the object does not depend on your viewpoint; somebody else, looking at the same object from a different angle, would have the same representation.

- Computational approach
  - Biederman
    - *Geon theory*: objects are represented in the head as a set of primitives (cylinders, cubes, pyramids, etc.), and the relationships between them

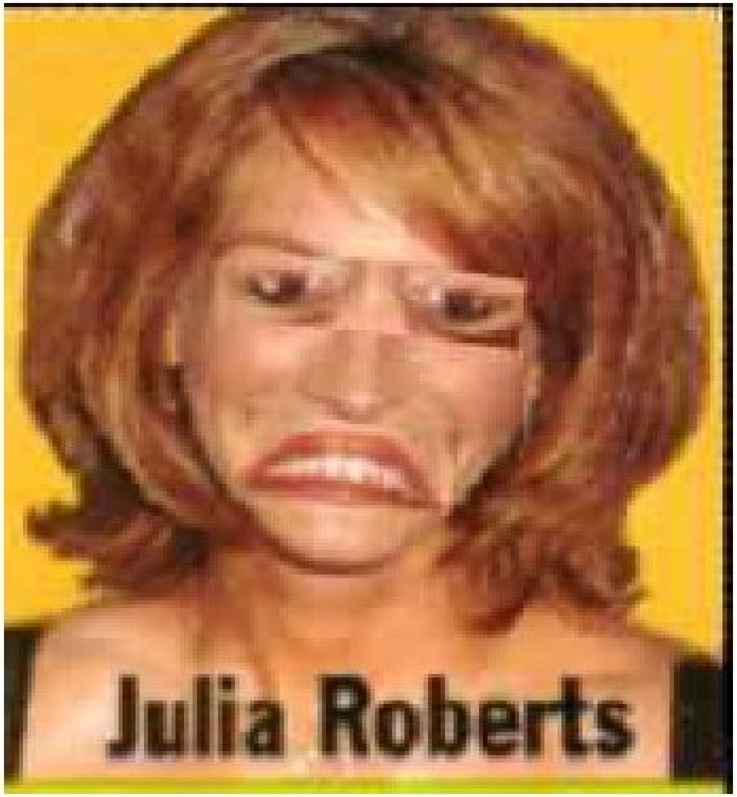
- Computational approach
  - Biederman
    - Geon theory

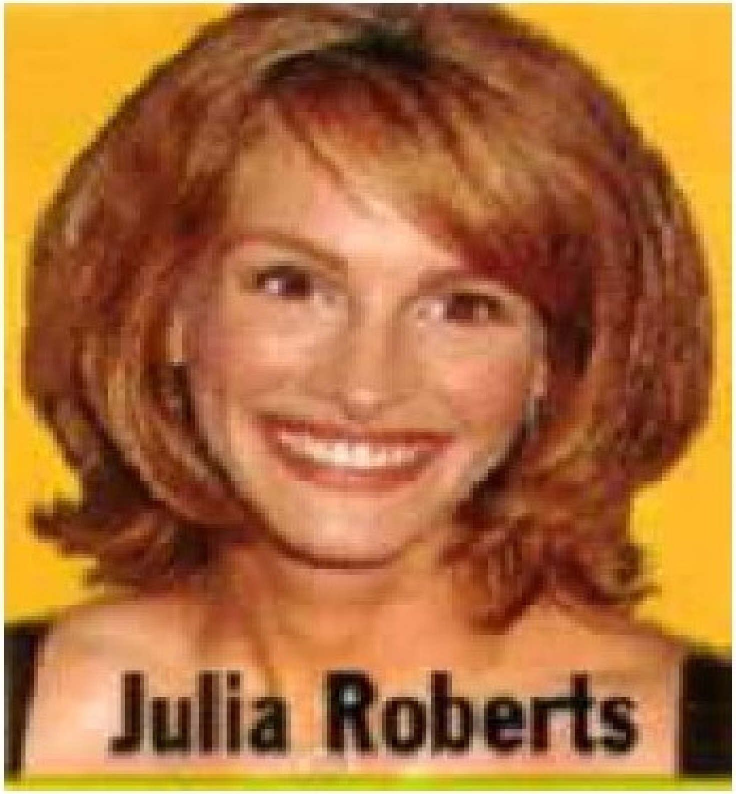


- Computational approach (cont.)
  - Other ideas – writing computer programs to compute the shape of a 2-dimensional image from . . .
    - . . .Shading
    - . . .motion
    - . . .highlights
    - . . .silhouette

- Computational approach (cont.)
  - One problem with most approaches is the assumption of *shape constancy:* things should look the same to us, even though its image might be changing. But:

- Computational approach (cont.)
  - Most people say that Julia Roberts looks much more disturbing in the second photo here, than previously.



