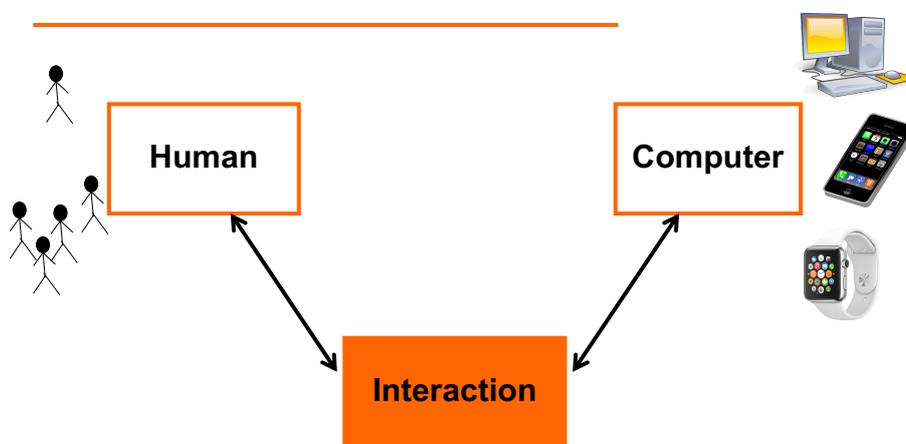

Evaluation Test (T1)

November 18, 14:30h

Interactive System components



Human

Human

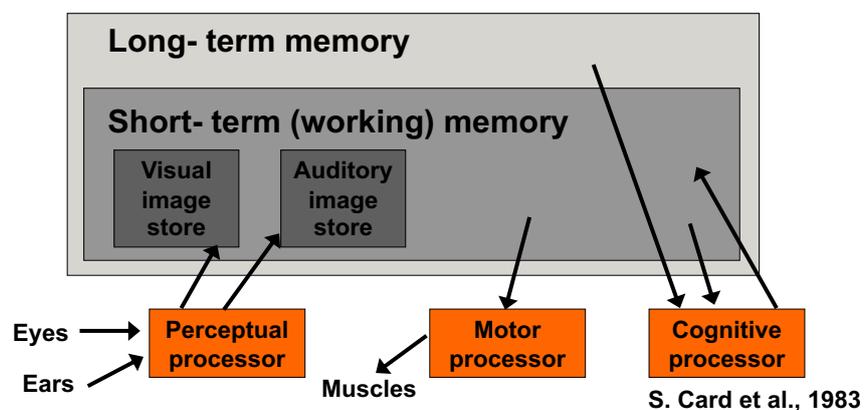
- **Human have limited capacities to process information**
- **The information is received and sent through several input/output channels:**
 - Visual
 - Auditory
 - Haptic
 - Movement
- **The information is stored in memory:**
 - Sensory memory
 - STM
 - LTM
- **The information is processed and applied:**
 - Reasoning
 - Problem solving
 - Knowledge acquisition
 - Error
- **Users share many capabilities, but, at the same time, they have many different characteristics that influence the way they interact with the surrounding environment.**

Human

- “Model Human Processor” (S. Card et al., 1983) – a simplified view of the human processing involved in interacting with computer systems:
 - Perceptual system – handle the sensory stimulus from the outside world.
 - Motor system – controls actions.
 - Cognitive system – provides the necessary processing to connect the two above.
- Processing and memory is required at all levels.
- The model includes a set principles of operation which dictate the behaviour of these systems under certain conditions.

Human

- Model Human Processor (MHP)



Human

- Model Human Processor (MHP)
 - Processors' cycle time
 - $T_p \cong 100\text{ms}$ [50-200ms]
 - $T_m \cong 70\text{ms}$ [25-170ms]
 - $T_c \cong 70\text{ms}$ [30-100ms]

Human

- Model Human Processor (MHP)
 - Perceptual fusion
 - 2 events (stimuli) in the same cycle time (Perceptual processor – $T_p \cong 100\text{ms}$) appear fused (in the same frame). 
 - Motion picture - $1/T_p$ frames/second are enough
 - Feedback in $< T_p$ feels instantaneous
 - Sense of causality

Human

- A more simple model:
 - Receive information and respond through input/output channels.
 - The information is stored in memory.
 - The information is processed and applied in several ways.
- Human capabilities are relevant...
- ...as well as the individual differences.

