User Centered Design

[2] Human Factors

Dr. Agnes Lisowska Masson
Human-IST Institute, University of Fribourg
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HUMAN-IST
HUMAN CENTERED INTERACTION SCIENCE & TECHNOLOGY

UNI FR

Different humans

- Why does it matter?
  - Physical differences
  - Different attitudes
  - Different habits

The human in HCI

- Which aspects of being human matter for HCI?
  - Physiology – the body
  - Cognitive processes – how people think
  - Emotions – how people feel
  - Society – how their surroundings influence them

Physiology

- Ideally: know how the body works
  - Alternative: understand the consequences and their implications for HCI
- Our body parts act as input/output channels
- Main sources
  - Vision
  - Hearing
  - Touch/feeling
  - Movement

Physiology – Vision

- Vision helps us
  - Interpret images/depth/dimensions and distance
  - Coordinate actions (hand-eye coordination)
  - Interpret colour
  - Compensate for movement
- Some general rules
  - We're good at detecting movement in peripheral vision
  - Further something is from the point of focus, the harder it will be to notice
  - Expectations affect how an image is perceived

Physiology - Vision

The quick brown

fox jumps over the

the lazy dog.

Physiology - Vision

- We perceive things differently depending on the context

Image source: Human Computer Interaction – Dix et al.

Physiology - Vision

- We perceive things differently depending on the context

Image source: Human Computer Interaction – Dix et al.

Physiology – Vision

- Colour blindness
  - Men: 1 out of 12
  - Women: 1 out of 100
- Why it happens
  - Damage to one or more cones
  - Is usually hereditary
- Different types exist
  - Red-Green
  - Blue-Yellow
  - Total

Physiology – Vision








Deuteranope (Red/Green)

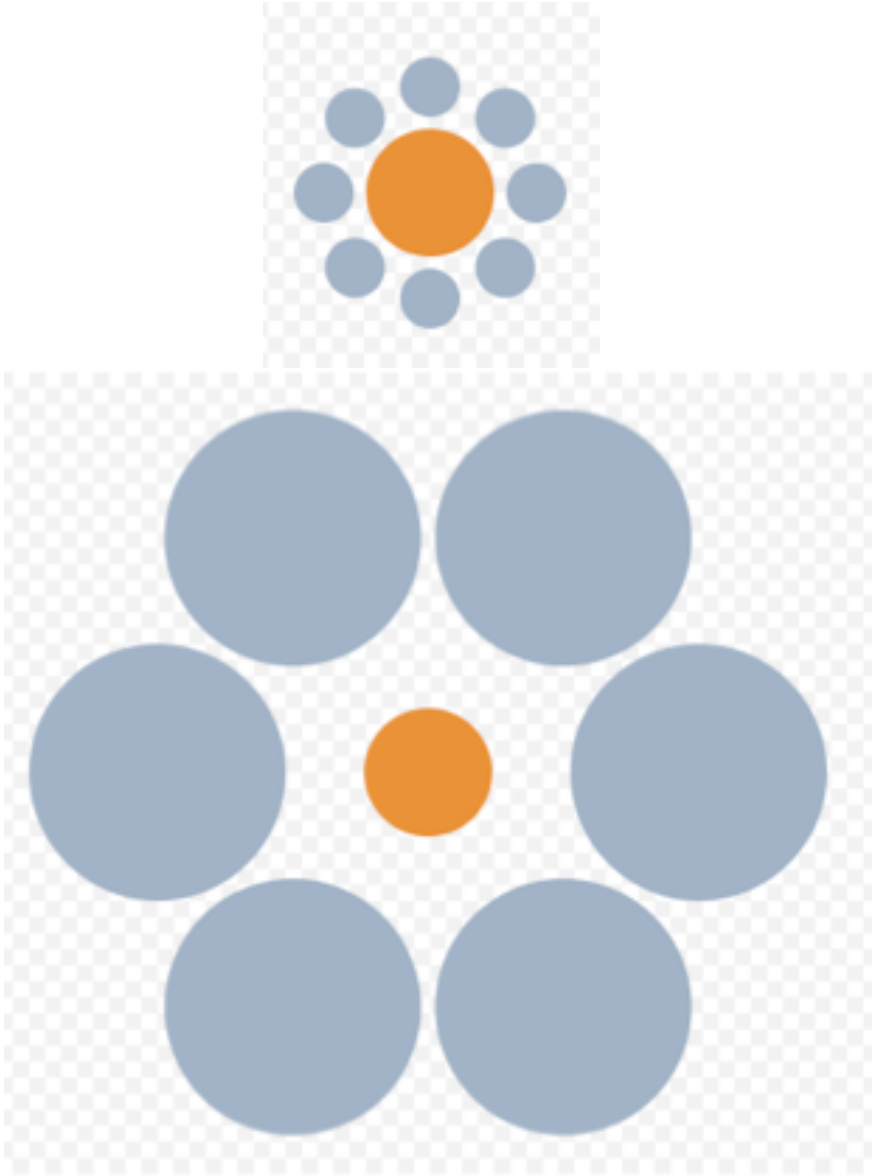
Protanope (Red/Green)

