

HCI-3- HUMAN CAPABILITIES AND LIMITATIONS (MENTAL)

Aims and Objectives: this is the second of the three lectures focusing on the understanding of human limitations and capabilities and their implications for HCI. The first of the three lectures looked at the five human senses as information input channels. In order for information about the outside world to be useful it must be processed once it has been perceived and so this second lecture looks at human mental capabilities and limitations. We focus particularly on human memory.

Lecture Notes

Mental Capabilities and Limitations

Using a computer system requires a high level of mental activity. For example we typically need to:

- Learn and remember how to use the system (e.g. which menu item use in a particular situation)
- Work out how to achieve a particular task (e.g. to calculate the average mark for a class of students using a spreadsheets)
- Interpret messages (e.g. what the implications of some error messages are)
- Solve problems (e.g. what to do when you have deleted something you didn't mean to).

These sorts of activity rely on and are influenced by various mental capabilities and characterised including:

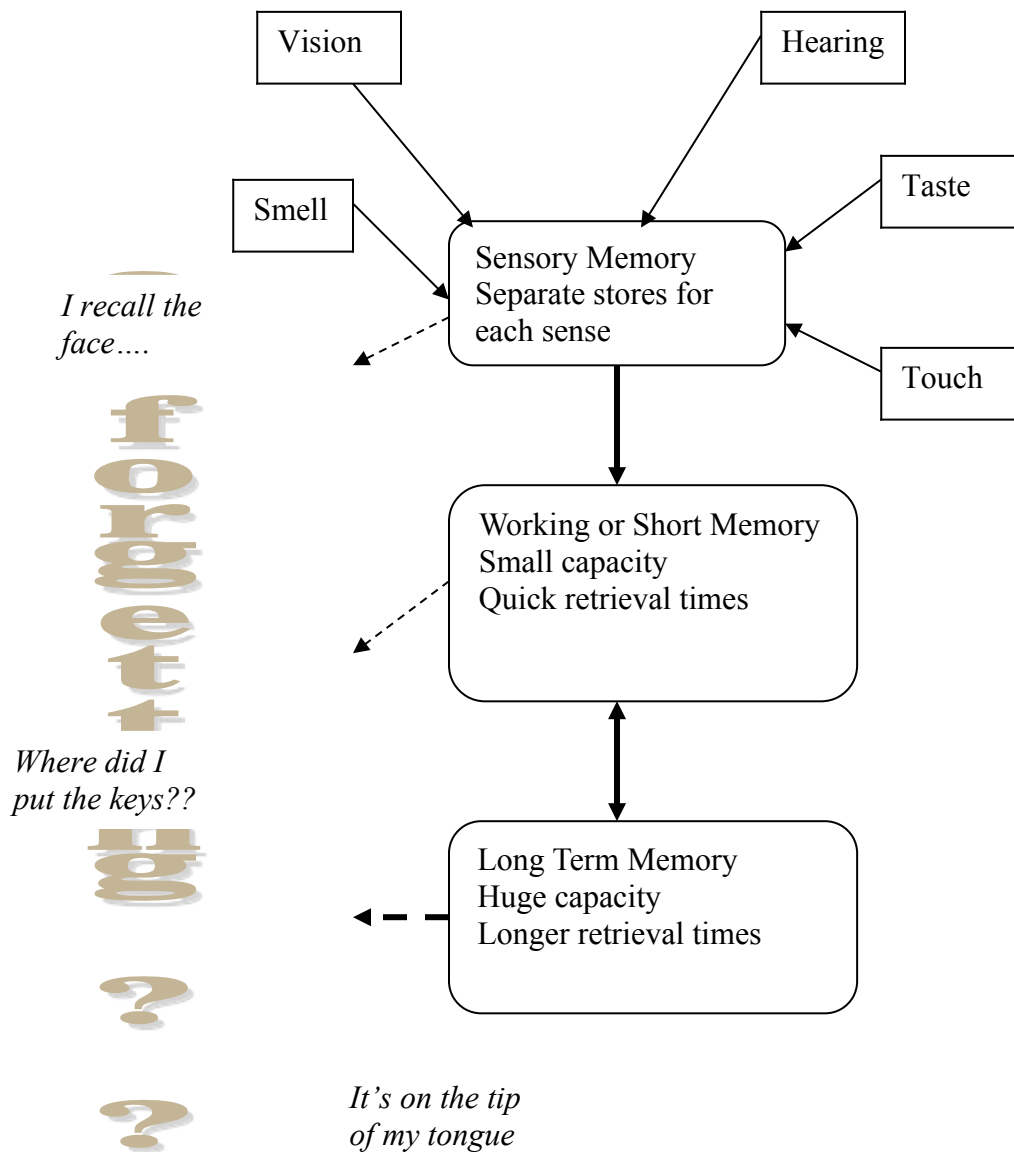
- reasoning and problem solving ability
- personality and motivation
- attention and concentration
- memory

