COGNITIVE SCIENCE (PERCEPTION)

HCI & WEB DESIGN – ROSANNE BIRNEY

OVERVIEW

- What is cognitive science?
- Cognitive processes
  - Perception
- Examining the relationship between understanding of cognitive processes and interaction design

COGNITIVE SCIENCE

INTRODUCTION – WHAT IS COGNITIVE SCIENCE?
INFORMATION PROCESSING THEORY
BASIC COGNITIVE PROCESSES

WHAT IS COGNITION?

- Cognition is the process of receiving, processing, storing and using information
- The mental processes underlying our ability to perceive the world, remember, talk about and learn from our experiences.
- It includes functions such as perception, memory, language and thought.

- Cognitive Science is the scientific study of cognition – it examines what cognition is, what it does and how it works.

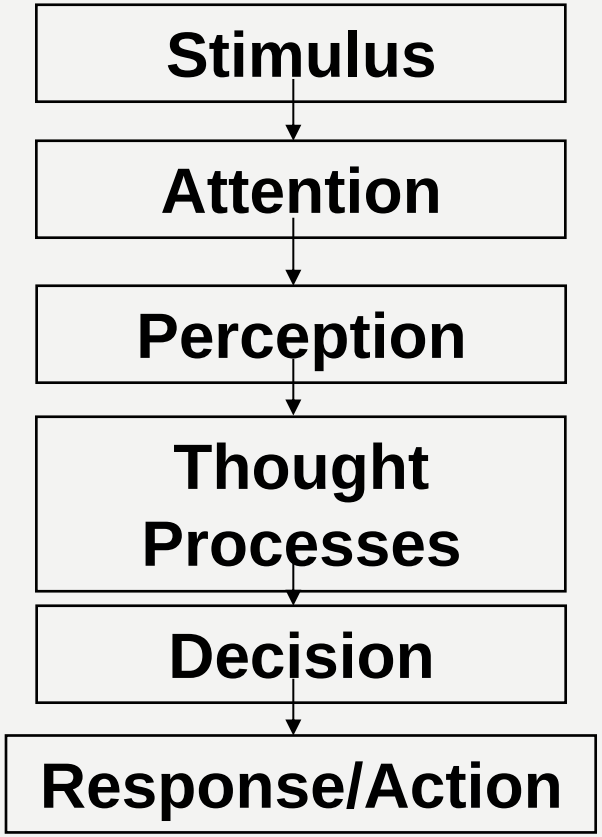
INFORMATION-PROCESSING APPROACH

- The information-processing approach was suggested by Sternberg in 1966
- This approach suggests that the human mind processes information in a series of steps (in a similar manner to a computer)
- The 'information' being processed refers to any input we receive from our external environment

Early version of Information Processing System

What are the problems with this model of cognition?

Diagram reproduced from Cognitive Psychology: A Student's Handbook by Eysenck & Keane, 5th Edition, p.2



INFORMATION PROCESSING MODEL

- As well as stimuli, cognitive processing is affected by an individual's past experiences, expectations etc.

- Also, this model only represents serial processing – parallel processing and cascade processing can also occur

INFORMATION PROCESSING MODEL

- Bottom-up processing:
  - Stimulus driven
- Top-down processing:
  - Concept driven
- Both can occur at the same time
- Updated versions of the information processing model take this into account

COGNITIVE PROCESSES

- Attention
- Perception and recognition
- Memory
- Learning
- Reading, speaking and listening
- Problem-solving, planning, reasoning and decision-making

WHY DO WE NEED TO UNDERSTAND USERS?