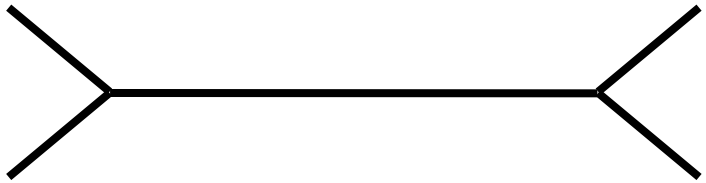
Tritanope (Blue/Yellow)

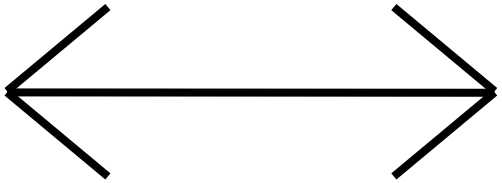
Monochromacy

Image source: http://health.howstuffworks.com/human-body/systems/eye/colorblindness2.htm

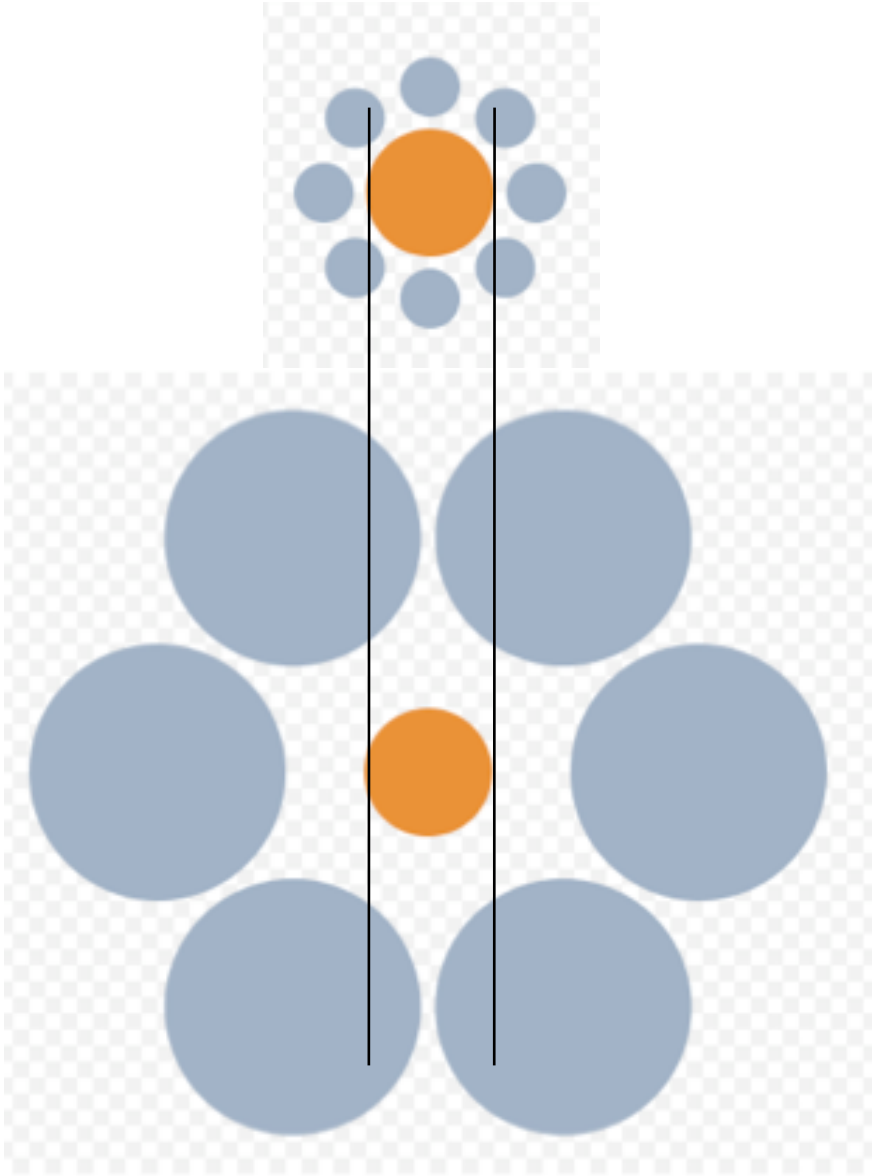
Physiology – Vision

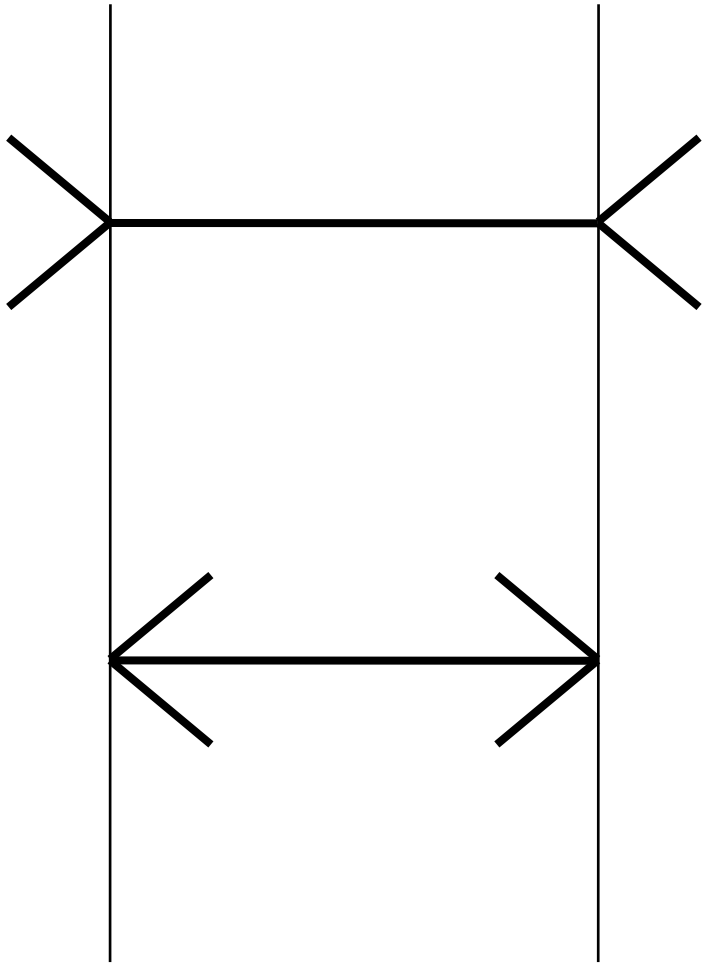




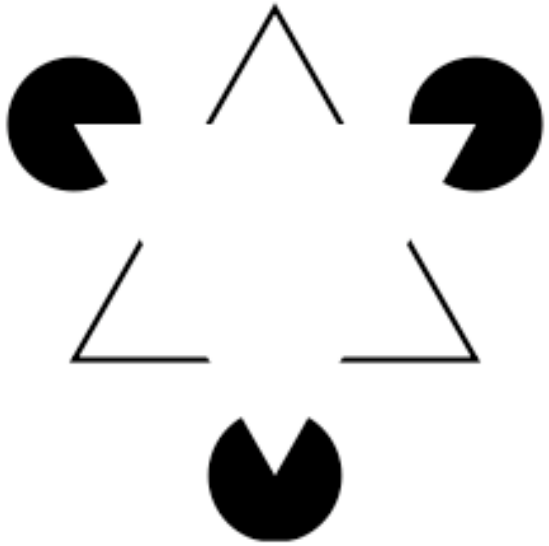


Physiology – Vision

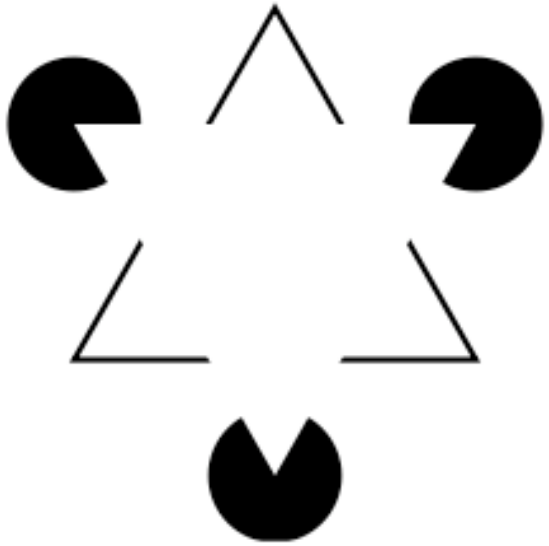


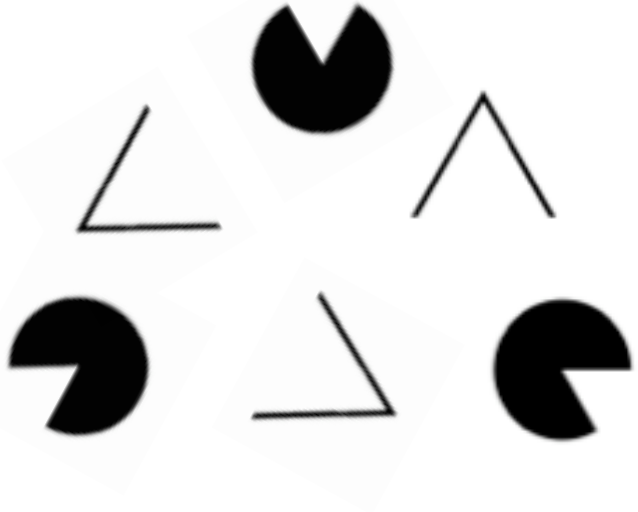


Physiology – Vision



Physiology – Vision





Physiology – Vision

- Optical illusions
  - We tend to see the center of the page as a bit above the actual center (optical center)
  - Perception of size is not completely reliable
  - Geometric shapes
    - ✓ square to appear square – slightly increase in height
    - ✓ lines will appear thicker if horizontal rather than vertical

Physiology – Vision

- Reading
  - Recognize familiar words using shape of the word
    - ✓ CAPITAL LETTERS make words harder to read