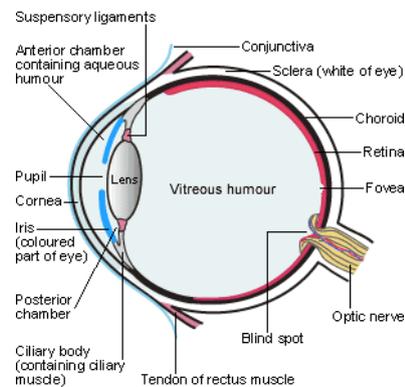
Human - I/O channels

- Input → senses
- Output → motor control
- Senses:
 - Sight, hearing, touch, smell and taste.
- Fingers, eyes, head, vocal system.

Human - Vision

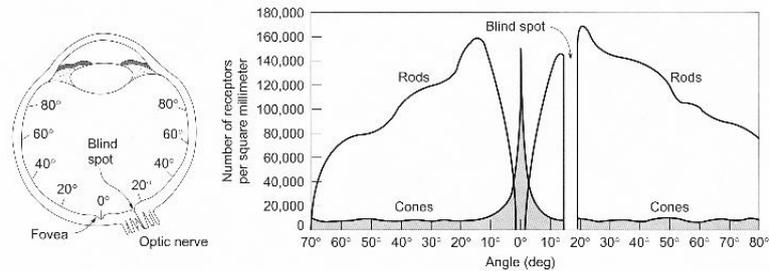
- Primary source of information for the average person
- Two stages:
 - Reception of physical stimuli
 - Stimuli interpretation and processing
- Vision apparatus: eye
 - Mechanism that receives light and transforms it in electrical energy.
 - Light is reflected from objects; their image is focused upside down in the back of the eye.
 - The retina contains 2 types of photoreceptors: **rods**, highly sensitive to light, allowing us to see under a low level of illumination (dominate peripheral vision); and **cones**, allowing colour vision (sensitive to different wavelength of light).
 - Ganglion cells: X-cells detect patterns and Y-cells detect movement.

Human - Vision



Human - Vision

Distribution of rods and cones in the retina



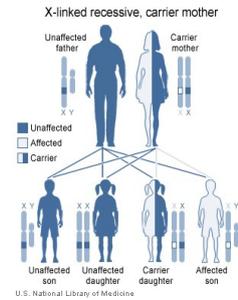
Human - Vision

- Colour
 - Cones are sensitive to light of different wavelengths. There are 3 different types of cones, each sensitive to a different colour light.
 - Only 3-4% of the fovea is occupied by cones which are sensitive to blue light (blue acuity is lower – don't use blue for small details).
 - 8% of males and 1% of females suffer from colour blindness.

Human - Vision

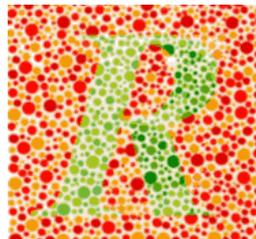
- Colour blindness
 - “Recessive” gene located in chromosome X
 - Males can only transmit colour blindness to their daughters.
 - Better night vision

Genotype	Phenotype
$X_D X_D$	Female with normal vision
$X_D X_d$	Female with normal vision
$X_d X_d$	Female with colour blindness
$X_D Y$	Male with normal vision
$X_d Y$	Male with colour blindness

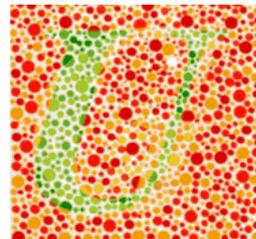


Human - Vision

- Colour Blindness
 - Ishihara test



1



2

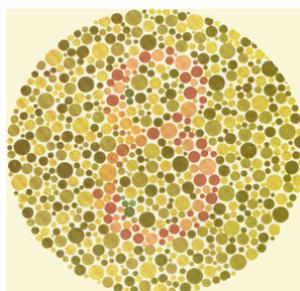
Human - Vision

- Colour blindness
 - Ishihara test

Image	Normal vision	Deficient perception of red and green	Lack of colour perception
1	R	E	--
2	U	G	--

