Université de Bouira
Faculté des sciences
Département de Informatique

Module IHM

3ème Année Licence

2

IHM

Introduction

Basic concepts and principles

BENAISSI Sellami s.benaissi@univ-blida.dz

2023-2024

PART

1

Rules

Interactive system?

Human-Machine interaction

- Human-Machine interaction, communication or dialogue represents all the **mechanisms** for **exchanging information** between a human and a machine to accomplish a **task** or achieve a particular **goal** for the human.
- It is characterized by the triplet:
  - human operator (or user),
  - machine,
  - and interaction environment

Interactive system?

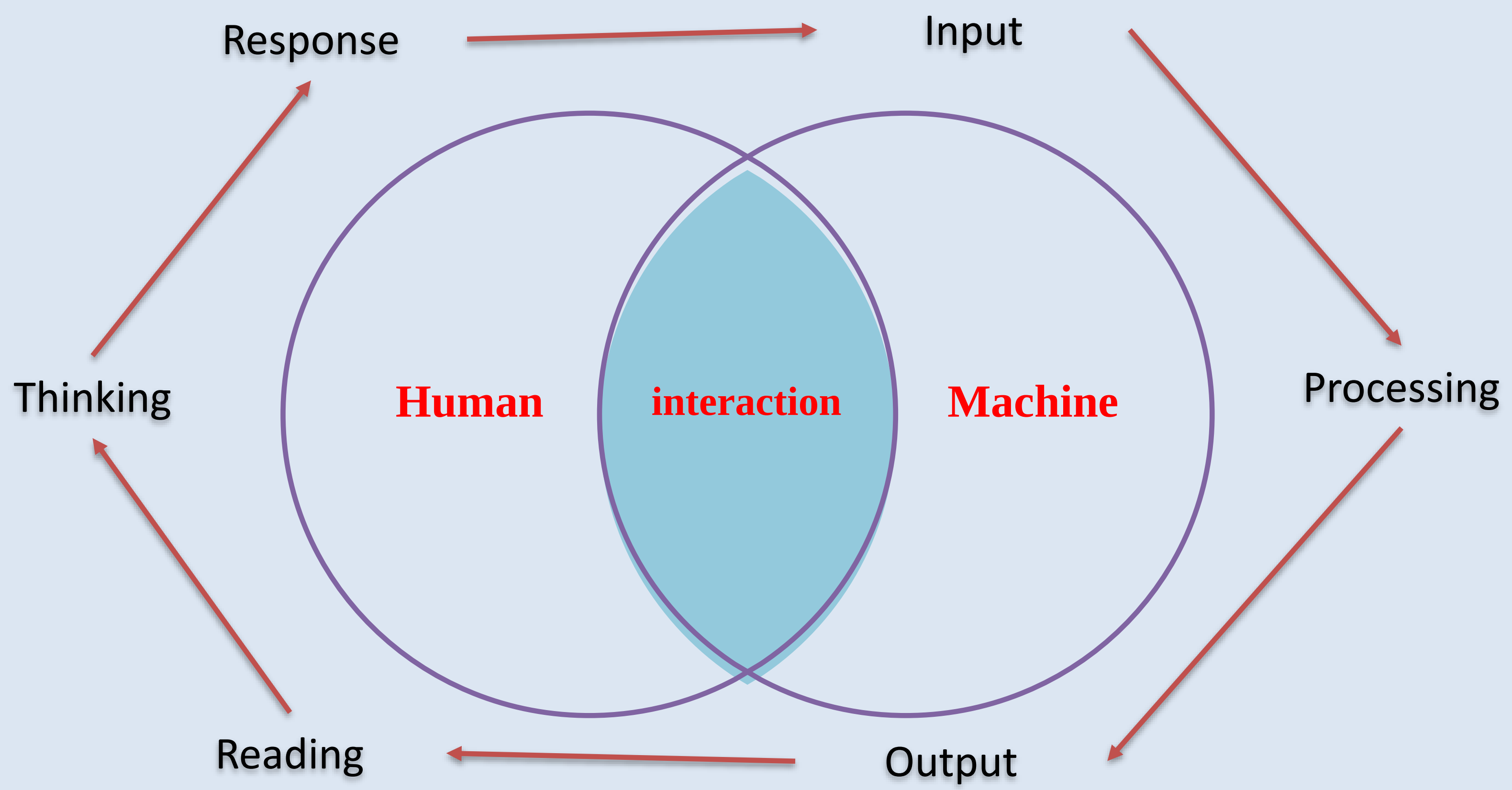
Human-Machine interaction

It consists of a two-way exchange of information giving rise to two types of interaction:

- **Input interaction:** exchange of information from the user to the machine when the user enters a system command.
- **Output interaction:** exchange of information from the system to the user:
  - Retroactive output interaction: occurs following an input interaction for which the user ensures that he has entered his command correctly.
  - Response output interaction: occurs following an input interaction (command/request) from the user to respond to this request.
  - The interaction output on initiative of the system: triggered by a stimulus produced by the system, of the alert type, etc.

Interactive system?

The 3 phases of the person-machine interaction cycle



Schneiderman's 8 golden rules

Schneiderman's 8 golden rules of interface design are a set of guidelines that can help designers create more user-friendly and efficient interfaces.

Schneiderman's 8 golden rules are widely used in user interface design and have helped to create many of the interfaces that we rely on today. By following these rules, designers can create interfaces that are more user-friendly, efficient, effective, and enjoyable for users to use.

Schneiderman's 8 golden rules

1. **Consistency:** Users should be able to expect that similar elements and actions will be presented and behave in a consistent manner throughout the interface.
    - Users should be able to predict what will happen when they interact with a system based on their previous experience with that system and other similar systems.
    - This means using consistent terminology, **commands**, and **design elements** throughout the interface. This makes the interface **easier to learn and use**, as users do not have to constantly re-learn how to do things.

Exemple : A website that uses the **same navigation menu and design elements** on every page is more consistent and easier to use than a website where the navigation menu and design change from page to page.

- A website **should use** the **same** font, colors, and navigation elements throughout its pages. This will help users to learn how to use the website quickly and easily.

2. **Shortcuts:** Once users have learned the basics of a system, they should be able to use shortcuts to perform common tasks more quickly and efficiently. This can be done by providing keyboard shortcuts, menu accelerators, and other features that allow users to bypass intermediate steps.

Exemple : A word processing program that allows users to press **Ctrl+S** to save a document is providing a shortcut for a common task. This can save users time and effort, especially if they save their documents frequently.

3. **informative feedback:** When users perform an action, the system (The interface) should provide clear and concise feedback to let them know what happened and whether their action was successful. This feedback should be clear, concise, and timely.This helps users to understand what is happening and to avoid errors.

Exemple : - A web browser that displays a **progress bar** while a page is loading is providing informative feedback to the user. This lets the user know that the browser is working and that the page will be displayed soon.

- When a user clicks on a button, the button should c**hange color** or otherwise indicate that it has been clicked. This will give the user feedback that their action has been registered

Schneiderman's 8 golden rules

4. **Completeness of dialogue: (Design dialogs to yield closure).** When users are asked to provide information or perform an action, the system should make it clear what is expected of them and how they can complete the task. The system should also provide a way for users to cancel the dialog or return to the previous state. The interface should indicate to users when a task has been completed or a dialog box has been closed. This helps users to avoid confusion and to feel in control of the interface.

Exemple : - A dialog box that displays a **confirmation message** before closing is providing closure to the user. This helps the user to **avoid accidentally** closing the dialog box and **losing any unsaved data**.

- When a user is asked to **fill out a form**, the form should indicate which fields are **required** and how to **submit** the form. This will help the user to **complete the task successfully**.

5. **Prevent errors:** The system should be designed to minimize the chances of users making errors. This can be done by providing clear instructions,
   - using defaults,
   - using constraints to limit user input,
   - providing warnings (confirmation dialogs) before users perform potentially destructive actions.
   - When users make mistakes, they should be able to easily undo their actions and return to the previous state, by offering undo and redo features.

Exemple : - A web form that validates user input before submitting it is preventing errors. This helps to ensure that the user's data is submitted correctly and that the server does not receive invalid data. This will help to prevent errors and make the website more user-friendly.

6. **Reversal of actions:** (Permit easy reversal of actions). Designers should aim to offer users obvious ways to reverse their actions. These reversals should be permitted at various points whether it occurs after a single action, a data entry or a whole sequence of actions. As Shneiderman states in his book:

> *"This feature relieves anxiety, since the user knows that errors can be undone; it thus encourages exploration of unfamiliar options"*.

Exemple : - A word processing program that allows users to undo their actions is providing reversal of actions. This helps users to recover from mistakes quickly and easily.

7. **Locus of control:** (Support internal locus of control). The interface should give users a sense of control over their interactions with the system and that their actions have the desired effect. This can be done by allowing users to make choices and by giving them feedback on the results of their actions, allowing users to customize the interface, and providing ways for users to get help when they need it.

   - Allow your users to be the **initiators of actions**.
   - Give users the sense that they are in **full control** of events occurring in the digital space.
   - **Earn their trust** as you design the system to behave as **they expect**.

Exemple : - A video game that allows the player to control the character's movements is giving the player a sense of control over the game. This helps the player to feel more engaged and satisfied with the game experience.

-A user should be able to customize the interface of a software program to meet their individual needs. This will give the user a sense of control over the program.

8. Reduce short-term memory load: Users should not have to remember a lot of information in order to use the system. This can be done by

- using clear and concise terminology,
- providing visual cues,
- keeping displays simple,
- avoiding multiple page displays,
- and minimizing the number of steps required to complete tasks.

Exemple : - A calculator that displays the current operation and operands on the screen is reducing short-term memory load. This helps the user to keep track of what they are doing and to avoid making mistakes.

- A software program should provide visual cues to help users to remember information. For example, a user interface might use different colors to indicate different types of information.

PART

2

Cognitive Psychology

Know the users

The user is the **most important element** in a computer system with an interface.

The importance of **understanding users** (and what they do) is often underestimated. However, this is a **critical point** because there is often (but not always) a notable gap in perception between the designers of a system and its users (in terms of training, knowledge, skill, attitude, point of view, vocabulary, …).

Know the users

The user is the **most important element** in a computer system with an interface.

- Taking users into account must occur fairly early in the analysis phase of a software project.
- It requires, on the part of designers, technical knowledge (knowing, know how) but also relational skills (knowing how to be) which result in:
  - **good listening** and **communication skills** (knowing how to argue)
  - **negotiator skills** (flexibility)
  - the ability to **extract important information** from unstructured data (knowing how to pull the plug)
  - the ability to put **oneself in the other's place** (empathy)

Know the users

User cognitive models

- **Many** attempts to **model** user behavior have been undertaken (and research is still ongoing).
- Unfortunately, there is no unification in these models which relate, for the most part, to **cognitive psychology.**
- Even if these models cannot be used as proof (the general problem is too difficult), they nevertheless make it possible, through their expressive power,
  - to offer formalized support for reasoning,
  - to work on rational bases and
  - to carry out experimental validations

Cognitive Psychology

Cognitive Psychology is a branch of psychology concerned with studying human mental and cognitive processes, such as

- memory,
- language,
- perception,
- problem solving,
- and decision making.