  - Patterned or textured backgrounds dramatically reduce readability
  - Contrast
    - ✓ dark characters on light background (or vice versa) increases legibility
    - ✓ contrast of over 70% is best
  - Line length
    - ✓ 2.3 inches (58mm) and 5.2 inches (132mm) are equally readable

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  - Size and spacing
    - ✓ fonts from 9-12 are equally readable **if** you have correct spacing
      - Hello world (9)
      - Hello world (10)
      - Hello world (11)
      - Hello world (12)

Physiology - Hearing

- Hearing helps us
  - Measure distance and direction
  - Differentiate between sounds
- Good to know
  - Selective hearing (cocktail party effect)
  - Can differentiate very subtle changes in sound
  - Can recognize familiar sounds without concentrating on the source

Physiology – Touch/Feeling

- How it helps us:
  - Feedback mechanism
- Information comes from a variety of different receptors
  - 3 sensory receptors
    - ✓ thermoreceptors - hot/cold
    - ✓ nociceptors – intense pressure, heat, pain
    - ✓ mechanoreceptors – pressure
      - – stop responding when continuous pressure is applied
      - – react more quickly when pressure is increased
- Kinesthesis
  - Awareness of body and limb position
    - ✓ affects comfort and performance

Physiology – Movement

- Reaction time ≠ movement time
- Reaction times
  - Difference between signals
    - ✓ auditory – 150ms
    - ✓ visual – 200ms
    - ✓ pain – 700ms
  - Combined signals gives faster response
  - Skill and practice can reduce reaction time, fatigue can increase it

Physiology – Movement

- Accuracy
  - Increased reaction time can reduce accuracy
    - ✓ not always case with people with skilled actions
- Speed and accuracy
  - Time to hit target = function of target size and distance to cover
  - More difficult to manipulate small objects
    - ✓ better to make targets large and distance small