- Interacting with technology is cognitive
- Need to take into account cognitive processes involved and cognitive limitations of users
- Provides knowledge about what users can and cannot be expected to do
- Identifies and explains the nature and causes of problems users encounter
- Supply theories, modelling tools, guidance and methods that can lead to the design of better interactive products

PERCEPTION

VISUAL PERCEPTION
SCENE PERCEPTION
OBJECT RECOGNITION
FACIAL RECOGNITION

PERCEPTION

- Perception involves the intake, analysis and integration of sensory information to guide thought and action.
- There are several processes at work:
  - Sensation
  - Visual form perception
  - Visual depth perception
  - Auditory perception
  - Object recognition
  - Face recognition

SENSATION

- Sensation is the first stage of perception
- Sensation is the transduction of energy (e.g. light or sound) into neural impulses
- Perception is the interpretation of these impulses to create meaningful representations of our environment

SENSATION

- Direct perception
  - We perceive information directly from our environments
  - Stimulus-based or bottom-up processing
- Information processing approach
  - There may be elements of top-down processing involved also
  - For example, our expectations or previous experiences may have an impact

SENSATION

- Filtering occurs in the early stages of sensation and perception – the amount of incoming information is reduced
- The most important information is retained
- There are many factors at play in how we decide which information to pay attention to and which to ignore

VISUAL PERCEPTION: WHAT YOU SEE ISN'T (ALWAYS) WHAT YOUR BRAIN GETS

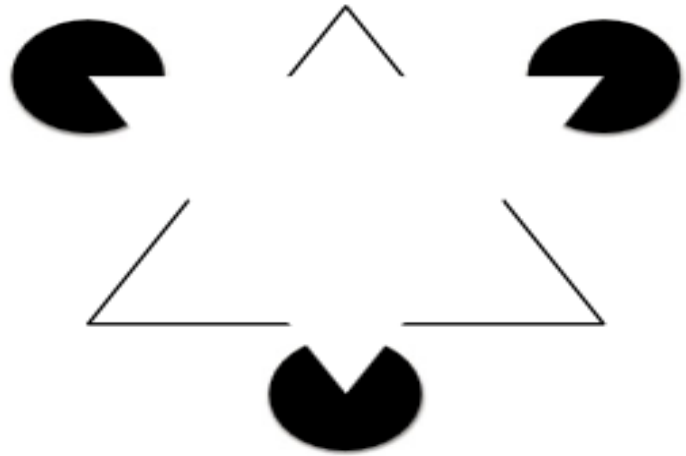


FIGURE 1.1 You see triangles, but they are not really there

FIGURE 1.2 An example of a Kanizsa rectangle

VISUAL DEPTH PERCEPTION

- In order to perceive where an object is, we must know its distance or depth
- There are a number of cues that combine to determine perceived distance
- These are known as Monocular or Binocular, depending on whether they use one or two eyes

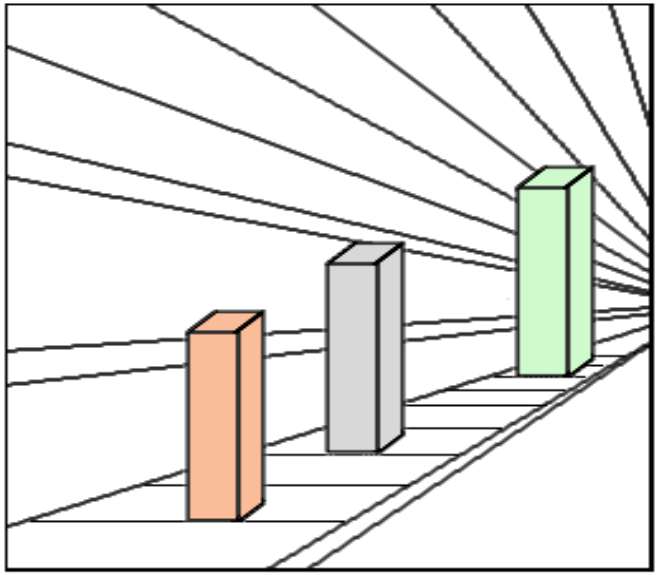
VISUAL DEPTH PERCEPTION

- Monocular cues include:
  - Relative Size
  - Superposition/Interposition
  - Linear Perspective
  - Accommodation
  - Lighting cues (e.g. shadow)
  - Motion cues

- See here for examples:
  - http://psych.hanover.edu/Krantz/art/index.html
  - http://www.scientificpsychic.com/graphics/

EXAMPLE: LINEAR PERSPECTIVE

The pillars are identical in size.
Our intuition about perspective influences what we see.



EXAMPLE: LIGHTING CUES

The shade of the center dot is the same in all the squares.
The shade of the background influences how we perceive it. All squares are uniformly shaded, but each square seems lighter on its left edge than on its right edge.

