What We Can Easily See

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Motivation

• How am I going to attract people’s attention to my
  – Web page
  – Product brochure
  – Marketing pamphlet

• Design is the key

• The key to a good design is to understand how people think visually
Motivation

• Purpose of this lecture
  – What makes a graphic symbol to be found rapidly
  – How something can be highlighted

• We want to ensure all visual queries can be effectively and rapidly served
  – Make sure meaningful graphic objects in a design have the right amount of salience
  – Visual queries should be supported with the most visually distinct objects
How do we see the world?

• Do you feel you can see the world vividly, in complete detail?
• We comprehend the world by constantly moving our eyes
• Something is easier to find than others
  – Blinking light
  – Bright red sweater in a crowd of people wearing black
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What about finding ‘q’ and why it is difficult?
Low Level Machinery
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• Primary visual cortex (V1) has cells that would fire (emitting a series of spikes of electrical current) when certain kind of patterns are put in front of eyes

• Different areas are processing different type of information
  – Color, shape, texture, motion, stereoscopic depth

• This information is passed to visual area 2 (V2)
  – Millions of fibers from the eye send info to billions of neurons in V1 and then V2
What and Where

• *What* and *Where* pathways
  – *What* pathway: processing information about the identity of an object
  – *Where* pathway: processing information about where the objects in the world are located
Eye Movement Planning

• How do the eyes get directed to the right location when we are looking for something?

• Bias competition
  – Neurons which process the type of info that we are looking for can shout louder
    • Color, orientation, size, motion, etc
  – Other cells keep quiet

• The biased responses are sent up the what pathway, and up the where pathway to make eye movements.
What Stands Out?

- Something you cannot miss even if you try

- The green dot pops out
- The oblique lines pop out
- The large circle pops out
- If two dots were to oscillate as shown they would pop out
Pre-attentive

• The time to respond did not depend on the number of distracters
  – This suggests a parallel automatic process
• The effects measured by this method were pre-attentive
  – Automatic mechanisms operating prior to the action of attention
• Pop-out effects are stronger when a single target differs from all other objects where all other objects are identical
• It is the degree of feature-level contrast between an object and its surroundings that makes it distinct.
• Common features are color, orientation, size, motion, stereoscopic depth – a striking correspondence to the early processing mechanisms.
What patterns do not show pop-out?

• Visual conjunctive search is hard
  – Finding green squares

• Features easy to see are done by neurons in the bottom of the visual processing. Hard to see features are done by neurons farther up the what pathway
Sufficient Differences

• For things to pop out, the low level feature differences need to be sufficiently large
  – 30 degree difference or more

• The extend of variation in the background is also important
  – Extremely homogeneous vs. busy background
Examples

The inverted T has the same feature set as the right-side-up T and is difficult to see. But the bold T does support pop-out and is easy to find.

Similarly, if a line is surrounded by other lines of various similar orientations it will not stand out.
Examples

6
difficult

2359807754321
5478904820095
3554687542558
558932450452
9807754321884
3554387542568
2359807754321

easy

- difficult

- easy
Feature Channels

• Channels are defined by the different ways the visual image is processed in V1
• Learning does not help
Lesson for Design

• If you want to make something easy to find, make it different from its surroundings according to some primary visual channel
  – Color, size, shape, blinking, and so on

• How to make several things easy to search at the same time?
  – Use different channels
  – GDP example
Lesson for Design

• Use multiple channels will make a symbol even easier to find
  – Differ in both size and color will make it easier
• Creating a display containing more than 8 to 10 independently searchable symbols is impossible – not enough channels
• We have only about three different steps in each channel
  – 3 sizes, 3 orientations, etc
• Visibility enhancements are not symmetric
  – Increase the size is more distinctive than decrease in size
Motion

• Motion is extremely powerful
• Things that emerge into the visual field is more powerful than things that simply move
• Think of example of email alert
• Rapid motion vs. slower and smoother motion
  – Urgent or gentle reminder
• Don’t overuse because it can be irritating
  – Because people cannot suppress it
The Visual Search Process

- Move and scan loop
- Eye movement control loop
- Pattern testing loop
Multi-scale structure for design

• To support efficient visual search, a design should be given large-scale as well as small-scale structure
• This allows our eyes to move to the likely neighborhood of a target, then the local pattern information provides a few candidates for individual detail eye fixation
Conclusion

• Visual search is something that is fundamental to almost all seeing

• There is a world of difference between something that can be located in a single eye movement and one that takes five or ten

• Use pop-out properties well can go a long way
Reference

• Visual Thinking for Design by Colin Ware