



Chapter 2

Interactive applications and cognitive psychology

Course inspired by:

- Cognitive psychology. An information processing approach - Editions Télé-Université
- Mental images and learning strategies - ESF Editor (available on books.google)
- Cognitive psychology - Bréal (available on books.google)



Course plan

- ⦿ Introduction
- ⦿ Structure of an interactive application
- ⦿ The 'Model-View-Controller' (MVC) pattern
- ⦿ Cognitive psychology
 - > Visual and/or auditory perception
 - > attention
 - > Learning
 - > Memory
 - > Mental representations



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Introduction

An interactive computer system takes input interactively

- ◉ it provides the user, during its execution, with a perceptible representation of part of its internal state, so that it can modify it by providing inputs.
- ◉ the inputs make it possible to modify the internal state of the system, and there is thus an interaction: the inputs provided by the user depend on the outputs produced by the system and vice versa.
- ◉ the system is open: the dependencies between inputs and outputs are inaccessible to the system.



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Structure of an interactive application

- ◉ An application with which the user can interact:
 - > The application performs operations in response to user actions
 - > Cooperation between program and user, controlled by the user





Programming interactive applications

Task that can be complex:

- ⦿ Because the task that the user must accomplish can be complex
- ⦿ Because you have to predict the interaction scenarios (and therefore the reactions of the application)
- ⦿ Because you have to be able to maintain and reuse
- ⦿ Scaling up (large application)



Programming interactive applications

Fortunately there are:

- ◉ **Concepts** (structures and models of interactive applications)
 - > MVC
 - > PAC
 - > Numerous 'Design patterns'
 - > ...
- ◉ **Tools** (to make these concepts a reality)
 - > Suitable programming languages/environments
 - > Libraries and their APIs (Application Programming Interfaces): toolboxes
 - > ...



Structure of an interactive application

- ⊙ The 'visible' part (**front office**): what we do and what we see
 - > Human-Machine Interface (HMI)
- ⊙ The 'invisible' part (**back office**): what's happening
 - > Data processing (storage and access)
 - > Communications



Course plan

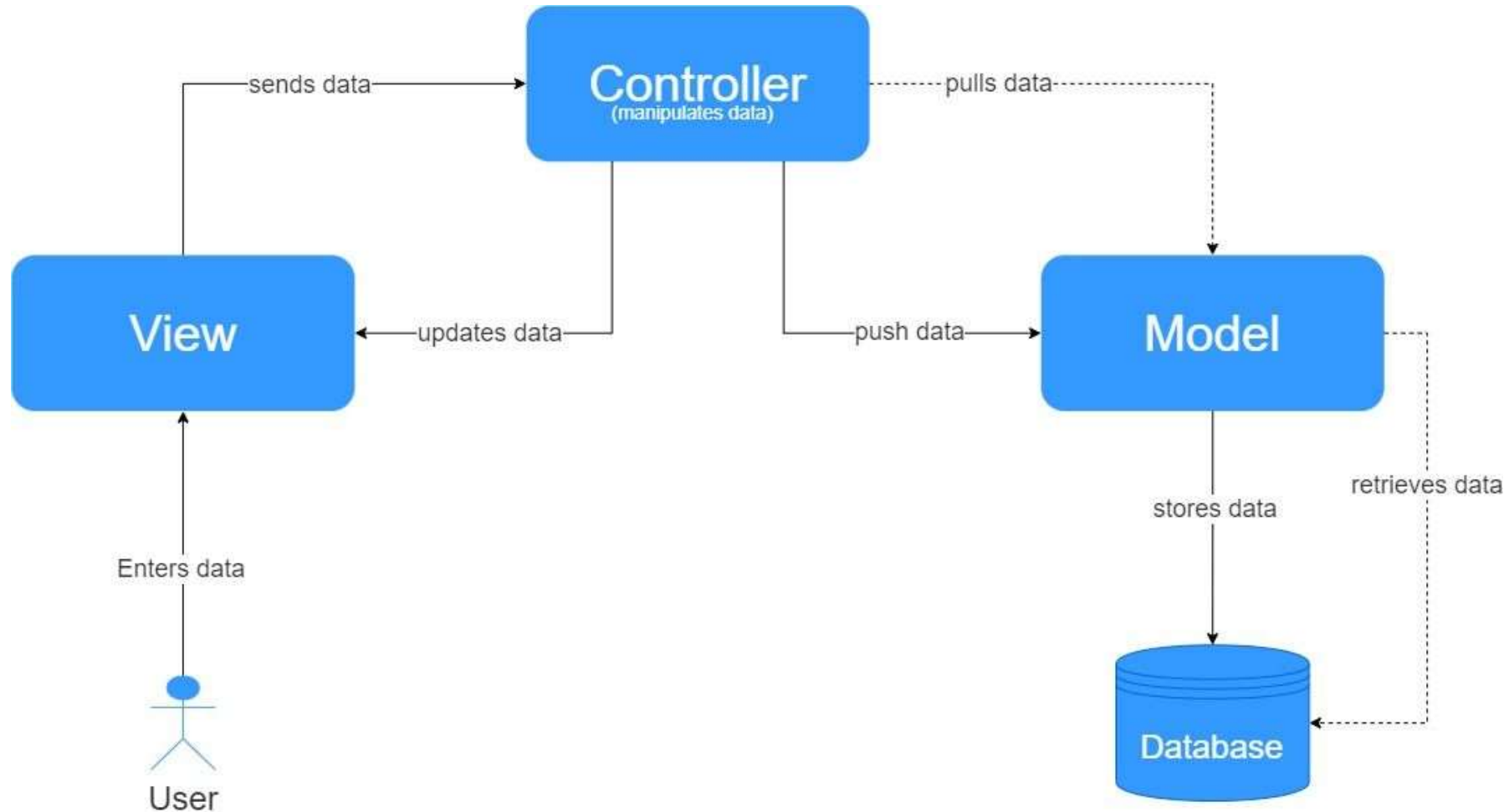
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The 'Model-View-Controller' (MVC) pattern

- ⊙ MVC is:
 - > A design pattern (a standardized solution to a problem, independent of programming languages),
 - > A software architecture (a way of structuring an application or set of software).
- ⊙ Organize, structure an interactive application by separating:
 - > Data and their processing (**The Model**)
 - > Data representation (**The View**)
 - > The behavior of the application (**The Controller**)

The 'Model-View-Controller' (MVC) pattern





The 'Model-View-Controller' (MVC) pattern

Benefits

- ◉ 'Clean' structure of the application
- ◉ Independence 'data' – 'representation' – 'behavior'
- ◉ Modular and reusable
- ◉ Facilitates multiple views and controllers

Disadvantages

- ◉ Complex installation for large applications
- ◉ Potentially too many updates
- ◉ Controller and View often remain strongly linked to the Model

