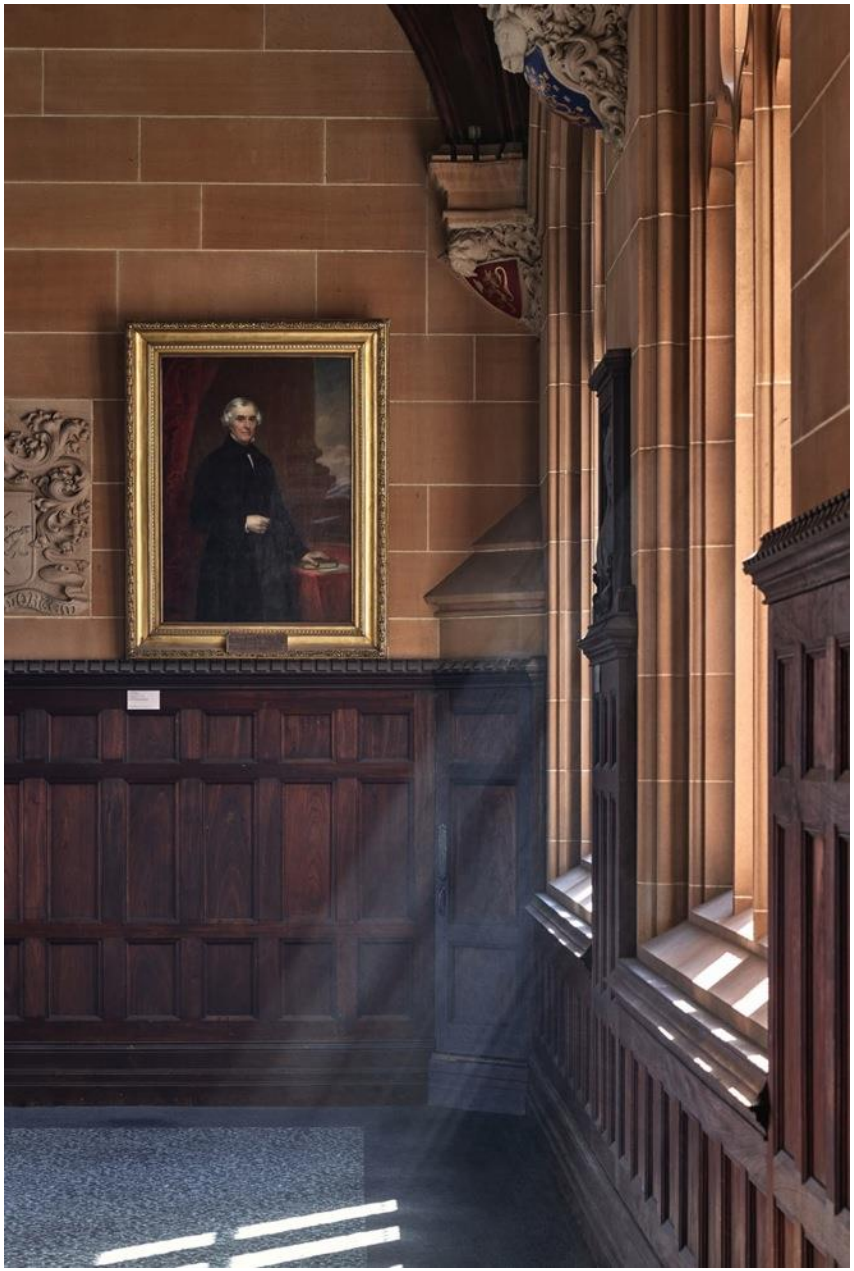
INFO3315 Human-Computer Interaction

Lecture 2 – Understanding Humans

Zhanna Sarsenbayeva



THE UNIVERSITY OF SYDNEY

Recap

- Human Computer Interaction
  - What?
  - Why?
  - Who?
- Usability Goals
- User Experience
- Interaction Design Rules
  - Standards
  - Guidelines
  - Principles
  - Patterns

HELP

Understanding Humans – Cognition







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Cognition in HCI

- Interacting with technology is cognitive.
- Provides knowledge about what users can and cannot be expected to do.
- Identifies and explains the nature and causes of problems that users encounter.
- Provides theories, models, and guidelines that can lead to the design of better products.

