Interacção Humana com o Computador

Aula 3

Departamento de Informática
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The Human - Movement

Fit's Law (1954)

Describes the time taken to hit a screen target:

$$\mathbf{Mt = a + b \log_2(D/S + 1)}$$

where: **a** and **b** are empirically determined constants,

Mt is the movement time

D is the distance to target,

S is the size of the target

⇒ **Rule**: targets as large as possible and distances as small as possible

The Human - Movement

The Hick's law (1952)

Models the time required to select one option among several possibilities:

$$T = b \log_2(n + 1)$$

where:

n is the number of possibilities,

T is the time taken to choose an option,

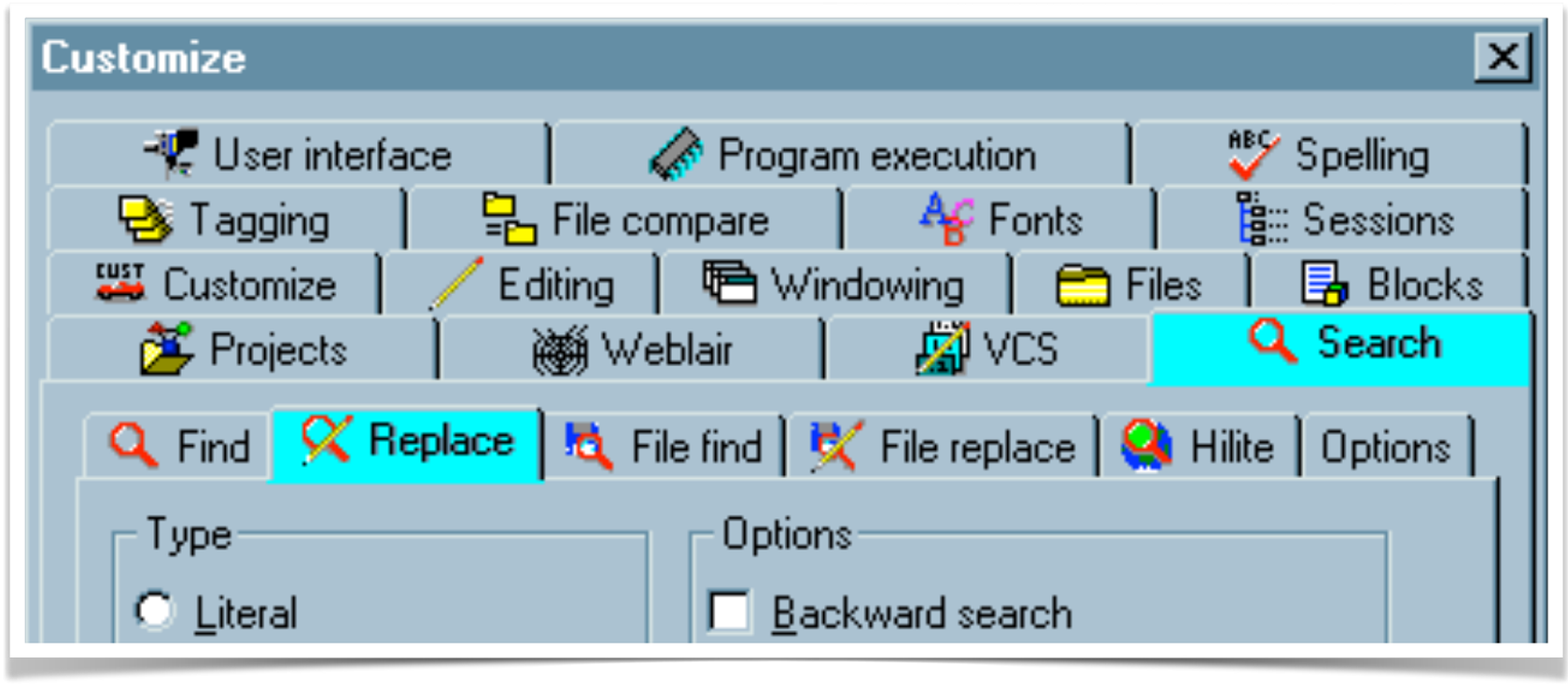
b is an empirical constant

⇒ **Principle**: always present the minimal number of choices in a given view. Less is much more!

The Human - Movement

The Hick's law (1952)

$$T = b \log_2(n + 1)$$



⇒ **Principle**: always present the minimal number of choices in a given view. Less is much more!

The Human - Information Proc. Unit

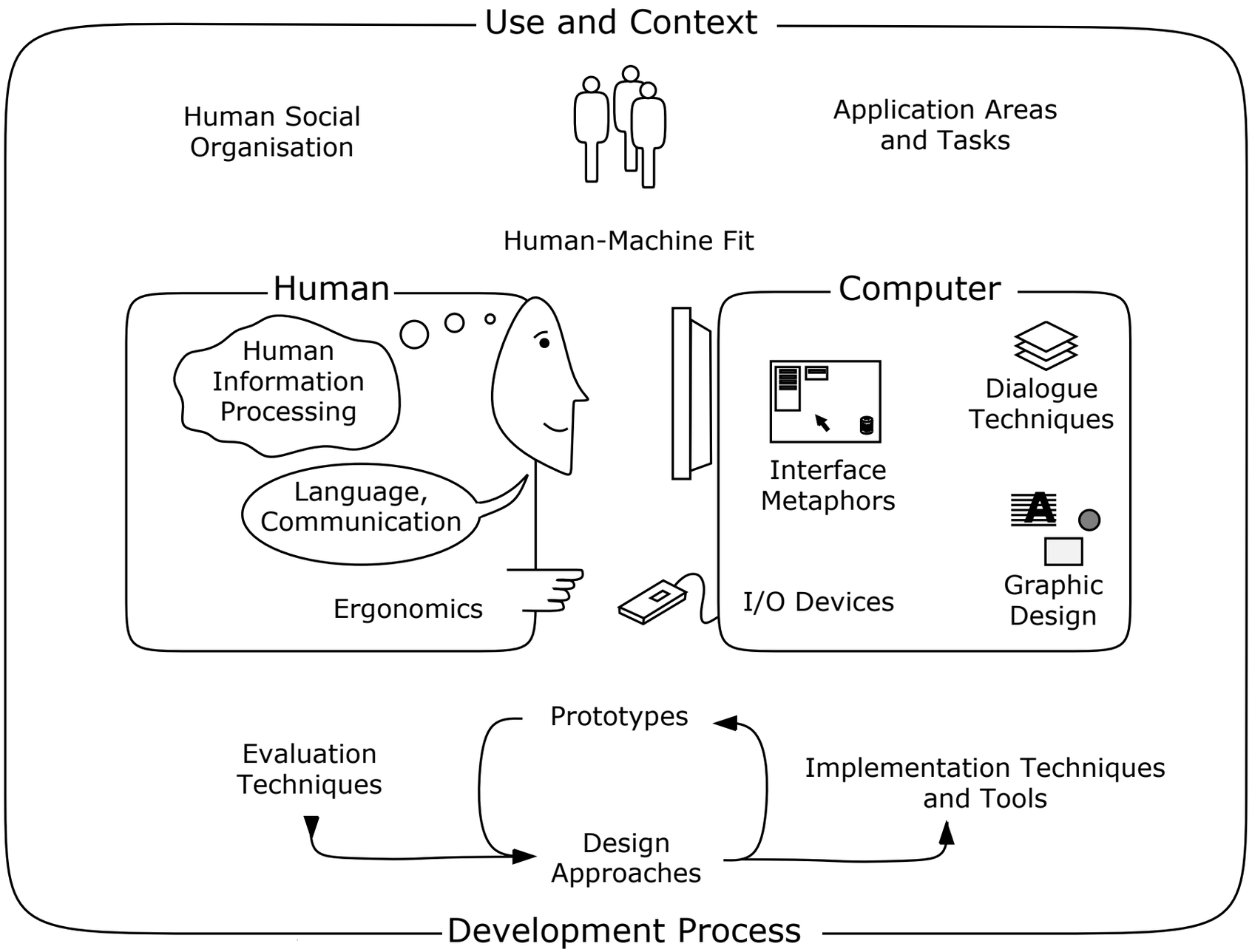
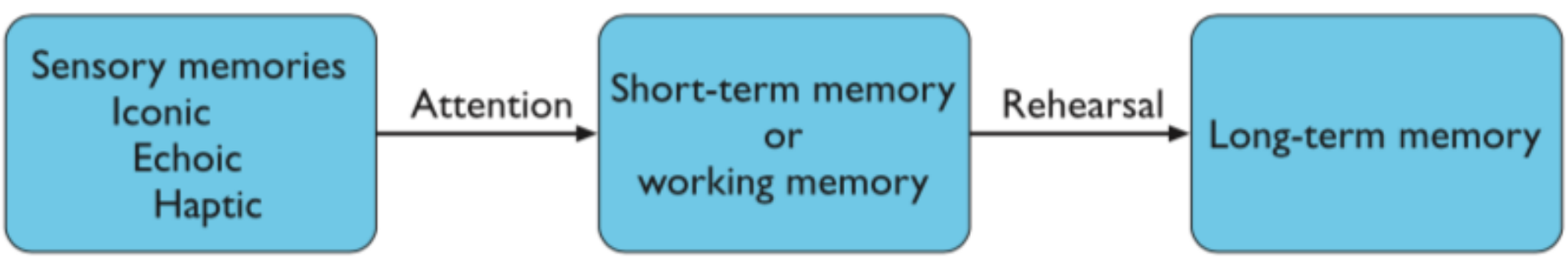


Figure 1.1: The nature of Human-Computer Interaction. Adapted from Figure 1 of the ACM SIGCHI Curricula for Human-Computer Interaction [Hewett et al., 2002]