Cognitive psychology identifies **strengths** (skills, aptitudes, etc.) and **weaknesses**; This identification is essential for the appropriate use of technology

Technology must allow the individual to: take advantage of their **strengths**, while supporting their **limits** and **weaknesses**

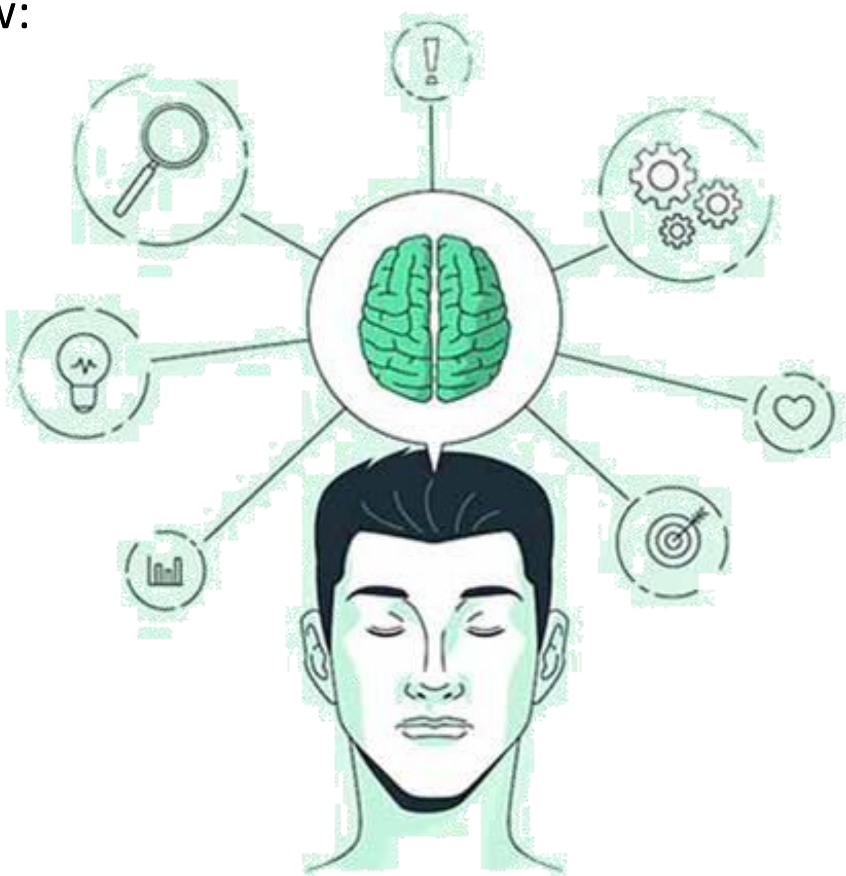
Cognitive Psychology

- **Cognitive psychology** uses models of **mental processes** to understand how users interact with the human-machine interface and to design interfaces that suit their cognitive ***needs*** and ***abilities***.
- Principles of cognitive psychology can be used to design interfaces that match users' cognitive abilities and make it **easier** for them to use the interface.
- Principles of cognitive psychology can be used to improve the **user experience** and make it **smoother** and more **effective**
- Principles of cognitive psychology can be used to improve **users' performance** and increase their **productivity** when using the human-machine interface.
- Principles of cognitive psychology can be used to improve **users' memory** and make the human-machine interface easier to use.
- Principles of cognitive psychology can be used to improve the **interaction** between the user and the human-machine interface and make it more effective and smooth.

Cognitive Psychology

Cognitive Psychology aims to study how:

- how **our brain works**
- how we **think**
- how we **memorize**
- how we **learn**



human processor model

The human processor model (HPM) is a model from cognitive psychology that allows us to evaluate the usability of a product.

- It was described in 1983 by *Stuart Card, Thomas P. Moran and Allen Newell*.
- The model represents the human subject as a **rule-governed information processing** system. The latter includes **three interdependent subsystems** (sensory, motor and cognitive) each equipped with a **processor** and a **memory**.
- The human processor model can be used to understand **how users interact** with computer systems and to design effective and user-friendly user interfaces.
- The phases of the human-machine interaction cycle can also be used to understand how users interact with computer systems and to design **effective** and **user-friendly** user interfaces.

human processor model

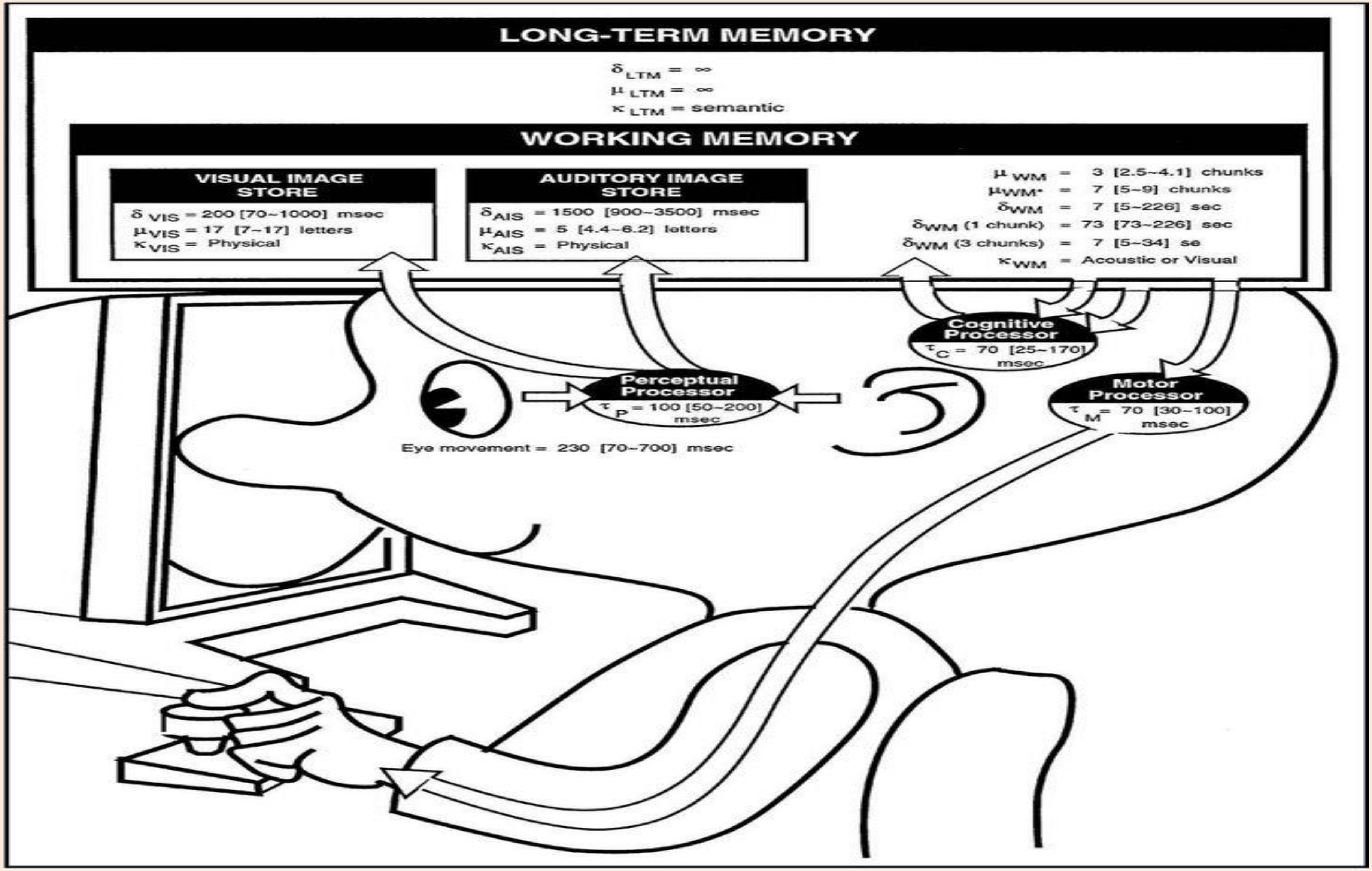
The human processor model (HPM)

The human processor model, also known as the **human information processing model**, is a theoretical model used in cognitive psychology to describe how individuals :

- acquire,
- process,
- store,
- and use information.

This model is inspired by the analogy with the functioning of a computer and offers a simplified representation of the **mental processes** involved in **information processing**.

human processor model



human processor model

The main work in the field of HCI is based on the **human processor model**.

- It aims to represent the human being through an analogy with the computer.
- The individual is described as a system that takes data as input (perceptual stimuli), carries out processing and produces outputs (motor actions).

- Model characteristics:
    - Low level of abstraction
    - Quantitative estimates
    - Easy experimental verifications
    - Efficiency oriented

human processor model

The human processor model is composed of three main elements:

1. **The sensory system:** it allows the user to perceive information from the outside world.
2. **The motor system:** it allows the user to act on the outside world.
3. **The cognitive system:** it allows the user to process information perceived by the sensory system and generate actions through the motor system.

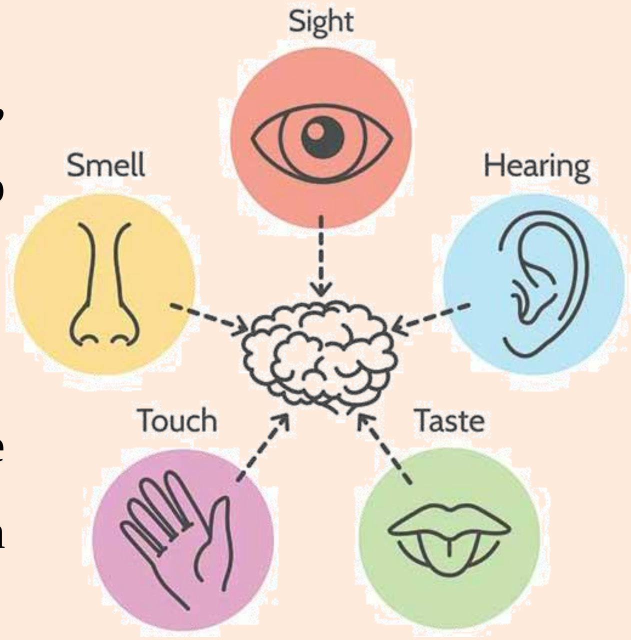
human processor model

The human processor model is composed of three main elements:

1. The sensory system:

The sensory system is made up of the five senses: **sight, hearing, touch, smell, and taste**. It allows the user to perceive information from the outside world.

Sensory information is transmitted to the brain by the nervous system. The brain processes this information and converts it into a mental representation of the world.



Sensory input (The sensory system) : This is the first stage where stimuli from the environment are picked up by the sense organs (e.g., eyes for vision, ears for hearing). Sensory information is transmitted to the cognitive system for processing.

human processor model

The human processor model is composed of three main elements:

2. The cognitive system

The cognitive system is made up of the brain and nervous system. It allows the user to process information perceived by the sensory system and generate actions through the motor system.

The cognitive system is responsible for the following mental processes:

- **Perception:** the process by which the user interprets sensory information.
- **Comprehension:** the process by which the user builds a mental representation of the world.
- **Decision-making:** the process by which the user chooses an action to perform.
- **Execution:** the process by which the user performs an action.

human processor model

The human processor model is composed of three main elements:

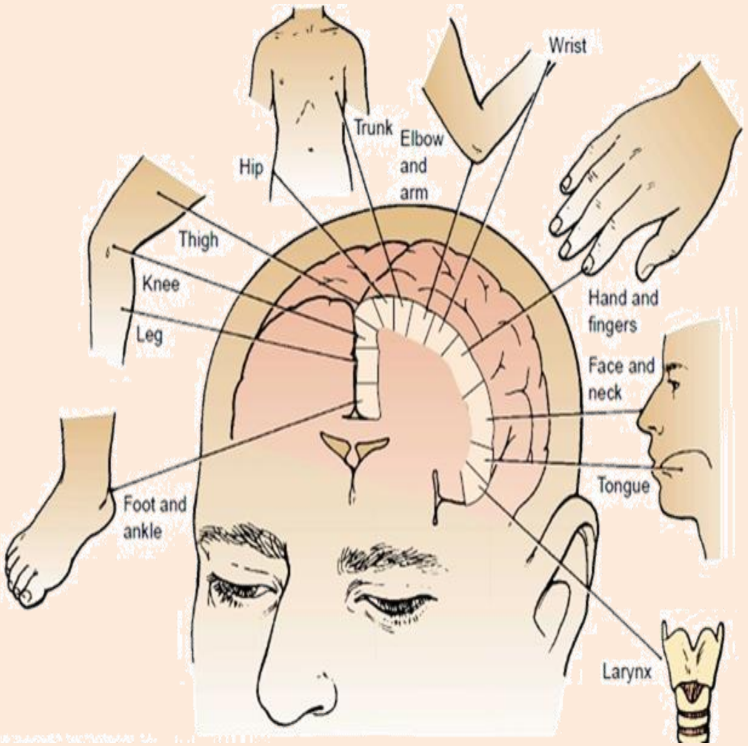
2. The cognitive system

Cognitive processing (The cognitive system) : In this stage, sensory information is processed by cognitive processes, such as perception, attention, memory, problem solving, decision making, language, etc. These processes make sense of information, organize it, store it in memory and manipulate it according to the individual's goals and knowledge.

human processor model

The human processor model is composed of three main elements:

3. The motor system



The motor system is made up of the **muscles** and **bones**. It allows the user to act on the outside world.