Human Information Processing Model

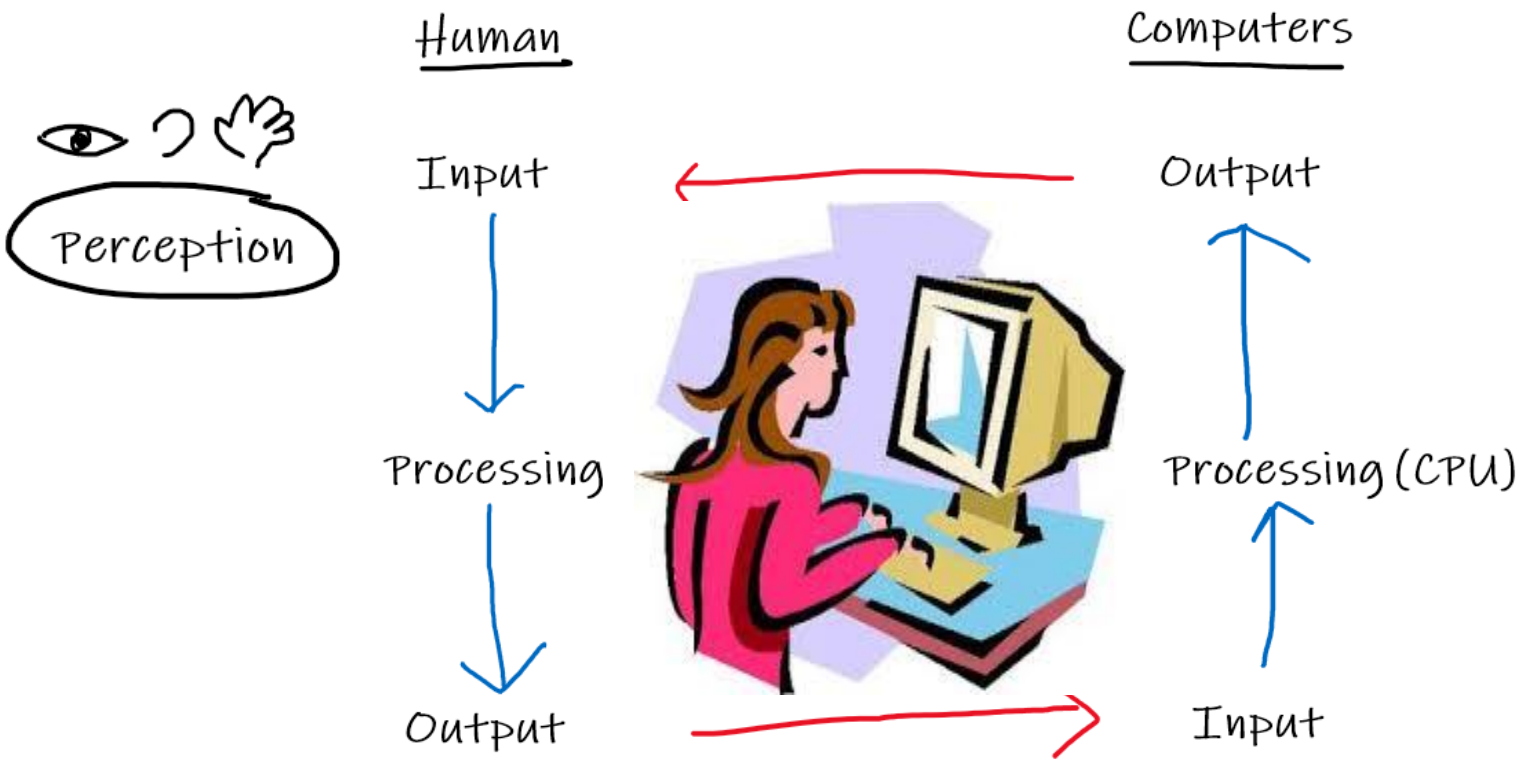
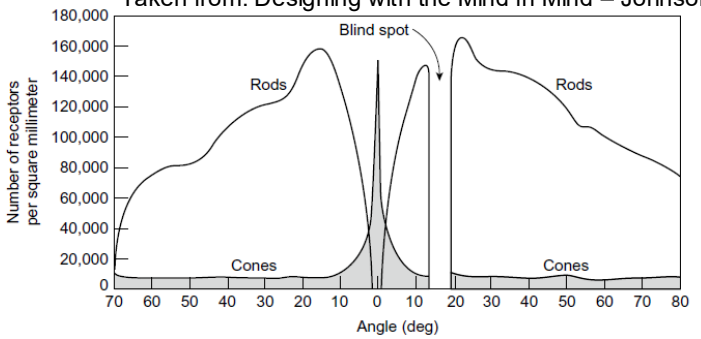