The Human — Memory

Memory

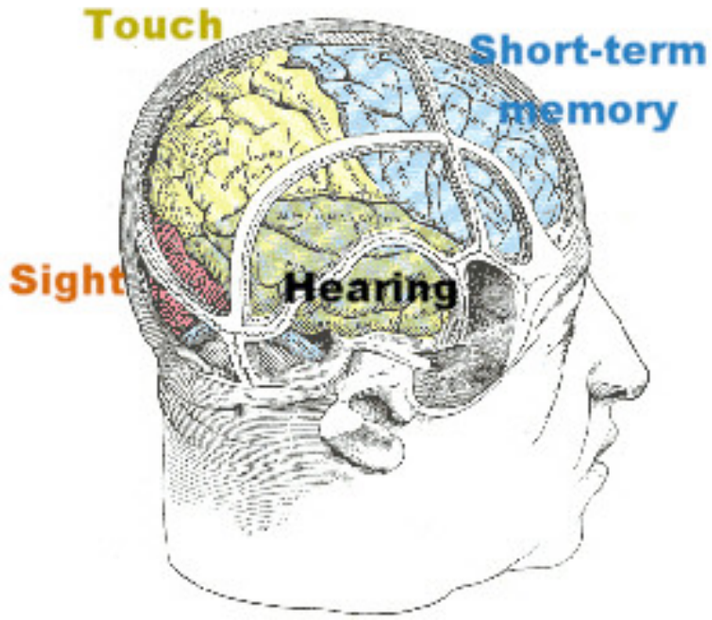
- Stores not only **facts**, but also **procedures** and **actions**
- Conceptual division in three types
  - **Sensory** memory
  - **Short-term**/working memory (STM)
  - **Long-term** memory (LTM)



The Human — Memory

Sensory Memory

- Buffers for stimuli received through senses
  - **Iconic memory:** visual stimuli
  - **Echoic memory:** aural stimuli
  - **Haptic memory:** tactile stimuli



- These buffers are constantly being overwritten.
- Stimuli and <u>selective attention</u> (cocktail party)

The Human — Memory

Sensory Memory

- Stimuli and selective attention, for example: what is going on in a **cocktail party**?

The Human — Memory

Sensory Memory

- Sensory memory is **transferred** to the short-term memory, through attention;

- **Attention** is the action of **focusing** on a given item, by filtering the remaining inputs received at that time;

- Without this filtering, we will rapidly become **overwhelmed** with information.

Short-Term Memory (STM)

- Works as a scratch-pad for temporary recall
  - When we read (stores recent words)
  - In mental calculations (intermediate values)

- Temporary data storage
  - It has a rapid acces **70 ms**.
  - But also a rapid decay **200 ms**.
  - Finite and very limited capacity: 7±2 chunks

Short-Term Memory

Examples:

212348278493202

Short-Term Memory

Examples:

0351 961 262 619

Short-Term Memory

Examples:

HEC ATR ANU PTH ETR EET

Short-Term Memory

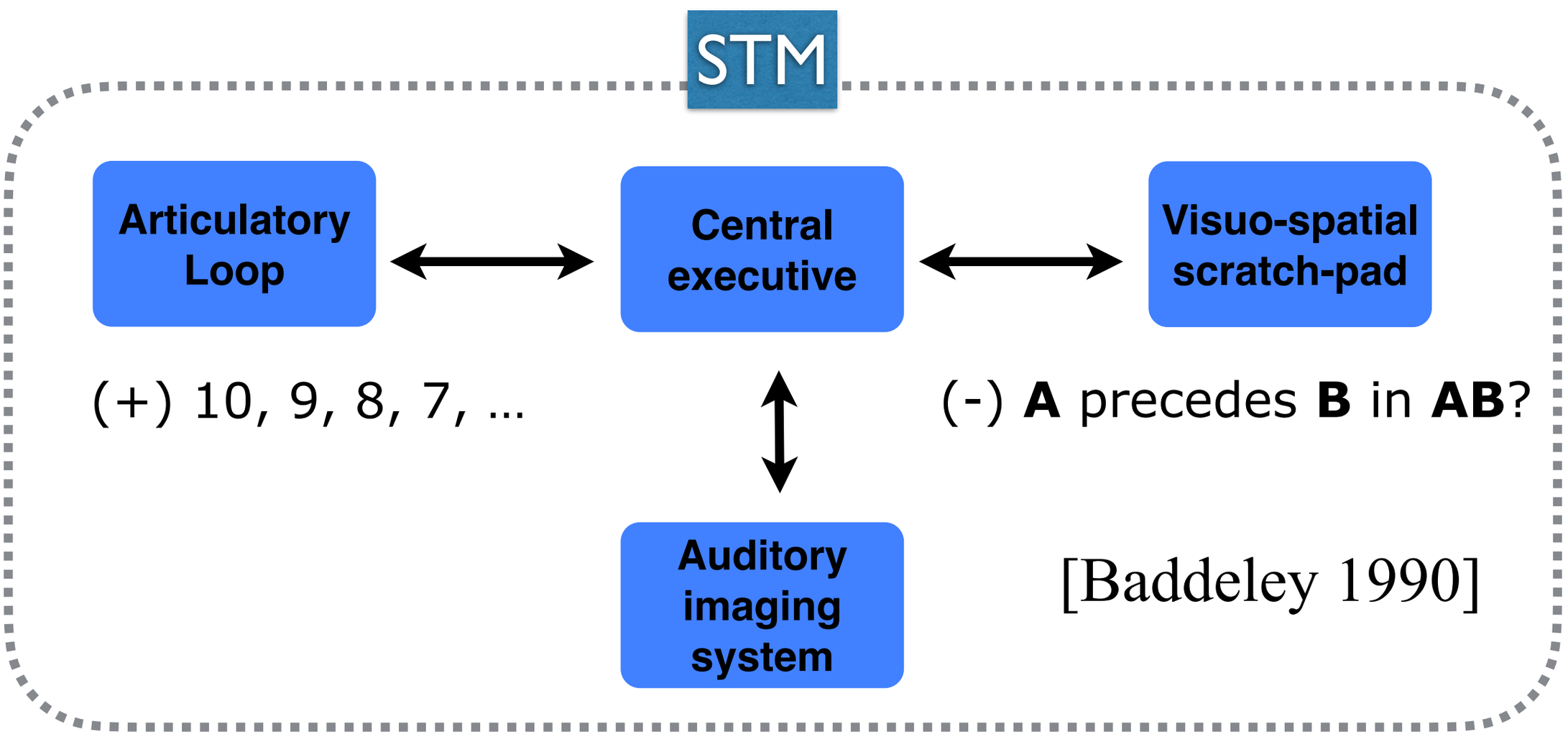
Examples:

THEC ATR ANU PTH ETR EE

THE CAT RAN UP THE TREE

Short-Term Memory

- **Recency effect**
  - e.g: remember last word & count
- **Interference**:
  - not symmetric: countdown (+) ≠ sentence processing (-)



Short-Term Memory

- **On average, a person can remember** 7 ± 2 items in his **STM** (Menus, Lists, Cmds) **<u>but</u>**: there are many things that can easily be remembered.

- Split data into information chunks enables 7±2 chunks

- ***Chunking*** (division into smaller meaningful pieces) increases memory usage efficiency

- Chunking leads to ***Closure***

- A failure in closure leads the user to lose mental location, causing him to make ***mistakes***

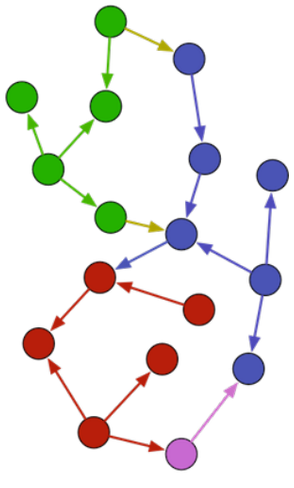
Short-Term Memory

- A ***failure in closure*** leads the user to lose mental location, causing him to make mistakes (e.g ATM)

Long-Term Memory (LTM)

- **Repository for all our knowledge**
  - slow access time ~ 100 ms
  - slow decay, if any (after minutes = after hours)
  - immense storage capacity

- **Two types**
  - **Episodic** – memorize sequences of events (episodes). Like when we hear a narrative