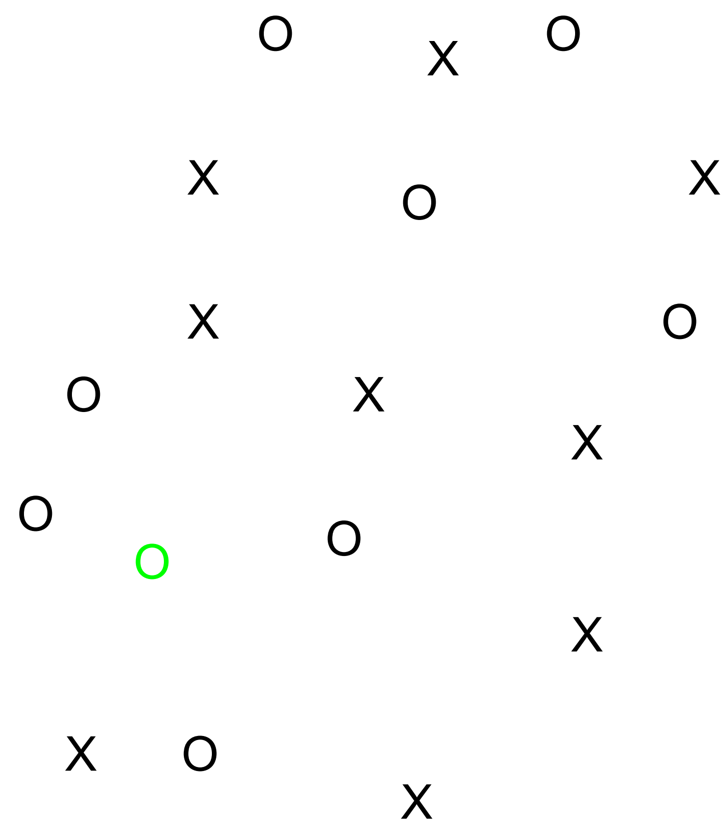


- *Feature integration approach*
  - Psychologically, objects start as a jumble of features – you have to pay attention to integrate those features into a meaningful whole.
  - So before you pay attention to this:

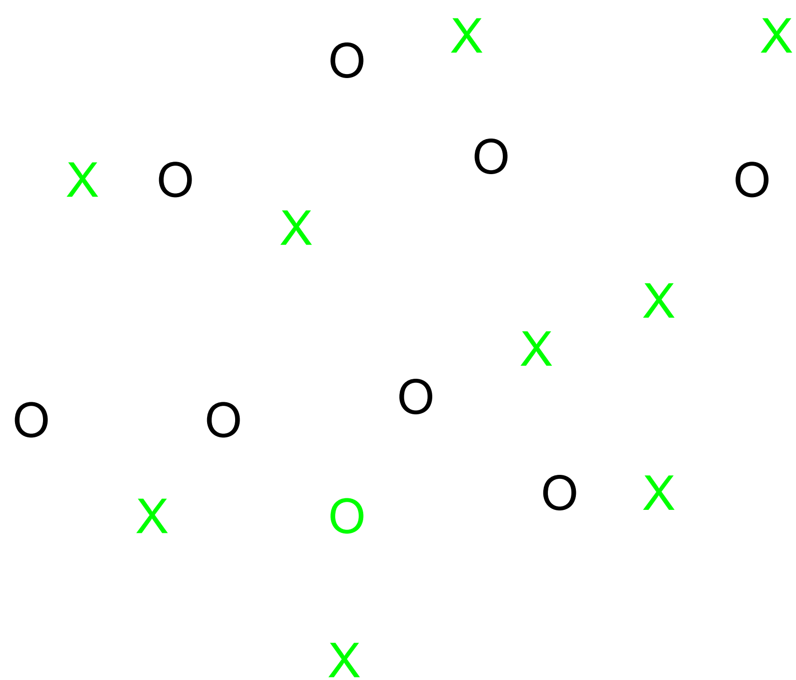
A

  - It exists in your head as two independent features: “green” and “letter A”

- Feature integration approach
  - BUT once you pay attention, those two features are integrated, so you can see a “green letter A”
  - *Treisman and Gelade (1980):* participants had to find (say) a green “O” in a field of both white “X”s and white “O”s.



- Feature integration approach (cont)
  - Treisman and Gelade (1980)(cont): THEN, participants had to find (say) a green “O” in a field of both green “X”s and white “O”s.



- Feature integration approach (cont)
  - Treisman and Gelade (1980)(cont):
    - The second task is much more difficult, presumably because in the first task, either “green” or “O” is sufficient to find the target, whereas the second time, they must be combined – either feature alone is insufficient.

- *Context (top-down) approach*
  - Read the following:

- The “H” in “the” and the “A” in “cat” are the same figure – how did you know one was “H” and the other “A”?

- Context (top-down) approach
  - *Bottom-up vs top-down*
    - Top-down perception implies that your state of mind is influencing your perception.
    - Bottom-up implies that it isn't
    - (although we generally assume that both are operating)
    - *Palmer (1975)* showed a scene (say, a picture of a farm, or a kitchen) and then several pictures, very quickly. People were asked to identify them. . .

- Context (top-down) approach
  - Bottom-up vs top-down
    - . . . and did better when the pictures "fit" within the context of the picture they had just been shown.

scene	Images	Recognition ability
A kitchen	Knives	Good
	Tractors	Bad
	Toast	Good
	Pigs	Bad
A farmyard	Knives	Bad
	Tractors	Good
	Toast	Bad
	Pigs	Good

List of terms, section 6

Spatial frequency

Degree of visual angle

Contrast

Contrast-sensitivity chart

Adaptation

Gestalt

Proximity

Similarity

Good continuation

Closure

Common fate

Law of pragnanz

Occam's razor

Prototype, prototype matching

Posner and Keele (1968) experiment

Computational approach

Primal sketch

two-and-a=half-d-sketch

3-d sketch

Viewer-centered

Object-centered

Geon theory

Shape constancy

Feature integration

Treisman and gelade (1980) experiment

Context (top-down) approach

Bottom-up

Top-down

Palmer (1975) experiment