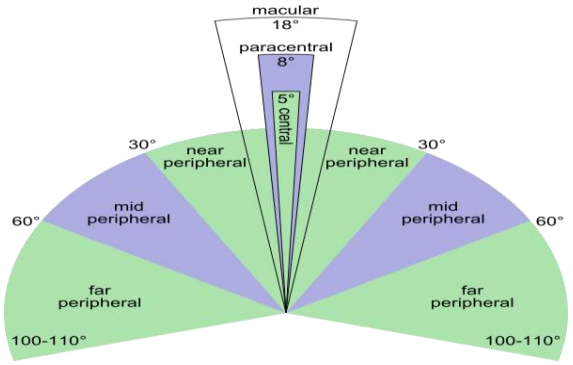
Image credit: http://www.clipartpanda.com/categories/using-the-computer-clipart

Visual Perception: Fovea vs. Peripheral

- Fovea Vision (cones)
  - Only a small part of our field of view is in focus (e.g., for reading)
  - The central area with an angle of sight of around 5-18°
- Peripheral Vision (rods)
  - Vision in the outer parts of the field of view is blurred
  - Used for discovery of stimuli (e.g., movement, brightness change)

Taken from: Designing with the Mind in Mind – Johnson





http://commons.wikimedia.org/wiki/File:Peripheral_vision.svg

Activity: Thumbs Up!

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Design Implications

- Put contents where users are looking.
- Example – error message.



Taken from: Designing with the Mind in Mind – Johnson

Design Implications

- Make important information stand out by using peripheral ‘pop’.
- A visual target will pop out in your periphery if it differs from surrounding objects in features the periphery can detect.
- More distinctive features of the target, the more it “pops”.

Task: Find the letter Z

L Q R B T J P L F B M R W S
F R N Q S P D C H K U T
G T H U J L U 9 J V Y I A
E X C F T Y N H T D O L L8
G V N G R Y J G Z S T 6 S
3 L C T V B H U S E M U K
W Q E L F G H U Y I K D 9

Task: Find the letter G

G T H U J L U 9 J V Y I A
L Q R B T J P L F B M R W S
3 L C T V B H U S E M U K
F R N Q S P D C H K U T
W Q E L F G H B Y I K D 9
G V N **G** R Y J G Z S T 6 S
E X C F T Y N H T D O L L8

Taken from: Designing with the Mind in Mind – Johnson

Design Implication



FIGURE 5.18 Air traffic control systems often use red to make potential collisions stand out.