Physiology – Affecting factors

- Factors that affect physiology
  - Individual differences
    - ✓ physical capabilities: reach, height, eyesight, hearing, motor control etc
    - ✓ intellectual capabilities: memory, problem solving etc.
    - ✓ variant: age
  - Fatigue and stress – mental, physical (RSI)
  - Physical limits to what you can do with your body
    - ✓ in general, comfortably, repeatedly
  - Environment
    - ✓ lighting conditions (vision)
    - ✓ temperature (emotion/mood)
    - ✓ noise (hearing)
    - ✓ distance (vision)

Cognition – Processes and frameworks

- Cognition
  - How we think
- Cognition Processes
  - Attention
  - Perception
  - Memory
  - Learning/acquiring skills
  - Reasoning
  - Problem solving

Cognition - Attention

- Definition
  - Ability to focus on only one of a number of competing stimuli
- Involves auditory and visual senses
- We can selectively focus
  - Choice influenced by interest and/or need
- How easy it is to focus depends on
  - Clear goals
  - Information needed is salient in surroundings
- Good to know:
  - Easier to do two things at the same time when they use different stimulus/response modalities
    - ✓ e.g. speaking and driving easier than reading and driving

Cognition - Perception

- Definition
  - Getting information about the environment using our senses, and transforming it into experiences
- Good to know
  - Make perception easier by presenting information in an appropriate form
    - ✓ form helps us recognize underlying meaning

  - Unexpected results can create sense of deception
    - ✓ e.g. lip synching – sound not in synch with mouth movements

Cognition - Memory

- 3 different types
  - Sensory
  - Short term
  - Long term
- Sensory
  - Constantly overwritten
  - One for every input channel
    - ✓ iconic – visual
    - ✓ echoic – aural
    - ✓ haptic – touch
  - Proof of existence
    - ✓ iconic – moving sparklers
    - ✓ echoic – questions while reading

Cognition - Memory

- Short-term
  - Temporary recall of information
    - ✓ reading, simple math, etc.
  - Can be accessed rapidly
  - Decays rapidly
  - Recency effect
    - ✓ recent things easier to remember
  - Recall damaged by interference from another source
    - ✓ but only if interference is on the same channel
      - – i.e visual memory is interrupted by a reading task

Cognition - memory

- Short-term
  - Limited capacity
    - ✓ chunking – can increase capacity
      - 7 +/- 2 digits/chunks = average digit span
        - 0041263009286 (13 chunks)
        - 00 41 26 300 9286 (5 chunks)
        - applies to things that need to be recalled, not visualized
    - ✓ pattern abstraction
      - telephone: area code city code number …
        - 41 26 300 9286 vs. HG AT ANB EWRE

Cognition - Memory

- Long Term
  - Factual information, experiential knowledge, procedural rules
  - Huge capacity
  - Slow access time
  - Little decay
  - Context dependant (encoding specificity)
  - Different functions
    - ✓ declarative memory
      - knowledge that
      - can express it with words
    - ✓ procedural memory
      - knowledge how
      - knowledge that can be expressed non-verbally

Cognition - Memory

- Long Term
  - 2 types
    - ✓ episodic
      - memory of events and experiences
    - ✓ semantic
      - record of facts, concepts, skills etc
      - derived from episodic memory
      - structured
        - access to relationships between pieces of information
        - allows for inference

Cognition – Memory

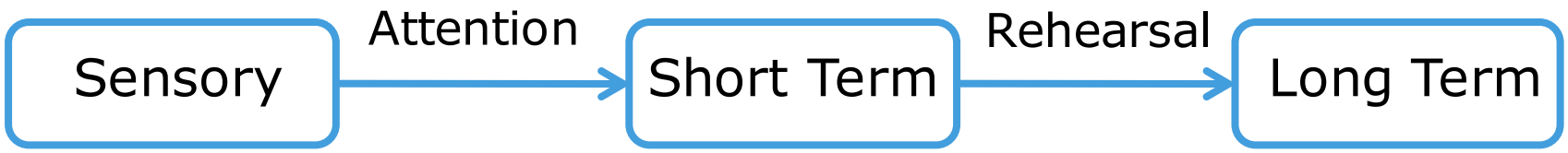
- 3 processes
  - Storage
    - ✓ total time hypothesis
      - ‘amount learned is directly proportional to the amount of time spent learning’
    - ✓ learning more effective if distributed over time
    - ✓ meaningful information is easier to remember
  - Forgetting
    - ✓ decay
      - logarithmic, rapidly at first, then slower
    - ✓ interference
      - acquiring new information causes loss of old information
        - e.g. home phone number
    - ✓ tend to remember positive and highly emotional events