Human - Vision

- Colour blindness
 - Ishihara test



Human - Vision

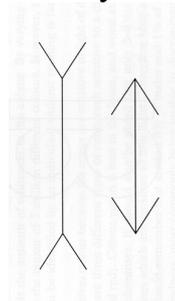
- Visual processing
 - Visual processing involves the transformation and interpretation of a complete image, from the light that is thrown onto the retina.
 - Our expectations affect the way an image is perceived:
 - If we know that an object is a particular size, we will perceive it as that size no matter how far it is from us.
 - Visual processing compensates for the movement of the images on the retina and changes in luminance.

Human - Vision

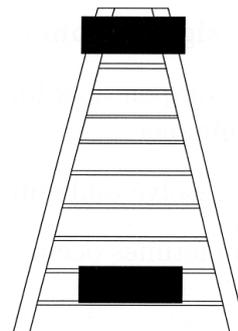
- Visual processing

Optical illusions sometimes occur due to overcompensation

The Muller-Lyer illusion



The Ponzo illusion



Human - Vision



Human - Vision

- Perceptions
 - are not a mere sum of sensations...
 - are influenced by:
 - our current emotional state
 - the context
 - our experience
 - ...

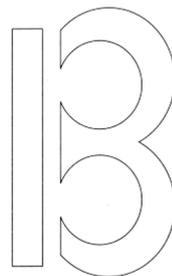
Human - Vision



From Joel Santos, Fotografia, Centro Atlântico, 2010

Human - Vision

- Visual processing
 - Context is used to solve ambiguities



Human - Vision

- Visual processing

Large outline letters A, B, and C.Small outline numbers 1, 2, 3, and 4.

Human - Vision

- Reading
 - When reading we make a series of fixation-saccade-fixation sequences.
 - Reading eye movements:
 - saccades, the eye movement itself
 - fixation duration or the intersaccadic interval
 - regressions (i.e. right-to-left eye movements)
 - return sweeps (going from the end of one line to the beginning of another).
 - No information is taken in during saccades (10-25 msec), regressions (10-25 msec) or return sweeps (40 msec).
 - During fixation (250 msec) a visual pattern is reflected on the retina.

Human - Vision

- Reading
 - Several stages
 - Visual pattern perception (characters and words)
 - Decode with reference to an internal representation of language
 - Interpretation by syntactic and semantic analysis
 - Font size, spacing, line length have influence in the reading speed.
 - Adults read approximately 250 words a minute.
 - Reading from a computer screen/Book: Speed? UX?

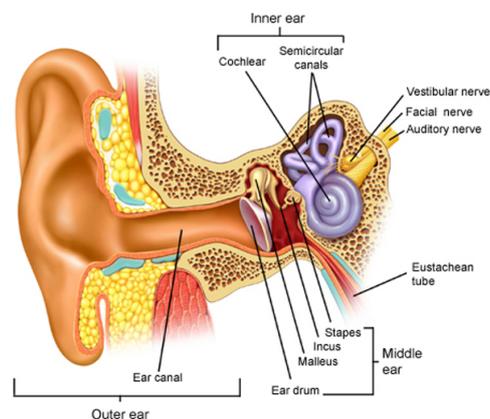
Human - Vision

- Reading
 - Font sizes of 9 to 12 points are equally legible, given proportional spacing between lines.
 - Line lengths of between 58 e 132 mm are equally legible.
 - Negative contrast (dark characters on a light screen) provides higher luminance and, therefore, increased acuity than positive contrast.