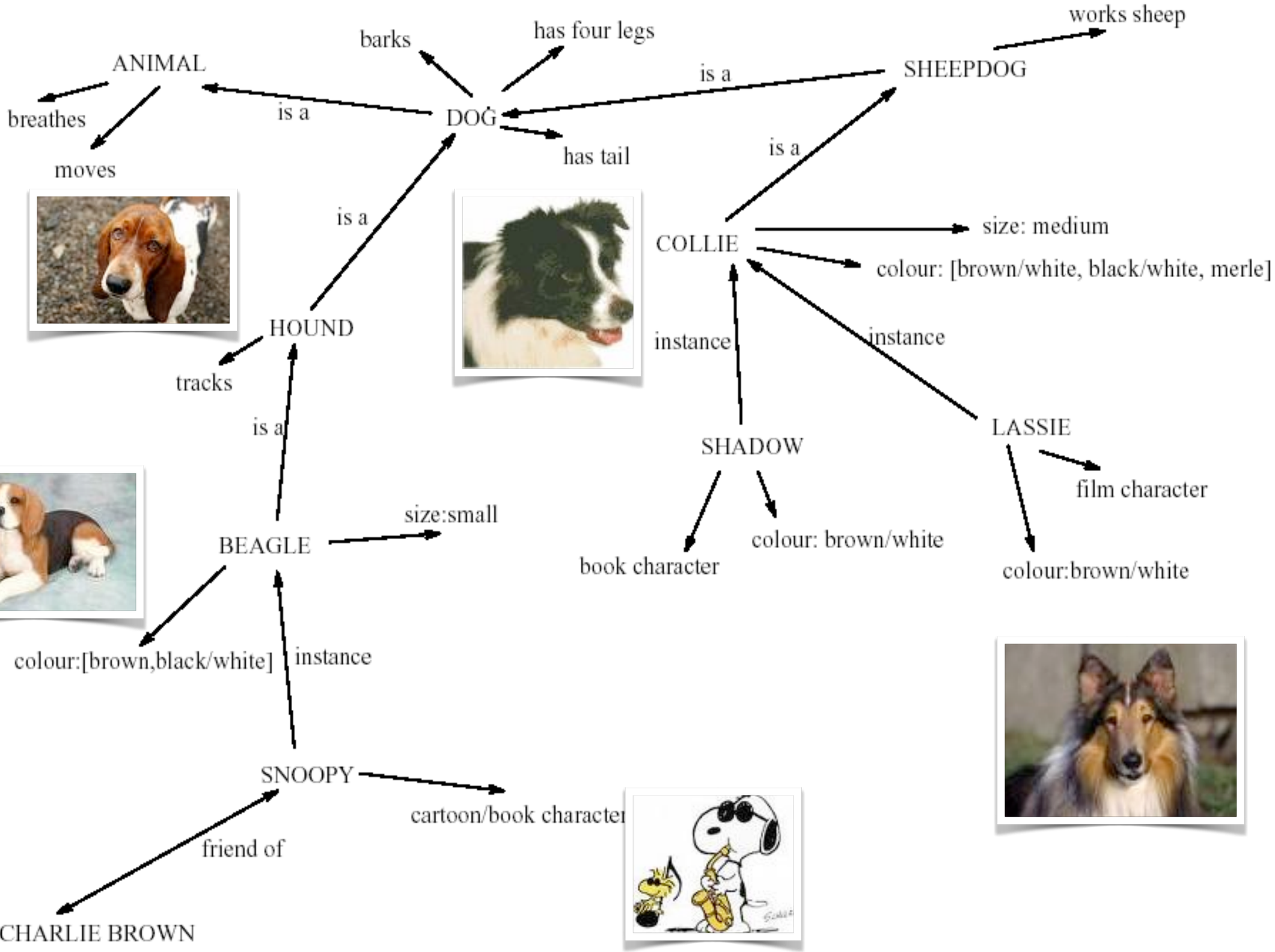
  - **Semantic** – memorize fact structures, concepts, skills, … We can think on a graph model (connected ideas), as well as classes with attributes and connections like inheritance as in OOP.
  - **The Semantic LTM derives from episodic LTM**

Long-Term Memory (LTM)

- **Structure of semantic memory** [Collins & Quinlan]
  - Facilitates the retrieval of information
  - Represents the relationship between two information units
  - Supports inference and generalisation

- **Model: semantic network**
  - **Inheritance**: derived concepts inherit "parent" properties
  - Define the **relationship** between information units
  - Allows **inference** through inheritance
  - Knowledge **associatively** organised

Models of LTM - Semantic Network



Models of LTM - Frames

- Information organised in data structures;
- Slots in structure instantiated with values for instance of data;
- Type–subtype relationships;
- An **extension** of a semantic network, with more informations details.

DOG

Fixed
legs: 4

Default
diet: carniverous
sound: bark

Variable
size:
colour

BOBY

Fixed
breed of: DOG
type: sheepdog

Default
size: 65 cm

Variable
colour

Memory transfers

Memory

I hear and I forget. I see and I remember. I do and I understand.

Confucius

LTM - Storage of information

- **Rehearsal**
  - Information moves from STM to LTM
- **Total time hypothesis**
  - Amount retained proportionally to rehearsal time [Ebinghaus 1885]
- **Distribution of practice effect**
  - Optimized by **spreading learning** over time [Baddley 1978]
- **Structure, meaning, and familiarity**
  - Information easier to remember
  - **difficulty**(concepts) **> difficulty**(objects)

LTM - Storage of information

- **Structure, meaning and familiarity**
  - Information easier to remember
  - **difficulty**(concepts) **> difficulty**(objects)

List A:

age, warm, faith, peaceful, idea, past, broad, bright, power.

LTM - Storage of information

- **Structure, meaning and familiarity**
  - Information easier to remember
  - **difficulty**(concepts) **>** **difficulty**(objects)

List B:

boat, tree, cat, black, child, flame,
city, church, police, aircraft

LTM — Retrieval

Recall

- Information reproduced from memory can be assisted by cues, e.g. categories, imagery, …
- Concrete information is easier to remember:

Recognition

- The information provides recognisable clues
- Less complex than recall, due to certain clues
- Contextual information will assist the subject

LTM - Storage of information

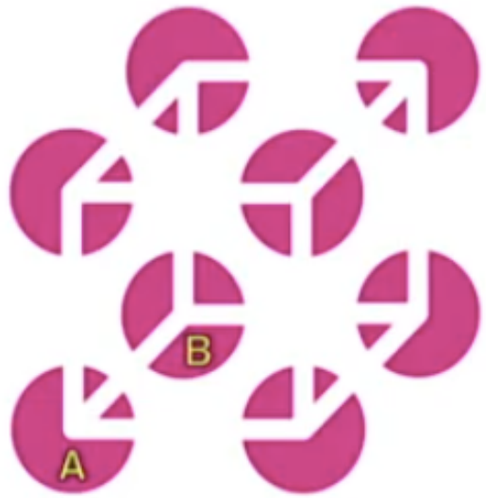
- **Structure, meaning , and familiarity**

  - **Baddley** (1932): experiments with memory, remembering **meaningful information**, opposed to **Ebinghaus** (1885), example: subjects listen to another culture's history

    - Non-familiars words are <u>substituted</u>
    - Re-familiarize new concepts, in order to <u>assimilate</u> them in the existing structures

  - **System security challenges**: lots of strange passwords

    <u>security</u> versus <u>memorization</u>



LTM - Storage of information

- **Rehearsal**
  - Information moves from STM to LTM
- **Total time hypothesis**
  - The amount of information retained in LTM is proportional to the rehearsal time **Ebinghaus** (1885).

LTM - Forgetting

There are two main theories:

- **Decay**
  - Information is lost gradually but very slowly
  - **Ebbinghaus** says it is logarithmic
  - **Jost's law**: if two memories are equally strong, the oldest last longer

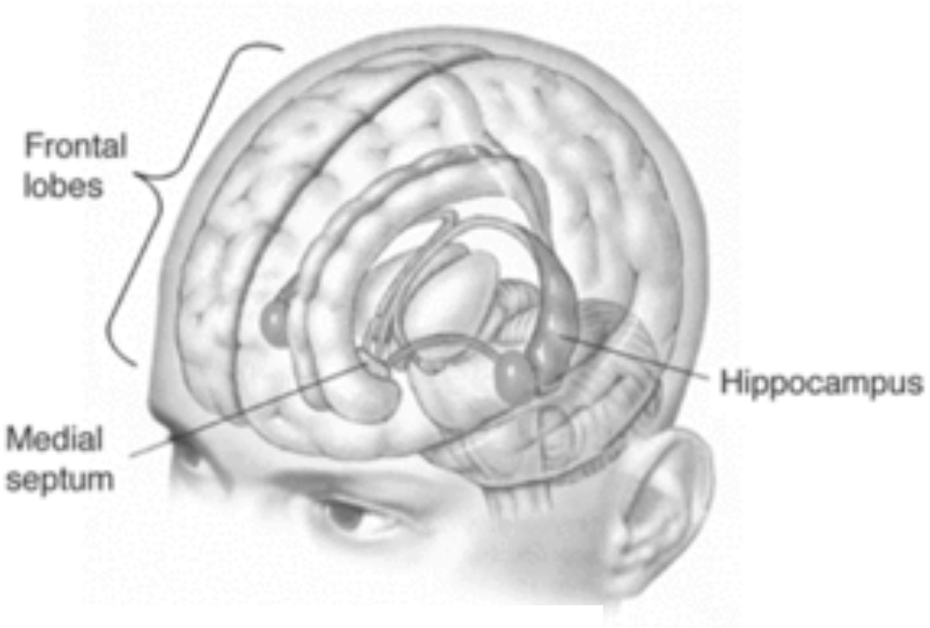
- **Interference**
  - New information replaces the old one: **retroactive interference**
  - Old may interfere with new: **proactive inhibition**, e.g: driving to our old house.
  - May not forget at all. Memory is selective and biased toward positive memories: *nostalgia*

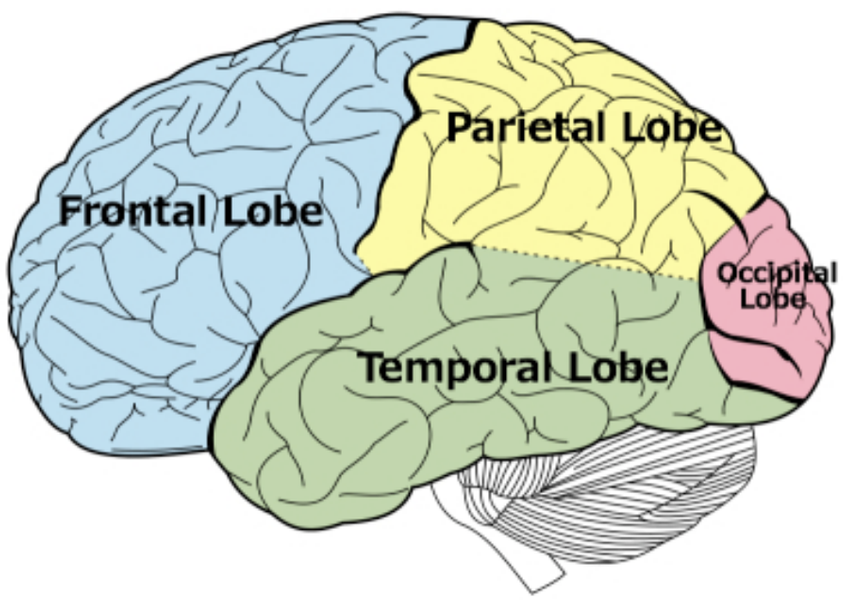
Affected by emotion <== *test with emotive words*

