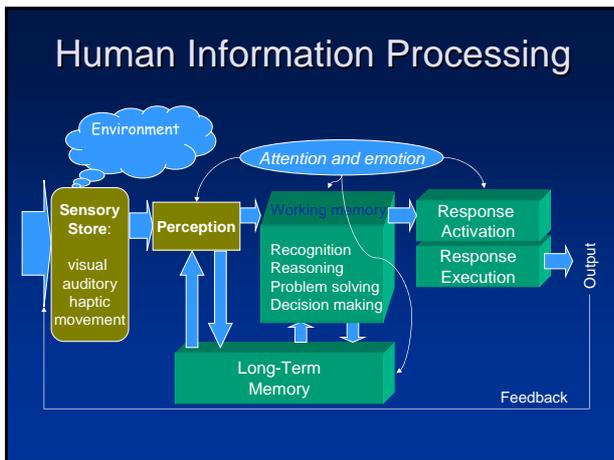
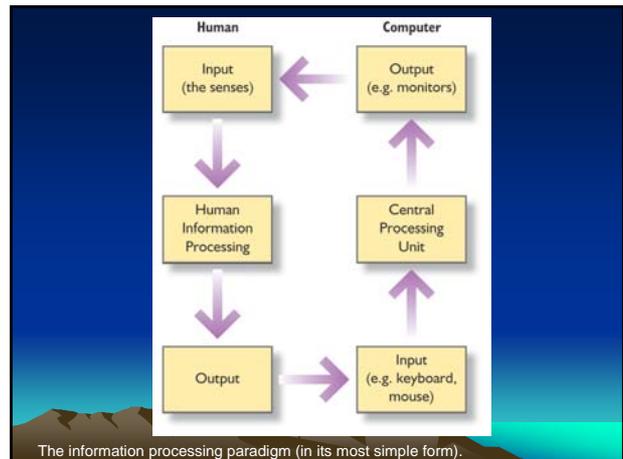


Lecture 2, Human cognition

Human Cognition

An important foundation for the design of interfaces is a basic theory of human cognition



The Sensors on Human Body

On muscles:

- Muscle and tendon receptors

On the head

- Vision
- Hearing
- Balance
- Taste
- Smell

On joints:

- Changes in joint position
- Speed of movement
- Position of the joint
- Pain sensation

On the skin:

- Head-cold
- Pain
- Touch-Pressure

The Human Brain

Human *Homo sapiens* 69-314

cortex

somatic sensory cortex

Memory

- Sensory memory
 - Buffers from stimuli received through senses
- Working memory (short term about 30 seconds)
 - small capacity
 - rapid access (~ 70ms) & decay (~200 ms)
 - pass to LTM after a few seconds

Lecture 2, Human cognition

Long-term Memory (LTM)

- Repository for all our knowledge
 - slow access – 1/10 second
 - slow decay, if any
 - huge or unlimited capacity
- Two types
 - episodic – serial memory of events
 - semantic – structured memory of facts, concepts, skills

semantic LTM derived from episodic LTM

How do you know that animal is a dog, not a cat?

Semantic Memory Structure

- provides access to information
- represents relationships between bits of information
- supports inference

LTM - Storage of information

- rehearsal
 - information moves from STM to LTM
- total time hypothesis
 - amount retained proportional to rehearsal time
- distribution of practice effect
 - optimized by spreading learning over time
- structure, meaning and familiarity
 - information easier to remember

LTM - retrieval

recall

- information reproduced from memory can be assisted by cues, e.g. categories, imagery

recognition

- information gives knowledge that it has been seen before
- less complex than recall - information is cue

LTM - Forgetting

decay

- information is lost gradually but very slowly

interference

- new information replaces old: retroactive interference
- old may interfere with new: proactive inhibition

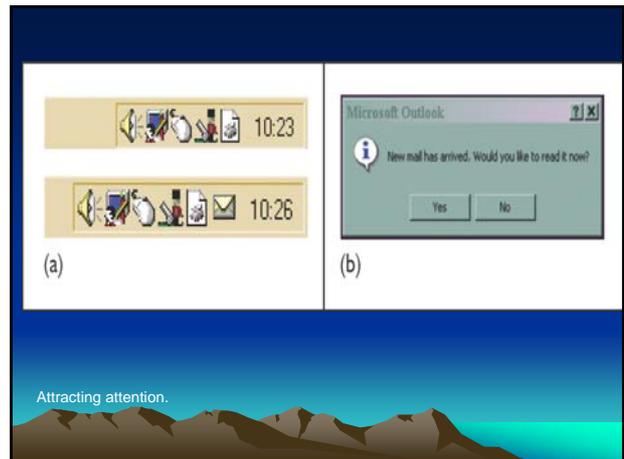
so may not forget at all, as memory is selective ...