Human - Audio

- Hearing
 - Provides us with information about our environment:
 - Objects, distances, directions, ...
 - Try to close your eyes and listen:
 - What sounds can you identify?
 - Where do they come from?
 - Human ear
 - Outer ear: protects the middle ear, collects sound waves and channels them down the ear canal to the middle ear and amplifies some sounds.
 - Middle ear: transmits the sound waves, as vibrations, to the inner ear and amplifies sound.
 - Inner ear: Chemical transmitters are released and causes impulses in the auditory nerve.

Human - Audio



Human - Audio

- Sound (vibrations in the air):
 - Pitch – sound frequency
 - Loudness - amplitude
 - Timbre - type or quality
- Humans are able to identify sound's location
- Audible frequencies: 20Hz a 20kHz
- The auditory system filters the sound – we are able to distinguish sounds despite of the background noise
 - Cocktail party effect

Human - Audio

- How can we use the properties of sound, effectively, in interface design?

Human - I/O channels

- Touch
 - Provides important feedback information about the surrounding environment.
 - Catch a glass of water without feeling it.
 - Manipulation of objects in virtual reality systems.
 - It is an essential sense for visual impaired people.
 - Stimuli are received by sensory receptors in the skin.
 - Some areas of the body are more sensitive than others.
 - Two-point threshold test
 - We are aware of the position of our body and limbs (affect performance).

Human - I/O channels

- Movement
 - Movement time:
 - Stimuli reception → processing → response generation
 - Depends on physical characteristics: age, fitness, ...
 - Reaction time
 - Depends on the type of stimuli
 - visual: 200ms
 - auditory: 150ms
 - pain: 700ms
 - Combined stimuli reduces reaction time.
 - Reduce with skills and practice and increases with fatigue.

Human - I/O channels

- Movement
 - Accuracy:
 - Speed of reaction results in reduced accuracy?
 - Depends on the task and the user
 - Video gamers / Keyboard operators
 - Speed and accuracy to move to particular target on the screen (button, icon, menu item).
 - Depends on the size of the target and the distance that have to be moved.

Human - Movement

- Fitts' Law
 - Describes the time a user takes to select a target on the screen.
 - Time (Mt) to move your hand to a target of size S at distance D is:
 - $Mt = a + b \log_2 (D / S + 1)$
 - Mt – movement time
 - a e b – empirically determined constants
 - D - distance
 - S - size
 - In general:
 - Targets should be as larger as possible
 - Distances should be as small as possible

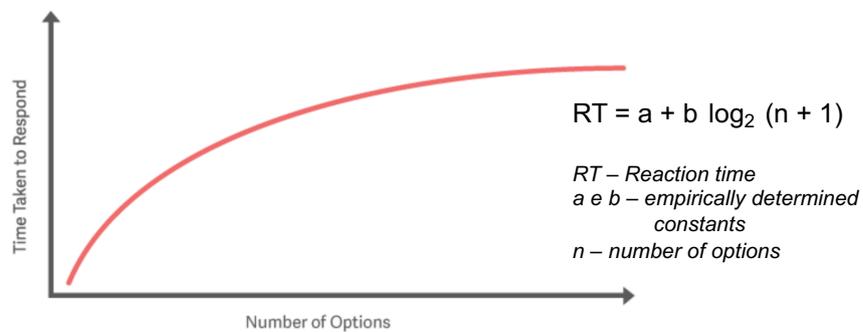
Human - Movement

- Fitts' Law

- Targets at screen edge are easy to hit
 - Mac/Windows menubar
- Hierarchical menus
 - Windows – 500ms timeout (sense of causality is lost).
 - Mac - triangular zone, spreading from the mouse to the submenu, in which the mouse pointer can move without losing the submenu.
- Linear pop-up menus vs pie menus
- [Fitts' law demo](http://fww.few.vu.nl/hci/interactive/fitts/) (<http://fww.few.vu.nl/hci/interactive/fitts/>)