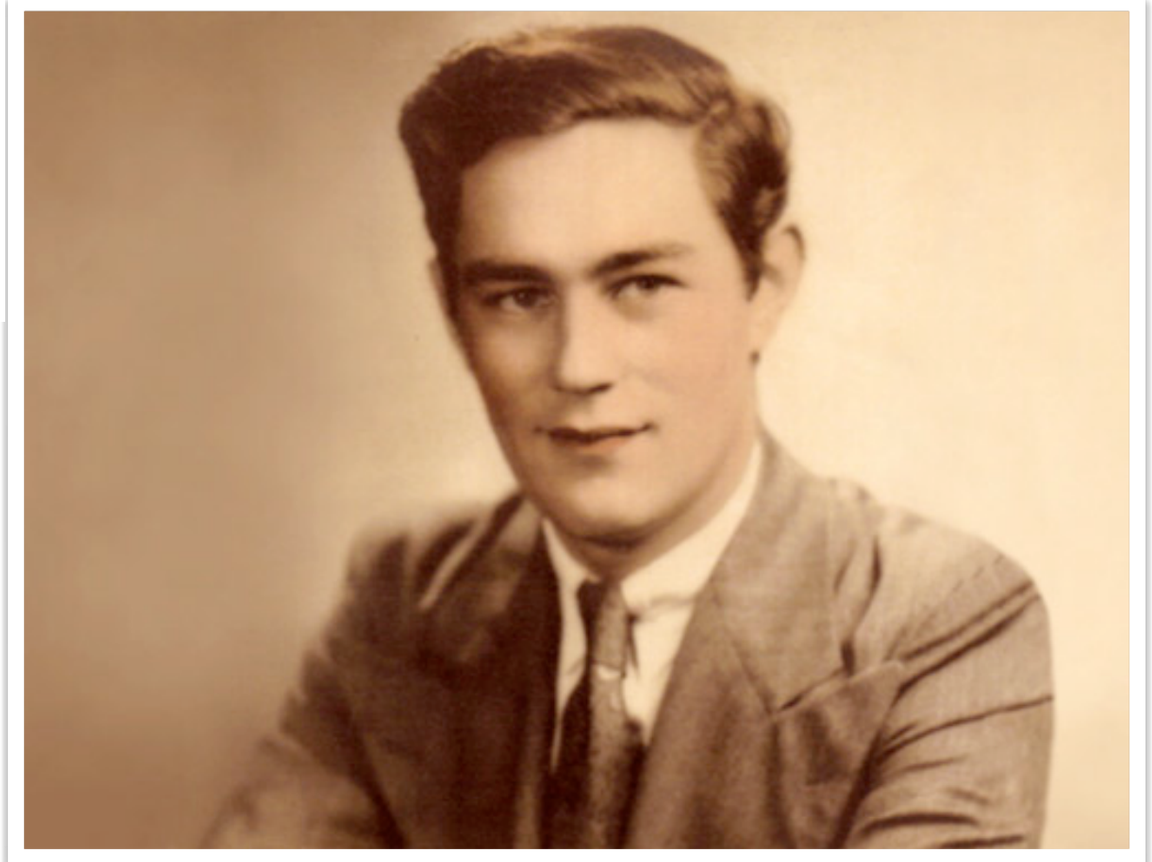
LTM - Forgetting

The man who cannot remember

- Henry Molaison 1958
- Hippocampus (partially removed <= accident)







The Human - Thinking

Thinking

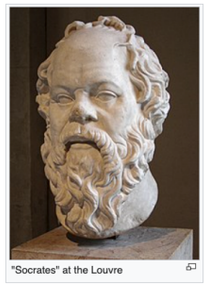
Different Kinds of Reasoning

Deductive, Inductive, Abductive

Problem Solving

Skills, Analogy

Deductive Reasoning


"Socrates" at the Louvre

All men are mortal.

Socrates is a man.

Therefore, Socrates is mortal.

- **Deduction**:
  - Derive logically necessary conclusion from given premises

    example:

    If Friday **Then** Anne will go to work

    It is Friday

    Therefore: Anne will be working today

- **Logical conclusion not necessarily true:**

  example:

  If raining **Then** the floor is wet

  It is raining now

  Therefore: the floor is wet

Deductive Reasoning

- **When truth and logical validity clash …**

  e.g. Some people are babies

  Some babies cry

  Therefore: Some people cry

  Is it correct?

- **People bring world knowledge to bear**

  premises, common sense, contextual information, ...

Inductive Reasoning

- **Induction:**
  - Generalize from cases seen to cases unseen

    e.g., *all elephants we have seen have trunks*
    therefore all elephants have trunks

- **Not 100% reliable**
  - Can only be **proven false**:

    e.g., find a negative surprise!

  … but very useful!

- **Humans aren't good at using negative evidence**

  e.g. Wason's cards

Inductive Reasoning

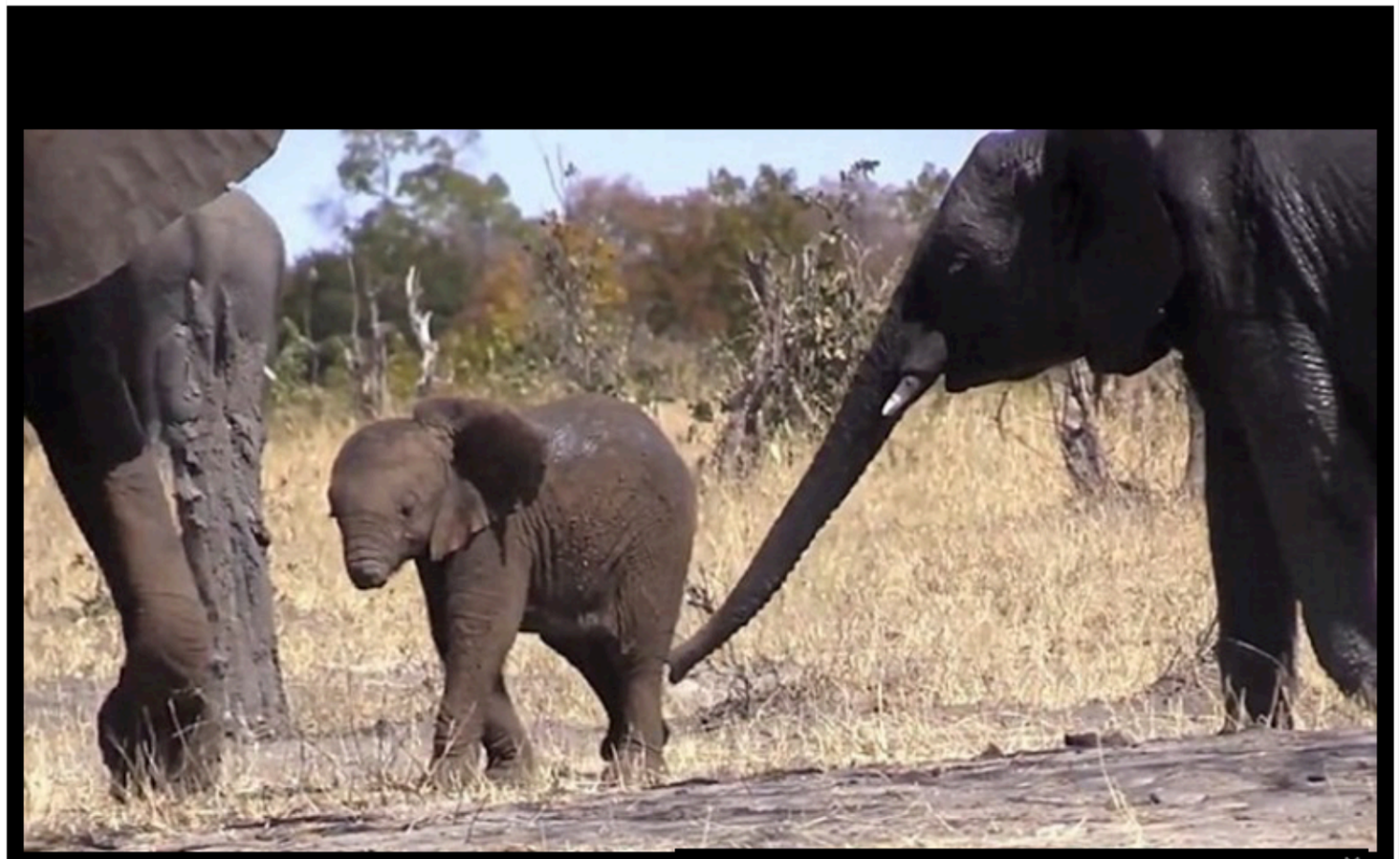
All elephants have trunks!? 🤔

cm MUNDO

Elefante sem tromba avistado na África do Sul

Especialistas mostram-se preocupados com a sobrevivência da cria.