Cognition – Memory

- 3 processes
  - Retrieval
    - ✓ recall – information reproduced from memory
      - – easier if
        - ○ things are categorized
        - ○ person makes own categories
      - – visualization helps
    - ✓ recognition – presentation of information shows it's been seen before
    - ✓ people better at recognition than recall
    - ✓ people good at remembering visual cues

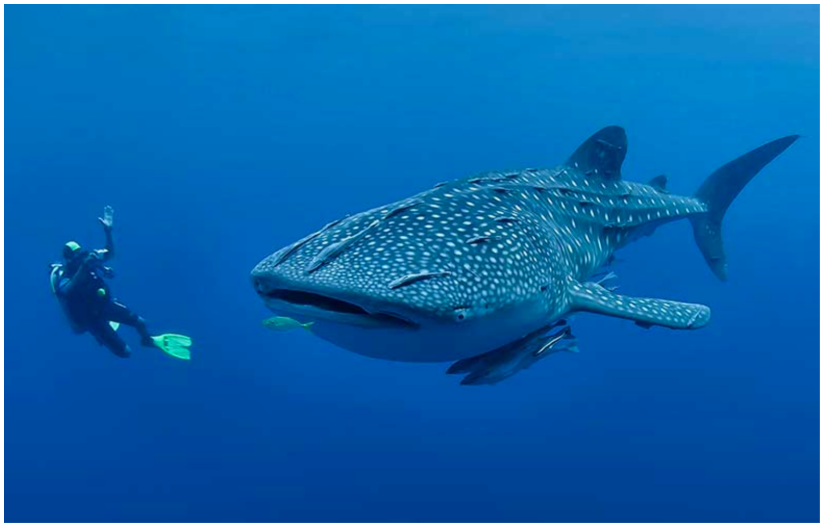
Cognition - Memory

- Model of memory structure and process



Cognition - Learning

- Novices and experts chunk/group information differently
  - Novices – superficial characteristics
  - Experts – underlying conceptual similarities
- Novices
  - Limited knowledge, make assumptions, user trial and error, explore
  - Slow, make errors, can be inefficient, irrational
- Experts
  - Knowledge, experience, strategies, think ahead, consider consequences



Cognition - Learning

- Model of skill acquisition (Dix et al. pg 47)

1. Learner uses general-purpose rules which interpret facts about a problem

Proceduralization

2. Learner develops rules specific to the task

Generalization

3. Rules are tuned to speed up performance

Cognition – Reasoning

- Definition
  - ‘the process by which we use the knowledge we have to draw conclusions or infer something new about the domain of interest’ [Dix et al. pg. 40]
  - 3 different types
    - ✓ Deductive
      - logically necessary conclusion derived from a set of given premises
      - has to be logical but doesn’t have to be true
        - example:

          Everyone who uses a computer is a programmer.

          John uses a computer.

          Therefore, John is a programmer

Cognition – Reasoning

- 3 different types (cont.)
  - ✓ Inductive
    - infer information about a new case by generalizing from known cases
    - can never prove this type of reasoning, only disprove it
    - Example:

      All of the swans I have seen are white.
      Therefore all swans are white.

  - ✓ Abductive
    - infer something to be the cause of something else
    - used to derive explanations of events we observe

Cognition – Problem Solving

- Definition
  - Using what we know to find the solution for an unfamiliar problem
- 3 theories
  - Gestalt
    - ✓ problem solving is both productive and reproductive
      - productive – involves insight and restructuring the problem
      - reproductive – draws on previous experience
        - fixation can make it harder to solve a problem

Cognition – Problem Solving

- 3 theories
  - Problem space theory
    - ✓ initial state + goal state
    - ✓ generate intermediate states using legal state transition operations
      - use heuristics to find intermediate states (means-end analysis)
  - Analogy
    - ✓ mapping knowledge relating to a similar known domain to the new problem
    - ✓ hard to use unless
      - information is semantically close
      - analogy is pointed out to them

Cognition – Mental models

- Definition
  - A mental (internal) representation of how something works/happens based on experience with it
- Classification
  - Structural models – what is
    - ✓ detailed understanding of something
    - ✓ information about internal structure of the system
    - ✓ independent of specific task
    - ✓ e.g. knowing how a car works – engine, brakes etc.
  - Functional models – how to
    - ✓ properties of something needed to do a specific task
    - ✓ less time and effort to acquire and maintain
    - ✓ e.g. knowing how to drive a car – turn steering wheel, change gears etc.