... affected by emotion – can subconsciously 'choose' to forget

Lecture 2, Human cognition

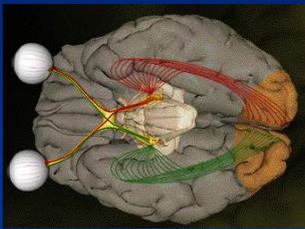
Attention

- Selective attention
 - Visual sampling
- Paralle processing and divided attention
 - Several items within the view field might be processed together
- vigilance



Visual Perception

Transformation and interpretation



Visual Perception

- Size and depth
 - Visual angle
 - Law of size constancy
 - Other visual cues (relative size, overlap, familiarity)
- Brightness
- color

Optical Illusions



the Ponzo illusion



the Muller-Lyer illusion

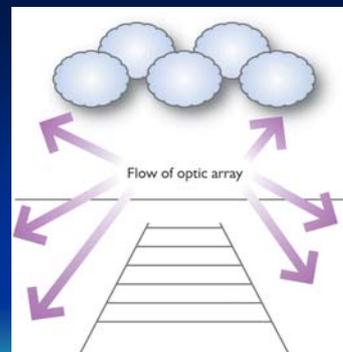
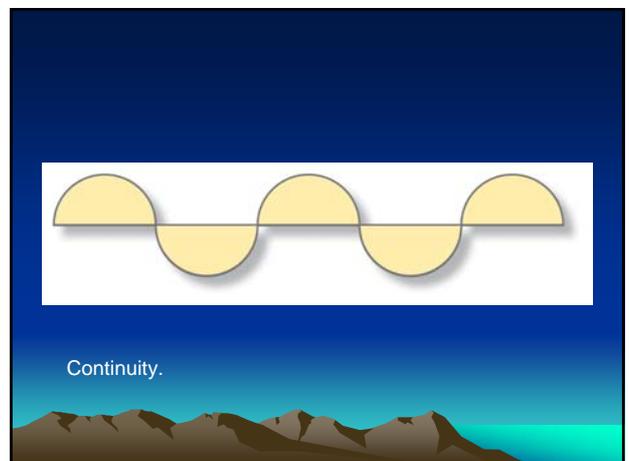
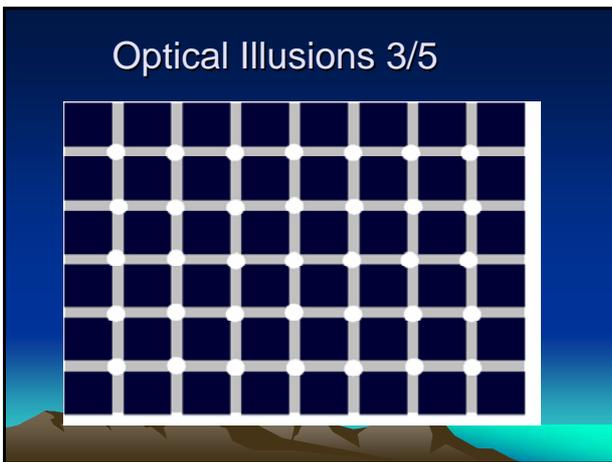
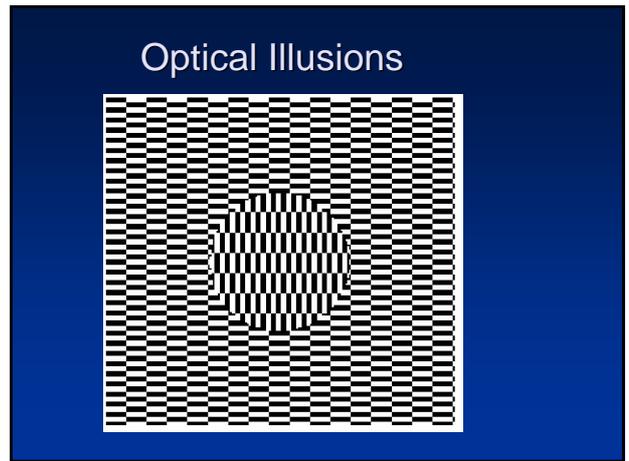
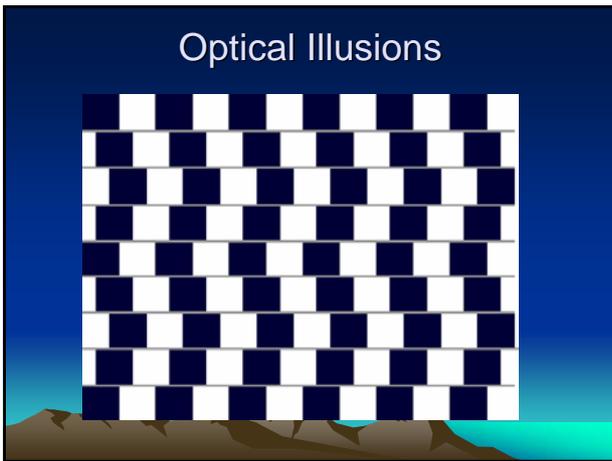
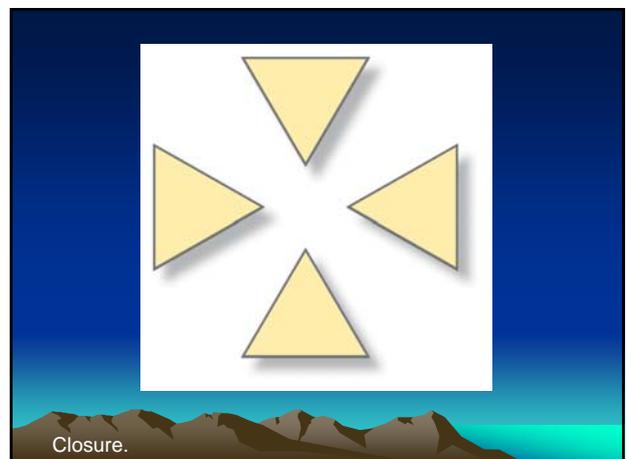
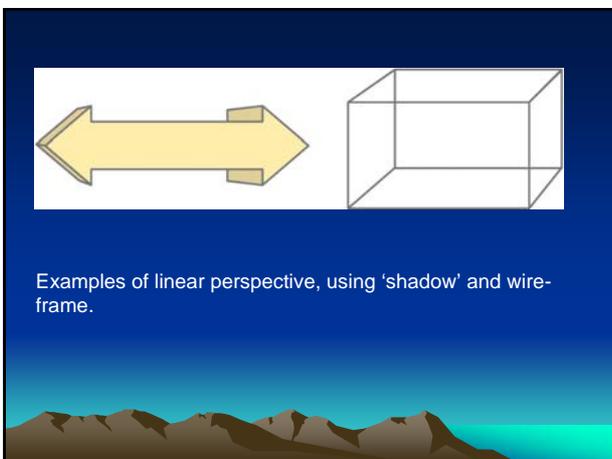
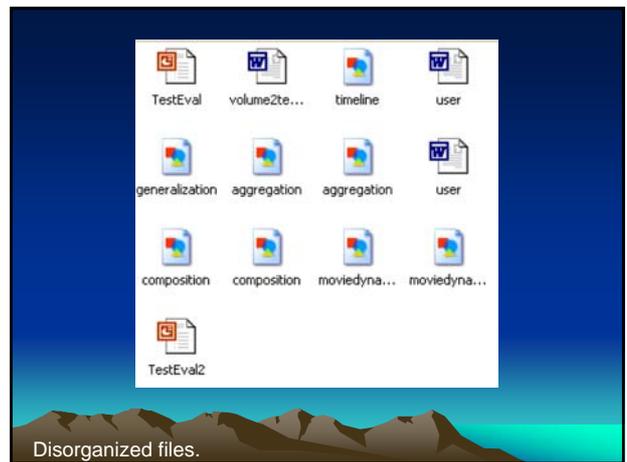
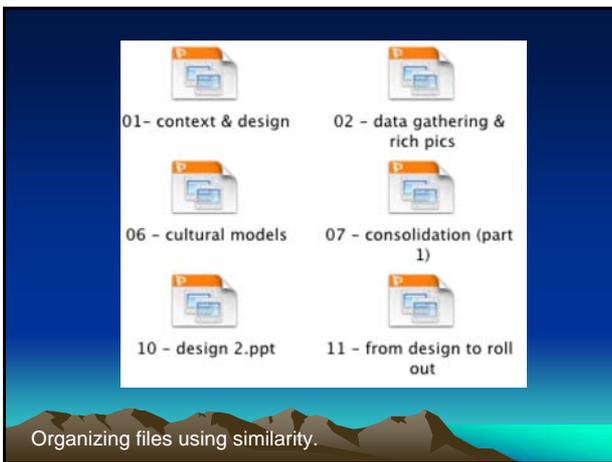
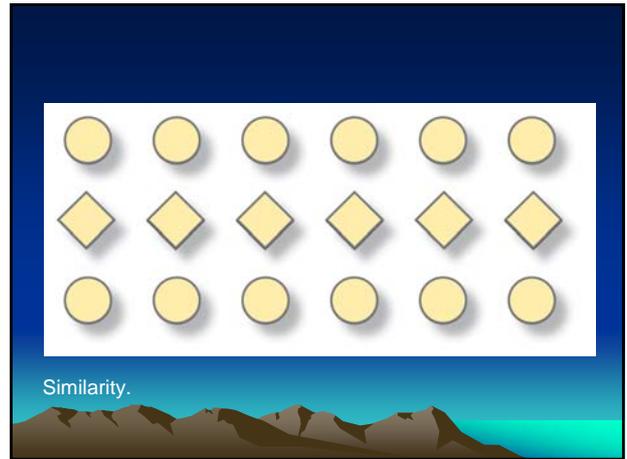