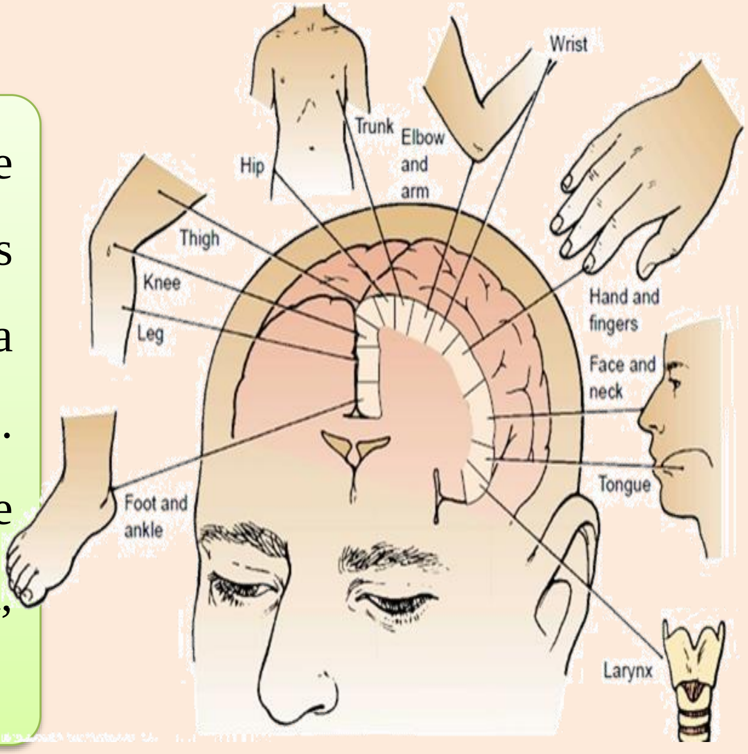
The user's actions are generated by the motor system. The brain sends signals to the muscles, which contract and produce movements

human processor model

The human processor model is composed of three main elements:

3. The motor system

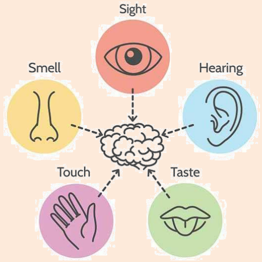
The behavioral response (The motor system) : Once the information is processed, a behavioral response is generated. This can be expressed as a motor action, a decision, a verbal response, a facial expression, etc. The behavioral response is influenced by the characteristics of the individual, the environment, motivations and goals.

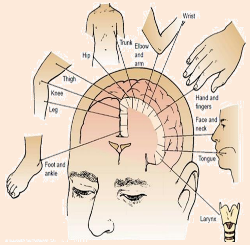


Subsystems and cycle times

Inputs, processing and outputs are managed by independent subsystems (like in a computer system):

- ❖ The perceptual system processes information **received** from the outside world (each sense is processed independently and uses sensory registers)
- ❖ The cognitive system **integrates** the information stored in the different sensory registers and carries out cognitive operations (with, if necessary, the search for information in short or long term memory)
- ❖ Finally, the motor system is responsible for carrying out the **actions** decided by the cognitive subsystem by acting on muscular stimuli.



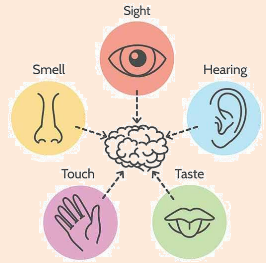


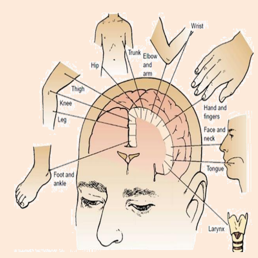
human processor model

Subsystems and cycle times

Determined experimentally, the cycle times of the different processors can be approximated by the following average values:

	perceptual processor	cognitive processor	motor processor
Fast man	50 ms	25 ms	30 ms
Middle man	100 ms	70 ms	70 ms
Slow man	200 ms	170 ms	100 ms



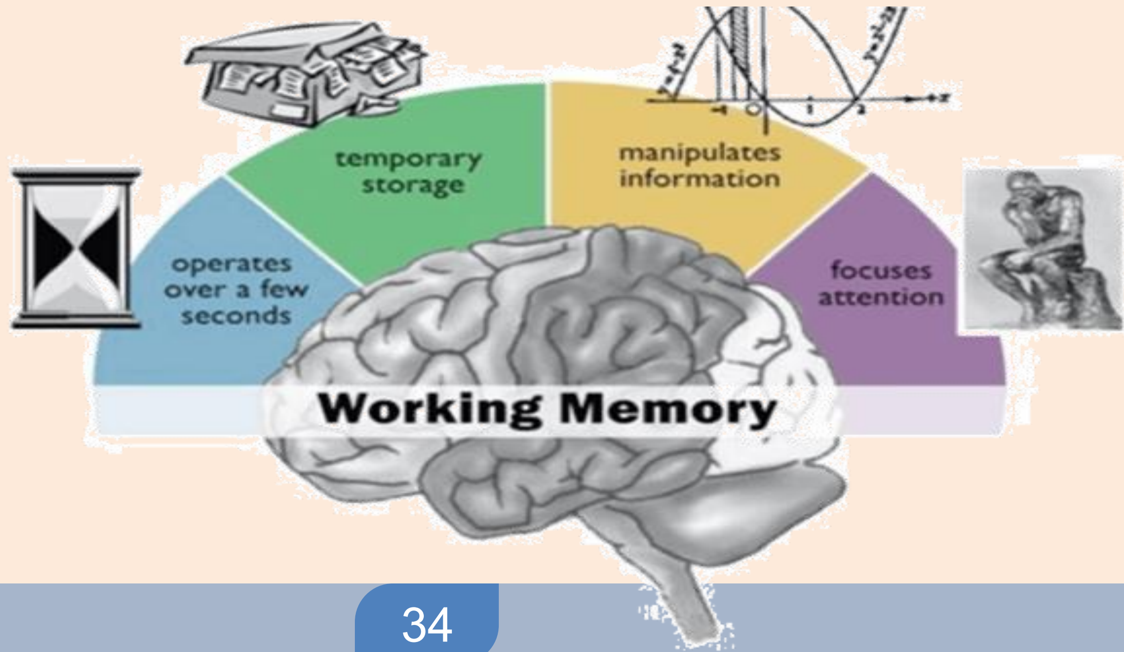


human processor model

Working memory

- **Working memory** is a temporary storage system that allows you to store and process information in the short term. It has a **limited capacity** and the information it contains is **quickly lost** if it is not processed.

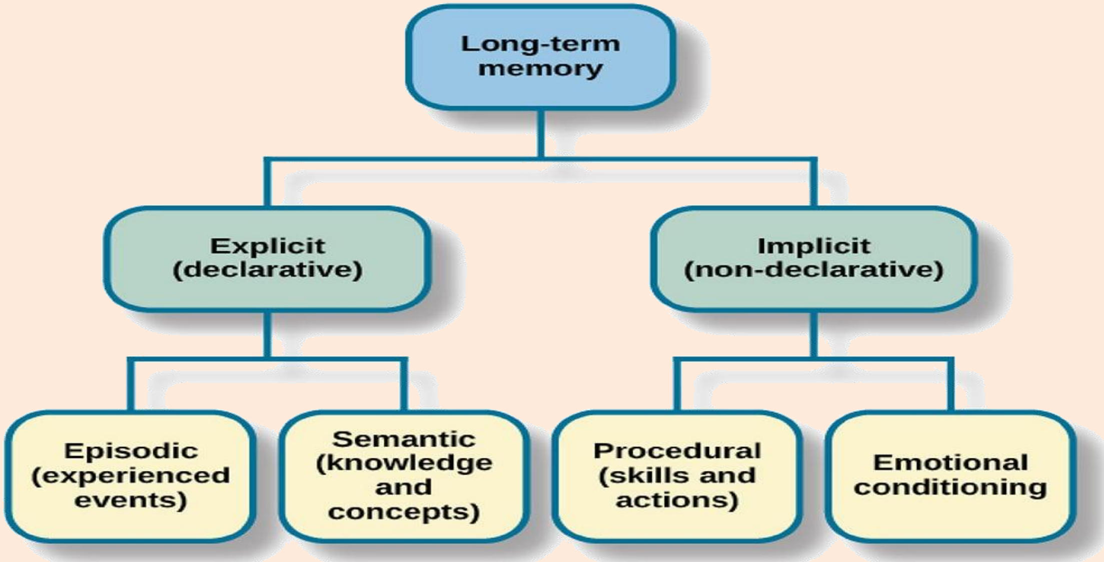
- **Working memory** is used to store the information needed to perform a task. For example, if a user is trying to remember a phone number, they will store it in their working memory.



Long-term memory

- **Long-term memory** is a permanent storage system that allows you to store and retrieve information in the long term. It has an **unlimited capacity** and the information it contains can be stored for years or even decades.

- **Long-term memory** is used to store the user's **knowledge** and **experiences**. This information can be used to perform tasks, make decisions, and solve problems.



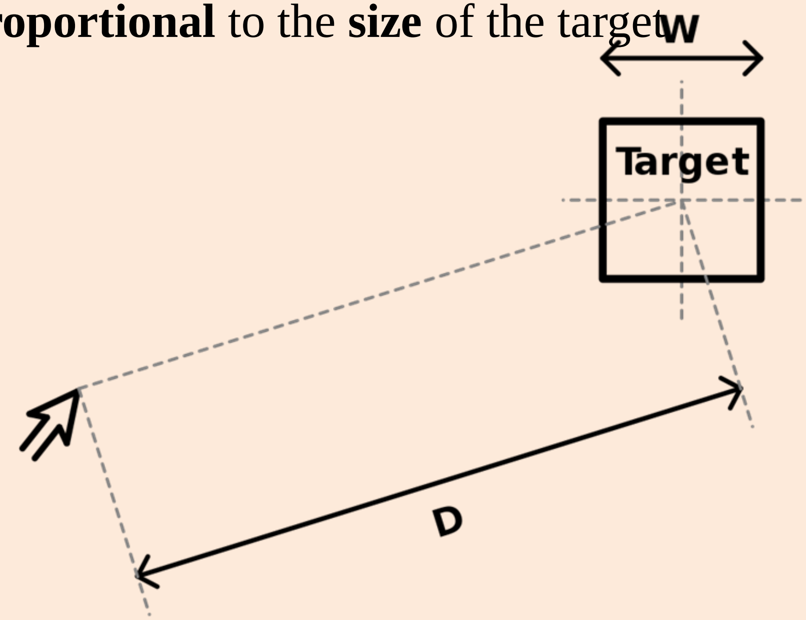
PART

3

Fitts's law

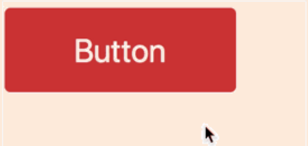
Fitts's law

Fitts's law (PaulFitts,1954) is a law in **psychology** that describes the **time** required to perform a pointing movement to a target. It states that the time required to perform a pointing movement is **proportional** to the **distance** between the user's current position and the target, and **inversely proportional** to the **size** of the target.