Cognition – Mental models

- Multiple models for one system
  - Depends on number of tasks a system can do (email, word processing, spreadsheets etc)
- Incorrect mental model can cause errors
- People can have different mental models
  - Causes of differences
    - ✓ variations in situations that trigger the model
    - ✓ change over time

Cognition – Theory of action

- What are the stages we go through when we want to do something?
  - 7 stages of activity (Norman, 1986)
    1. Establish a goal
    2. Form an intention
    3. Specify an action sequence
    4. Execute an action
    5. Perceive the system state
    6. Interpret the state
    7. Evaluate the system state with respect to the goals and intentions

Source: Norman, 1986.

Emotions

- 2 aspects
  - Reaction to something relevant to our needs or goals
  - Involves physiological, affective, behavioral and cognitive components
- Emotions, moods, sentiments
  - Emotions
    - ✓ are intentional
    - ✓ imply and involve relationships
      - scared **of**, angry **at,** excited **about …**
  - Moods
    - ✓ non-intentional
      - can be caused by a specific object
      - experienced as more diffuse and general
  - Sentiment
    - ✓ assigned property of an object (not state of a person)
    - ✓ can persist indefinitely

Emotions - Effects

- Effects of emotions
  - Attention
    - ✓ tend to be absorbing
    - ✓ emotionally relevant thoughts tend to dominate conscious processing
    - ✓ pay more attention to things relevant to current mood
  - Memory
    - ✓ emotional events are better remembered
    - ✓ negative events are better remembered than positive
  - Performance
    - ✓ positive emotions enable creative thinking and solve complex problems
    - ✓ negative emotions trigger narrow focused thinking
  - Assessment
    - ✓ mood influences judgment and decision making
      - – person in a good mood will judge their work more positively
    - ✓ positive mood decreases risk-taking

Emotions - Causes

- Causes of emotions
  - Needs and goals
    - ✓ how much something helps or hinders reaching needs and goals effects emotional state
  - Appraisal theories
    - ✓ state of uncertainty can lead to negative emotions – need feedback
    - ✓ high control ➔ sense of challenge in positive situations
    - ✓ high control ➔ stress in negative situations
  - Moods and sentiments
    - ✓ 'an application that users like can do no wrong, whereas one that users dislike does everything to anger them, regardless of the application's actual behaviour' [Jacko et al., 2003]
  - Contagion
  - Previous emotional state

Emotions - Causes

- Causes of mood
  - Intense or repetitive emotional experiences
  - Anticipated emotion (based on sentiment)
  - Contagion
  - Colour
    - ✓ warm colours ➔ active feelings
  - Other
    - ✓ music
      - minor scales -> negative emotions
      - major scales -> positive
    - ✓ weather
    - ✓ temperature
    - ✓ sleep
    - ✓ food
    - ✓ lighting

Emotions - recognition

- Affect recognition by users
  - Constantly adjust interactions based on affect of interlocutor
  - Give precedence to non-verbal cues in judgments about affect
  - Can distinguish emotion in automated characters
  - Can distinguish emotion with 50% accuracy in text-to-speech (only 60% in human speech!)

Behaviour

- 9 common behaviour patterns relevant for HCI [from Tidwell, 2006]
  - Safe exploration
    - ✓ 'allows people to try something unfamiliar, back out, and try something else, without stress'
  - Instant gratification
    - ✓ 'people like to see immediate results from the actions they take'
  - Satisficing (satisfying + sufficing)
    - ✓ 'people are willing to accept 'good enough' instead of 'best' if learning all the alternatives might cost time and effort'
  - Changes in midstream
    - ✓ 'people change what they're doing in the middle of doing it'