Figure 5.9 Flow of optic array.

Lecture 2, Human cognition

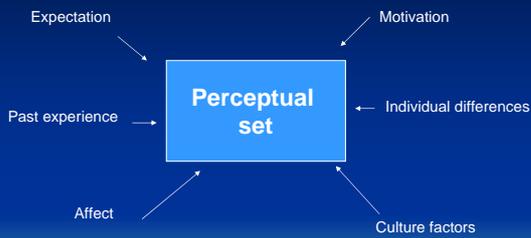


Lecture 2, Human cognition



Lecture 2, Human cognition

Factors Affecting Perception

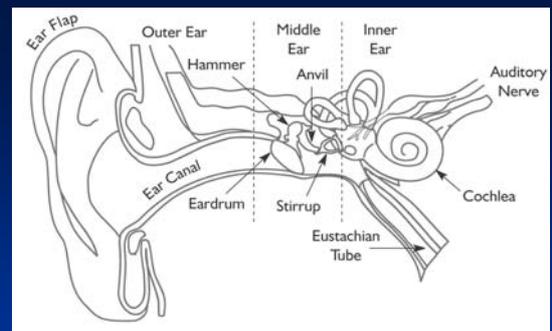


Mental Models

- inferences about how to carry out tasks.
- fathom what to do, when
 - something unexpected happens
 - encountering unfamiliar systems.
- Engineers mental model \neq users mental model.

Cognitive models describe and predict users' problem solving behaviour with interactive systems. Cognitive models are used to design and improve interactive systems.

Hearing and Haptics



Physical apparatus:
 outer ear – protects inner and amplifies sound
 middle ear – transmits sound waves as vibrations to inner ear
 inner ear – chemical transmitters are released and cause impulses in auditory nerve

Hearing

- Provides information about environment: distances, directions, objects etc.
- Sound
 - pitch – sound frequency
 - loudness – amplitude
 - timbre – type or quality
 - tone – a sound wave that evokes a sensation of pitch

Using Sound for Interface Design

- Reduce visual loading
- Grabbing attention
- Disabled users

Problems with sound:

- Discrimination
- Transient

Lecture 2, Human cognition

The Meaning of the Sounds

- Auditory icons: The everyday sounds we hear
 - immediately understood by the user
- Earcon: diversified artificial-composite sounds

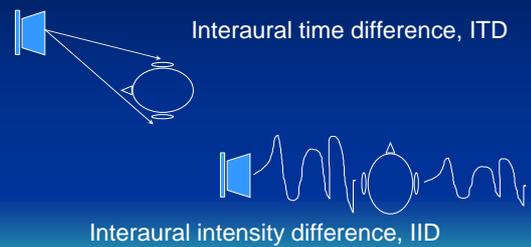
Design of Earcons

- Earcons are potentially useful to represent information that is quite complex
 - designed through methods such as repetition, alteration, or comparison
 - there is a cost : a learning period that requires significant time and effort
 - Context play important role.

