



Cognitive psychology

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- ▶ Cognitive Psychology give us theoretical model for the brain behavior in the knowledge processing;
- ▶ Ergonomics provides common sense (based on experiences) rules for HCI design.

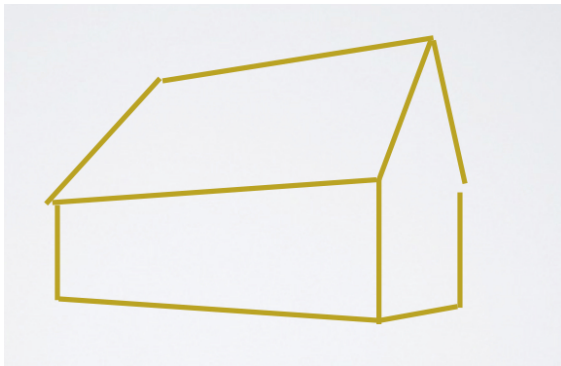
- ▶ acquisition pipeline;
- ▶ human vision
- ▶ action
- ▶ memory
- ▶ reasoning

- Motivations: to understand skills and limits of the human being

- Visual stimuli: contrast, colors



- Perception: area, line orientation



- interpretation of an assembly of primitives



- Underlying concepts



- ▶ linguistic process:

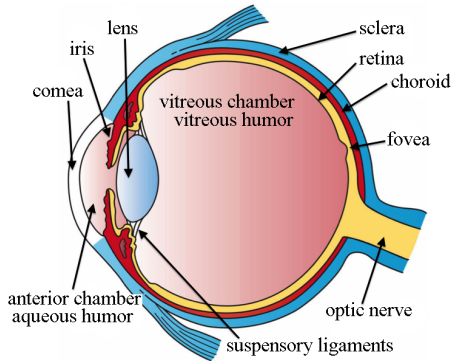
Maison
en bois

- semantic level : ideas are understood, organized in the brain.



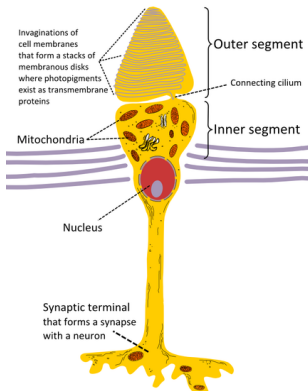
- ▶ complex task
- ▶ 2 steps
 - ▶ physical stimulus reception
 - ▶ treatment and interpretation of the stimulus
- ▶ skills and limits
 - ▶ physical stimulus reception : shape, movement, tint;
 - ▶ interpretation : object reconstruction

- focus on the retina

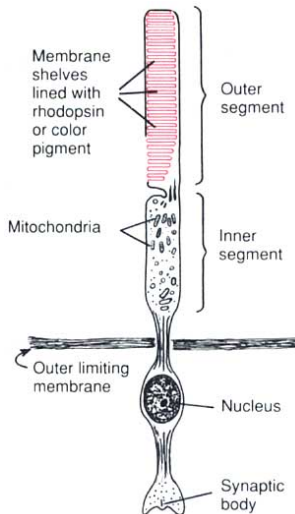


- ▶ 2 kinds of receptors
 - ▶ rods : sensitive to light (night vision)
 - ▶ cones : sensitive to color (3 types of cones : RGB)
- ▶ 2 kinds of Nerve cell :
 - ▶ Xcells : sensitive to shape
 - ▶ Ycells : sensitive to movements

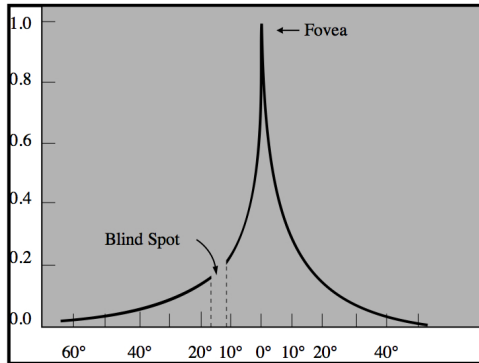
Cones and Rods



Cone cell



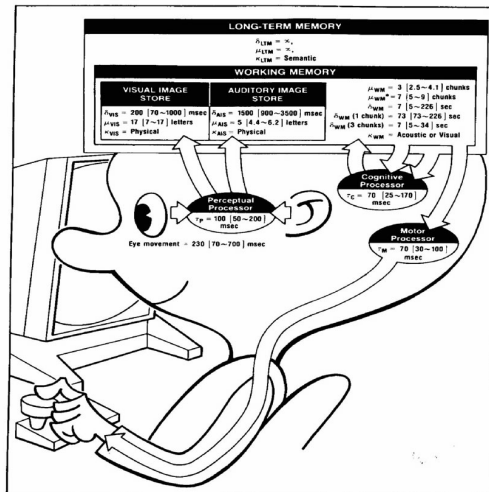
- ▶ retina perceived Informations are filtered and transmitted in order to:
 - ▶ identify the scene (research for coherency)
 - ▶ evaluate the distances (3D vision - stereoscopy)
 - ▶ distinguish the colors