For the purposes of study it is useful to separate mental capabilities from physical ones such as the five senses that we looked at the last lecture. It is however. Important to realise that to some extent this is an arbitrary distinction. For example the eye is sensitive to light but the brain interprets what is seen. Both are needed to make sense of the statement below.

WE LOVE BILL GATES

Because of its fundamental importance we will focus on human memory in this lecture and ignore the other mental capabilities (e.g. reasoning) mentioned above. We will look at the structure and characteristics of memory and the review the implications of these for the design of computerised systems.

A simplified model of the structure of Human Memory



The diagram above shows the main divisions of human memory and how they are related. Each one is briefly described below.

Sensory memory

Sensory memory is like a set of initial input buffers for the information coming in via the five senses. Experiments have shown that there are separate stores for each of the input channels (e.g. iconic memory of sights, echoic memory for sounds etc). Filtering of stimuli occurs so that not everything received gets transferred into short term memory. Stimuli that are particularly strong (e.g. a loud noise) or are something we are concentrating on (e.g. the amber light when waiting for the traffic lights to change) or seem significant to us (hearing our own name mentioned across the room) are most likely to gain our attention. Other stimuli may be over written almost immediately by new incoming sensations.

Working on Short Term Memory

This is like a scratch pad where things must be held for current processing. Short term memory has very limited capacity so that if information isn't transferred very quickly to long-term memory it will be lost. Experiments by Miller in the 1950's established that people are generally able to hold 7 plus or minus 2 pieces of information in their working memory at any one time. This effect is influenced by chunking of data. For example it is probably more difficult to remember the 11 digit number 97334783352 than a number of equivalent length that is divided up like a phone number e.g. 01813327856.

As well as being of limited size. Short term memory is also, as the name suggests of limited persistence. For instance, when you look up an unfamiliar telephone number in a directory, unless you write it down or dial it immediately you are likely to forget it. The fact that having dialled it you are also likely to forget the number very quickly illustrates other characteristics of short term memory, which is that of closure. Because we are all aware of the limited nature of our short term memory we tend to feel stressed by the need to hold things in it. In such situations we subconsciously want to complete the task that requires us to remember something so that we feel safe to forget it and are ready to load our memory up ready for the next task. The cue that it is now safe to forget something (i.e. flush out short-term memory) is what is termed closure. For example, when we are reading, to make sense of a sentence it is necessary to hold all of its meaning (if not all of its individual words) in memory at the same time. Closure in this case is given by reaching the full stop. We use it as a signal that we have got to the end of the sentence, understood it and are now ready to process the next one.

Long Term Memory

Long term memory is virtually infinite in capacity. So unfortunately “Please Miss, my brain is full” is not a good excuse to leave a lecturer! The length of time it takes to retrieve something from the term memory is variable. It can be very quick (e.g. “what is your name?”) or may take a few seconds or minutes or even days (e.g. “I’ve just remembered that name of that movie actor I was trying to tell you about yesterday”).

Things are “forgotten” when their memory becomes inaccessible. Whether they are still stored somewhere in the brain becomes irrelevant if it is no longer possible to retrieve them. It is interesting that we don’t have total conscious control over what is remembered and what is forgotten. We have all been in exams desperately trying to remember some vital fact that just won’t come to mind. Equally, we have probably all done or said things that we somehow can’t help but remember even when we’d much rather forget.

One conscious technique that we often use to try to push things from short term memory into long term is rehearsal. In rehearsing things we go over and over them again until somehow they stick in memory. Some things stick much easier than others do.