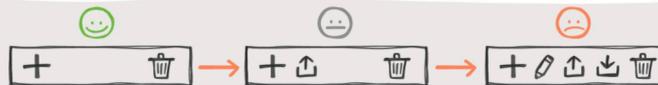
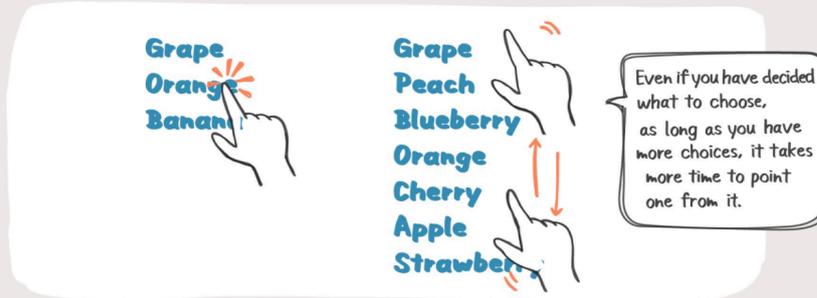
Human - Movement

- Hick's Law



Hick's Law

When you point at an item from a list, you take time in proportion to the number of options.

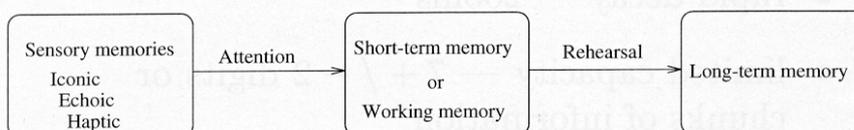


If you add a button on the toolbar, users take more time to click one than before.

©Sociomedia

Human - Memory

- Three types of memory:



- Sensory Memory
 - Buffers for stimuli received through the senses:
 - iconic – visual stimuli
 - echoic – aural stimuli
 - haptic – touch
 - Constantly overwritten as new information arrives.

Human - STM

- Short-Term Memory (STM)
 - “Scratch-pad” for temporary recall of information
 - Example: Mental calculations, reading.
 - Quick access: 70ms
 - Quick decay: 200ms
 - Interference causes faster decay
 - Limited capacity: 7 ± 2 information blocks (Miller's law).
 - Desire to complete and close tasks held in the STM

Human - STM

- Example:

7561093

Human - STM

- Example:

?

Human - STM

- Example:

36B789C563

Human - STM

- Example:

?

Human - STM

- Example:

643 71B 83M6

Human - STM

- Example:

?

Human - STM



Human - LTM

- Long-Term Memory
 - Knowledge repository
 - Slow access time: 1/10 second
 - Little decay (if any)
 - Huge capacity (or unlimited)
 - Two types:
 - Episodic: memory of serial events.
 - Ex: remember the events that took place in a certain moment of our lives.
 - Semantic: structured record of facts, concepts and skills. Represents relationships between information.
 - Ex: if Snoopy is a dog => Snoopy has 4 legs.
 - Semantic LTM derived from episodic LTM

Human - LTM

- Processing in the LTM
 - Information storage
 - STM → LTM by rehearsal
 - Studies show:
 - Total time hypothesis - The amount of information learned is proportional to the amount of time spent learning.
 - Distribution of practice effect - Learning time is most effective if it is distributed over time.
 - Structure, meaning and familiarity make information easier to remember.

Human - LTM

- Processing in the LTM
 - Forgetting
 - Information is gradually and slowly lost.
 - LTM is selective and influenced by emotions
 - We tend to remember highly emotive events than mundane ones.
 - “Good old days”
 - Apparently, new information replaces the old one (retroactive inhibition), but sometimes old memory interferes with new information (proactive inhibition).
 - Do we forgot information or we just are not able to retrieve it?
 - Tip of the tongue experience
 - Recognition

Human - LTM

- Processing in the LTM
 - Information retrieval
 - Recall (relembrar)
 - Information is reproduced from memory. Cues can be helpful (categories, images, ...)
 - Recognition (reconhecer)
 - The presentation of the information provides the knowledge that the information has been seen before. Easier than the recall process – the information is the cue.
 - Examples: Colleagues from the 4th grade, quiz shows.