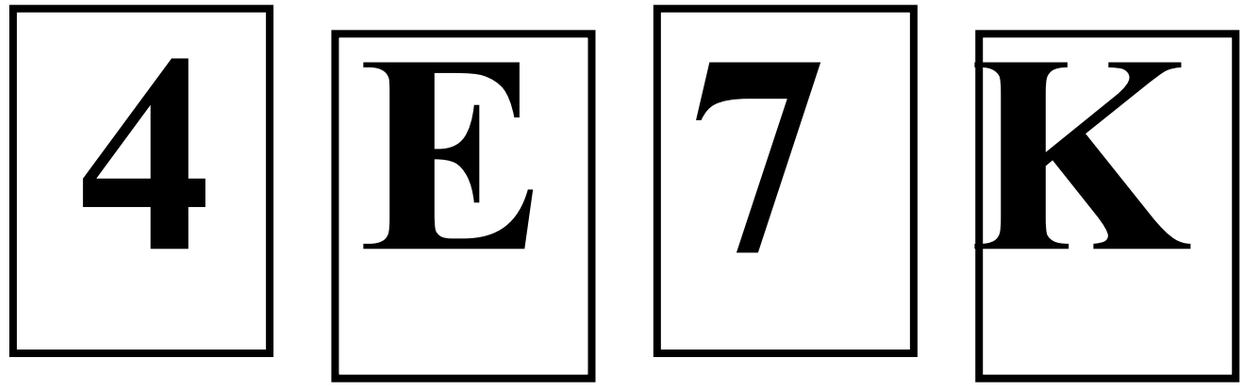
13:26



Cria de elefante foi avistada na África do Sul

Getty Images

Inductive Reasoning - Wason's cards



If a card has a **vowel** on one side **Then**

it has an **even** number on the other side

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**

ex: Sam drives fast when drunk

Last night I saw Sam driving fast

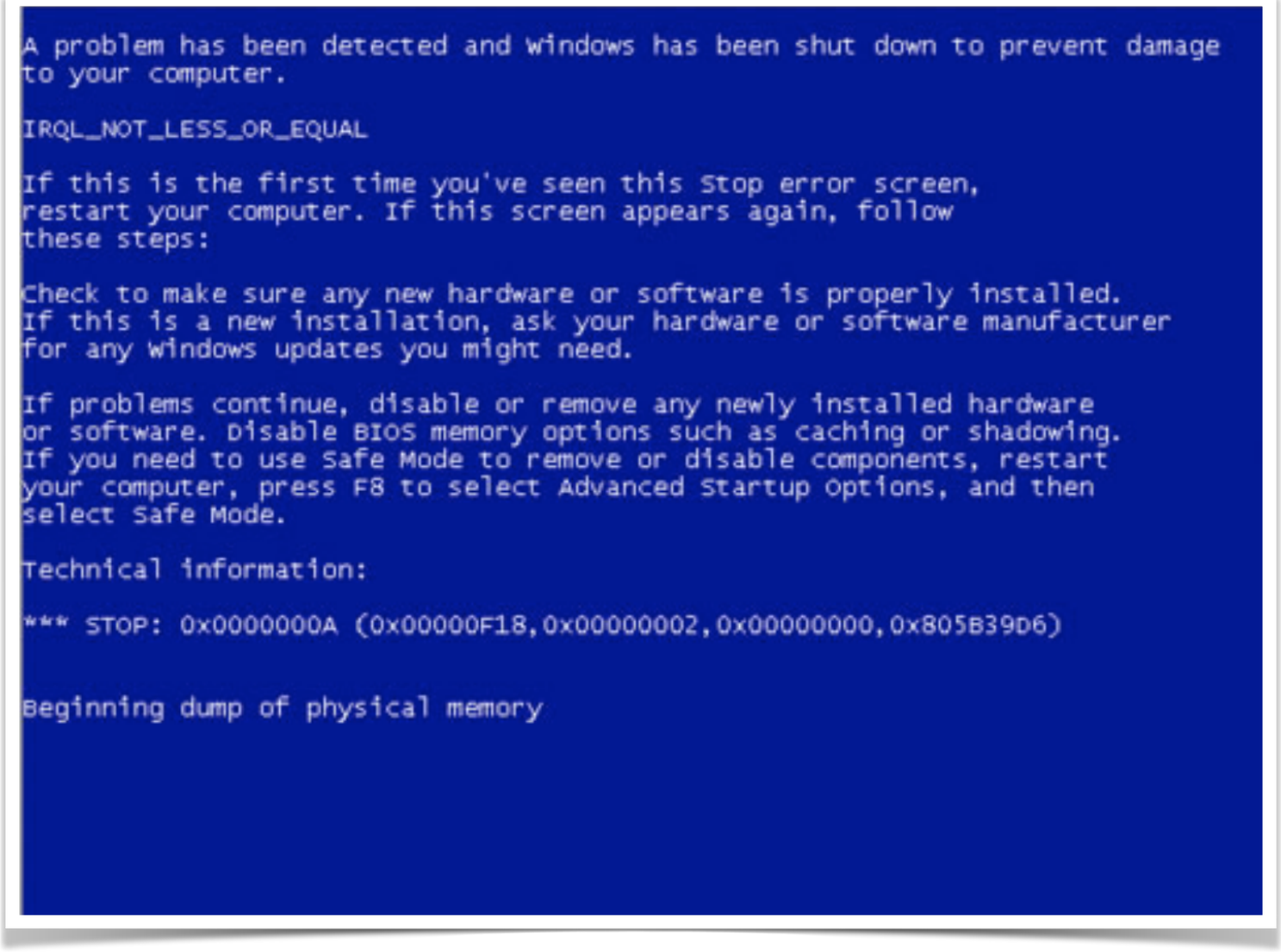
I assume that Sam was drunk

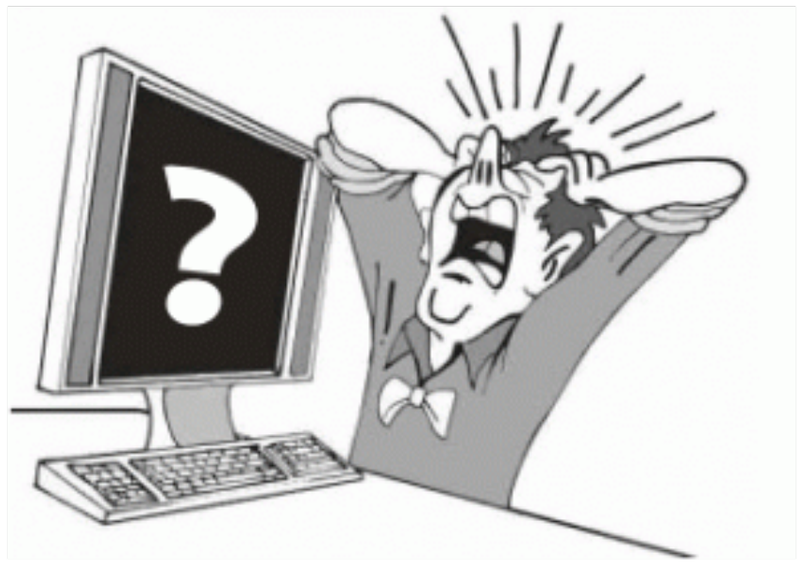
- **Unreliable:**
  - Can lead to false explanations
  - User: event => action

Abductive Reasoning

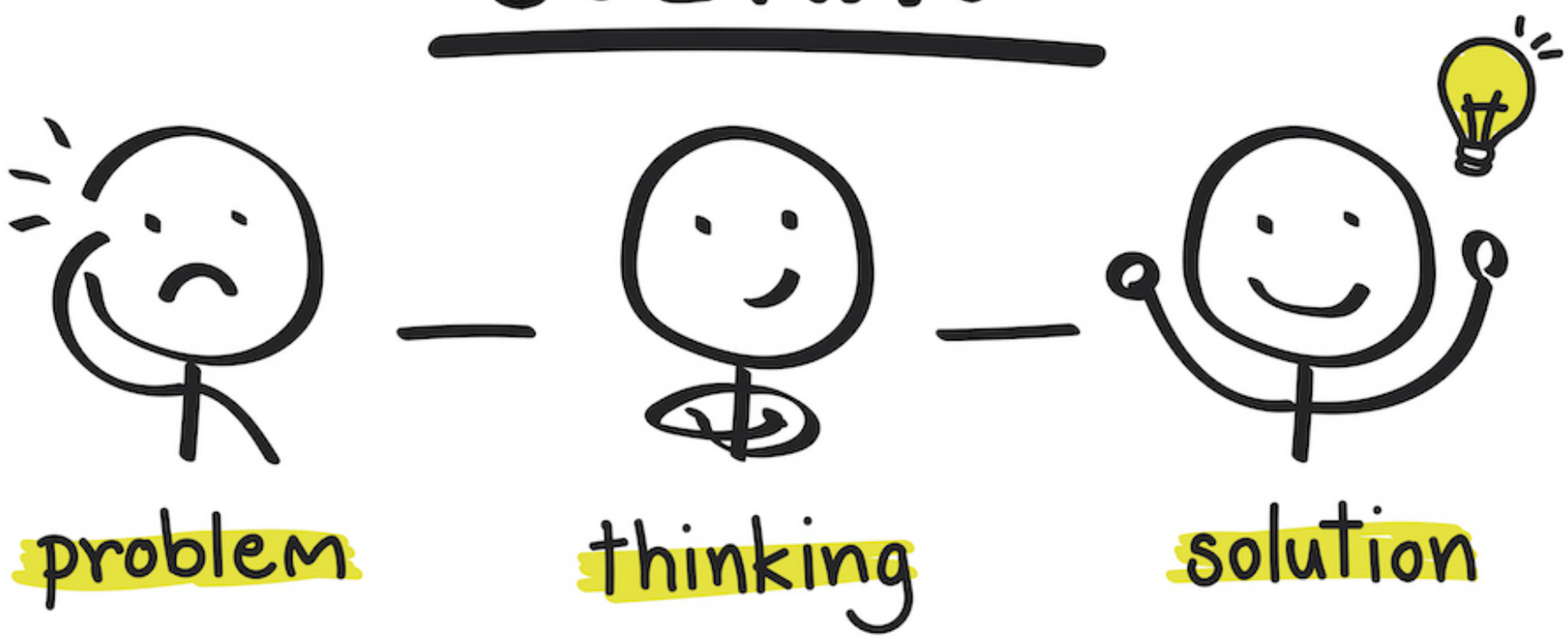
- **Unreliable:**
  - Can lead to false explanation
  - User: event => action