The next section looks at some of the characteristics of memory in more detail.

Quick Quiz Questions 1

What is meant by the following terms:

- a) Closure
- b) Chunking

Some Features of memory

First of all a brief experiment, with you as the subject! In a moment (but not yet) turn to the list of words at the end of this lecture and read it for about 40 seconds. Then turn the page over, wait a few seconds and try to write down as many of the words as you can remember. Check your answer and then turn back to here and continue reading the lecture notes.

OK – turn to the list now

Make a note on the original list of the ones you remembered correctly.

What the experiment is meant to show

The experiment was hardly carried out under controlled scientific conditions so it is possible that it hasn't shown any of the things it was meant to. Anyway, here we will discuss what it was meant to illustrate and you can judge whether it did or not.

Words remembered are likely to be affected by the following:

- **Primacy effect**

Words at the beginning of the list may get recalled because you may have rehearsed the first one or two words in the list so that they enter long term memory.

- **Recency effect**

Words at the end of the list may get remembered better because they are still in short term memory when you come to write them down

- **Significance or emotional impact**

Words that have personal significance (e.g. name of your home town) or strong emotional impact (good or bad) are likely to go into long term memory

- **Meaning aids memory**

Words whose meanings are unknown are especially difficult to remember. For instance not everyone knows that psittacine is a disease of parrots and may find it difficult to recall. On the other hand the fact that it is such a strange word amount other hand the fact that it is such a strange word among other rather ordinary ones may make it stand out in the case.

- **Multiple coding aids memory**

For example meanings given as both word and sound are more likely to be recalled. In the list there is one word where the meaning is represented visually as well as in the meaning of the word. Did you remember it? Another effect of this is that it is easier to remember words for objects than words for concepts. This is because we often visualise the objects and so have the memory of the image reinforcing the memory of the word itself.

Other Characteristics of Memory

- **Prompts aid recall**

Memory can be prompted. So if I say that there was a word in the list meaning a drink beginning with ‘L’ you are more likely to remember it than with no prompt.

- **Recognition is easier than recall**

For instance if I ask the word ‘quake’ appeared in the list you are more likely to be able to answer accurately than you were to remember it correctly in the first case.

- **Chunking**

We already discussed this effect sort term memory. It means that the capacity of memory can be increased if information is grouped into **chunks**.

e.g 0121 440 5022 versus - 01214405022

pop lup tig versus ptloiugpp

- **Similarity of the recall situation to the learning one**

You are more likely to recall something when in a similar location or state of mind to the one in which you learned it. For example, a common experience is to go from one room to another to get something but find that you have forgotten what it was you wanted. You go back to the first room and ‘find’ the memory.

Are there any implications of this effect for exam revision?

- **Mood and environment**

It is easier to store and recall memories when happy and in a relatively stress free environment. This is one of the things that make recalling things in an exam particularly difficult.



- **Learning during sleep**

Unfortunately it doesn't happen

Quick Quiz Question 2

List six things that affect how easy it is to remember something

Implications of Memory Capabilities and Limitations for HCI

We have now discussed the nature in quite a bit of detail. It is now time to consider the implications for designing systems.

Most people dislike having their memory over-stretched and are likely to make errors if it is. So in general the design of an interface should reduce the need for the user to remember things. Where things must be remembered then the design of the system should:

- aid learning
- aid recall

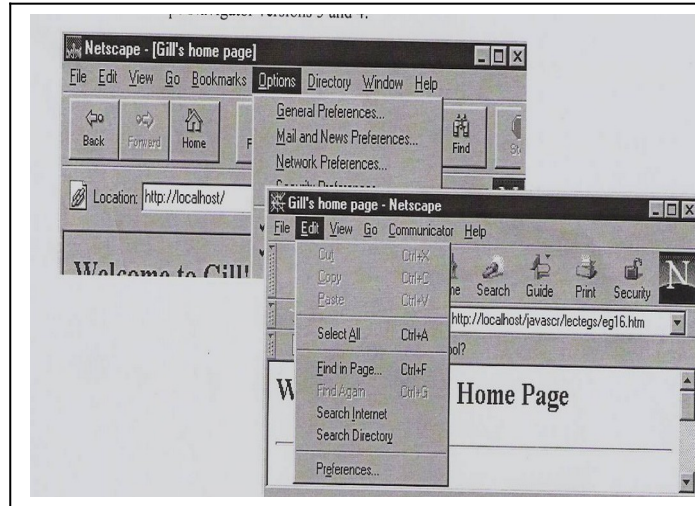
Some Interface Guidelines Based on memory Capabilities and Limitations

1. Maintain Consistency

It is easier to remember things when consistency is maintained. For instance this can be consistency of data formats (e.g. for date entry) or consistency of action (e.g. the action to delete something). The consistency can be:

- Within a system – e.g. it would be confusing to have to enter a date in mm/dd/yy format in one part.

