

HUMAN-COMPUTER INTERACTION **THIRD EDITION** **DIX FINLAY ABOWD BEALE**

chapter 1

the human

part 2

(modified extract for AISD 2005)

HUMAN-COMPUTER INTERACTION

Memory

There are three types of memory function:

Sensory memories

↓ **Attention**

Short-term memory or working memory

↓ **Rehearsal**

Long-term memory

Selection of stimuli governed by level of arousal.

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sensory memory

- Buffers for stimuli received through senses
 - iconic memory: visual stimuli
 - echoic memory: aural stimuli
 - haptic memory: tactile stimuli
- Examples
 - “sparkler” trail
 - stereo sound
- Continuously overwritten

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Short-term memory (STM)

- memory of the just present
- invaluable
- information is retained in automatically
- info is retrieved without effort
- limited and fragile

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Short-term memory (cont)

- Scratch-pad for temporary recall
 - rapid access ~ 70ms
 - rapid decay ~ 200ms
 - limited capacity - 7 ± 2 chunks

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Examples

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HEC ATR ANU PTH ETR EET

Long-term memory (LTM)

- memory for the past
- invaluable
- information is retained through rehearsal
- information is retrieved with effort
- interpretation, organisation
- unlimited

Long-term memory (cont)

- memory for arbitrary things
 - rote learning, e.g. alphabet, the multiplication table
- memory for meaningful relationships
 - meaningful structure can organise what may seem arbitrary
- memory through explanation
 - understanding
 - mental models

Long-term memory (cont)

- Declarative memory
 - stores facts and events
 - standard textbook learning
 - pair: stimulus – response
 - can be put into words
- Procedural memory
 - skills and procedures
 - "how to" knowledge
 - difficult to verbalise
 - very durable

Long-term memory (cont)

- 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

Long-term memory (cont)

Semantic memory

- facts and concepts, meanings and understandings
- storage requires rehearsal

Episodic memory

- autobiographical memories
- explicit memory of events
- narratives, includes time, space and emotions
- easy to store

Long-term memory structures

- Semantic networks
- Slots
- Frames
- Scripts

Long-term memory (cont)

- Semantic memory structure
 - provides access to information
 - represents relationships between bits of information
 - supports inference
- Model: semantic network
 - inheritance – child nodes inherit properties of parent nodes
 - relationships between bits of information explicit
 - supports inference through inheritance

LTM - semantic network



Models of LTM - Frames

- Information organized in data structures
- Slots in structure instantiated with values for instance of data
- Type-subtype relationships

| DOG | COLLIE |
|-------------------|----------------|
| Fixed | Fixed |
| legs: 4 | breed of: DOG |
| Default | type: sheepdog |
| diet: carnivorous | Default |
| sound: bark | size: 65 cm |
| Variable | Variable |
| size: colour | colour |

Models of LTM - Scripts

Model of stereotypical information required to interpret situation

Script has elements that can be instantiated with values for context

| Script for a visit to the vet | | | |
|-------------------------------|---|---------|---|
| Entry conditions: | <i>dog ill</i> <i>vet open</i> <i>owner has money</i> | Roles: | <i>vet examines</i> <i>diagnoses</i> <i>treats</i> <i>owner brings dog in</i> <i>pays</i> <i>takes dog out</i> |
| Result: | <i>dog better</i> <i>owner poorer</i> <i>vet richer</i> | Scenes: | <i>arriving at reception</i> <i>waiting in room</i> <i>examination</i> <i>paying</i> |
| Props: | <i>examination table</i> <i>medicine</i> <i>instruments</i> | Tracks: | <i>dog needs medicine</i> <i>dog needs operation</i> |

Models of LTM - Production rules

Representation of procedural knowledge.

Condition/action rules

if condition is matched
then use rule to determine action.

IF dog is wagging tail
THEN pat dog

IF dog is growling
THEN run away

Long-term memory processes

- Storage or remembering
- Forgetting
- Information retrieval

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 - 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 memory is selective ...

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

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

Thinking

Reasoning

deduction, induction, abduction

Problem solving

Deductive Reasoning

- Deduction:
 - derive logically necessary conclusion from given premises.
 - e.g. If it is Friday then she will go to work
It is Friday
Therefore she will go to work.
- Logical conclusion not necessarily true:
 - e.g. If it is raining then the ground is dry
It is raining
Therefore the ground is dry

Deduction (cont.)

- When truth and logical validity clash ...
 - e.g. Some people are babies
Some babies cry
Inference - Some people cry
Correct?
- People bring world knowledge to bear

Inductive Reasoning

- Induction:
 - generalize from cases seen to cases unseen
e.g. all elephants we have seen have trunks
therefore all elephants have trunks.
- Unreliable:
 - can only prove false not true
- ... but useful!
- Humans not good at using negative evidence
e.g. Wason's cards.

Wason's cards

7 E 4 K

If a card has a vowel on one side it has an even number on the other

Is this true?

How many cards do you need to turn over to find out?

.... and which cards?

Abductive reasoning

- reasoning from event to cause
e.g. Sam drives fast when drunk.
If I see Sam driving fast, assume drunk.
- Unreliable:
 - can lead to false explanations

Problem solving

- Process of finding solution to unfamiliar task using knowledge.
- Several theories.
- Gestalt
 - problem solving both productive and reproductive
 - productive draws on insight and restructuring of problem
 - attractive but not enough evidence to explain 'insight' etc.
 - move away from behaviourism and led towards information processing theories

Problem solving (cont.)

Problem space theory

- problem space comprises problem states
- problem solving involves generating states using legal operators
- heuristics may be employed to select operators
e.g. means-ends analysis
- operates within human information processing system
e.g. STM limits etc.
- largely applied to problem solving in well-defined areas
e.g. puzzles rather than knowledge intensive areas

Problem solving (cont.)

- Analogy
 - analogical mapping:
 - novel problems in new domain?
 - use knowledge of similar problem from similar domain
 - analogical mapping difficult if domains are semantically different
- Skill acquisition
 - skilled activity characterized by chunking
 - lot of information is chunked to optimize STM
 - conceptual rather than superficial grouping of problems
 - information is structured more effectively

Errors and mental models

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

Emotion

- Various theories of how emotion works
 - James-Lange: emotion is our interpretation of a physiological response to a stimuli
 - Cannon: emotion is a psychological response to a stimuli
 - Schacter-Singer: emotion is the result of our evaluation of our physiological responses, in the light of the whole situation we are in
- Emotion clearly involves both cognitive and physical responses to stimuli

Emotion (cont.)

- The biological response to physical stimuli is called *affect*
- Affect influences how we respond to situations
 - positive → creative problem solving
 - negative → narrow thinking

“Negative affect can make it harder to do even easy tasks; positive affect can make it easier to do difficult tasks”

(Donald Norman)

Emotion (cont.)

- Implications for interface design
 - stress will increase the difficulty of problem solving
 - relaxed users will be more forgiving of shortcomings in design
 - aesthetically pleasing and rewarding interfaces will increase positive affect

Individual differences

- long term
 - sex, physical and intellectual abilities
- short term
 - effect of stress or fatigue
- changing
 - age

Ask yourself:
will design decision exclude section of user population?

Psychology and the Design of Interactive System

- Some direct applications
 - e.g. blue acuity is poor
 - ⇒ blue should not be used for important detail
- However, correct application generally requires understanding of context in psychology, and an understanding of particular experimental conditions
- A lot of knowledge has been distilled in
 - guidelines (chap 7)
 - cognitive models (chap 12)
 - experimental and analytic evaluation techniques (chap 9)