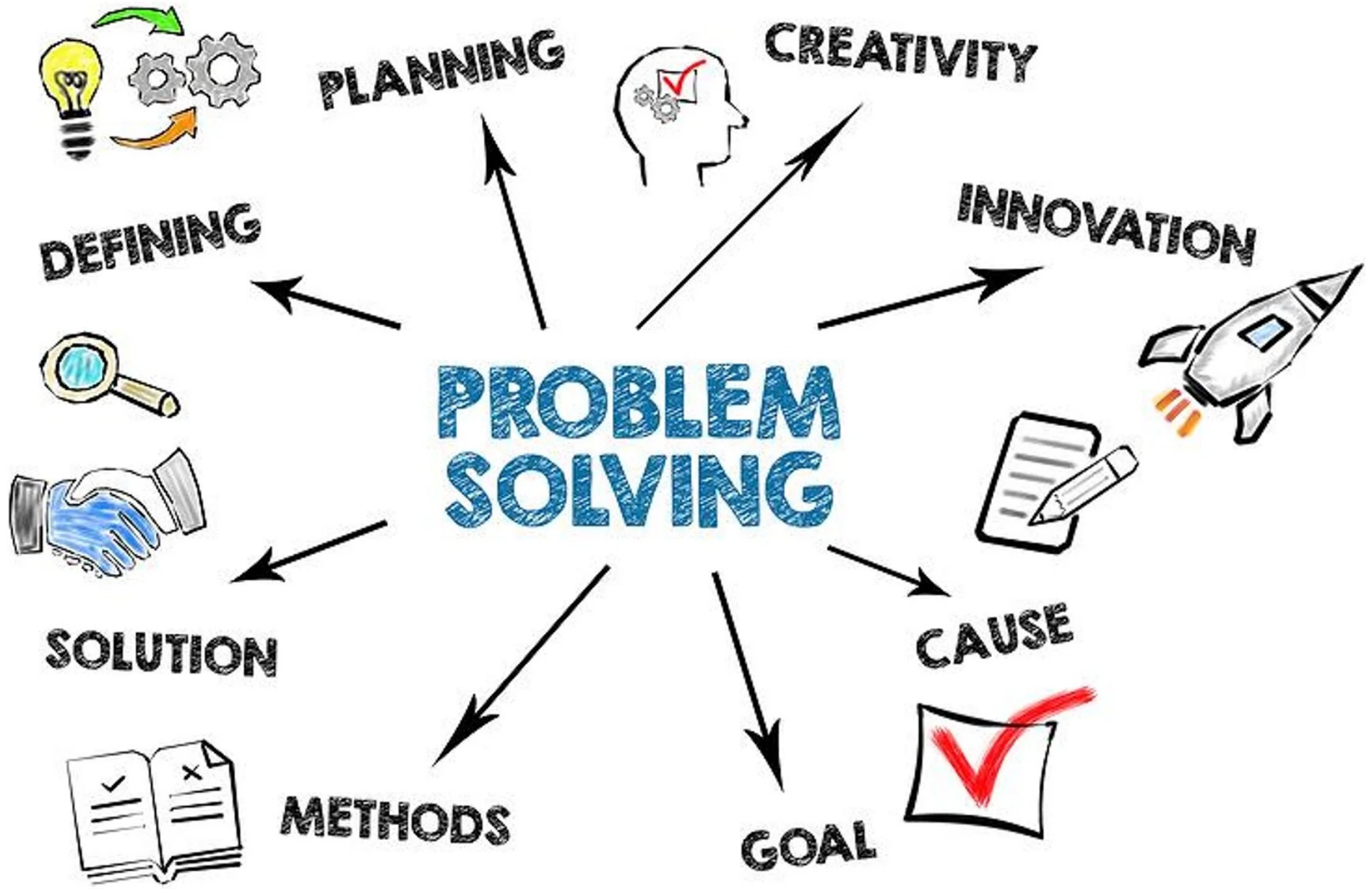
    e.g. Blue Screen: "Ups! What have I done?!?"





PROBLEM SOLVING




PLANNING
CREATIVITY
DEFINING
INNOVATION
PROBLEM SOLVING
SOLUTION
METHODS
GOAL
CAUSE

Problem Solving

- **Process of finding solution to unfamiliar task using knowledge**

- **Several theories:**
- **Behaviourism** (comportamentalistas)
  - –Reproductively **OR** trial and error cycle
- **Gestalt (**non behaviorists**)**
  - –Problem solving both **productive** and **reproductive**
  - –**Productive** draws on **insight** and **restructuring** of the problem, e.g., *Maier's Pendulum Problem* or the *Dunker's Candle*
  - –Attractive but not enough evidence to explain **insight**
  - –Move away from behaviourism and **led towards information processing theories.**

Problem Solving

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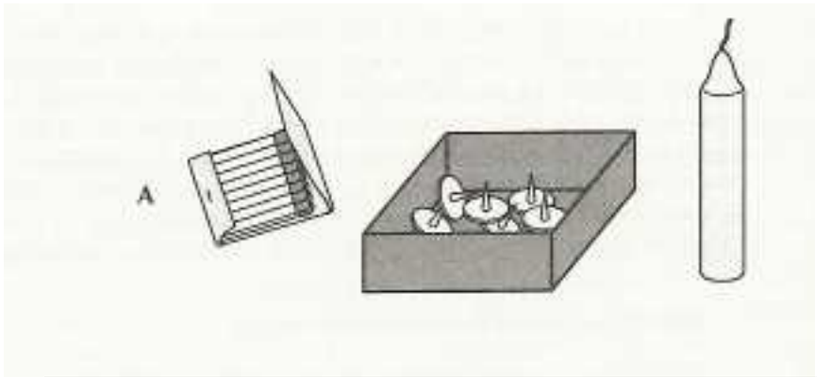

???

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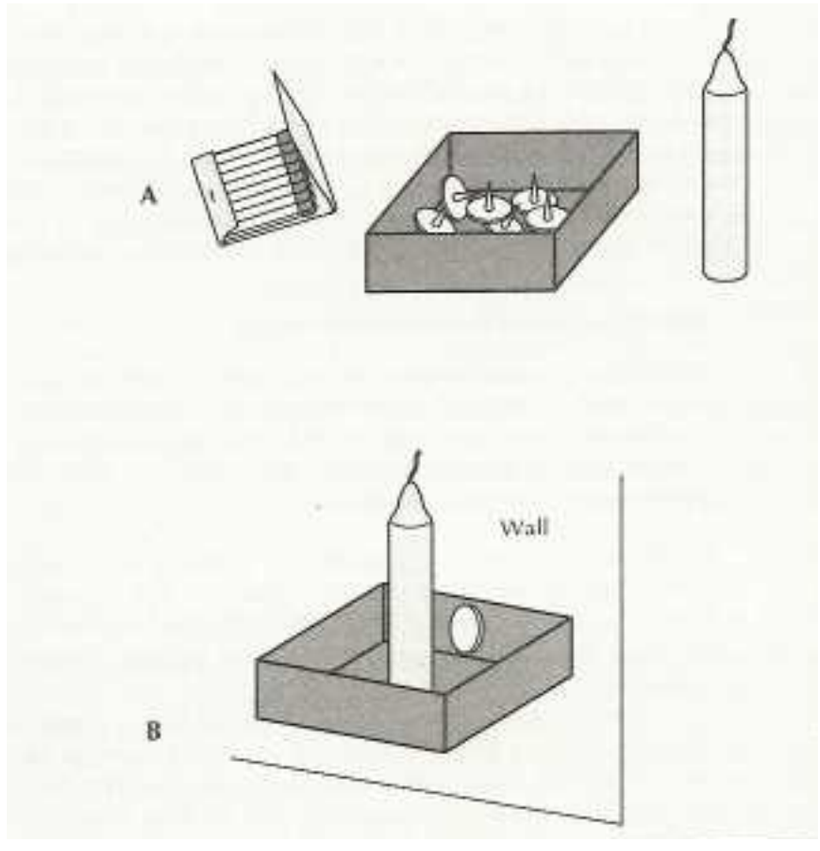

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Problem Solving

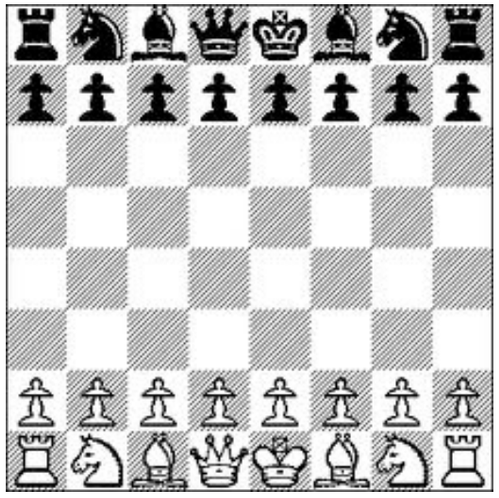
Problem Space Theory

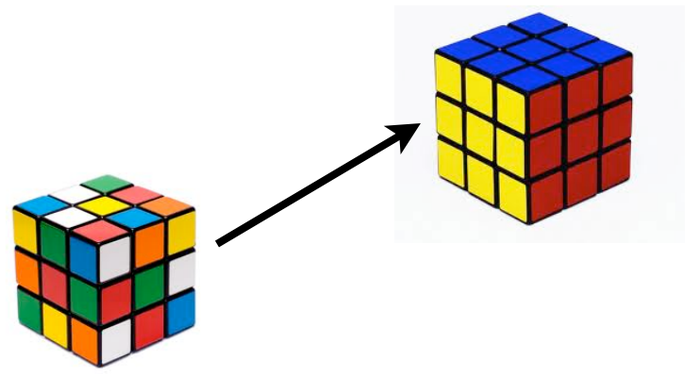
- Problem space comprises **problem states**
- Problem solving involves generating states using **legal operators**
- **Heuristics** may be employed to select operators
  e.g. means-ends analysis
- Operates **within human information processing** system
  e.g., considers the STM limits, …
- **Largely applied** to problem solving in well-defined areas
  e.g., puzzles rather than knowledge intensive area