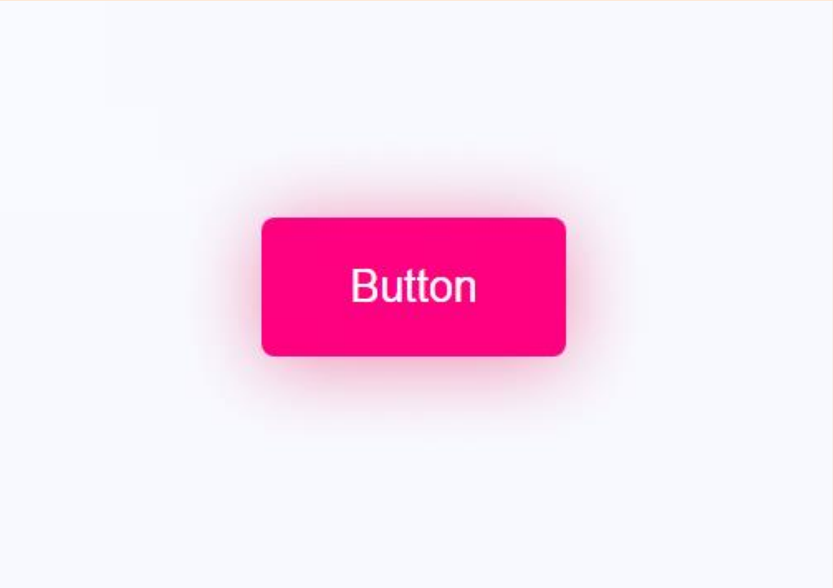


By following the principles of Fitts's law, user interface designers can create interfaces that are **easier** and **faster** to use. This can **improve** the user experience and increase the efficiency of users.

Fitts's law

Fitts's law gives us the relationship between the time it takes a pointer **(such as a mouse cursor, a human finger, or a hand)**  to move to a particular target **(e.g., physical or digital button, a physical object)** 

in order to interact with it in some way **(e.g., by clicking or tapping it, grasping it, etc.)**

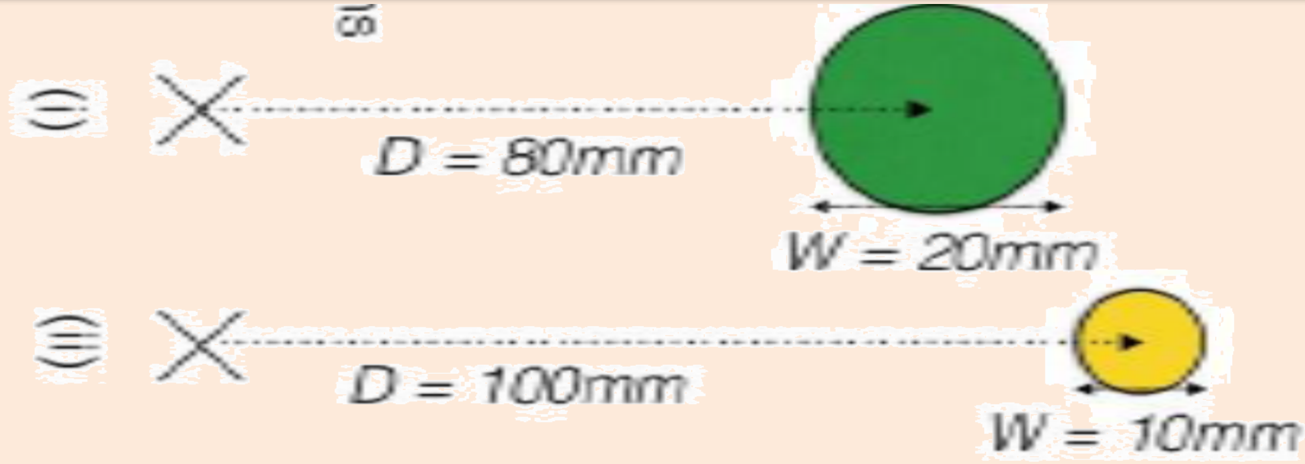


Fitts's law

$$T = a + b\ \log_2 \frac{2D}{W}$$

- **T** is the **time required** to perform the pointing movement
- **a** and **b** are **constants** that depend on the user and the interface
- **D** is the **distance** between the user's current position and the target
- **W** is the **width** of the target

Fitts's law



Assume $a = 50ms$, and $b = 150ms$

$$MT_i = 50 + 150 \log_2 (80/20 + 1) = 398 \text{ ms}$$

$$MT_{ii} = 50 + 150 \log_2 (100/10 + 1) = 569 \text{ ms}$$

Fitts's law

Examples of specific applications of Fitts's law:

- **Increase the size** of clickable elements to make them easier to select, such as action buttons
- **Increase the size** of icons and labels to make them easier to select
- **Reduce the distance** between clickable elements and the user's attention zone to reduce movement time

Fitts's law

Examples of specific applications of Fitts's law:

- **Button design:** The size and placement of buttons on a user interface can have a significant impact on how quickly and easily users can interact with the system. Fitts's law can be used to determine the optimal size and placement of buttons to minimize the time it takes for users to point and click on them.

- **Target selection**: Fitts's law can also be applied to the design of other types of targets, such as icons and checkboxes. By making targets larger and closer to each other, designers can reduce the time it takes for users to select them.

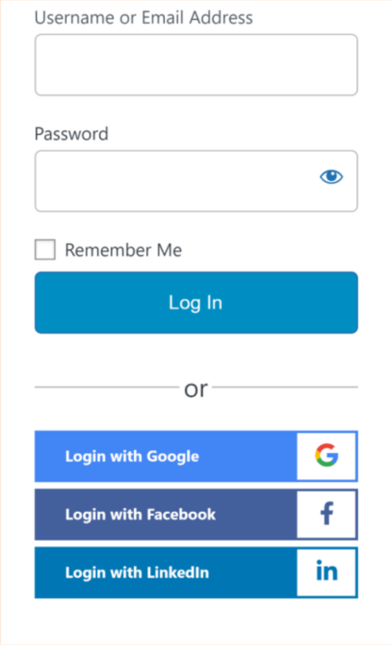
- **Keyboard design:** Fitts's law can also be applied to the design of keyboards. For example, designers can arrange the keys in a way that minimizes the distance that users have to move their fingers to reach the keys they need.

- **Game design:** Fitts's law can also be applied to the design of games. For example, designers can place targets in a way that encourages players to make efficient movements.

Fitts's law

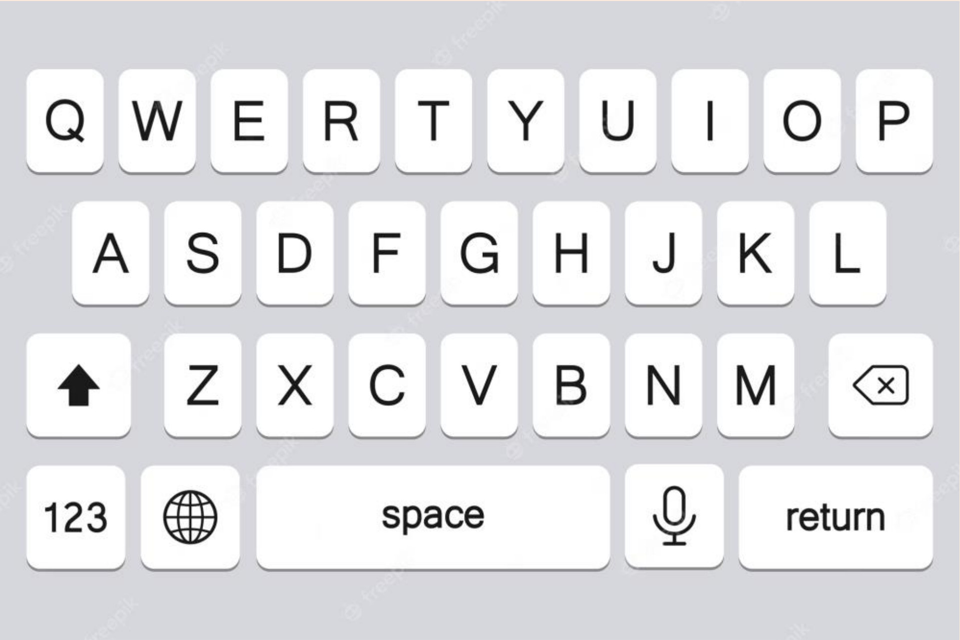
- The **Google search bar** is always located in the **middle** of the screen, with the **search button** directly next to it. This makes it easy for users to point and click on the search button without having to move their cursor very far.

- **Logins** are usually located in the upper right-hand corner of a website's navigation. This is because the upper right-hand corner of the screen is a common place for users to look first when they visit a new website.



Some examples of how Fitts' Law is used in real-world products:

Fitts's law



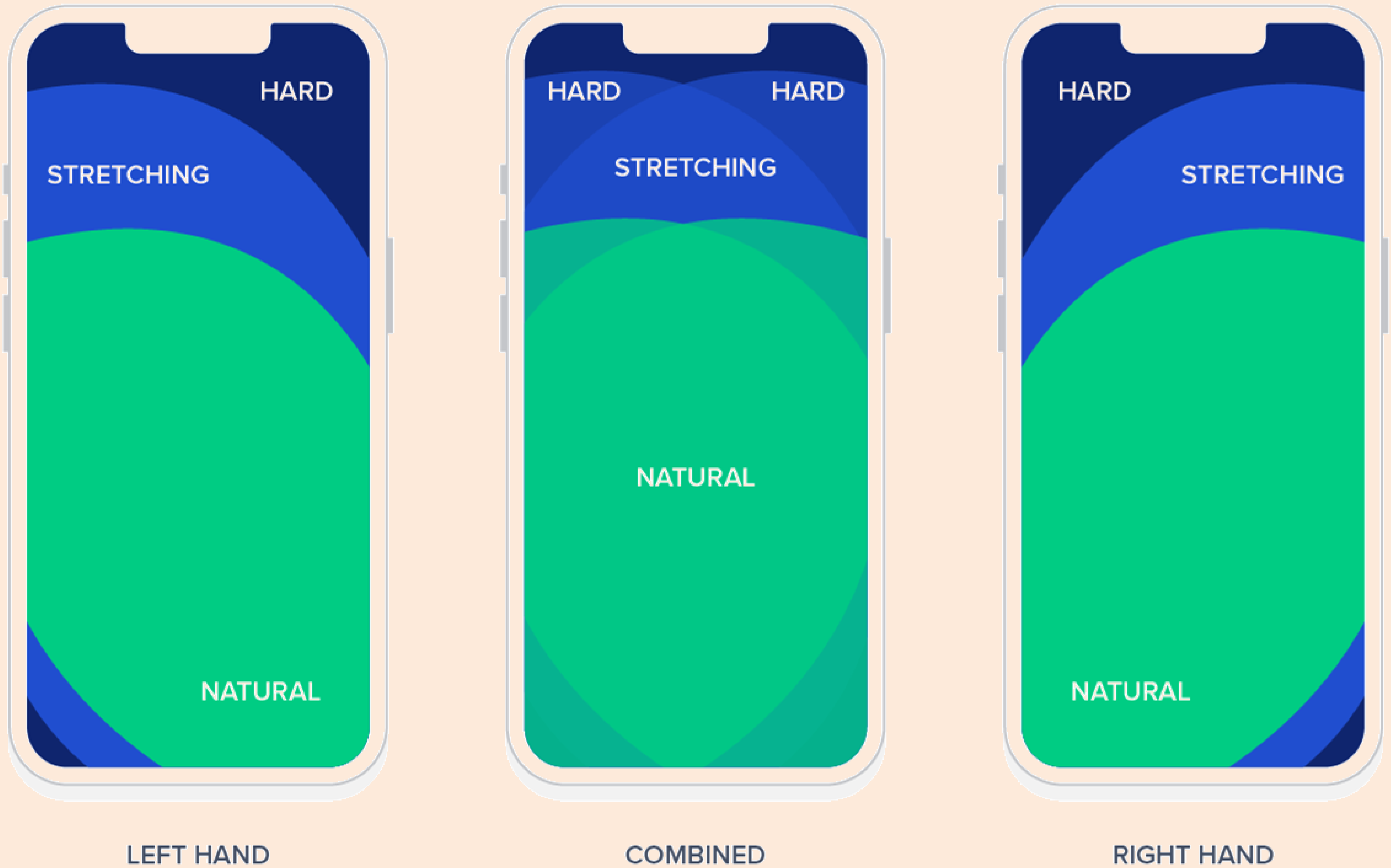
The buttons on a smartphone's keyboard are usually larger and more widely spaced than the buttons on a desktop keyboard. This is because smartphone users have to use their thumbs to type, which makes it more difficult for them to accurately point and click on small targets.