Theoretical model for human perception

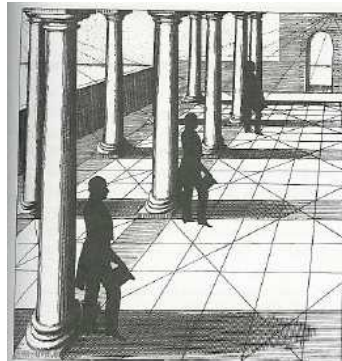
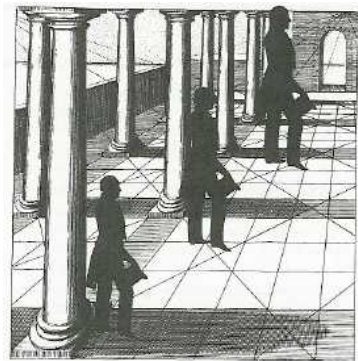


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- ▶ Size on the retina depends on the distance of the object;
- ▶ Identification of the object (Independently of its distance);
- ▶ Perceived distance give informations on the size (it is impossible to evaluate the distance of an object which its size is unknown)

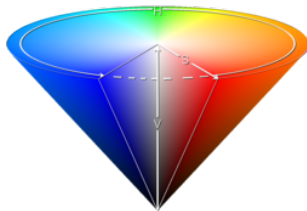
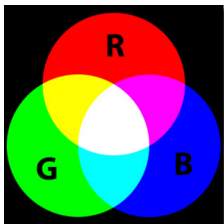
Size Evaluation



- ▶ The eye is sensitive to the radiance (luminance in french) of objects;
- ▶ The radiance is a quantity of flux per area and per projected solid angle;

- ▶ Contrast is a radiance difference
- ▶ The more the light, the easier and precise is the vision;
 - ▶ Blinking Artificial light is more annoying if the light is powerfull
 - ▶ Pay attention to the frequency (lights/monitors)

- ▶ perception model;
- ▶ digital model.

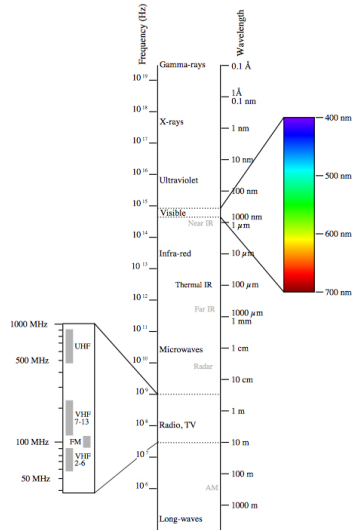


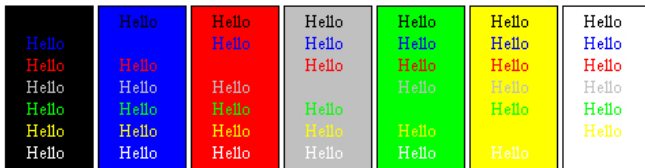
Color Perception



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- ▶ Electromagnetic flux;
- ▶ Human color perception is concerned with a small part of it.