Problem Solving

Problem Space Theory

- **Largely applied** to problem solving in well-defined areas
  e.g. puzzles, certain games, …





Tempo	Segunda	Sala	Terça	Sala	Quarta	Sala	Quinta	Sala	Sexta	Sala	Sábado	Sala
8-9												
9-10					6627-PL1	0625	6629-PL2	0619				
10-11					6627-PL1	0625	6629-PL2	0619				
11-12	6627-PL2	0614	6627-TE1	0603	6629-PL1	0619	6628-PL2	0613	6626-PL1	0625		
12-13	6627-PL2	0614	6627-TE1	0603	6629-PL1	0619	6628-PL2	0613	6626-PL1	0625		
13-14												
14-15	6628-TE1	0626	6630-TE1	0615			6629-TE1	0602	6626-PL2	0619		
15-16	6628-TE1	0626	6630-TE1	0615			6629-TE1	0602	6626-PL2	0619		
16-17	6628-PL1	0613	6630-PL1	0615			6626-TE1	0602				
17-18	6628-PL1	0613	6630-PL1	0615			6626-TE1	0602				
18-19												

- Economy
- Politics
- Science

Problem Solving

- **Analogy**
  - Analogical mapping:
    - novel problems in new domain?
    - use knowledge of similar problem from similar domain
      e.g. radiation-tumor vs. general-fort (10% ==> 80%)
  - Analogical mapping difficult if domains are semantically different

- **Skill acquisition**
  1. Skilled activity characterized by **chunking**. Information is chunked to optimize STM
  2. Conceptual rather than superficial grouping of problems
  3. Information is structured more effectively

Problem Solving

- **Skill acquisition (*Procedimentalisation*)**

IF cook[type, ingredients, time]
THEN
cook for: time

cook[casserole, [chicken,carrots,potatoes], 2 hours]
cook[casserole, [beef,pasta,carrots], 2 hours]
cook[cake, [flour,sugar,butter,eggs], 45 min]

IF type is casserole
AND ingredients are [chicken,carrots,potatoes]
THEN
cook for: 2 hours

IF type is cake
AND ingredients are [flour,sugar,butter,eggs]
THEN
cook for: 45 mins

Problem Solving

- **Skill acquisition (*Procedimentalisation*)**

IF cook[type, ingredients, time]
THEN
cook for: time

cook[casserole,[chicken,carrots,potatoes], 2 hours]
cook[casserole,[beef,dumplings,carrots], 2 hours]
cook[cake,[flour,sugar,butter,eggs], 45 min]

IF type is casserole
AND ingredients are [beef,pasta,carrots]
THEN
cook for: 2 hours

Problem Solving

- **Skill acquisition (*Procedimentalisation*)**

IF cook[type, ingredients, time]
THEN
cook for: time

cook[casserole,[chicken,carrots,potatoes], 2 hours]
cook[casserole,[beef,dumplings,carrots], 2 hours]
cook[cake,[flour,sugar,butter,eggs], 45 min]

IF type is casserole
AND ingredients are **ANYTHING**
THEN
cook for: 2 hours

Generalisation

Human Error


JUST KIDDING
TO ERR IS HUMAN, GARTH!
BUT, IT'S NOT MY FAULT!
AND TO BLAME SOMEONE ELSE IS EVEN MORE HUMAN!
Copyright 2009 by Rod Maclean
www.justkiddingcartoons.com
1-11
Maclean©

Human Error

Errors and Mental Models

Types of error

- **Slips** (deslizes/falhas/faltas)
  - Right intention, but failed to do it right
  - Causes: poor physical skill, inattention, …
  - Similar aspect but different functionality

- **Mistakes** (enganos)
  - Wrong intention
  - Cause: incorrect understanding

humans create mental models to explain behavior.
if wrong (different from actual system) errors can occur

Errors and Mental Models

Types of error

Humans create mental models to explain behavior.
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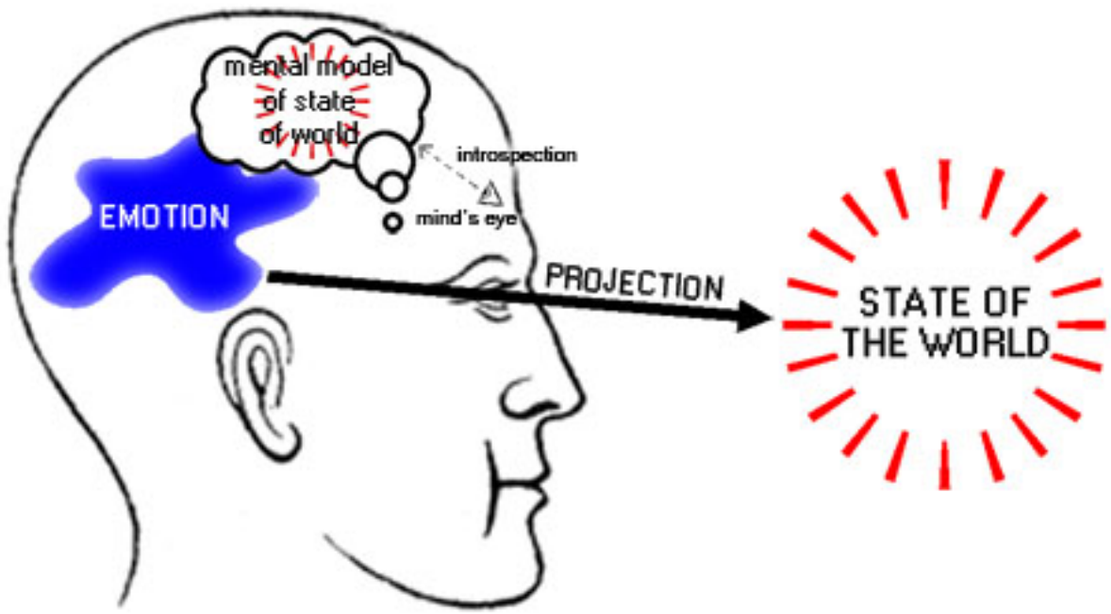
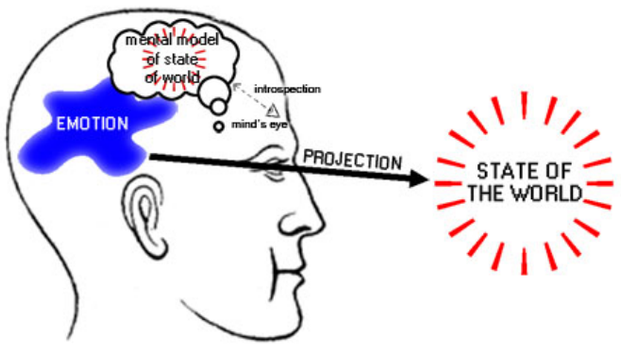


Errors and Mental Models



Types of error

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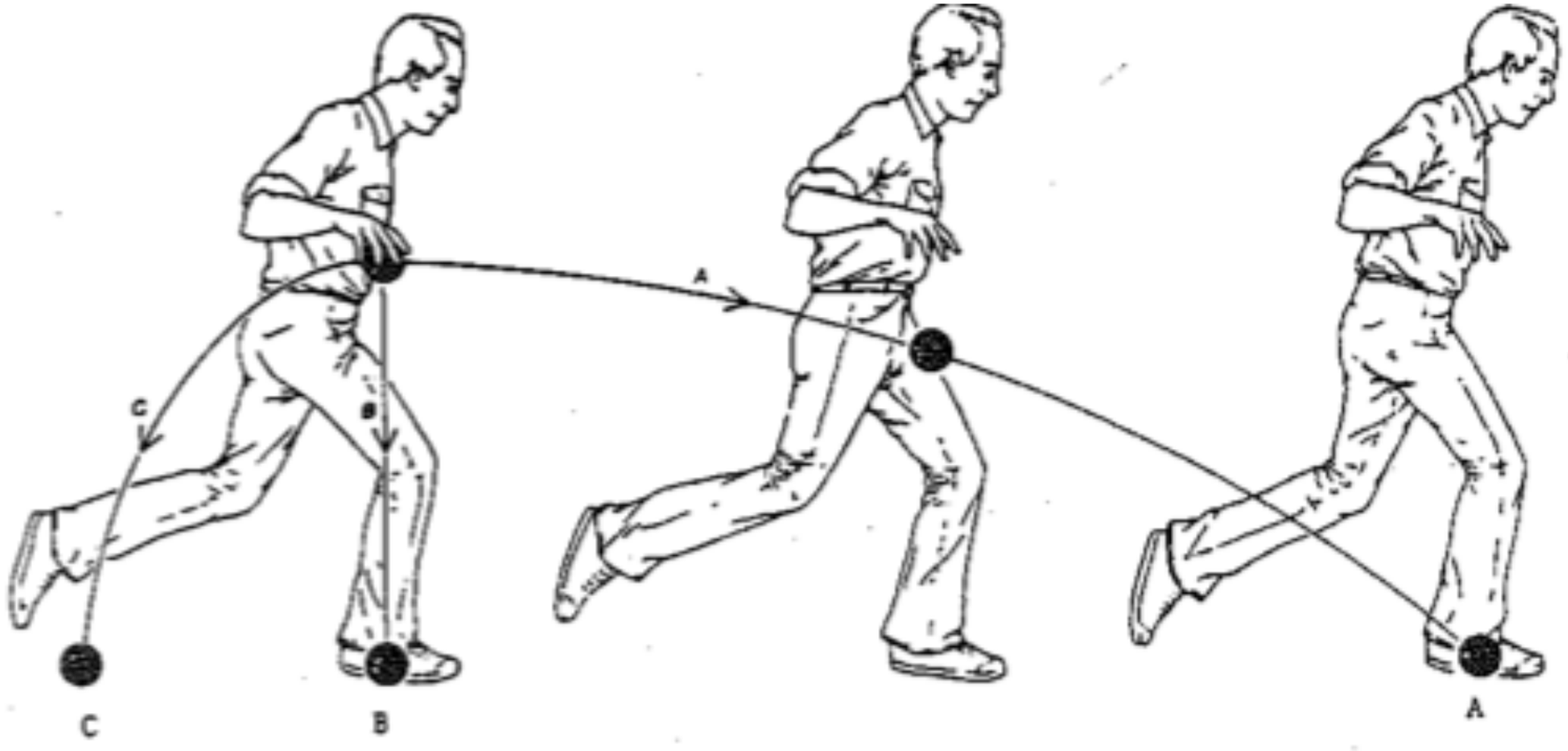