Fitts's law

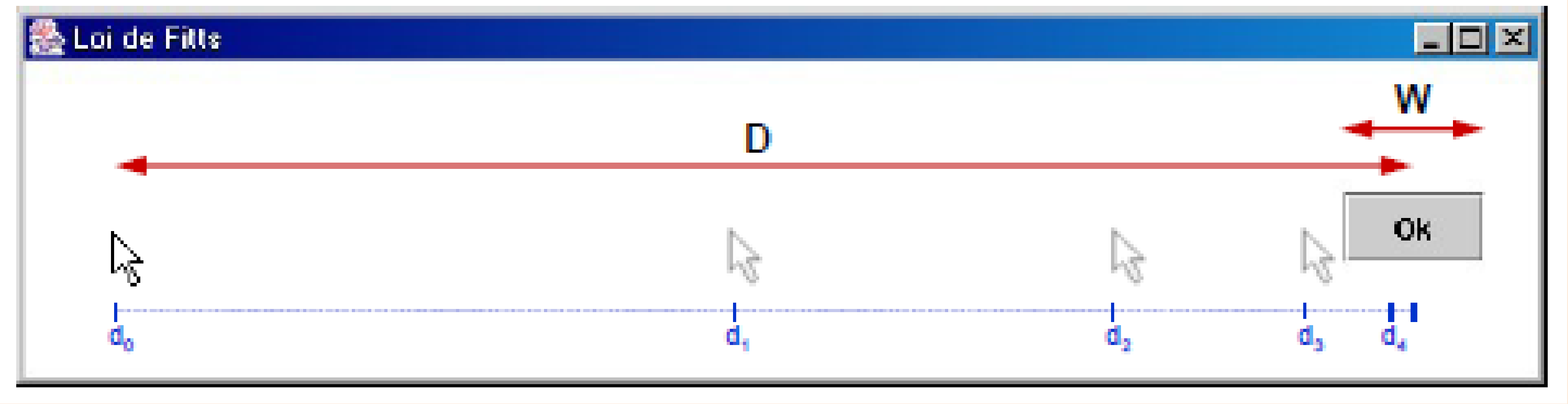
- The targets in many video games are designed to be large and easy to hit. This is because video game designers want players to be able to focus on the action of the game without having to worry too much about aiming.

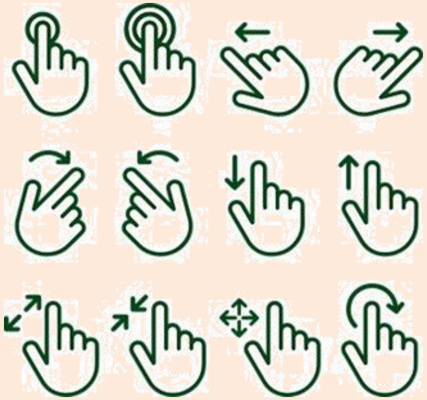
By understanding and applying Fitts's law, designers can create products and interfaces that are easier and more efficient for users to interact with.

Fitts's law


HARD
STRETCHING
NATURAL
HARD
HARD
STRETCHING
NATURAL
HARD
STRETCHING
NATURAL
LEFT HAND
COMBINED
RIGHT HAND

Fitts's law





PART

4

Hick's law

Hick's law

The Hick's Law (Hick-Hyman 1952-1953), also known as the **Hick-Hyman Law**, is a concept in cognitive psychology that establishes a relationship between the **reaction time** required to **make a decision** and the **number of choices** available.

It states that the time it takes to make a decision is proportional to the logarithm of the number of available choices.

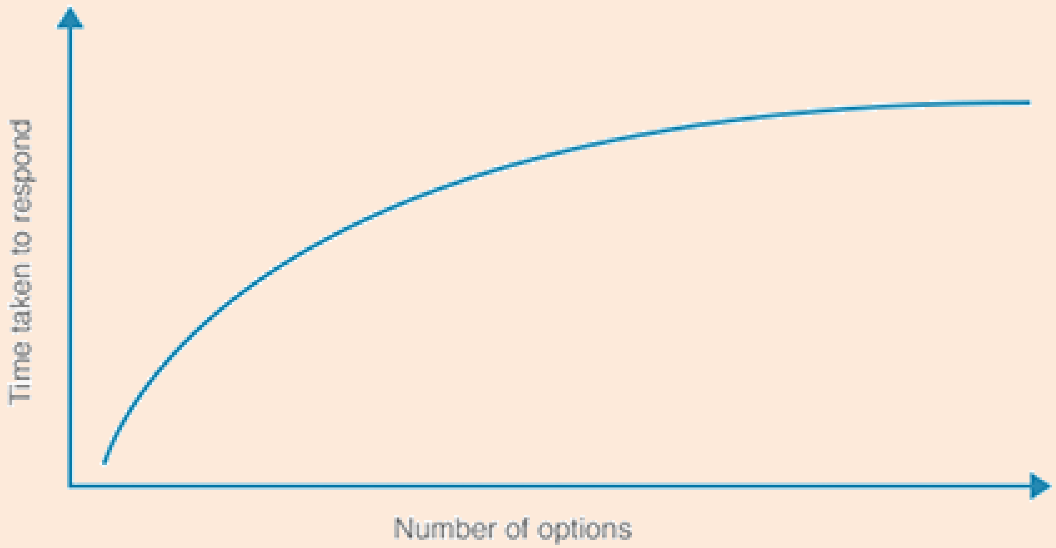
This means that :

the more choices a person has,

the longer it will take them to make a decision.

Hick's law

$$T = a + b * \log_2(n)$$

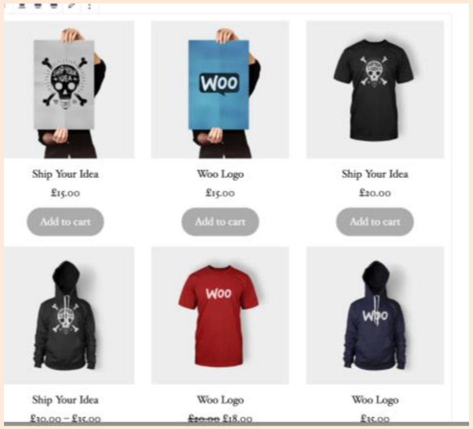


- **T** is the time needed to make the decision
- **a** and **b** are constants that depend on user and task
- **n** is the number of available options

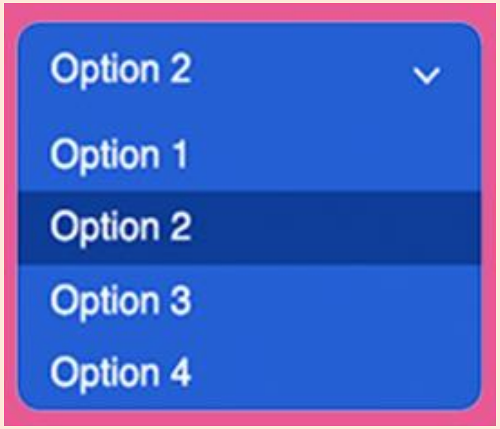
Hick's law

Applications:

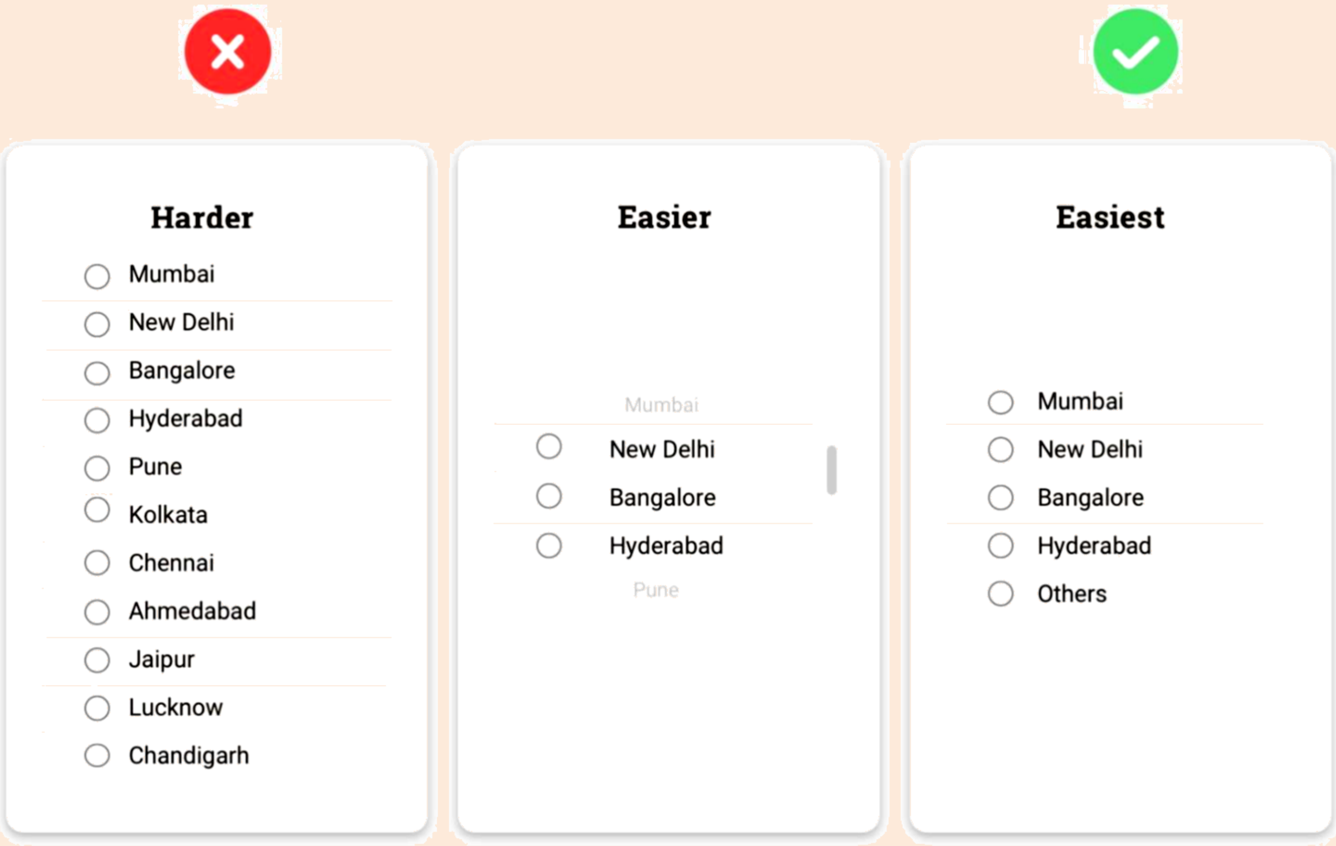
The Hick-Hyman Law can be applied to a variety of tasks, including:

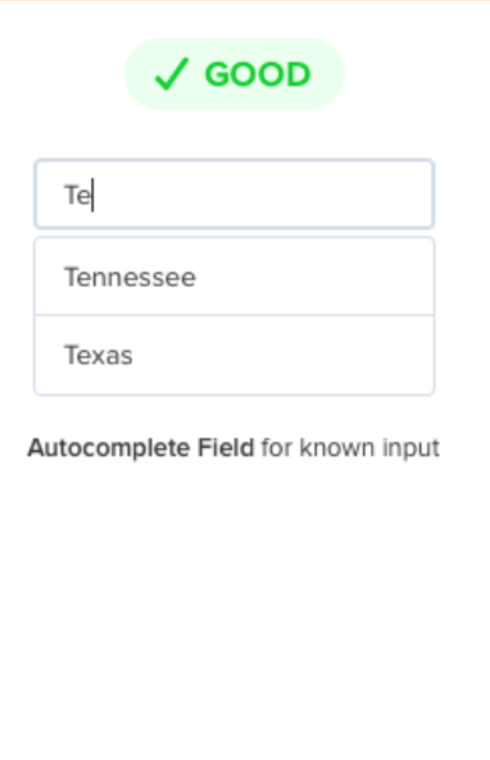


- ❖ Choose an option from a menu.
- ❖ Choose an answer to a question.
- ❖ Choose an item to buy.
- ❖ Choose a path to follow.
- ❖ Choose medical treatment.



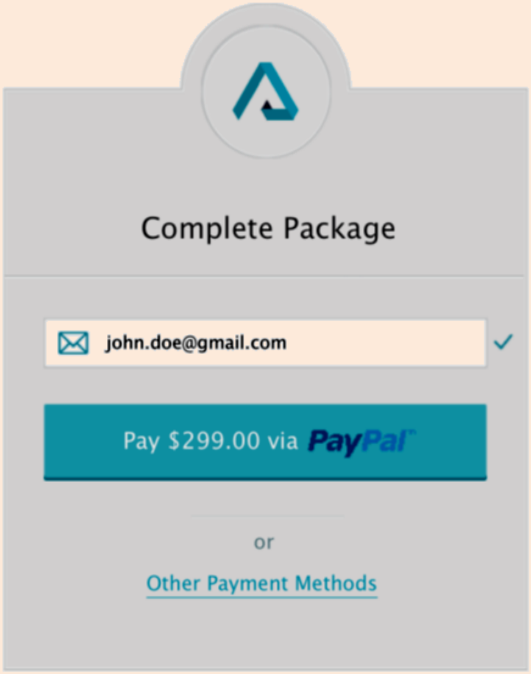
Hick's law


Harder
Mumbai
New Delhi
Bangalore
Hyderabad
Pune
Kolkata
Chennai
Ahmedabad
Jaipur
Lucknow
Chandigarh
Easier
Mumbai
New Delhi
Bangalore
Hyderabad
Pune
Easiest
Mumbai
New Delhi
Bangalore
Hyderabad
Others