MVC: Example

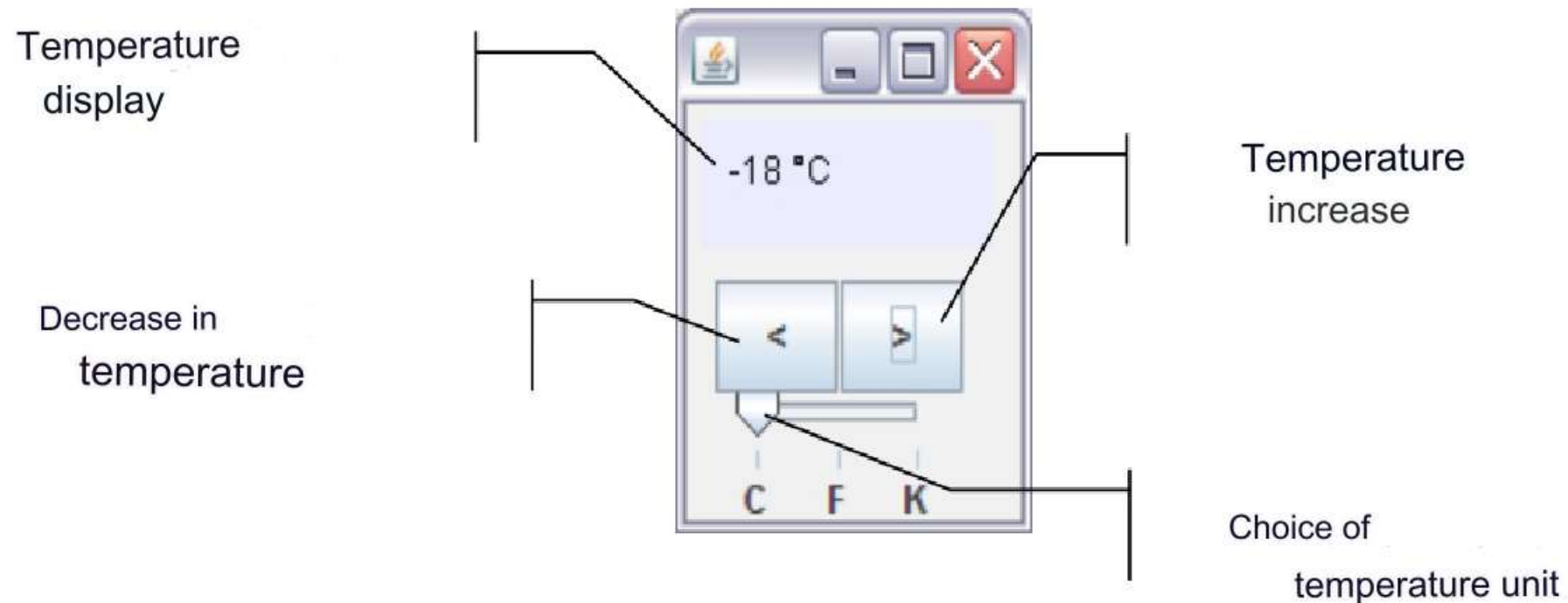




MVC: Usage Example

- ⊙ Create an interactive application simulating a thermometer, on which the user can act to control the temperature
- ⊙ The app will provide:
 - > A **textual display** of the current temperature measured by the thermometer in °C or °K or F
 - > Controls allowing the user to **decrease** and **increase** the current temperature of the thermometer
 - > A **control** allowing you to choose the **temperature display unit**

MVC: Usage Example

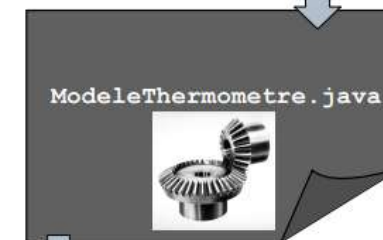


MVC: Usage Example

The model

- ◉ Data and processing carried out:
 - > Current temperature
 - > Maintains current temperature status
 - > Temperature conversions in different units
- ◉ Features exposed:
 - > Increase the temperature by 1° (C or K)
 - > Reduce the temperature by 1° (C or K)
 - > Give the temperature in °C, °K or F

```
public void rechauffement();  
public void refroidissement();
```



```
public double temperatureEnKelvin();  
public double temperatureEnCelsius();  
public double temperatureEnFahrenheit();
```

MVC: Usage Example

View

- Displays current temperature as text
- Adapts its display to the current unit

-30 °C

243 °K

-22 F

```
public void redessiner();  
public void reglerUnite(Unite unite);
```

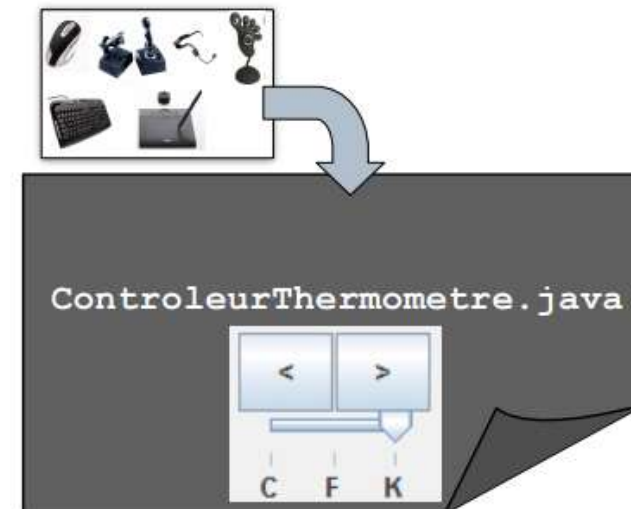
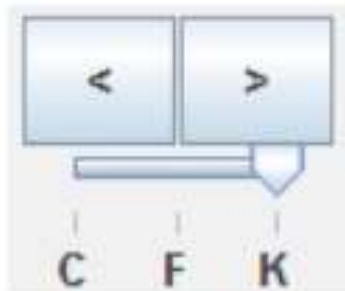
VueThermometre.java

-30 °C

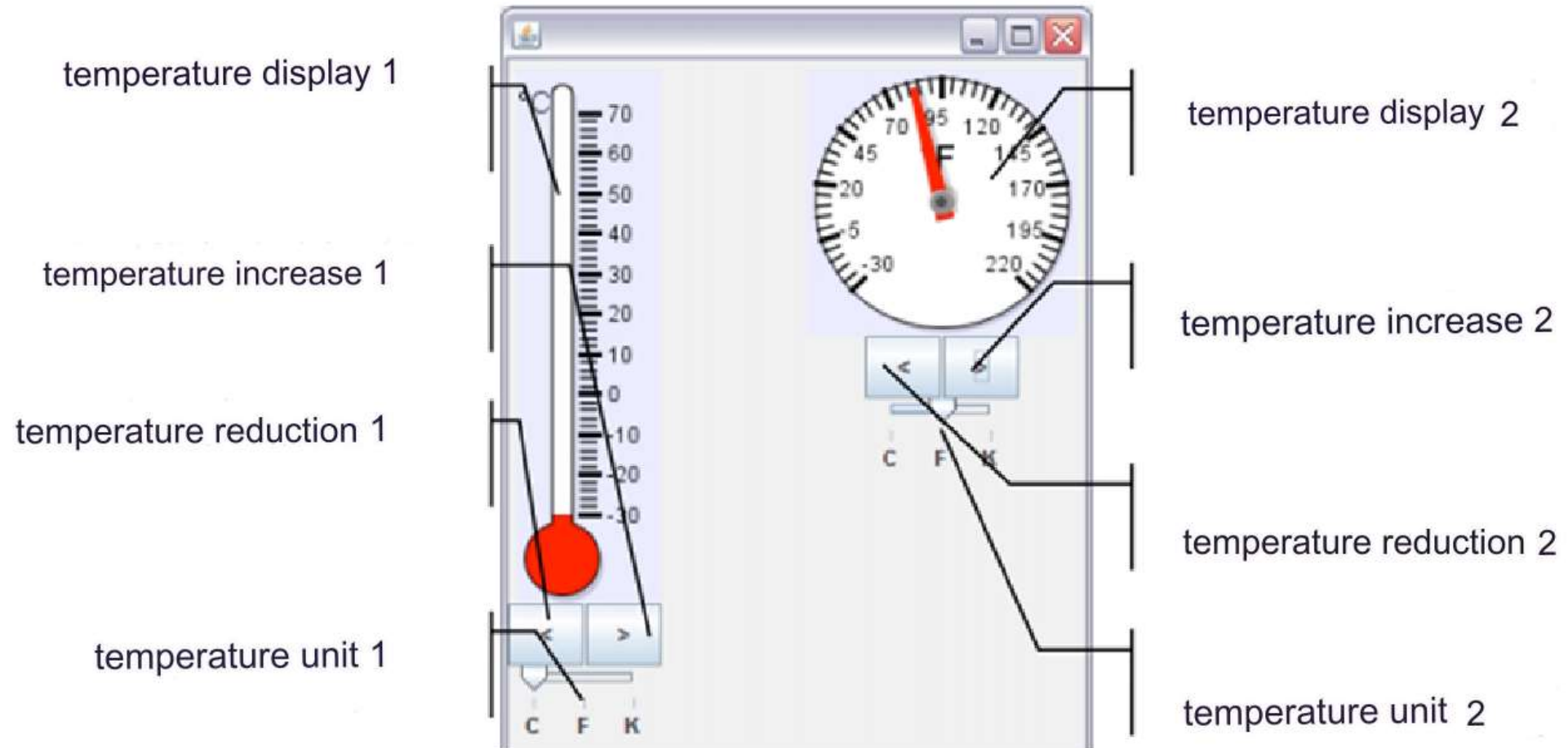
MVC: Usage Example

The controller

- ◉ Provides the user with controls on the model: increase or decrease the temperature
- ◉ Translates user actions into operations on the model: triggers processing by method calls on the model
- ◉ Select and update the view



MVC: Achievement!!???