Errors and Mental Models

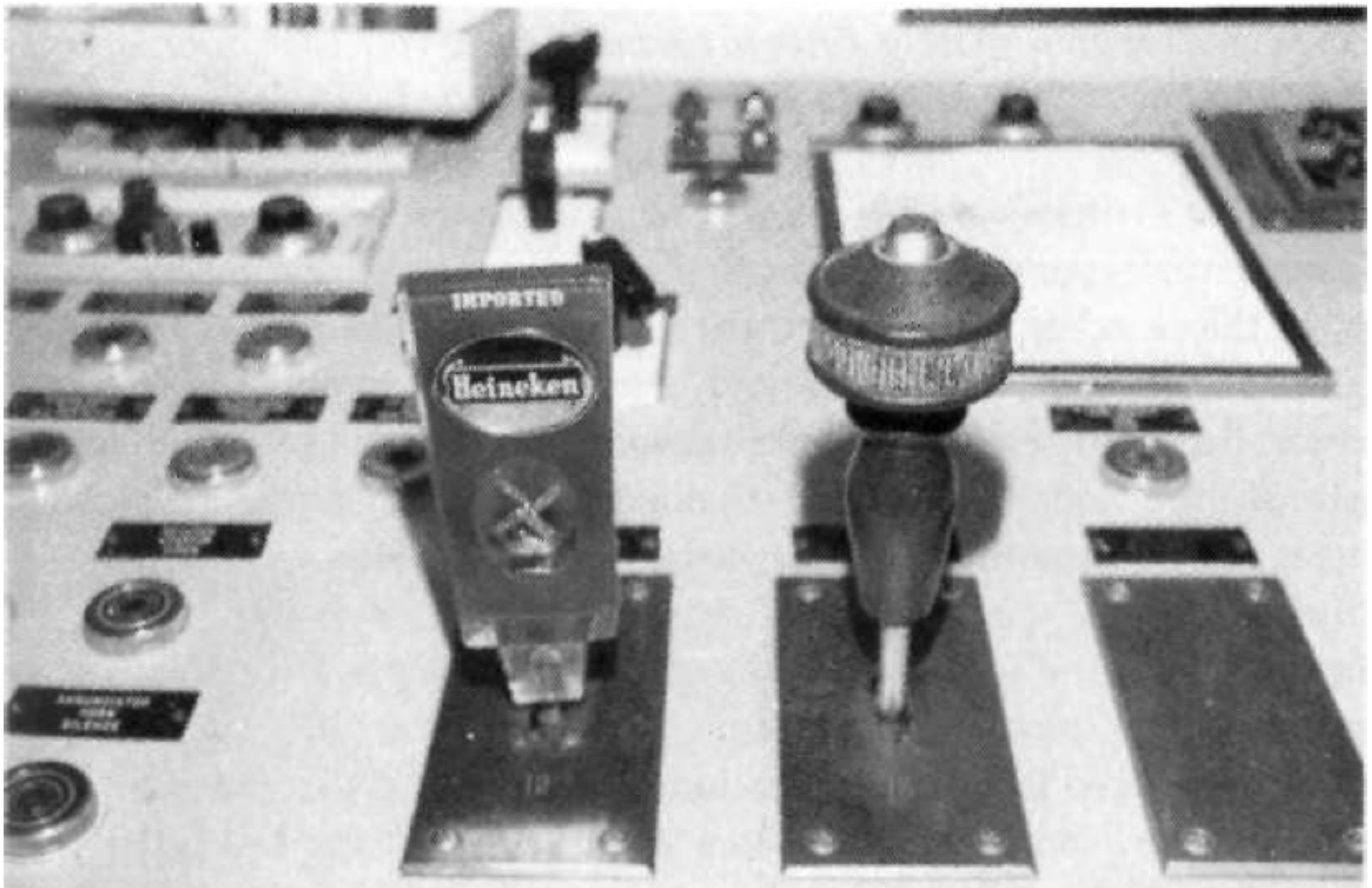
Types of error

Humans create mental models to explain behavior.
if wrong (different from actual system) errors can occur

4.5 A Clock Radio, "Human Engineered" to Simplify Operation.
Note the row of identical-looking switches!

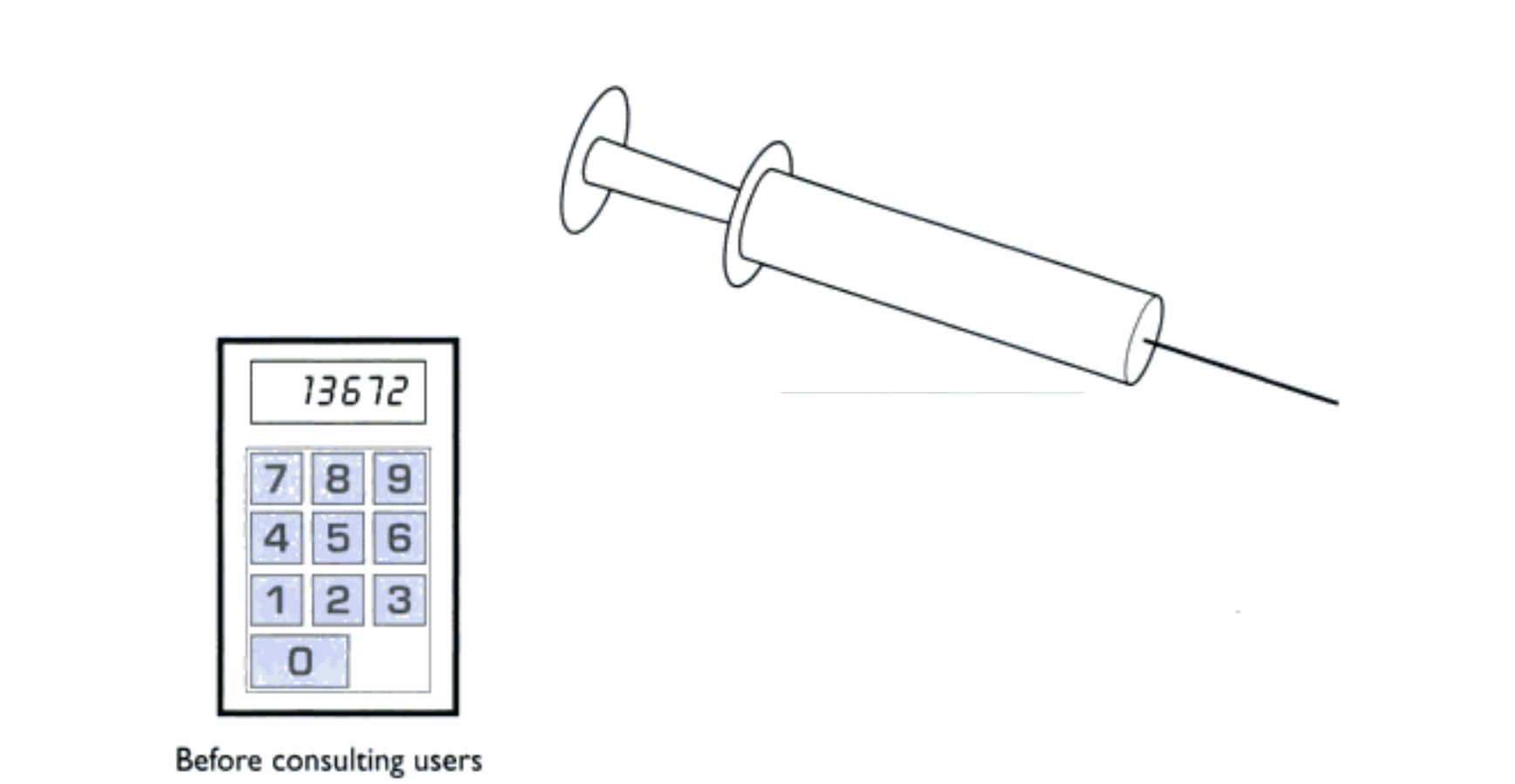
Errors and Mental Models

4.6 Make the Controls Look and Feel Different. The control-room operators in a nuclear power plant tried to overcome the problem of similar-looking knobs by placing beer-keg handles over them. This is good design, even if after the fact; the operators should be rewarded. (From Seminara, Gonzales, & Parsons, 1977. Photograph courtesy of Joseph L. Seminara.)



Errors and Mental Models

Controlling an electronic syringe



Before consulting users

Figure 0.1 Automatic syringe: setting the dose to 1372. The effect of one key slip before and after user involvement

Before **After**