Taken from: Designing with the Mind in Mind – Johnson



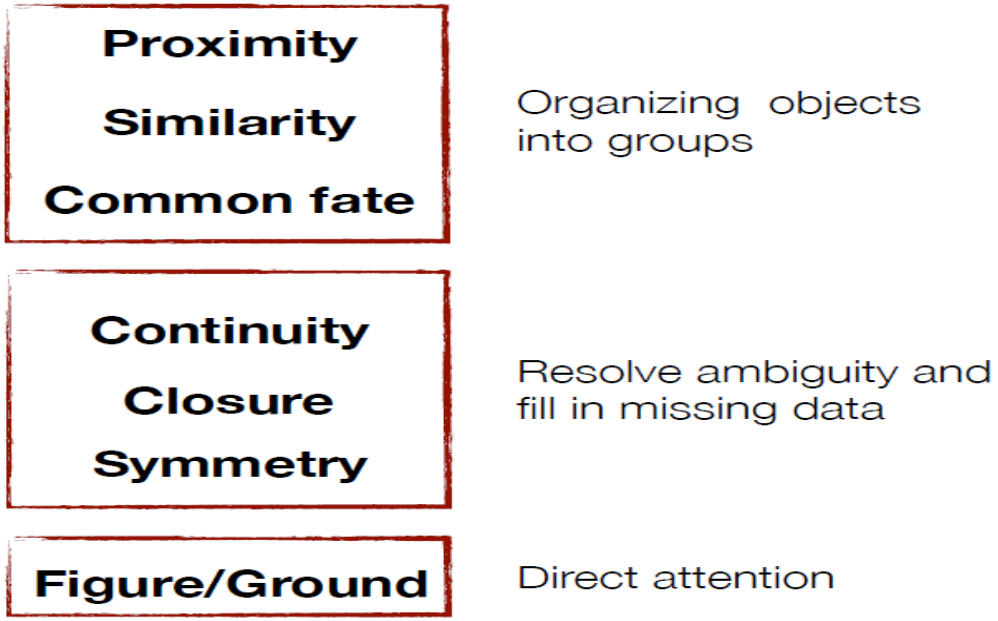
FIGURE 5.17 Google Maps uses color to show traffic conditions. Red indicates traffic jams.

Visual Perception

– What do you see in this picture?

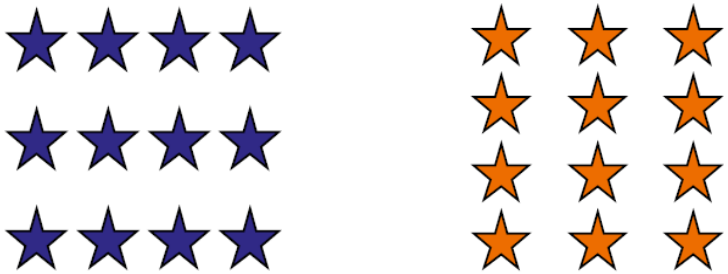


Gestalt Laws of Perception



Proximity

- Objects that are close to each other are perceived as forming a group
- Items that belong together should be grouped together
- Separate the items not belonging together by putting space or separator lines in between



Similarity

- Objects that look similar are perceptually grouped together

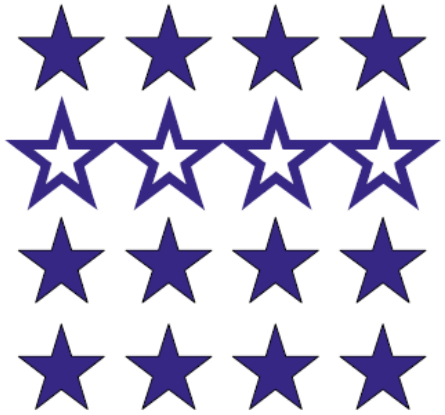


FIGURE 2.5

Similarity: Items appear grouped if they look more similar to each other than to other objects.