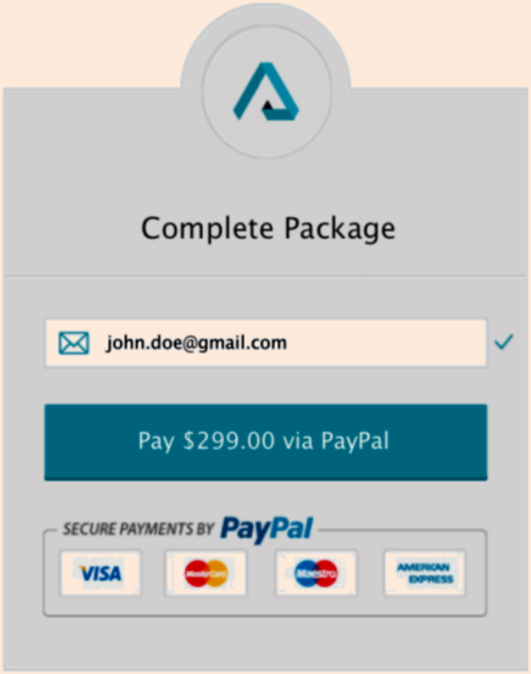

✓ GOOD
Te
Tennessee
Texas
Autocomplete Field for known input

Hick's law

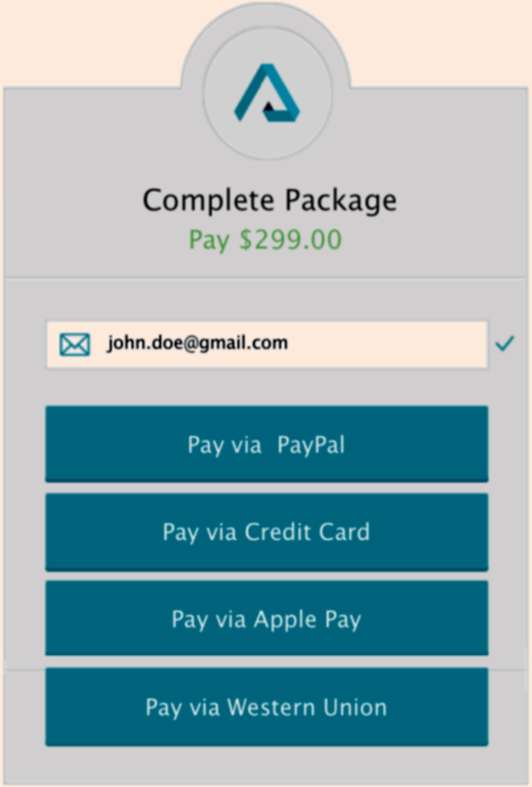
One option with hiden secondary options



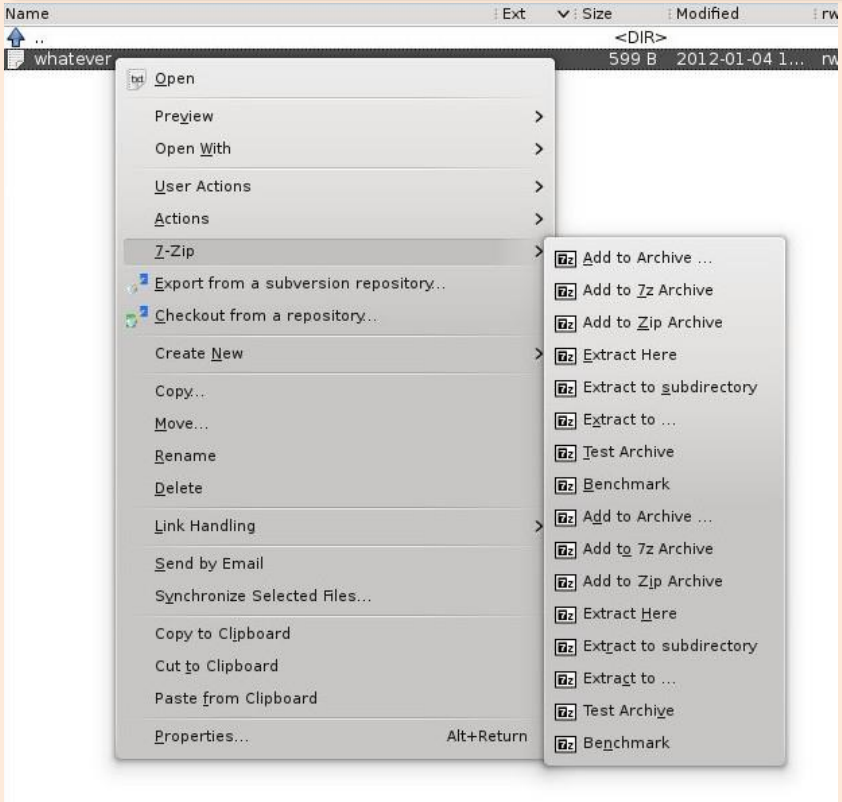
Only one option

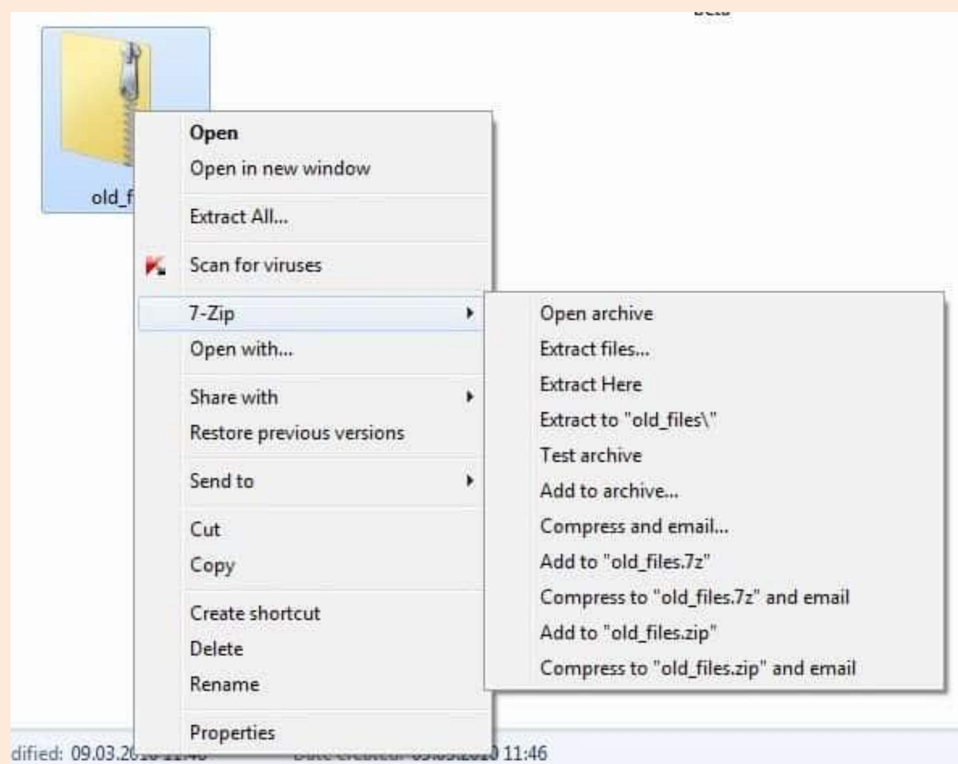


Few options

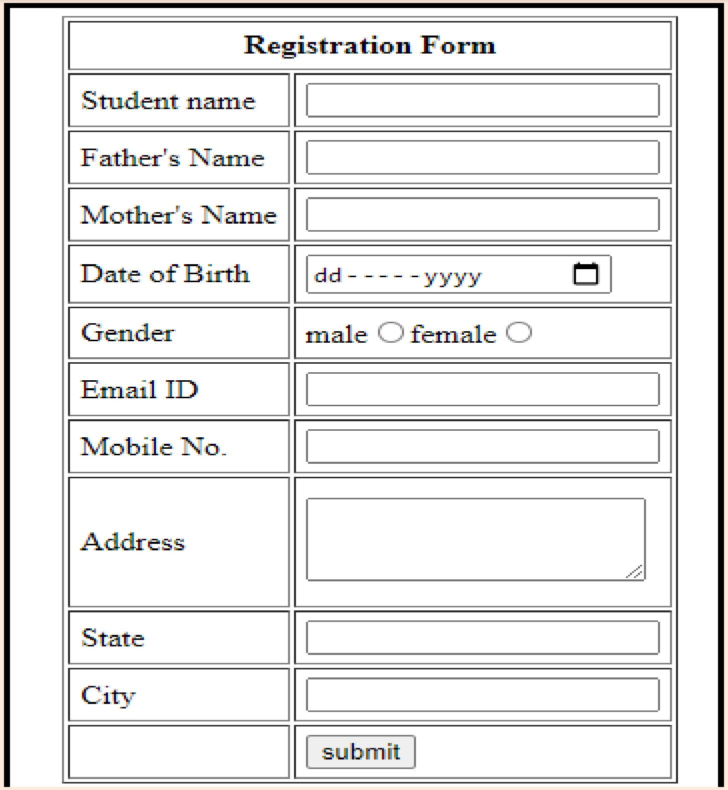


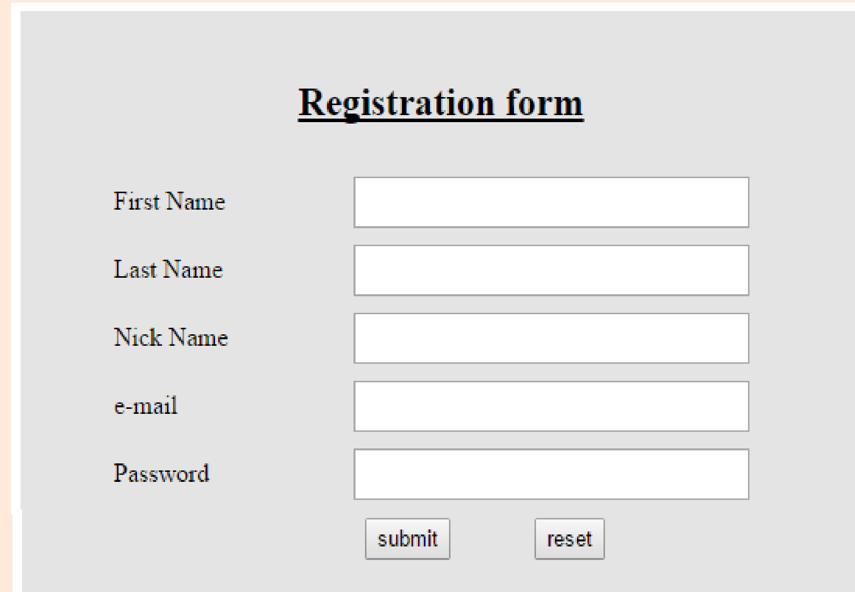
Hick's law



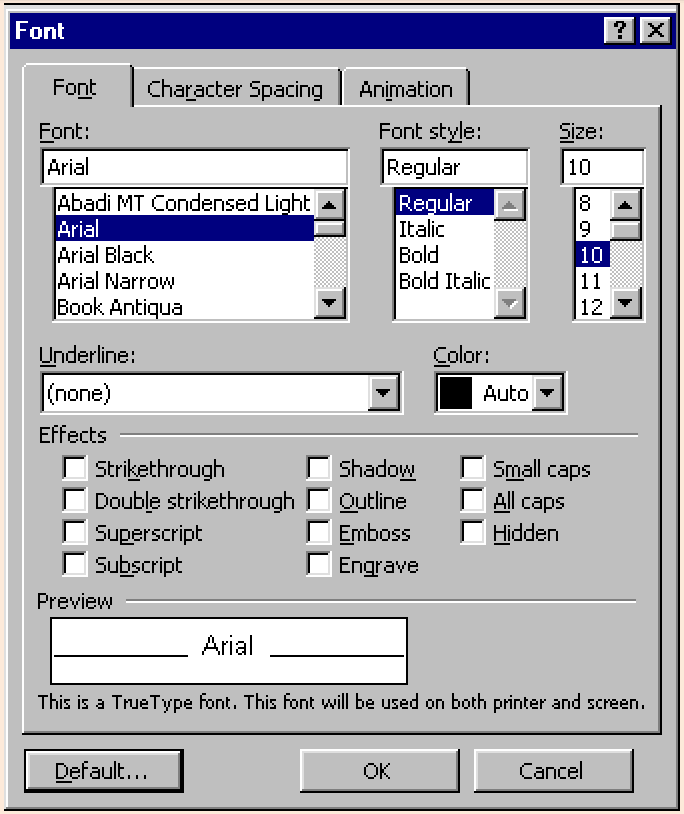


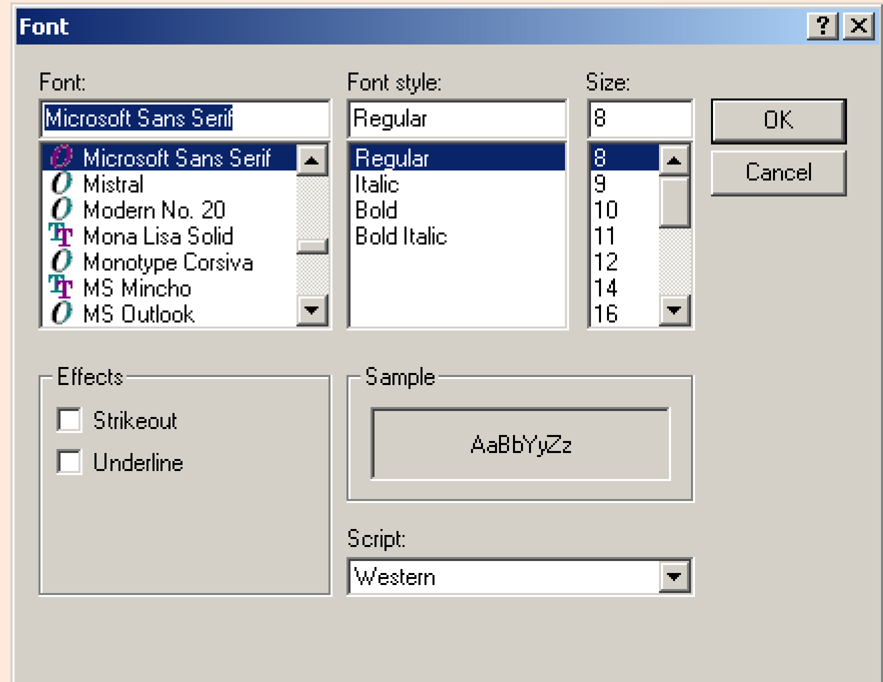
Menus: Designers can limit the number of options in a menu to make it easier for users to find the option they are looking for. For example, a menu with 7 options will be easier to use than a menu with 20 options.





Forms: Designers can limit the number of fields in a form to make it easier for users to fill out the form. For example, a form with 5 fields will be easier to fill out than a form with 10 fields.





Dialog boxes: Designers can limit the number of options in a dialog box to make it easier for users to make a decision. For example, a dialog box with two options will be easier to use than a dialog box with five options.

Hick's law

Video games: Designers can limit the number of options in a video game to make the game easier to play. For example, a video game with two control buttons will be easier to play than a video game with five control buttons.

PART 5

Perception

Perception

The concept of perception refers to the **process** through which we **interpret** and **make sense** of **sensory information** from our **environment**. It involves the selection, organization, and interpretation of sensory stimuli to create our **subjective experiences** of the world.

Perception is a complex cognitive process that involves the **integration** of

- **sensory inputs,**
- **prior knowledge,**
- **and expectations.**

It allows us to **recognize** and **understand**

- **objects,**
- **events,**
- **and situations,**

and to **navigate** and **interact** with our **environment**.

Perception

- While our sensory receptors are constantly collecting information from the environment, it is ultimately how we interpret that information that affects how we interact with the world.
- Perception refers to the way sensory information is organized, interpreted, and consciously experienced.
- Perception involves both **bottom-up** and **top-down** processing.
  - ❖ **Bottom-up processing** refers to the fact that perceptions are built from sensory input.
  - ❖ On the other hand, how we interpret those sensations is influenced by our available knowledge, our experiences, and our thoughts. This is called **top-down processing**.

Perception

Here are some key components and principles related to perception:

1. Sensation: Sensation is the initial process of detecting and encoding sensory stimuli through our senses (such as vision, hearing, taste, touch, and smell). It involves the conversion of physical stimuli into neural signals that can be processed by the brain.

When you see a red apple, the light reflected from the apple enters your eyes, and your visual receptors detect the wavelengths of light associated with the color red, allowing you to perceive the apple's redness.

Perception

Here are some key components and principles related to perception:

2. Attention: Attention is the selective focus of our awareness on specific sensory inputs or stimuli. It determines which sensory information receives priority and is processed more deeply. Attention plays a crucial role in filtering out irrelevant stimuli and directing our cognitive resources.

Imagine you are in a crowded room with multiple conversations happening simultaneously. You selectively focus your attention on one conversation, filtering out the others, and directing your cognitive resources to listen and process that specific auditory input.

Perception

Here are some key components and principles related to perception:

3. Perception of Form and Depth: Our perception organizes sensory inputs into meaningful forms and structures. Gestalt principles, such as figure-ground, proximity, similarity, and closure, explain how we perceive objects and patterns. Depth perception allows us to perceive the relative distance and three-dimensional structure of objects in our visual field.

When you look at a photograph of a group of people, your perceptual system organizes the visual elements based on the principles of proximity and similarity. People standing close to each other are perceived as a group, and individuals wearing similar clothing are perceived as part of the same category.

Perception

Here are some key components and principles related to perception:

4. Perceptual Constancy: Perceptual constancy refers to the ability to perceive objects as stable and consistent despite variations in sensory inputs. For example, we can recognize an object as the same even if it appears different in size, shape, or lighting conditions.

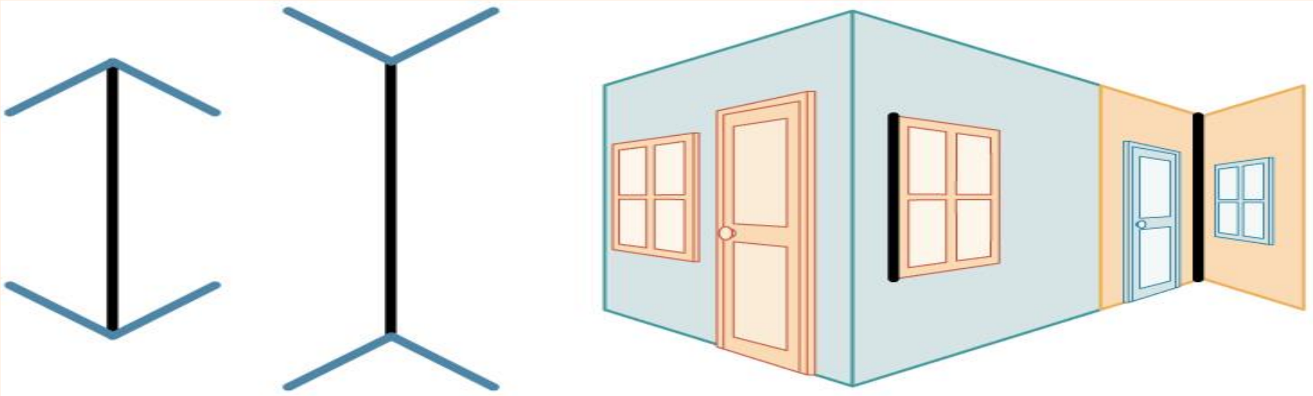
Let's say you are looking at a rectangular book from different angles. Despite the changing retinal image size and shape, you perceive the book as a stable rectangular object due to size constancy and shape constancy.

Perception

Here are some key components and principles related to perception:

5. Perceptual Illusions: Perceptual illusions are phenomena that occur when our perception deviates from the physical reality of a stimulus. They demonstrate the role of cognitive and contextual factors in shaping our perceptual experiences.

