HCI -2 –HUMAN CAPABILITIES AND LIMITATIONS (THE SENSES)

Aims and Objectives: this is the first of the three lectures focusing on understanding human limitations and capabilities and their implications for HCI. This first lecture in the series explains why it is important for system designers to be aware of human capabilities and limitations and then discusses the nature of the five human senses: sight, hearing, touch, taste and smell.

Lecture Notes

Why Do Systems Designers need to Understand Human Capabilities and Limitations?

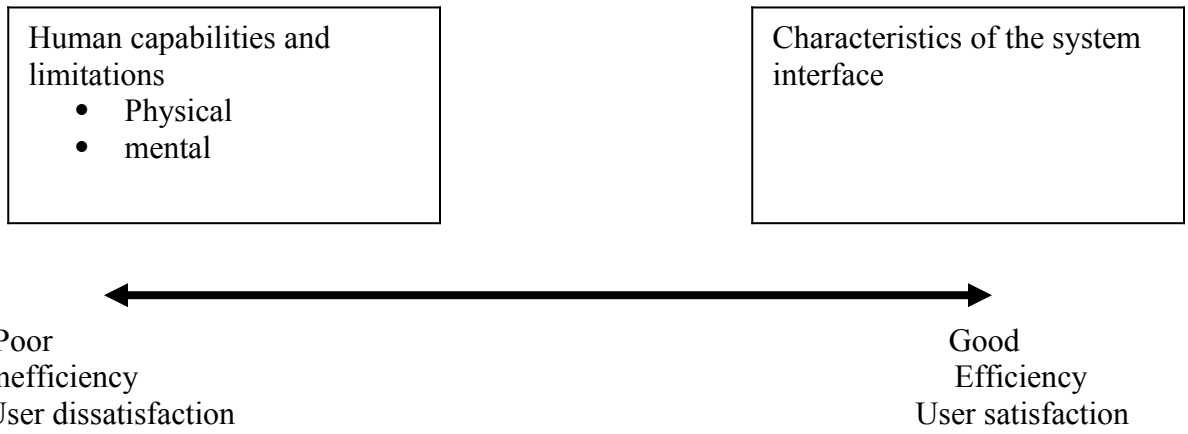
Systems designed for use by humans must respect human capabilities and limitations

- Physical limitations (e.g. the range of colour that can be perceived)
- Mental (e.g. the ability to remember how to use a piece of software)

The following systems would be doomed to failure:

- A system that outputs complex information by smell
- A medical records system that requires the user to memorise the patient ids of all the patients
- An in-car navigation system that requires the user to perform hundreds of price comparison calculations per second.
- A system that requires Control + Alt + Shift + Y + F12 to be pressed simultaneously
- A game that induces convulsions (sudden violet body movement that cannot be controlled, caused by muscle contraction) in players

These are extreme examples but systems that push users near to the physical or mental limits of their capabilities will cause problems. Systems need to be designed such that the characteristics of the interface match the capabilities of the human users. A poor match leads to: low efficiency (e.g. errors, slowness), decreased user satisfaction, at the extreme health and safety problems



Health and safety problems

Part of studying of HCI is about understanding human capabilities and limitations and the implications of those on interface design. These capabilities and limitations are both **physical** (e.g. the five senses and human anatomy) and **mental** (e.g. memory and problem solving ability). Additionally it is important to take account of **human diversity** e.g. age range, cultural background, possible disabilities, education etc.

We must always remember that we are designing systems for human beings and not 'cartoons'. In this lecture we will look at the five senses. In following lectures we will look at other topics including mental capabilities (especially memory), ergonomics and health and safety issues and accommodating human diversity.

The senses

The five senses can be thought of as **human input devices** or channels. The five senses are normally considered to be: taste, vision, hearing, smell and touch.

Quick Quiz Question 1

This is not so much of a quiz question but rather a chance for reflection. In what order of importance would you place the five senses identified about for receiving output and feedback from ***current*** computer systems?

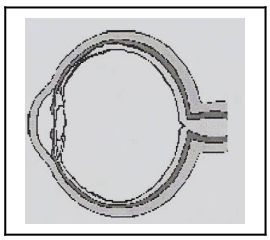
Is it the same order as their importance in everyday life?

We will now look at each of the senses in some detail.

Vision

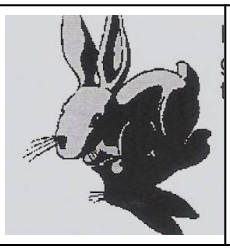
The basic capabilities and limitations of vision are determined by the characteristics of the eye and the placement of the eyes on the head

The rods and the cones of the retina detect the brightness and Colour of light entering the eye



Although the **human eye** is an incredibly powerful and sophisticated organ there are some things humans can't see e.g.

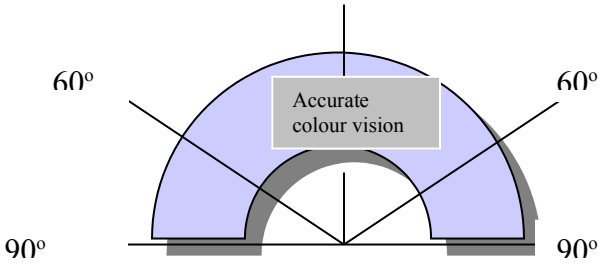
- Colours outside the visible spectrum e.g. infra red
- Things that move too fast
- Very slow motion
- Things outside your field of vision
- Very small differences in brightness



Hare's have a much greater field of vision than human beings

Colour Perception

- Normal colour perception can distinguish over 7 million different shades
- Colour sensitivity is not uniform over the field of vision – it is best at the front and decreases towards the periphery (edge or boundary)



- Peripheral colour vision is worst for red, green and yellow and best for blue
- Blue is a good background colour for large displays
- Directly in front colour vision is best for red and yellow and worst for blue
- Small (especially pale) blue objects tend to disappear on the screen

Colour perception differs

- From user to user
- According to screen brightness
- With age-older eyes tend to be less sensitive to blue and see all colours less brightly

Colour interpretation differs with culture e.g.