MVC: Conclusion

- ⊙ A model for:
 - > **Analyze** a “problem”
 - > **Structuring** an interactive application
 - > **Implement** a system in a modular, flexible and reusable way

- ⊙ Guarantees and facilitates:
 - > **Front-office** (IHM) – **back-office** (data and processing) independence
 - > Maintenance and **reuse of** modules

- ⊙ But this is not a universal solution...



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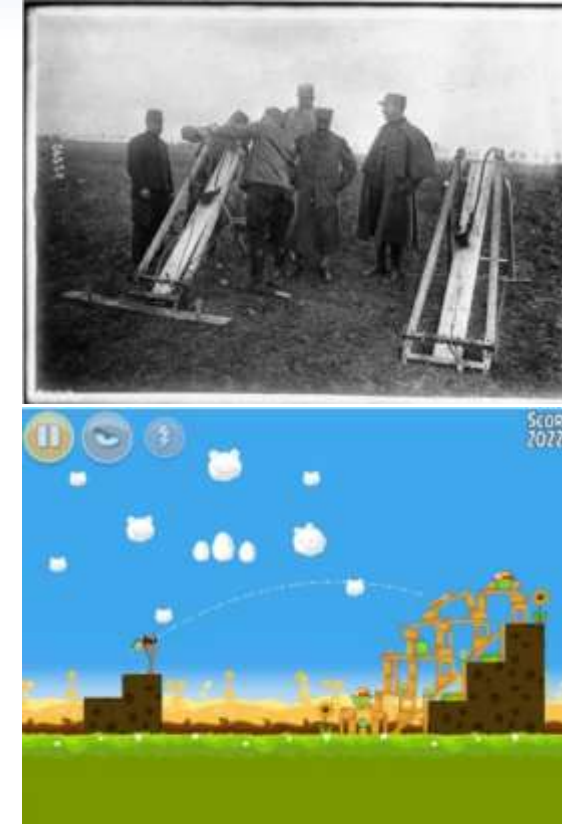
Cognitive psychology

- Cognitive psychology studies the processes that go from perception to the production of complex behaviors, including the processing of information by the brain.
 - > We often talk about understanding what is happening “in the black box”.

Cognitive psychology

Whether for

- > set up a catapult for waging war or crushing pigs,
- > shopping in the local store or in an online supermarket,



these are the same processes that are at work in the real world and in the virtual world



Cognitive psychology

For this, we will use:

1. vision and/or auditory, to perceive area, **visual and/or auditory perception**
2. Attention ,
3. **learning** processes to improve over time
4. memory **to** store information
5. “ **mental representations** ” to organize information

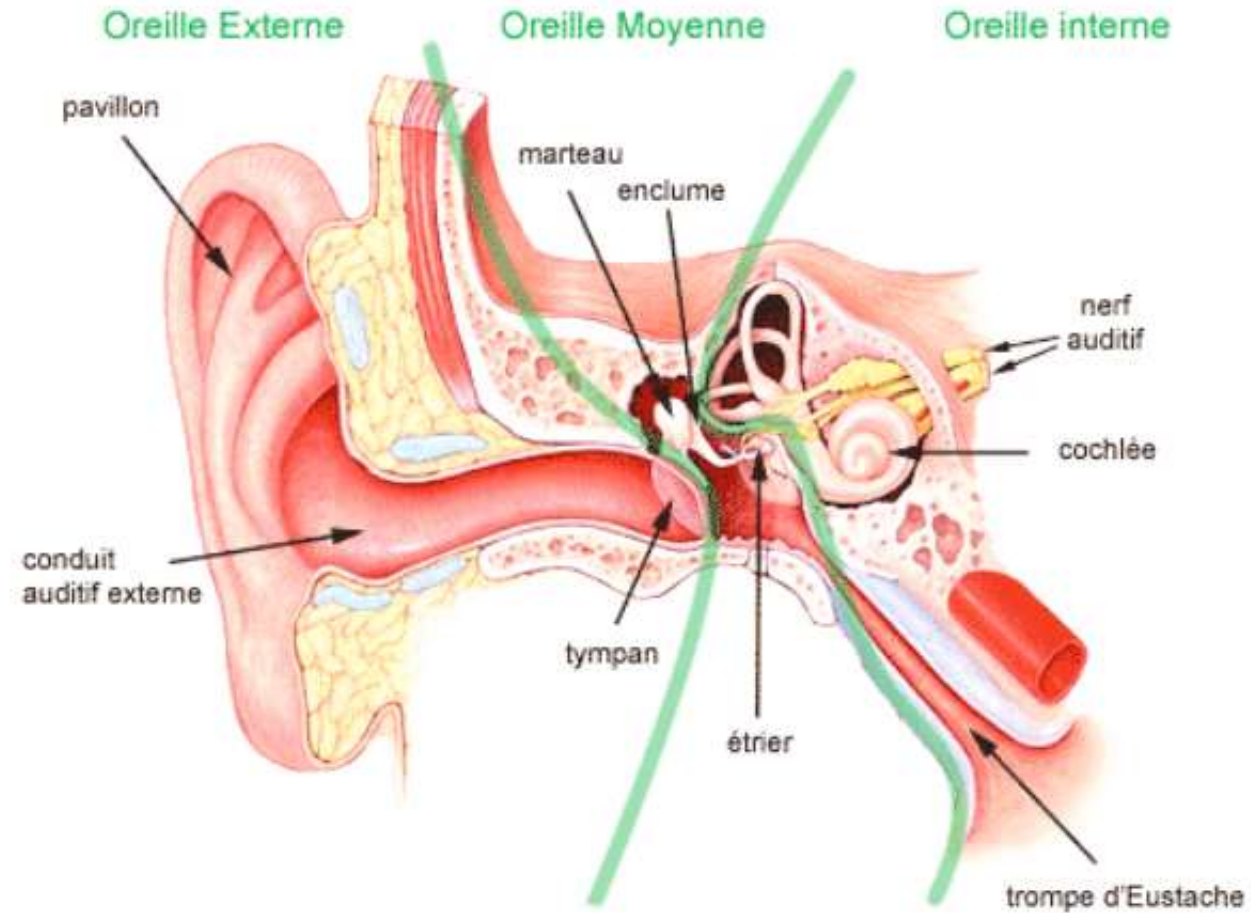


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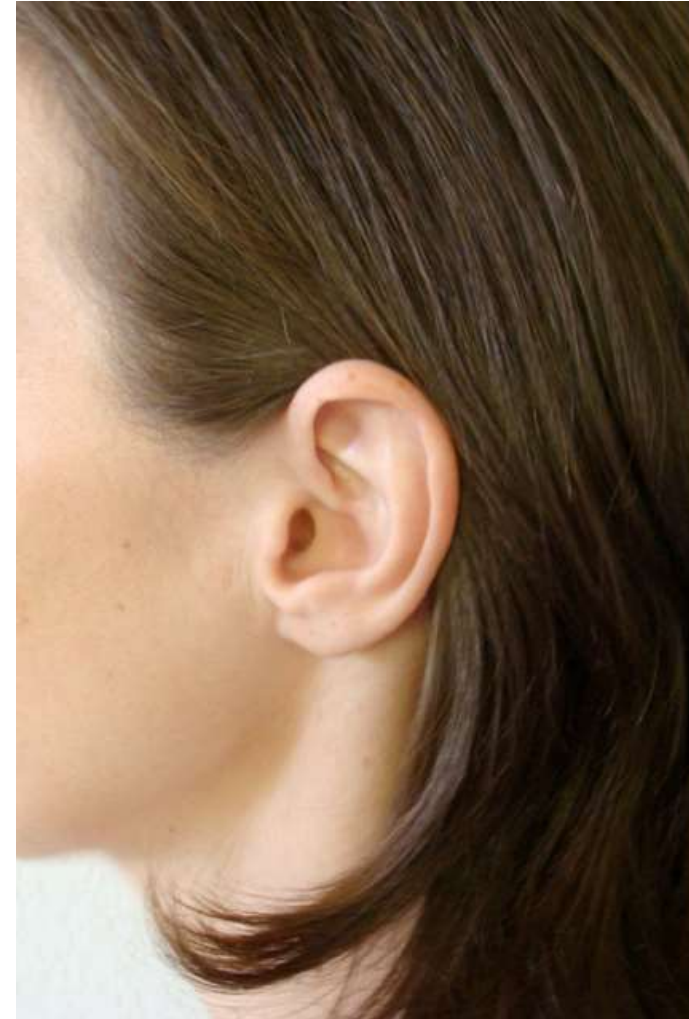
Auditory perception