- Across versions of a piece of software. Software producers often change things considerably between versions of a piece of software. It may well be that these changes are improvements but they are very confusing for existing users. For example the “preferences” option swapped menus between Netscape Navigator versions 3 and 4.



- Between software /systems



Notice the three different icons used by these systems for the “paste” operation. Does this make it easier or more difficult to remember?

2. Reduce the Burden on user’s Working Memory

Any example of the sort of thing not to do is this example of a badly designed student records system

To view details for a particular named student the user has to look up their 8 digit registration number on a list screen. Then enter it into another screen to pull up the full details.

It would obviously be much better to allow the user to select the record from the list screen and request the detail rather than have to remember and then re-enter the registration number.

3. **Make use of the user's ability to recognise rather than recall**

For example use menus rather than the user having to learn a series of commands.

4. **Give users cues about what to do next**

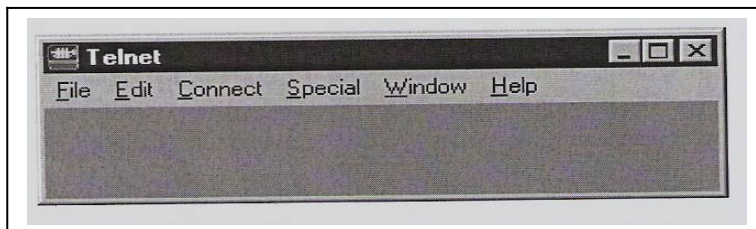
It is especially important to guide novices in this way. It should be possible to turn off such prompts for expert users.

5. **Make Items Meaningful**

Make use of meaningful menu items, icons and options as these:

- are easier to memorise
- act as memory prompts to aid recall of their purpose

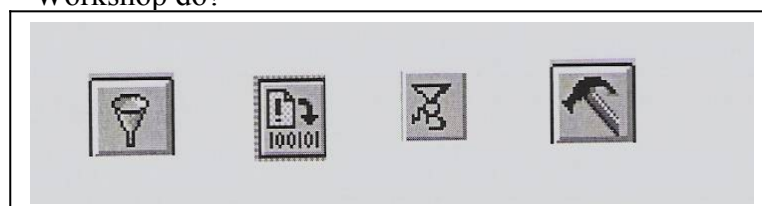
For example it should be easy to remember where to find a particular menu item.



Which menu is the option to print under?

Designing meaningful icons for some things can be even more difficult than meaningful menu items.

- What do these icons from WinEdit, Borland C++ and Microsoft Help Workshop do?



- How can the problem of obscure icons be tackled?
- Provide good documentation both on and off-line

Of-course!

QUICK QUIZ QUESTION 3

One guideline for HCI is to make the interface consistent. One aspect of this is to make things consistent between different parts of a system. What other things should be thought about in considering consistency?

Summary

This lecture has discussed human memory in some detail. It has looked at the structure and nature of memory and then considered how this should be taken into account when designing systems.

Having completed it you should:

- Be able to describe the structure and nature of human memory
- Be able to apply your knowledge of human memory in order to evaluate a given system or to design a new one.

Tutorial Exercises

1. Consider the web browser that you normally use. In order to use it what things do you need to be able to remember? Identify whether or not and in what ways the system complies with each of the guidelines given in the lecture notes.
2. The lecture included an experiment to illustrate some of the characteristics of memory. Devise an experiment to investigate the effect of chunking and try it out on your friends or colleagues.

When told to in the notes read through the list below:

mug
erase
hat
vague
psittacine
examination
lemonade
cough

Italics
disparate
accra
faith
maggot
logical
cowboy
quake