Common Fate

- Objects that *move* together are perceived as grouped or related

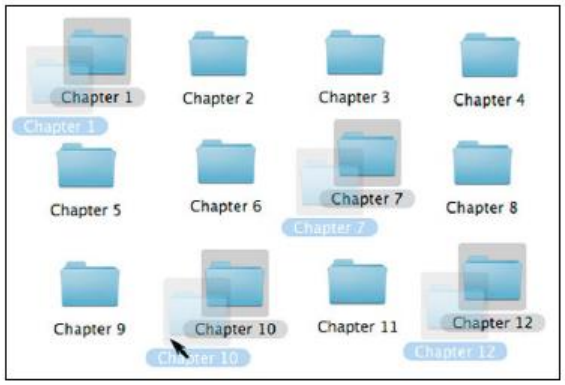
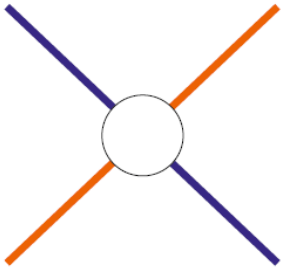


FIGURE 2.23

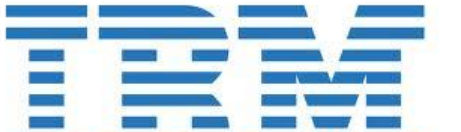
Similarity and Common Fate: When users drag folders that they have selected, common highlighting and motion make the selected folders appear grouped.

Continuity

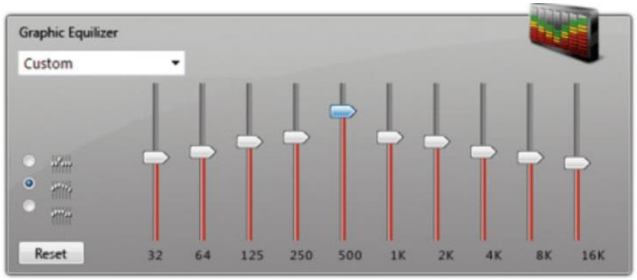
- We are biased to perceive continuous forms rather than disconnected segments











Closure

- Our visual system automatically tries to close open figures so that they are perceived as whole objects

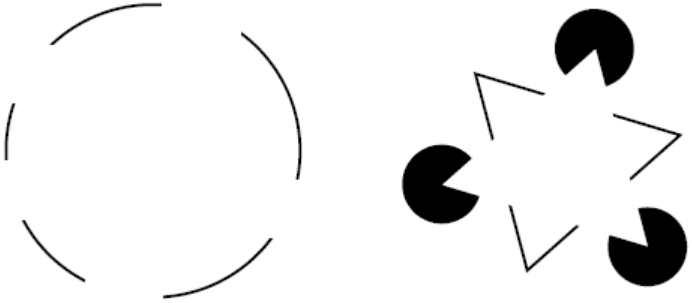




FIGURE 2.12

Icons depicting stacks of objects exhibit the Closure principle: partially visible objects are perceived as whole.

Symmetry

- Complex scenes are parsed in a way that reduces symmetry
- Providing symmetric design helps users in their interpretation