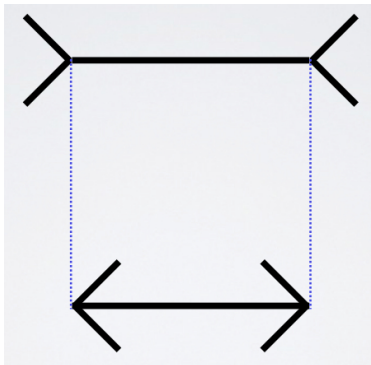
- pay attention to color contrast

Limits of human perception

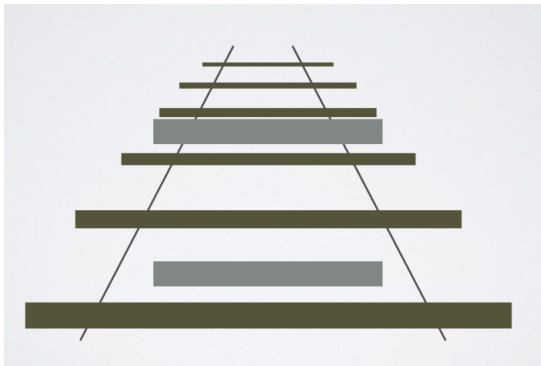


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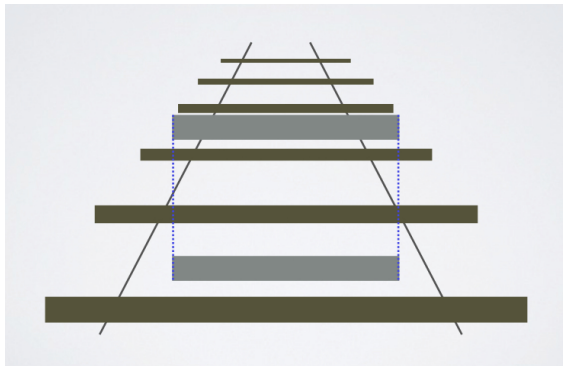
- ▶ whole image interpretation
- ▶ we perceive what we are expecting;
- ▶ we compensate for the movement.



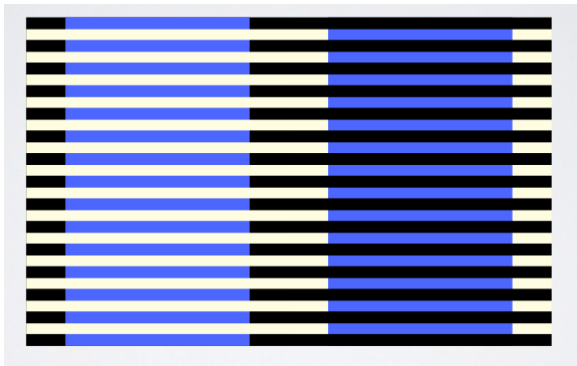
- Muller - Lyer



► Ponzo



► Ponzo



- ▶ Two distinct blue colors ?



- Two distinct blue colors ?

What consequences on HCI?



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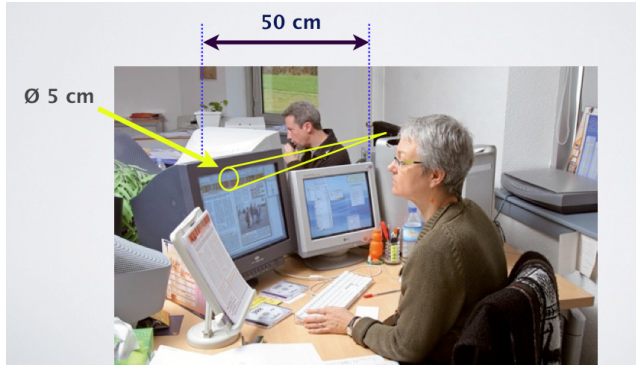
- ▶ Use of color to emphasis elements (grouping, hierarchy)
- ▶ Use of well distinct colors
- ▶ Not too many colors (use of large area of neutral tint)

What consequences on HCI?



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- ▶ Use of the symbolic of colors ;
- ▶ Use the fact that we perceive what is expected;
- ▶ Avoid poor contrasting colors;
- ▶ Do not overload the screen.



- At a distance of 50cm, the screen area which is projected on the fovea is a circle of 5cm diameter;

- ▶ 3 steps in reading process
 - ▶ motif identification;
 - ▶ decoding depending on the internal language;
 - ▶ syntactic and semantic decomposition.
- ▶ the reading is the result of irregular movements of the eye (94% of time is paused, 6% of movements);
- ▶ words are identified as a whole (as fast as sole characters).

Voici une fois de plus l'exemple d'un texte que l'on peut lire sans problème alors que les lettres de chaque mot ont été bouleversées. Seules la première lettre et la dernière ont gardé leur place. Le processus a ses limites et la lecture devient bien plus difficile si l'on augmente le désordre des lettres.

Le texte reste lisible sans
problème alors qu'on n'en
voit que la tiers supérieur.
C'est loin d'être le cas avec
la tiers inférieur.

On traite l'esthétique sans
problème alors qu'on n'en
voit que le tiers supérieur.
C'est tout à fait le cas avec
le tiers inférieur.

The quick brown
fox jumps over the
the lazy dog.

- Search for the typo !