The ear



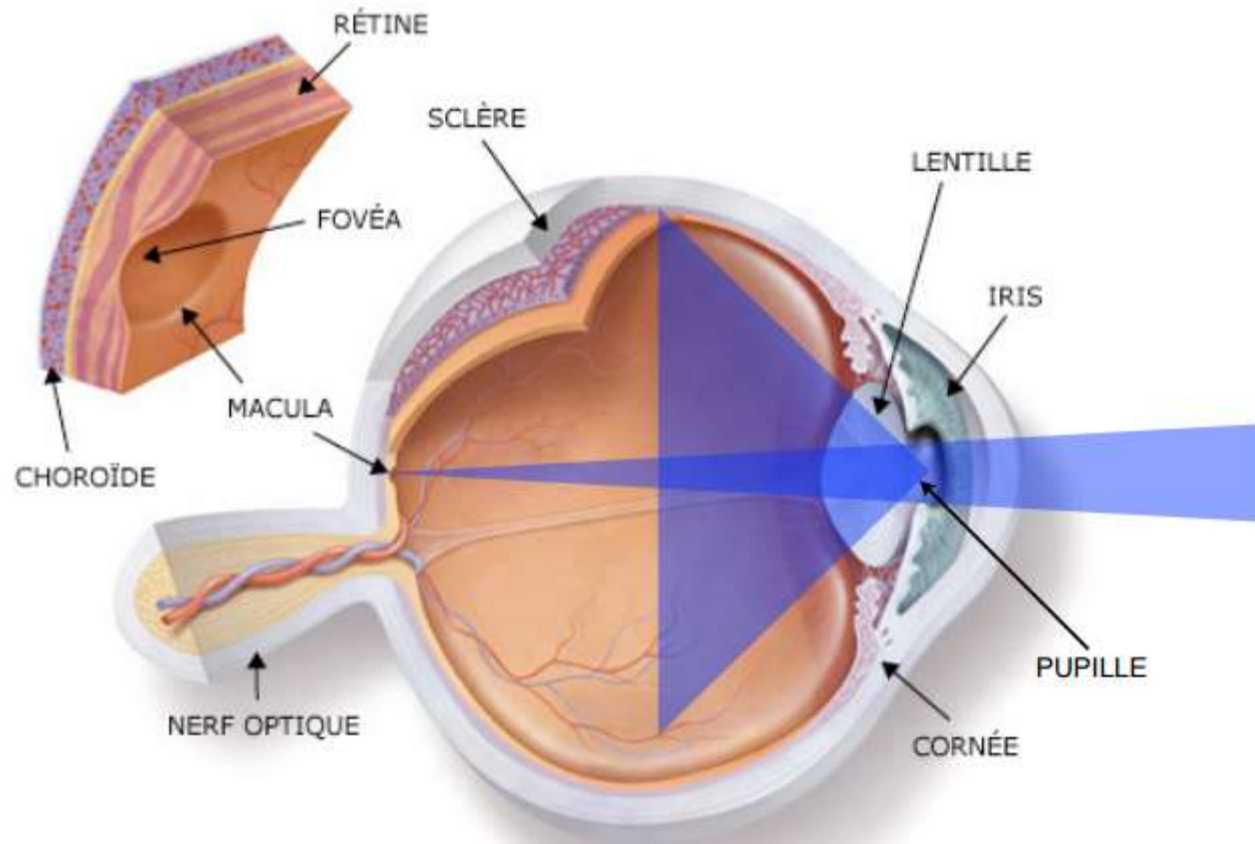
Auditory perception

- ◉ Sound is analyzed as a periodic complex wave, that is to say one which reproduces with the same shape).
- ◉ This wave is analyzed according to:
 - > intensity: the strength of the sound (air pressure);
 - > frequency: the number of vibrations per second;
 - > timbre: the perception of the complexity of the sound wave.



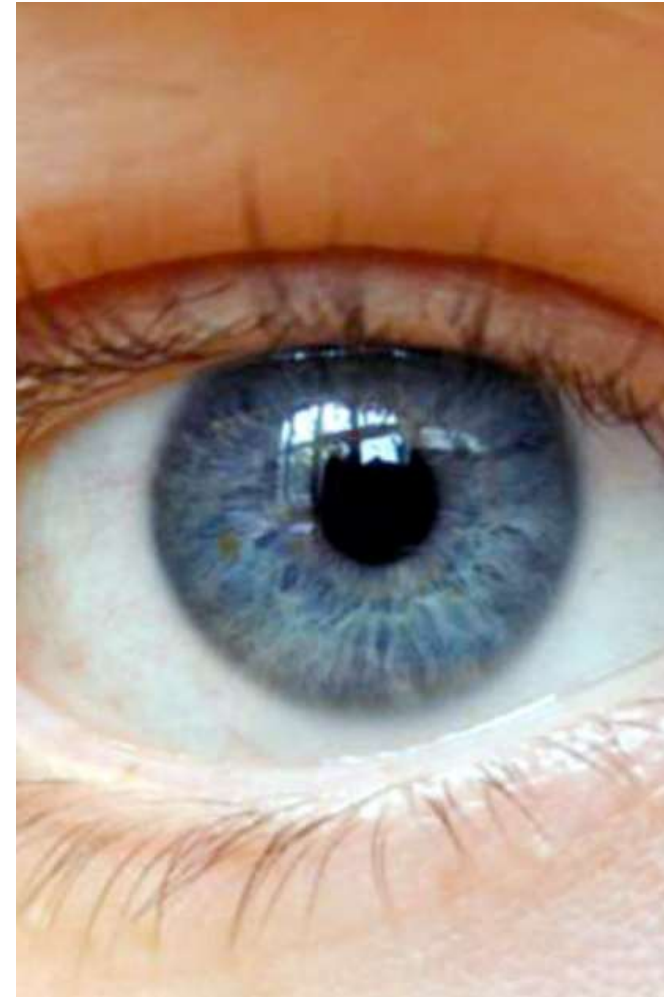
Visual perception

The eye



Visual perception

- ◉ The eye works like a camera: light enters the eye through the pupil (like a lens) and is directed by the lens which produces a well-defined image on the retina (like film from a roll of film).) at the back of the eye.
- ◉ The image captured on the retina is then carried through the optic nerve to the brain (like a developmental laboratory) which processes the information.





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attention

- ◉ All controlled processes require attention. They appear when the time to execute a task increases depending on the load.
- ◉ Some tasks do not require attention. They are the result of automatic processes.



attention

- ◉ Attention has 3 characteristics:
 - > **selection** , which concerns the orientation of mental resources towards a single message by eliminating irrelevant information;
 - > **sharing** , which involves paying attention to multiple messages simultaneously;
 - > **vigilance** , which is mobilized when we pay sustained attention to detect an infrequent message.





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Learning

- ◎ The concepts **of learning** and **memory** are closely related, however:
 - > the term **learning** is used to designate the systematic modification of behavior based on experience,
 - > the term **memory** designates the set of structures which allow these modifications.



Classical learning

- ◉ Pavlovian conditioning is based on the existence of a **reflex response** which is triggered by the presentation of a specific stimulus.



Operant (or instrumental) learning

- ◉ Skinner (1951) studied the learning behavior of rats using an experimental system
- ◉ There is no understanding (as in humans), but only learning.



Social learning

- ◉ Among higher mammals, there are other fundamental forms of learning:
 - > learning by **imitation** , which results from the reproduction of a behavior performed by a model;
 - > **observational (or vicarious)** learning , which requires acquiring elaborate mental representations.