The Müller-Lyer illusion is an example of a perceptual illusion. It involves two lines of equal length, one with arrowheads pointing inward and the other with arrowheads pointing outward. Even though the lines are the same length, the one with outward arrowheads appears longer due to the influence of the surrounding context.

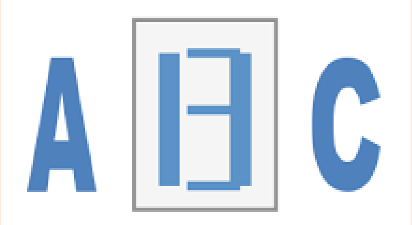


(a) (b)

Here are some key components and principles related to perception:

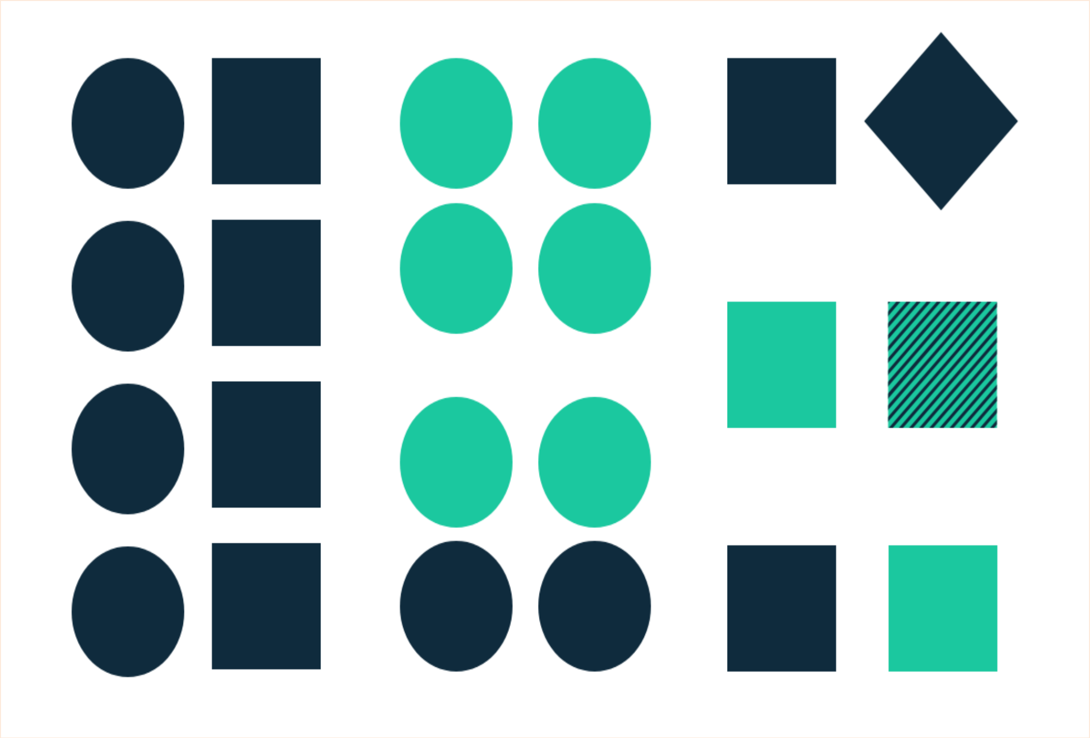
6. Cultural and Individual Differences: Perception can be influenced by cultural and individual factors. Culture shapes our perceptual processes, including how we interpret and assign meaning to sensory information. Additionally, individuals may have unique perceptual biases or sensitivities based on their prior experiences and cognitive abilities.

Cultural differences can influence perception. For example, in Western cultures, individual objects are often emphasized, while in Eastern cultures, the context and relationships between objects may be given more weight. Individual differences can manifest as well. People with a heightened sense of taste may perceive subtle flavor differences in food that others may not notice.

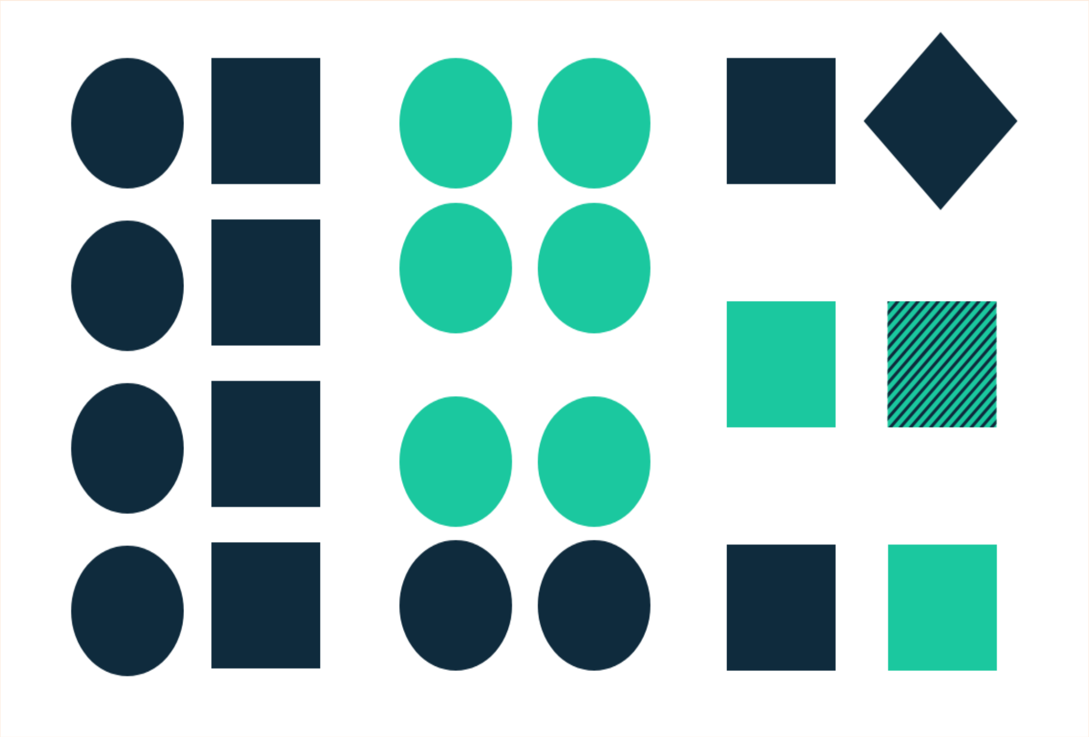


Perception

These examples illustrate how the key components and principles of perception operate in various sensory modalities and cognitive processes, shaping our subjective experiences and understanding of the world around us.

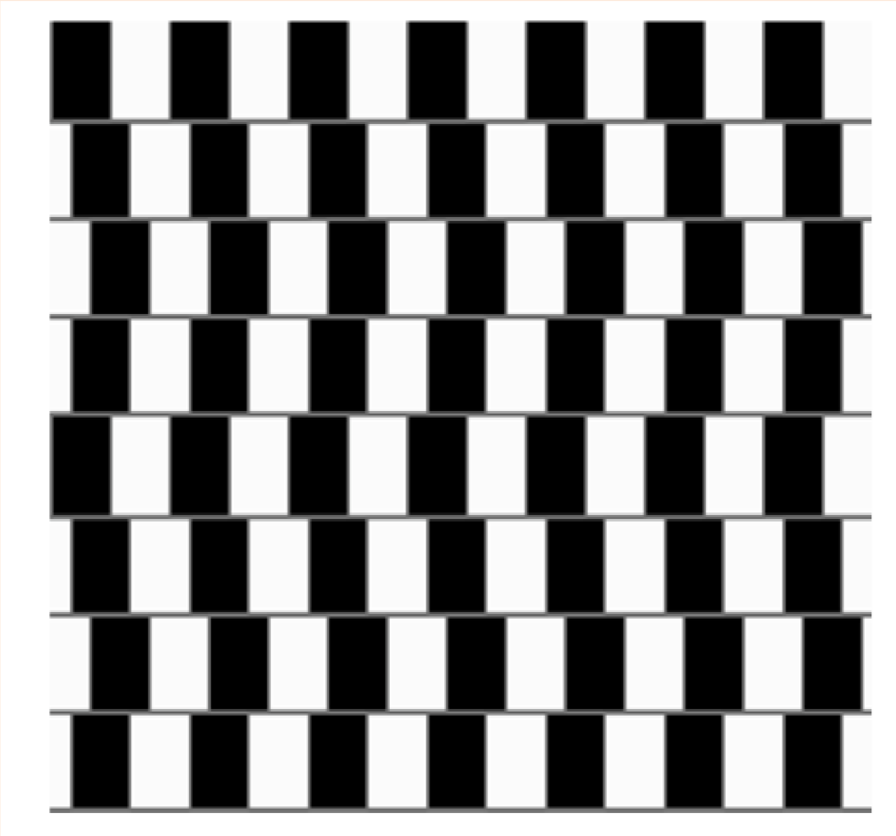


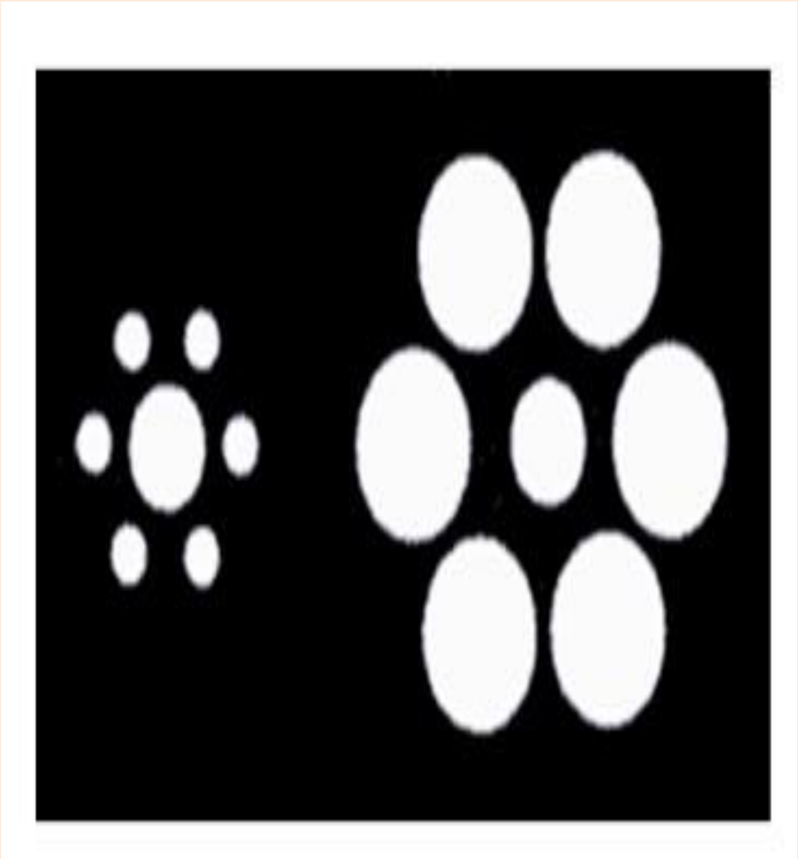
Perception



Perception

Perception





Perception

Sleon une édtue de l'Uvinertisé de Cmabrigde, l'odrre des ltteers dnas un mot n'a pas d'ipmrotncae, la suele coshe ipmrotnate est que la pmeirère et la drenèire letrte soit à la bnnoe pclae.

Le rsete peut êrte dnas un dsérorde ttoal et vuos puoevz tujoruos lrie snas porlblème.

Cest prace que le creaveu hmauin ne lit pas chuaqe ltetre elle mmêe, mias le mot cmome un tuot.

Perception

منزل
سيارة
صفحة
ملف
مجلد
كتاب
قلم
كمبيوتر

أسود
أصفر
أبيض
أخضر
أسود
أحمر
أزرق
أصفر