Source: Tidwell, 2006

Behaviours

- 9 common behaviour patterns relevant for HCI [from Tidwell, 2006]
  - Incremental construction
    - ✓ ‘when people create things, they don’t usually do it all at once’
  - Habituation
    - ✓ ‘when one uses an interface repeatedly some frequently used physical actions become reflexive’
  - Spatial memory
    - ✓ ‘when people manipulate objects and documents, they often find them again later by remembering where they are, not what they are named’
  - Prospective memory
    - ✓ ‘plan to do something in the future and arrange some way to reminding ourselves to do it’
  - Other people’s advice
    - ✓ ‘as strong as our opinions may sometimes be, what our peers think tends to influence us’

Source: Tidwell, 2006

Attitudes

- Humans have social rules, strategies and expectations they tend to follow when interacting with other humans
- We apply rules to computers too
  - Overuse of human social strategies (gender, groups)
  - Overlearned social behaviour (politeness, reciprocity)
  - Premature cognitive commitment (specialist/generalist labels)
- Characteristics associated with the human 'prototype'
  - Words as output
  - Interactivity
  - Filling traditionally human roles

Source: Nass and Moon, 2000

Attitudes - Overuse of categories

- Gender stereotypes
  - Dominant behaviour by males well received, bad from females
  - Evaluation is 'move valid' when it comes from a male
  - Certain topics are more masculine or feminine
    - ✓ women know more about feminine topics
- Experiment
  - Computer with male or female voice
  - 3 tasks – tutoring, testing, evaluation
  - Results
    - ✓ female voiced evaluator less friendly even though content was identical
    - ✓ tutor computer more competent when praised by male-voiced computer than a female-voiced computer
    - ✓ female-voiced computer more informative about love and relationships, male-voiced computer more informative about computers

Source: Nass and Moon, 2000

Attitudes - Overlearning

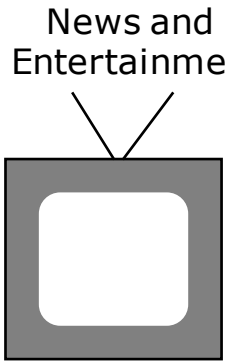
- Politeness
  - 'when an individual is asked to evaluate another person in a face-to-face setting the resulting evaluation tends to be more positively biased (we give polite evaluations so that we don't hurt the other person's feelings)'
  - Experiment
    - ✓ participants worked with computer A, then interviewed about A's performance (all text based)
    - ✓ interview was conducted by computer A, or computer B (which was identical to A)
    - ✓ Results
      - evaluations were more positive when computer asked about itself
      - people were polite to the computer!!!

Source: Nass and Moon, 2000

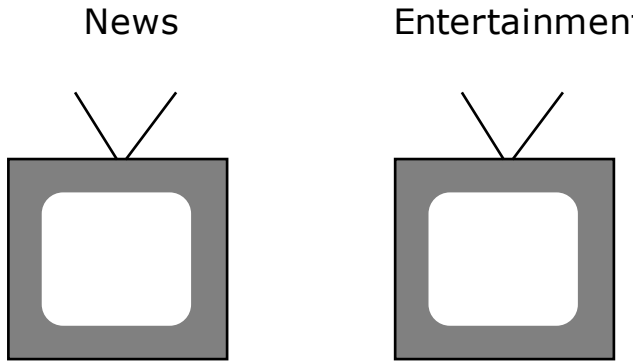
Attitudes – Premature commitment

- Premature cognitive commitment
  - Tend to assume that certain things will be true based on what we're told
  - Experiment
    - ✓ TV sets set up in 2 conditions, same tv segments shown in both conditions

Condition 1



Condition 2



  - Results
    - ✓ news of specialist tv was higher quality, more informative, more interesting
    - ✓ entertainment on specialist tv was funnier, more relaxing

Source: Nass and Moon, 2000

Other factors

- Culture (localisation)
  - How we perceive our environment
  - Social norms
    - ✓ behaviour, symbolism etc.
- Habituation
  - Tend to form habits that are hard to break

What you should know by now

- Which aspects of human physiology are relevant to HCI?
- How does each of the human 'input channels' influence interaction with technologies?
- Which cognitive processes are important for human-computer interaction?
- How do human memory, problem solving and reasoning skills work, and how are they important to the design of computer systems and technologies?
- How can the emotions and attitudes of a user influence how they perceive and interact with a technology?
- How can a person's surroundings influence their interaction with a system?

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