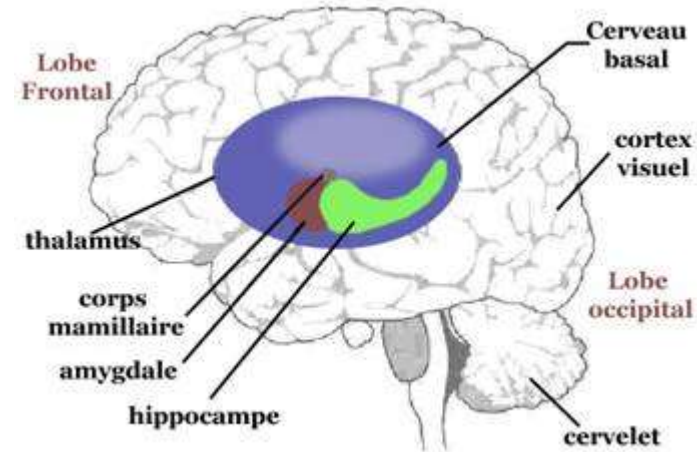
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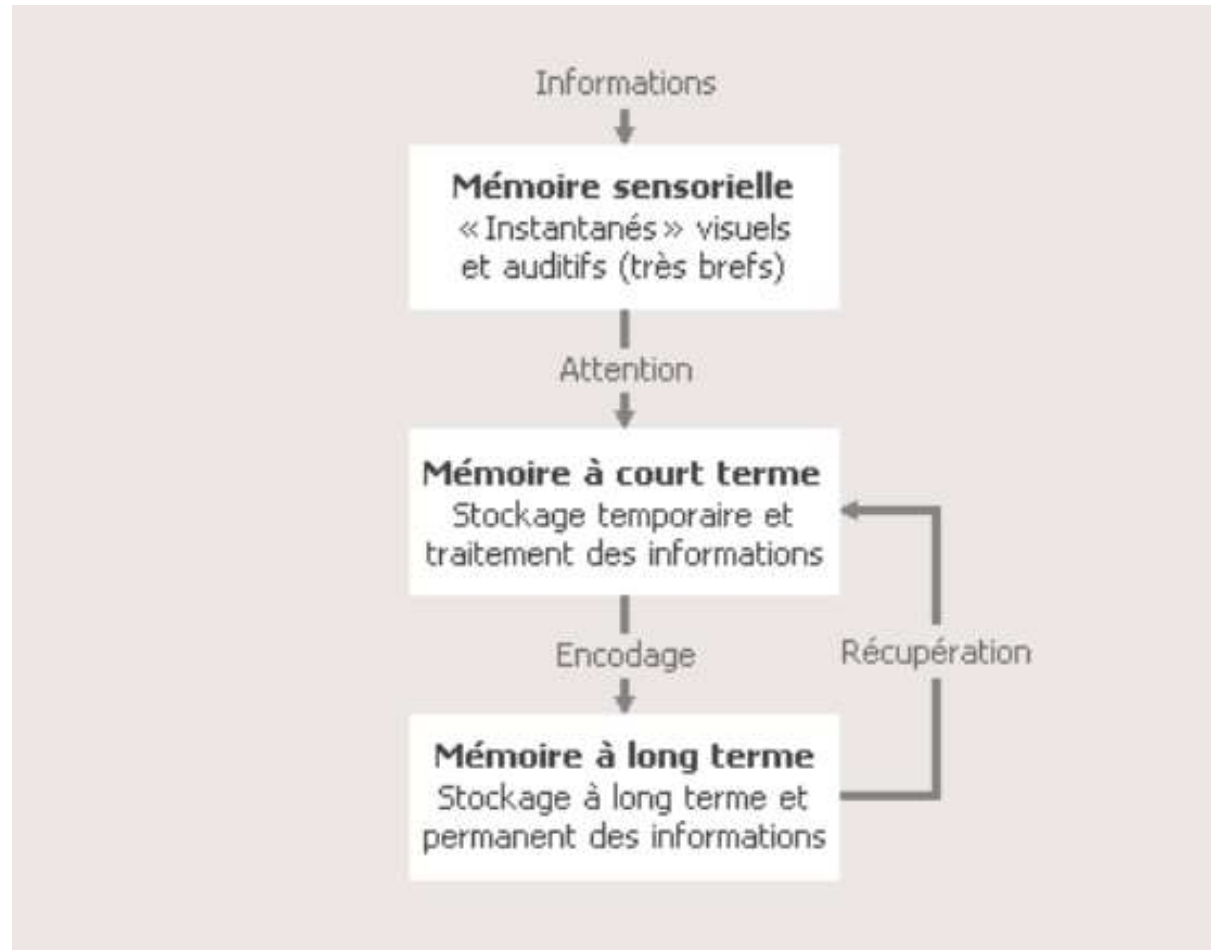
Memory

We distinguish :

- ◉ **short-term memory (STM)** , characterized by limited storage capacity and rapid forgetting;
- ◉ **long-term memory (LTM)** , characterized by very large capacity and progressive forgetting.



Memory



Memory

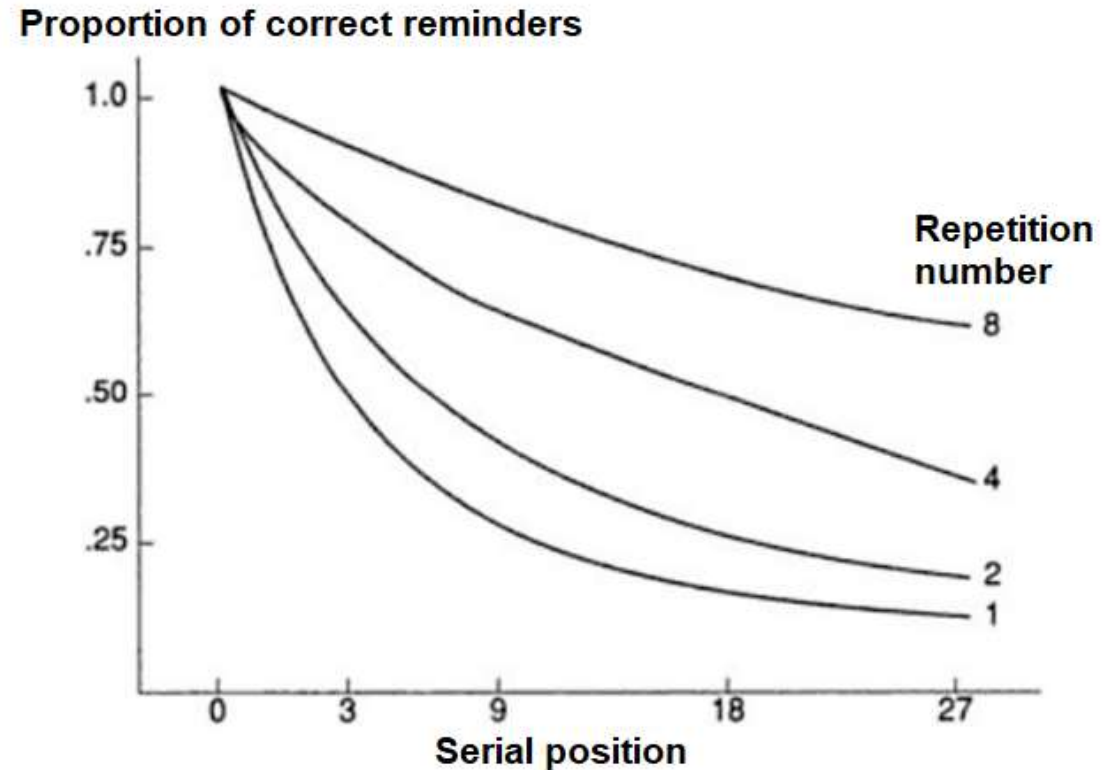
Some main factors of memorization

- ◉ Repetition is an important factor for information storage in LTM .
- ◉ We distinguish :
 - > **maintenance repetition** , which serves to keep information active in STM (or working memory);
 - > **elaboration repetition** , which uses meaning to store information (mnemonic).



Memory

Some main factors of memorization



Effect of repetition on
memorization - Hellyer , 1962

Memory

Some main factors of memorization

- ◉ Craik and Lockhart (1972) demonstrated that repetition is not everything. The level of information **processing is also a determining factor for its memorization.**
- ◉ **Deep processing**, which corresponds to the meaning of the words, is better than superficial processing, which corresponds to the physical characteristics of the words (sound, etc.).
- ◉ So, a hierarchical presentation is better than a random presentation.