Human - Memory

- You will see 10 3-character string
- One at a time
- Try to remember them
- The order is not important
- Can't write them down before I say so

Human - Memory

**WAT
HEP
CAX
NOF
TEH
DOK
RIJ
ZIB
BAL
MEQ**

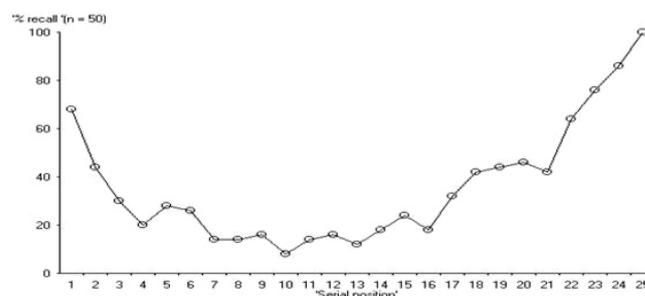
Human - Memory

Write down the strings you remember,
now!

Human - Memory

- Primacy and recency effects

Typically words at the start of the list and especially those at the end
tended to be recalled most often



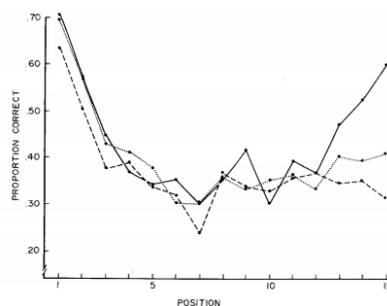
Murdock, 1962

Human - Memory

- Same exercise, but...
- Wait 30 seconds (count down from 30) before recall (writing down the strings).

Human - Memory

- Primacy and recency effects
Delaying recall by 30 seconds prevented the recency effect.



Glanzer and Cunitz, 1966

Human - Thinking

- Reasoning
 - Deductive: derives the logically necessary conclusion from the given premises.
 - Ex: Ex: If $x=3$ AND if $y=4$ Then $x+3y=15$
 - Inductive: generalize from cases we have seen to infer information about cases we have not seen.
 - Ex: all the elephants I have seen have trunks, so all the elephants have a trunk.
 - Not reliable: we can only prove that it is false.
 - We are better using positive than negative evidences.
 - Abductive: reasoning from a fact to the action or state that causes it. Method we use to derive explanations.
 - Ex: Manuel drives at high speed if he is drunk => if Manuel drives at a high speed than he is drunk.
 - Not reliable: the cause could be different than the usual, leading to false explanations → confusion in interactive systems.

Human - Thinking

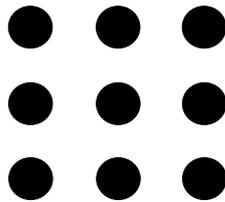
- Reasoning
 - Watson's cards
 - Each card has a number on one side and a letter on the other.
 - Which cards would you need to turn to evaluate if the following statement is true? “If a card has a vowel on one side it has an even number on the other”



Human - Thinking

- Problem solving

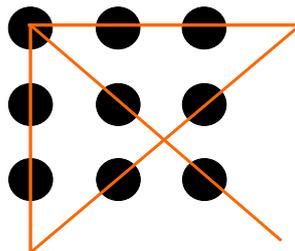
📖 Conceptual Blockbusting, James L. Adams, Basic Books, New York, 2001



Human - Thinking

- Problem solving

📖 Conceptual Blockbusting, James L. Adams, Basic Books, New York, 2001



Human – Individual differences

- Individual differences
 - In interface design we should consider individual differences
 - Three main types of differences
 - Long term: sex, physical and intellectual capabilities
 - Short term: stress, fatigue, ...
 - Changes: age, idiosyncrasies...
 - Be aware if a design decision may exclude part of the target users population.
 - In the same group of target users significant differences can be noticed.
 - **The users should not be forced to work on their perceptual and cognitive limits.** They should feel comfortable in using the systems.

Human - Emotions

- Emotions
 - The biological response to physical stimulus is called affect.
 - Affect influences how we respond to situations
 - Positive emotions – creative thinking, complex problem solving
 - Negative emotions – restrict reasoning.

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

Donald Norman, Emotional Design

- Build interfaces that promote positive responses (aesthetic).

References

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