Red = danger (war culture – blood)
Or
Red = Happiness (love, valentines)

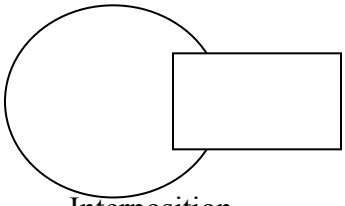
Colour blindness

- Affects 8% men and <1% women
- People with red-green colour blindness seen both red and green as grey

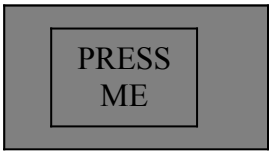
What does this mean for the use of colour on display devices?

- How many colours should be used at one time on a screen?
- Should colour be used as the sole method of conveying some information?
- Is too much colour better than none at all?

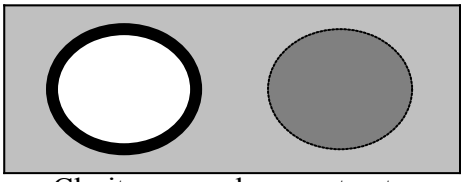
Computer display devices are usually flat however often the illusion of three dimensions is desirable. In order to simulate three dimensions, designers make use of various depth cues (words or actions that signal someone to do something) e.g.



Interposition



Shadow

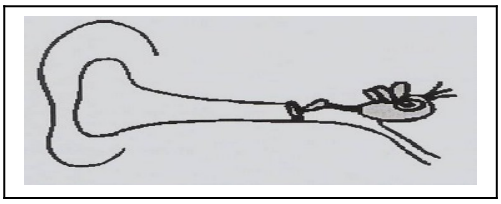


Clarity and contrast

Quick Quiz Question 2

Directly in front colour vision is best for which colours and worst for which colour?

Hearing: changes in air pressure caused by sound waves are detected by the ear. Sound waves vary in loudness and pitch.



Pitch: (i.e. sound wave frequency) is measured in hertz (Hz)

- The normal hearing range is 20 to 20,000 Hz

Loudness (i.e. sound wave amplitude) is measured in decibels

- The normal hearing range is 0 to 140 decibels – above this damage is likely to occur.

Sensitivity to sound is reduced with age and approximately 10% of the population have some form of hearing impairment.

Sound as Feedback

In real life auditory feedback often means success and silence failure. This is positive auditory feedback e.g. talking on the phone, starting a car, shutting a door.
Computers systems do this to some extent (e.g. keyboard clicks) but often give sound as (irritating) negative feedback (beep!). Some designers feel that more use of sound should be made for positive feedback.

''our software should give us constant small audible cues just like our keyboards. .. The program could issue a soft 'coo' every time the user entered valid input to a field. If the program didn't understand the input, it would remain silent and the user would be immediately informed of the problem…without embarrassment or ego-bruising.'' (cooper 1995)

When is sound a good choice for feedback and alert? BEEP BEEP!!!

- When urgent user response is required- people react more quickly to sound than visual cues. Reaction time to sound is approximately 150ms whereas reaction time to a visual signal is approximately 200ms.
- The information conveyed is short and is not needed to be referred to later
- The visual system is already overburdened (e.g. crowded screen)
- The user is moving about and may not be looking at a screen (UPS's)
- Sound will not be intrusive and distractive for other users

Quick Quiz Question 3

Approximately what percentage of the population suffers from some hearing impairment?

Touch

Skin contains different types of nerve endings that are sensitive to pressure, temperature and pain. In everyday life touch is a very important sensation and it would be difficult to carry out even simple actions such as picking up an object without the feedback of the sensation of pressure. Touch can also be trained to be highly accurate (e.g. reading Braille).

In computer systems tactile feedback (using the sense of touch) is important in the use of input devices such as keyboards and mice. For example, it is much more difficult to type accurately using a keyboard where the keys don't physically move. Apart from this sort of immediate feedback touch is not used very much for computer output. This may change in the future, as virtual reality systems and mobile computing become more commonplace.

Taste and Smell

Neither taste nor smell are as highly developed in humans as in many other animals. At present not used in Human-Computer Interaction. In the future it is possible that taste and smell may be used for entertainment purposes (e.g. the smell of a virtual rose in a virtual garden) but it seems unlikely that they will ever play a major part in HCI.

Summary

This lecture has discussed the need to understand human capabilities and limitations and has looked in some detail at the five human senses of vision, hearing, touch, taste and smell.

Having completed it you should:

- Be able to explain the need for HCI practitioners to understand human capabilities and limitations
- Describe the nature of the five human senses and discuss their importance in HCI

Tutorial Exercises

1. Reading text from the screen is more difficult than reading it from a printed page. Find one or more references on the web (try www.useit.com) about designing screen text to be legible. What are the main recommendations? Experiment with designing web pages with different fonts and colours to see if you agree with the recommendations.

2. Imagine you are to redesign the email client that you normally use for use by people who are completely unable to see. Think about the various visual elements of the interface (e.g. menu options, the list of messages received detailed text of the messages, message attachments, indication of system status etc). How might you replace these visual elements by auditory ones?

3. It is possible to conduct experiments to investigate peripheral vision. For example you can move objects from behind someone's back so that they gradually move into their filed of view,. Design and conduct an experiment to determine the filed of vision for recognising the following colours: red, green, blue, purple, yellow, white and black. Does it seem to vary from person to person?