- ▶ the reading speed for a given text informs on the readability;
- ▶ 9 points to 12 points for the body characters
- ▶ 58 to 132 points for the interLine
- ▶ dark characters on light background show an improved readability;
- ▶ but this contrast is worse for blinking

- ▶ Reaction delay before the action:
 - ▶ sound signal : 150 ms;
 - ▶ visual signal : 200 ms;
 - ▶ tactile signal (pain) : 700 ms;
- ▶ training reduces the delay but increase the tiredness;
- ▶ delay reducing diminishes the preciseness (keyboard, mouse);

- ▶ the delay to attain a target depends on :
 - ▶ the distance to the target;
 - ▶ the size of the target.
- ▶ this is formalized by the empirical Fitt's Law;

Theorem

$$t_m = a + b \log\left(\frac{d}{T} + 1\right)$$

with

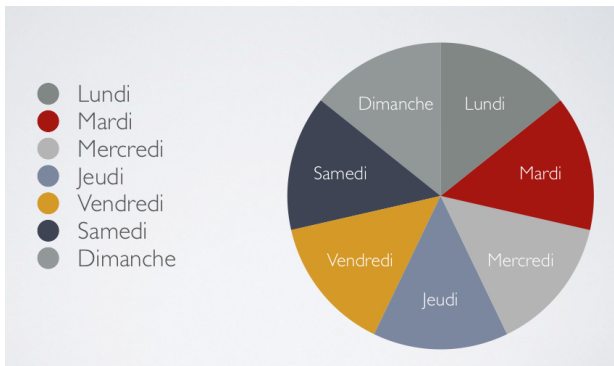
t_m is the duration of the movement

a and b are constants (elaborated by measures)

d is the distance to the target

T is the target size

Radial figure or List ?



► Radial figure or List ?

Memory :

- ▶ stores facts
- ▶ stores procedures and actions
- ▶ allows to repeat actions, to use language and new informations given by sensitive organs.
- ▶ provides an identity by recording passed events.

- ▶ Memory is considered nowadays as made of three parts:
 1. sensory memory
 2. short term memory
 3. long term memory

- ▶ Memory corresponding to various stimuli (input Buffer)
- ▶ constantly re-written (input stimuli)
- ▶ Visual memory;
- ▶ Filtered transmission :
 - ▶ conversation in noisy environment
 - ▶ reading in noisy environment (movements)
- ▶ to avoid cognitive overload, events are filtered

Short Term Memory :



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- ▶ buffer to recall recent informations
 - ▶ intermediate results (calculus)
 - ▶ beginning of a phrase when we attain its end
- ▶ access time : 70ms;
- ▶ a human being can store 7 digits (± 2)

Short Term Memory :



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- Try to memorize 2653976208

Short Term Memory :



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- Try to memorize 071 242 6378

- ▶ organize information by blocs;
- ▶ identifier, file number
- ▶ date (various display depending on cultural background)
- ▶ use the correct number of digits after the comma,
- ▶ an interrupting task during short term memorizing results in a start over.

Bad example



- Microsoft Calculator

- ▶ Main memory;
- ▶ Stores knowledge, experiences, rules...
- ▶ Limited capacity (3 billions neurons)
- ▶ access time: 100 ms;
- ▶ after a few seconds, information is moved from short term memory to long term memory if needed.
- ▶ 2 kinds of long term memory:
 - ▶ serial events storing
 - ▶ semantic (facts and structured concepts)

- ▶ Semantic networks
 - ▶ relation between concepts (*"is a", "is part of", "is alike as"*)
- ▶ conceptualizing
 - ▶ abstraction
 - ▶ inference
 - ▶ Inheritance
- ▶ connections between semantic networks are commons

- ▶ How is informations treated ?
 - ▶ use of (even incomplete knowledge) to infer something
 - ▶ use of knowledge to draw conclusions;
- ▶ Reasoning :
 - ▶ deductive
 - ▶ inductive
 - ▶ abductive

deductive reasoning :



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- ▶ logical conclusion of a set of facts (modus ponens)
- ▶ *every monday, I attend the HCI course. This is monday, so ...*
- ▶ the knowledge often bypass the reasoning
- ▶ *I am fully aware that I am now attending the HCI course ;-)*

- ▶ inference of an information by generalizing known facts
 - ▶ *Every Elephant I have seen possess a trunk, therefore all the elephants possess a trunk*
- ▶ Sometimes this fails
 - ▶ my nephew (5 years old) once said : "*Je sais, les chevaux c'est les noirs et les chevaux c'est les blancs*"
- ▶ induction is used on a daily basis and permits to elaborate assumptions which are checked until proof or re-elaboration.

abductive reasoning :



- ▶ try to find the cause;
- ▶ *Paul is upset when he drinks coffee, he is upset now, so he must have been drinking coffee.*
- ▶ abduction is often used to formulate assumptions
- ▶ assumptions are validated later (or not)

- ▶ a clear organization of the information to ease the semantic network construction for the user;
- ▶ a clear organization of tasks in simpler sub-tasks;
- ▶ prefer deductive reasoning
- ▶ avoid induction and abduction reasoning.

- ▶ use knowledge on cognition to define design rules in HCI
- ▶ various users lead to various cognition
- ▶ change is hard ;-)