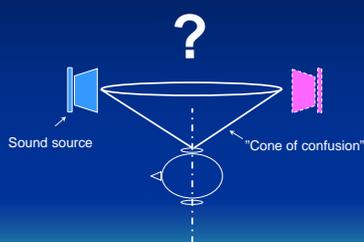
Design of Earcons

- Design guidelines
 - easy comprehension and memorization,
 - short and simple,
 - easily distinguishable from other earcons,
 - convey only one meaning

3D - audio



Confusion



3D audio: Auditory Localization and Navigation

- Localization, give better situation awareness
- Shorten visual searching time
- Interesting application on 3D audio display via headphones

Problems:

- head-related transfer function (HRTF)
- individual difference

Lecture 2, Human cognition

Haptic Perception

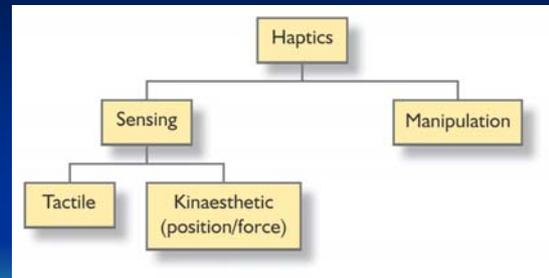
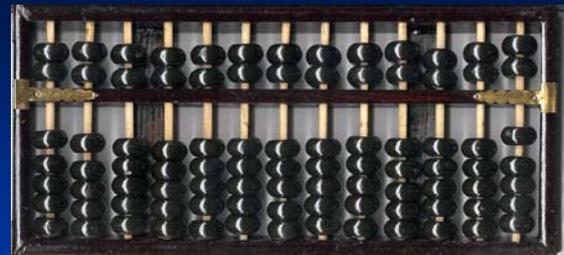


Figure 16.4 Defining haptics.

Source: after Tan, H.Z. (2000) *Perceptual user interfaces: haptic interfaces*, Communications of the ACM, 43(3), pp. 40-41. © 2000 ACM, Inc. Reprinted by permission.

Touch

- Provides important feedback about environment.
- May be key sense for someone who is visually impaired.
- Stimulus received via receptors in the skin:
 - thermoreceptors – heat and cold
 - nociceptors – pain
 - mechanoreceptors – pressure
(some instant, some continuous)
- Some areas more sensitive than others e.g. fingers.
- Kinesthesia - awareness of body position
 - affects comfort and performance.



An abacus, which combines tangible input, output and the data being manipulated.
Source: <http://www.sphere.bc.ca/test/sruniverse.html>. Courtesy of Sphere Research Corporation.

Movement

- Time taken to respond to stimulus:
reaction time + movement time
- Movement time dependent on age, fitness etc.
- Reaction time - dependent on stimulus type:
 - visual ~ 200ms
 - auditory ~ 150 ms
 - pain ~ 700ms
- Fitts law:
 - The time taken to hit a target is a function of the size of the target and the distance that has to be moved

Errors

Types of error

- slips
 - right intention, but failed to do it right
 - causes: poor physical skill, inattention etc.
 - change to aspect of skilled behaviour can cause slip
- mistakes
 - wrong intention
 - cause: incorrect understanding
humans create mental models to explain behaviour.
if wrong (different from actual system) errors can occur

Lecture 2, Human cognition

Emotion

- Various theories
- cognitive and physical responses to stimuli
- The biological response - *affect*
- Affect influences information process
- Affect computing

How Emotions are Manifested/Measured

- Physiological response
 - Heart rate
 - Respiration
 - Skin response
 - Blood pressure
- Questionnaire
- Facial expression
- Voice
- Brain activity
- Gestures and actions

Scott Brave and Cliff Nass: Emotion in Human-Computer Interaction
<http://www.research.umbc.edu/~research/CHI/Handbook/nass.html>

Goal and Information Presentation

- If we know exactly what we want to find out, we try to match this with the information that is available
- The way information is displayed can also greatly influence how easy or difficult it is to attend to appropriate piece of information

Individual Differences

- long term
 - sex, physical and intellectual abilities
 - short term
 - effect of stress or fatigue
 - changing
 - age
 - attention
- Ask yourself:
will design decision exclude section of user population?

Summary

- Human information processing and cognition
 - Memory
 - Attention
- Sensory Perception
 - Visual
 - Auditory
 - Haptic

Questions

- How does human process information?
- What is memory? What is the difference between working memory and long-term memory?
- What is attention? What is vigilance? How attention works?
- How many "laws" of visual perception are described in the book? Please make a list and write a short explanation to understand them. How would these "laws" affect the interface design?
- What is mental model? What kind of properties a mental model shall have? What does mental model use for?
- How can we use sound for interface design? Please indicate the positive and negative of using sound for the design.
- Try to compare the difference of visual display and sound display, so you can understand better how to use the right modality to display right information.
- What is haptic perception?