VISUAL DEPTH PERCEPTION

- Binocular cues include:
  - Convergence
  - Retinal Disparity

- Another example of how the brain makes up for missing information (blind spot):
  - http://serendip.brynmawr.edu/bb/blindspot1.html

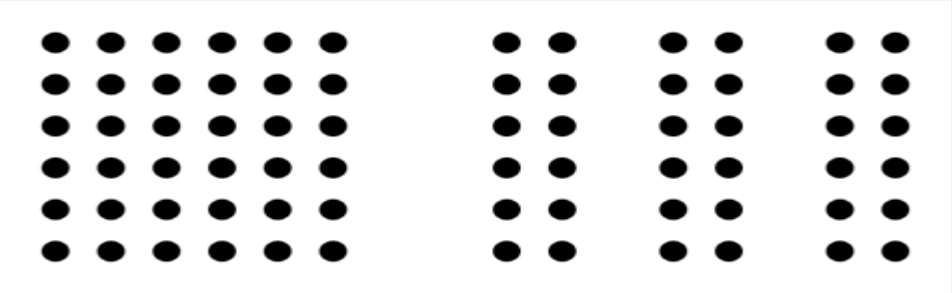
VISUAL FORM PERCEPTION

- Our brains try to perceive forms as whole shapes (even when those shapes are not actually there!)

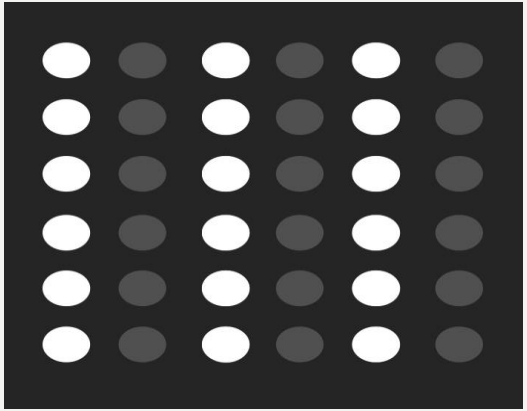
- Gestalt theory states that we perceive forms as distinct from each other and from their background by grouping elements together based on the following principles:
  - Proximity
  - Similarity
  - Continuation
  - Closure

GESTALT THEORY

- Proximity

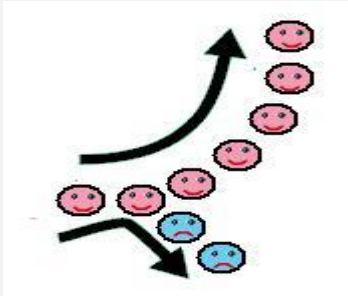


- Similarity

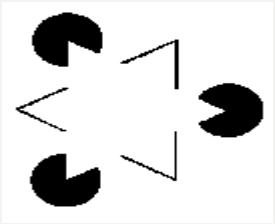


GESTALT THEORY

- Continuation



- Closure



DISCUSSION

- How can the principles discussed above be applied to interface design?
  - Gestalt theory
    - Proximity
    - Similarity
    - Continuation
    - Closure

SCENE PERCEPTION

- Studies have shown that our perceptions of a scene are not always complete
- There are two problems which often occur:
  - Change blindness – failure to note changes
  - Inattentional blindness – failure to perceive part of a scene

- Examples:
  - http://www.youtube.com/watch?v=vJG698U2Mvo
  - http://www.youtube.com/watch?v=IGQmdoK_ZfY
  - http://www.youtube.com/watch?v=1nL5ulsWMYc

THE GEON THEORY OF OBJECT RECOGNITION

- This theory (put forward by Biederman, 1985) states that there are around 24 basic shapes that we recognise
- These are called 'geons' (geometric icons)
- We use our knowledge of these basic shapes to recognise what an object is and also make inferences about what it does or its '**perceived affordances**'