Memory

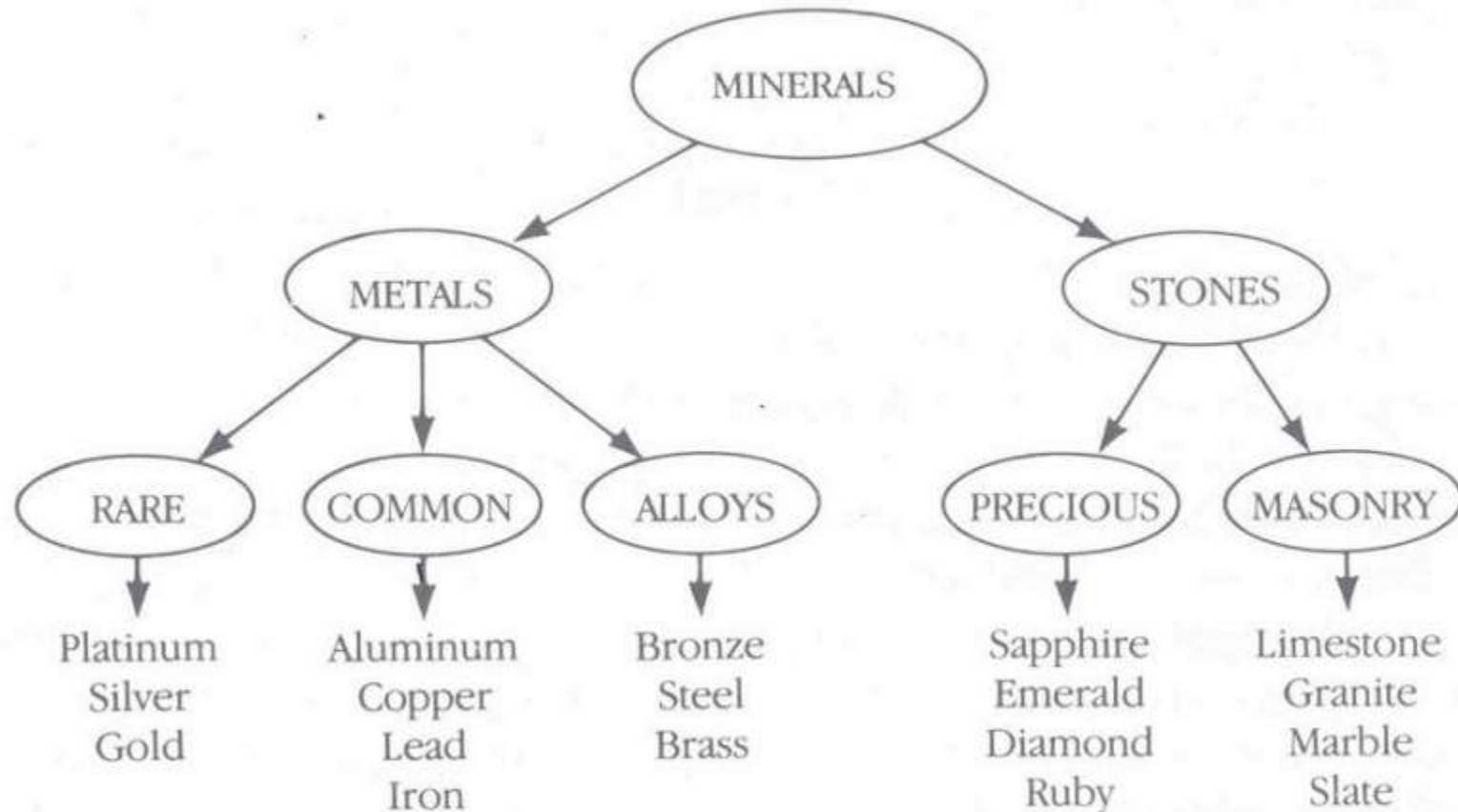
Some main factors of memorization

- **Mental images** also have an important role in memorization.
- Paivio (1969) developed the **dual coding theory**. This theory postulates that memorization is better when information can be encoded **in pictorial and verbal form**. These are concrete objects (table, tree, etc.). Abstract objects are encoded only verbally (freedom, etc.).



Memory

Some main factors of memorization



The level of information processing - Bower , Clark,
Lesgold and Winzenz (1969)



Memory

Forms of long-term memory

- ◎ **Semantic memory** has very high stability and is little affected by retrieval contexts.
 - > Ex, brings together the general knowledge necessary for linguistic production and understanding (words, verbal symbols, meanings, referents, etc.)
- ◎ **Episodic memory** is more flexible and remains sensitive to contextual variations.
 - > Ex, brings together temporally dated representations of events (events or episodes personally experienced).

Propriétés	Mémoire épisodique	Mémoire sémantique
Information : Origine Unités Organisation Référence Validité	Sensation Événements, épisodes Temporelle Moi Croyance personnelle	Compréhension Faits, idées, concepts Conceptuelle Univers Consensus social
Processus : Registre Codage temporel Affect Possibilité d'inférence Dépendance contextuelle Vulnérabilité Accès Questions de récupération Conséquences de la récupération Mécanisme de récupération Expérience récollective Compte rendu Développement Amnésie infantile	Existentiel Présent, direct Important Limitée Forte Forte Délibéré Quand? Où? Système modifié Synergie Souvenir Je me souviens Tardif Oui	Symbolique Absent, indirect Moins important Riche Faible Faible Automatique Quoi? Système inchangé Association, inférence Connaissance Je sais Précoce Non
Applications : Education Utilité générale Intelligence artificielle Intelligence humaine Domaine empirique Situations de laboratoire Domaine judiciaire Amnésie	Non pertinent Moins utile Possible Sans relation Oubli Mémorisation d'épisodes singuliers Témoignage oculaire Oui	Pertinent Plus utile Excellent Très pertinent Analyse du langage Connaissance générale Expertise Non



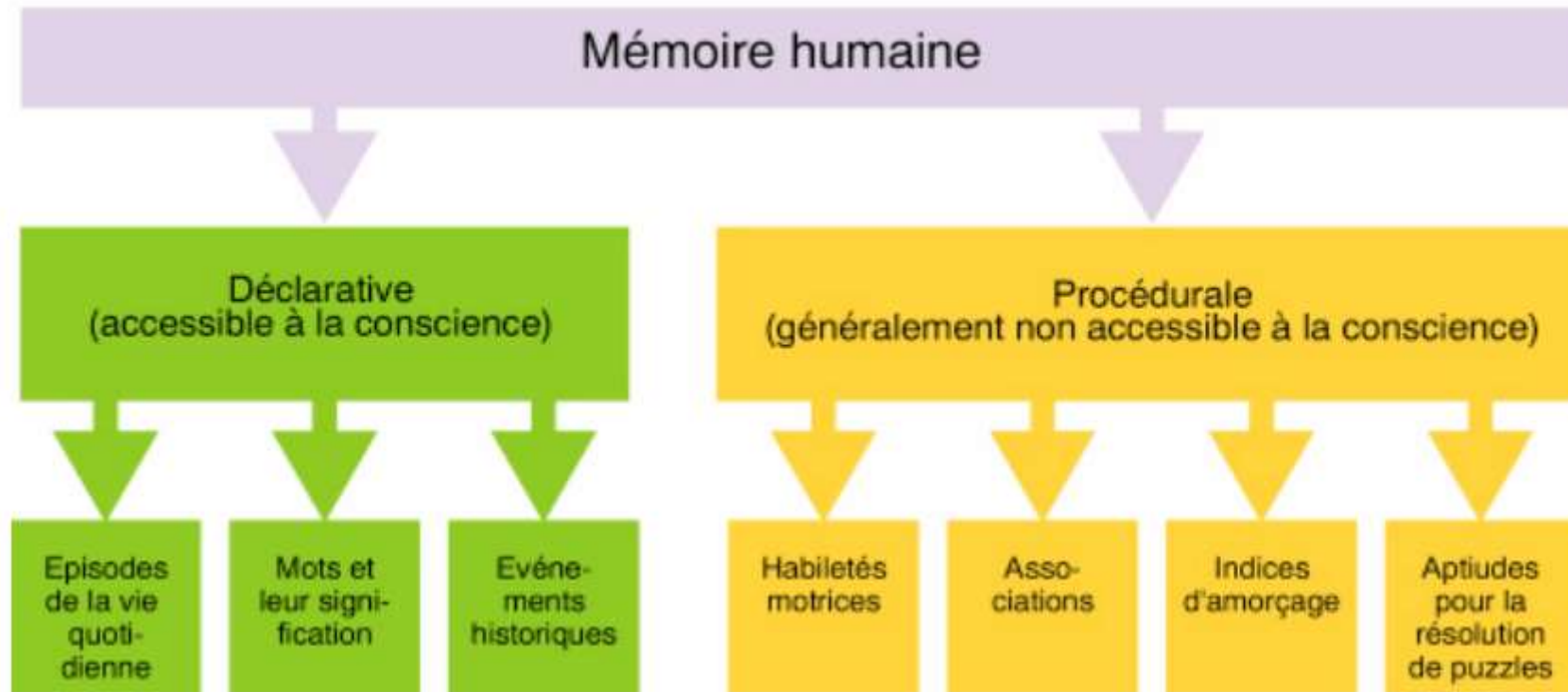
Memory

Forms of long-term memory

- ◉ **Declarative memory** includes memories that can be called into consciousness and expressed as memories of events, images, and sounds, etc.
- ◉ **Procedural memory** (or non-declarative memory) includes motor skills, cognitive skills, classical conditioning and any other information that can be acquired and retrieved non-consciously.

Memory

Forms of long-term memory

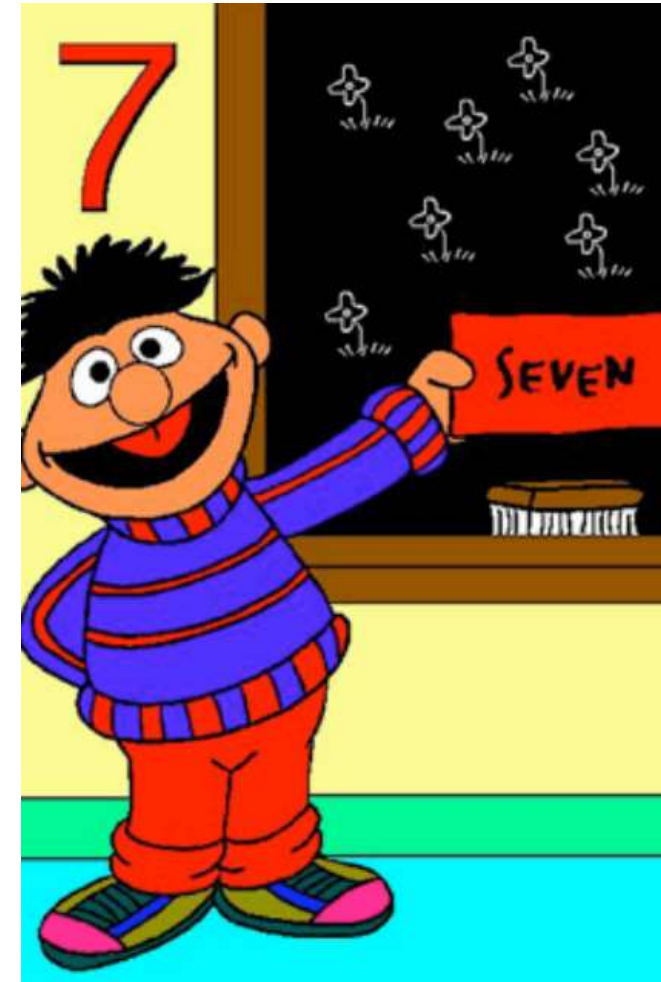


Declarative memory and procedural memory

Memory

Characteristics of short-term memory

- Miller (1958) demonstrated that the number **7** (thus called **the magic number**) was a constant in our processing of information in STM. Thus, it is possible to store 7 elements, more or less, in STM (digits, letters, numbers, images, words, etc.).
- There is therefore a **limitation** on the amount of information that can be encoded, maintained and recalled in STM.



Memory

Characteristics of short-term memory

Forgetting in STM can be explained by:

- ◉ the theory of **the erasure of the trace** ;
- ◉ **interference** theory .



Memory

short-term memory test

Q	L	T	A	E	R	N
U	E	E	R	S	I	S
A	C	S	T	S	S	E
N	H	T	I	O	D	N
D	A	P	L	U	A	T

Memory

short-term memory test

Q	L	T	A	E	R	N
U	E	E	R	S	I	S
A	C	S	T	S	S	E
N	H	T	I	O	D	N
D	A	P	L	U	A	T

Memory

short-term memory test

- Regarder la liste de mots sans rien noter
- Munissez vous d'un papier et d'un crayon
- A la fin du temps imparti, écrire le plus de mots possibles
- Comparer avec la liste de mots et comptabiliser le nombre de mots identiques
- Vous avez 3 mn pour apprendre la liste de mots



Memory

short-term memory test

ATTENTION C'EST PARTI POUR
3 MN

ROULETTES
DRIBBLE
TENNIS
RUGBY
AVIRON
DANSE

SKATE
HAND
MARCHE
VTT
GYM

BASKET
FOOT
SURF
COURSE
ATHLE

SKI
TIR
RANDONNEE
VELO
NATATION



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 - > **Mental representations**

Mental representations

- Very often, the operator must mentally represent the operation of the system or the state of the work objects on which he is operating.
- Even when there is immediate perception, a mental representation of the work in progress or to be carried out serves as a guide to the activity



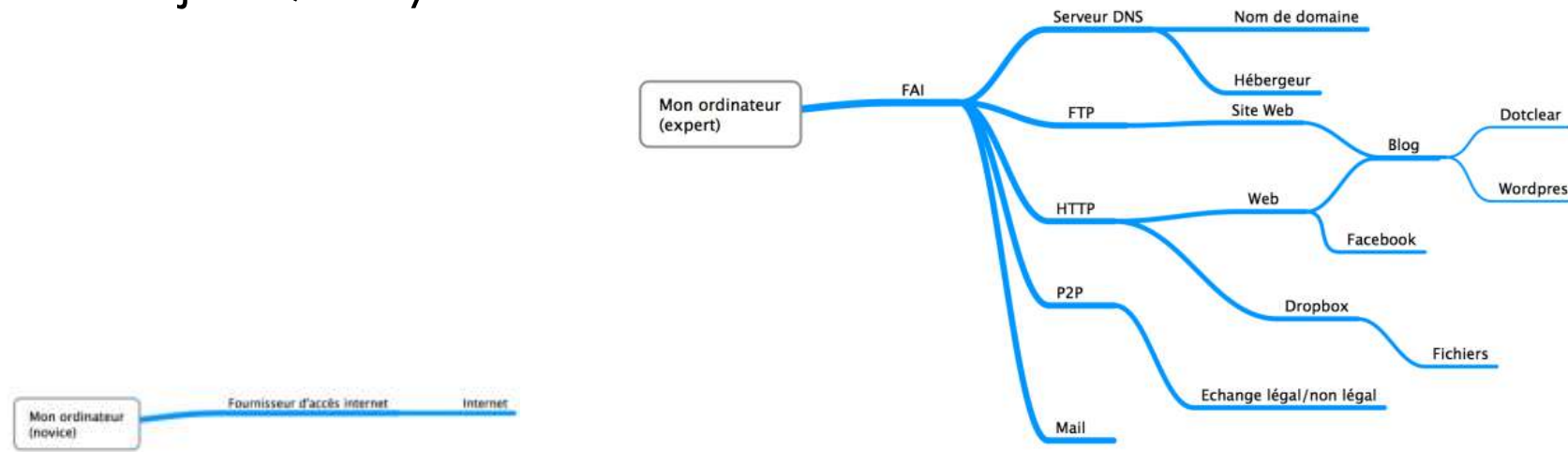
Mental representations

- Mental representation fulfills a utilitarian assistance function in information-gathering and reasoning processes.