EXAMPLE OF GEONS

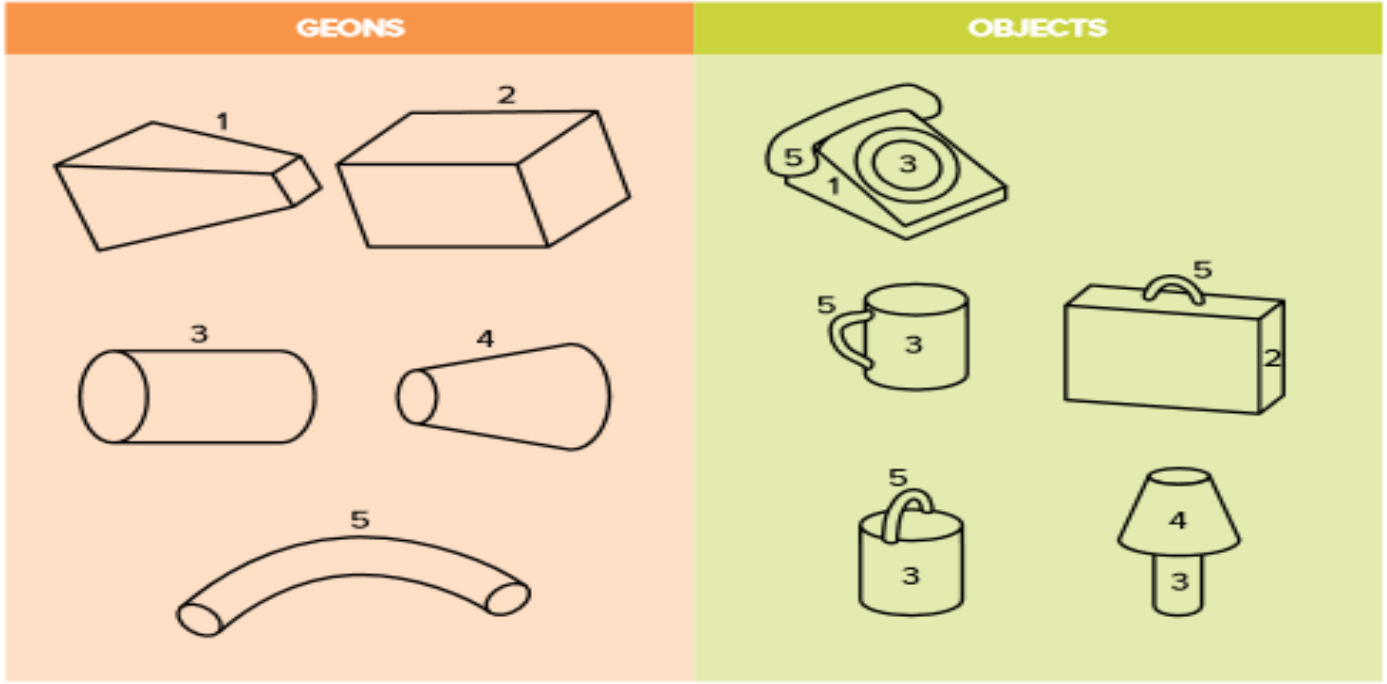


FIGURE 3.2 Some samples of Biederman's geons

FACE RECOGNITION

- Shares some features with object recognition, but also differs in many ways
  - Face recognition occurs in a different part of the brain to object recognition
- Precise configuration of features is important – all faces include the same basic features, but yet we are able to tell them apart
- Orientation affects our ability to recognise faces – see example here:
  - http://faculty.washington.edu/chudler/java/faces.html

PEOPLE REACT TO FACES ON A WEBPAGE FASTER THAN ANYTHING ELSE ON THE PAGE

We look where the face looks

Eye-tracking research shows that if a picture of a face looks away from us and toward a product on a Web page (see **Figure 4.1**), then we tend to also look at the product.

But remember, just because people look at something doesn't mean they're paying attention. As you consider your Web approach, you'll have to decide whether you want to establish an emotional connection (the face looking right at the user) or direct attention (the face looking directly at a product).

FIGURE 4.1 We look where the person looks

COGNITIVE SCIENCE AND DESIGN

- A talk by Alex Faaborg (Designer @ Android) given at the Google I/O 2013 conference discusses how cognitive science theories are applied in the design of Google products
  - https://www.youtube.com/watch?v=z2exxj4COhU
  - First 20 minutes relates to perception