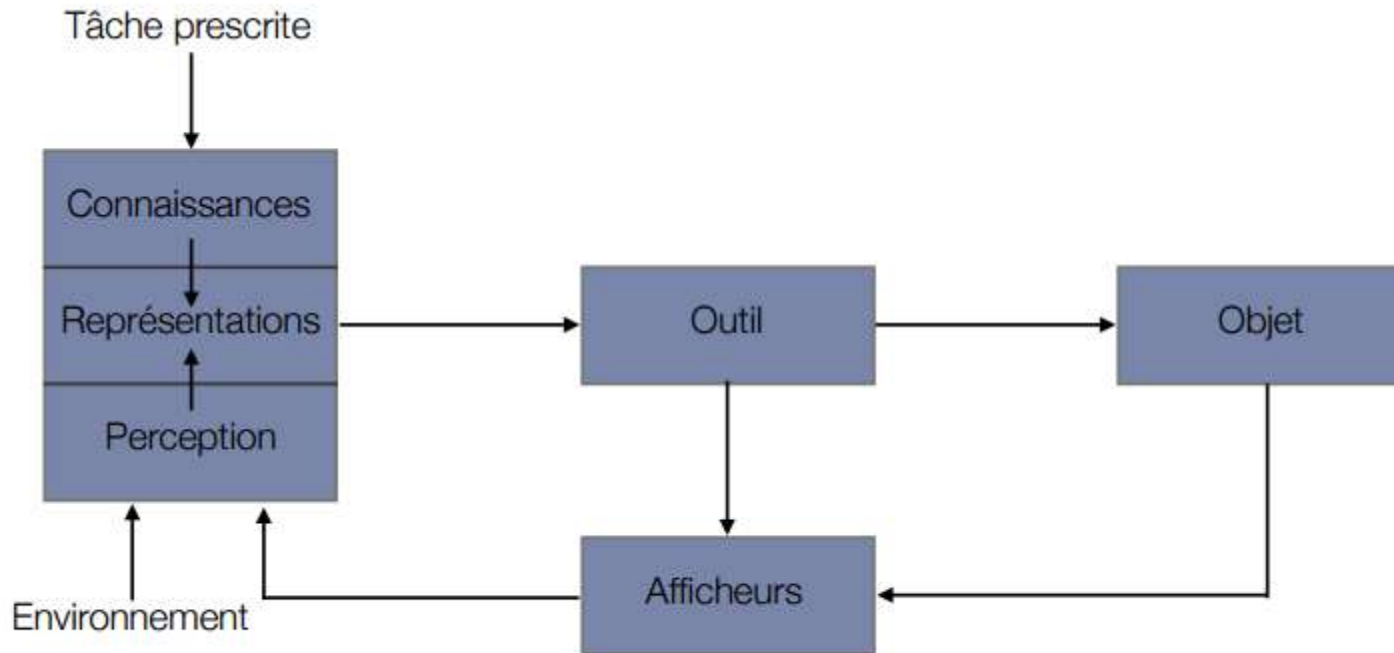


Mental representations

- But also...
- Mental representation is an image, a functional construction of a situation, an object, a system.



Mental representations



Representations in a Human-Machine system -
Gaillard (1997)

Mental representations

Reasoning activities

- ◉ Reasoning strategies proceed by algorithms or heuristics:
 - > **The algorithm** is a systematic procedure which gives the assurance of achieving the solution of the problem for which the algorithm is designed
 - > **The heuristic** is a non-systematic procedure, sometimes faster and simpler than the algorithm, but which does not allow us to achieve the solution of the problem with certainty. Heuristics respond to the principle of cognitive economics



Mental representations

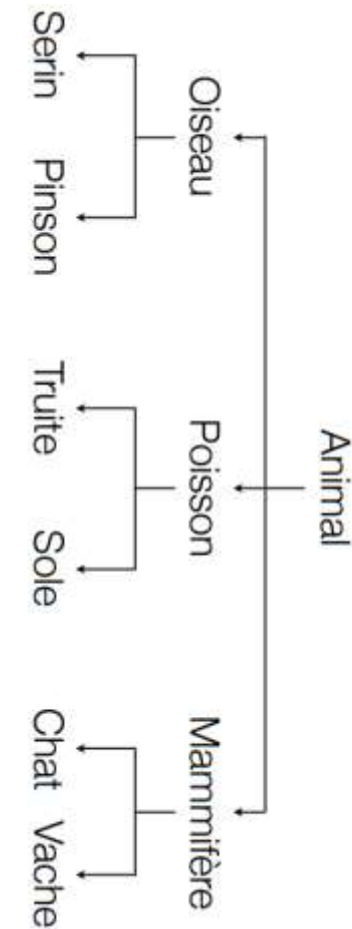
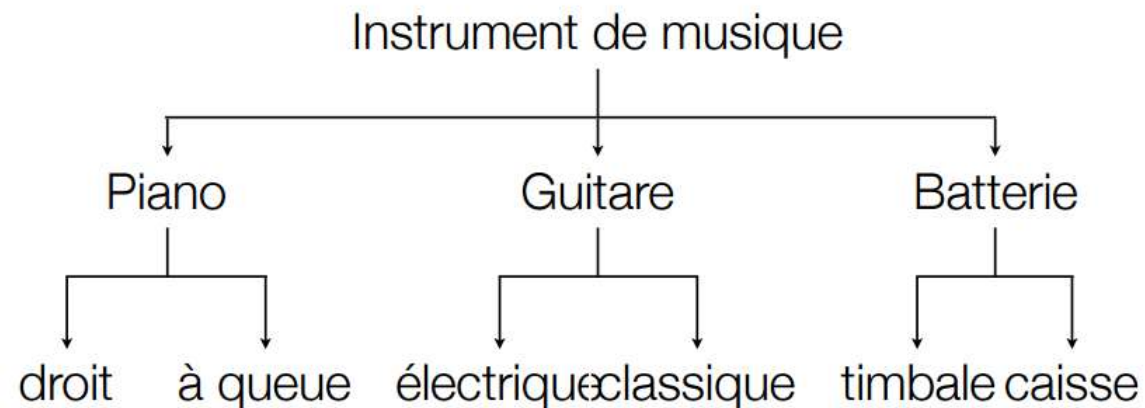
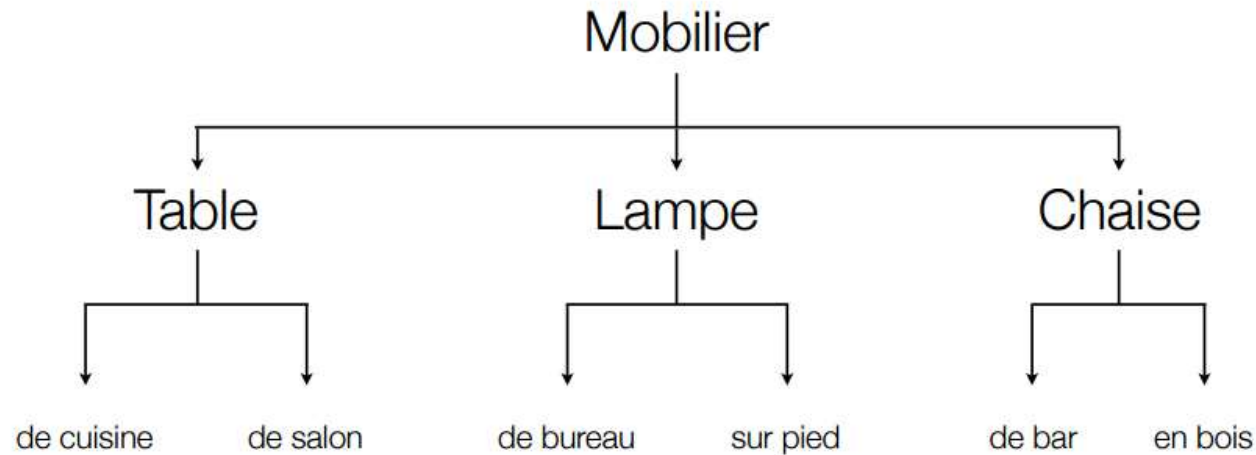
Categorization and stereotyping

- ◉ The concept of categorization refers to a mental activity which consists of organizing and arranging information from the environment
 - > The objects are thus classified by category, according to their resemblance
 - > **Categories** are organized hierarchically



Mental representations

Categorization and stereotyping



Mental representations

Categorization and stereotyping



Mental representations

Categorization and stereotyping

- ◉ The higher an item has a family resemblance score, the more representative it will be of its category.
- ◉ The more representative an element is of its category, the more quickly and easily it will be processed in a classification task.



Mental representations

Categorization and stereotyping

- ◉ The categorization process is based on a simplification of reality
- ◉ This simplification consists of accentuating the similarities between the elements of the same category, and accentuating the differences between the categories