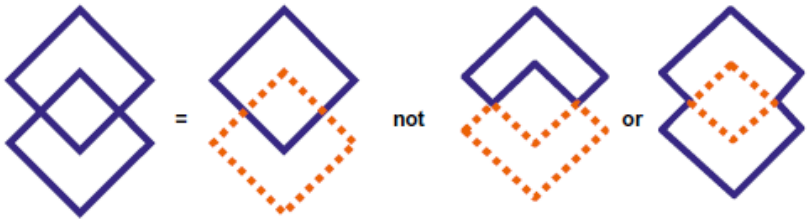
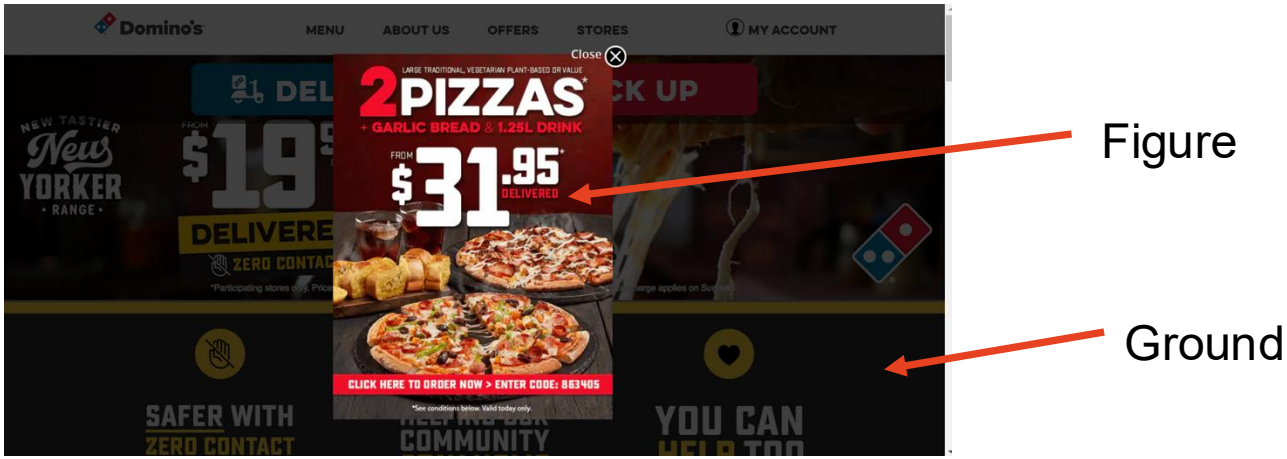


FIGURE 2.13

Symmetry: The human visual system tries to resolve complex scenes into combinations of simple, symmetrical shapes.

Figure/Ground

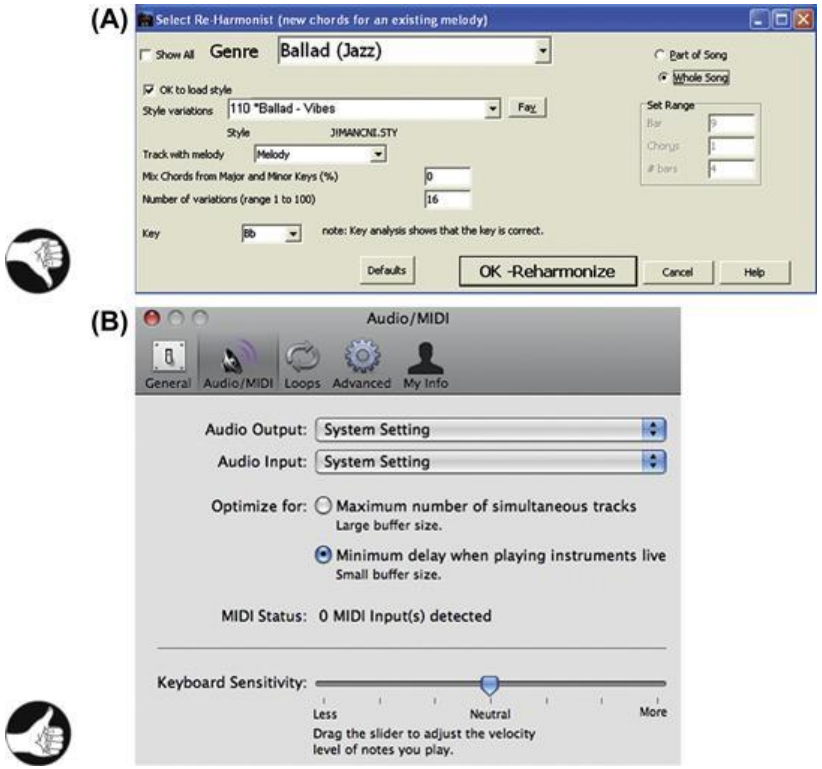
- Visual field is separated into figure (foreground) and ground (background)
- Pop up windows help to focus our view.



Design Implications

- Use visual hierarchy to help people focus on relevant information.

- Can you spot which Gestalt Law is utilized in (B).



Taken from: Designing with the Mind in Mind – Johnson

Human Information Processing Model

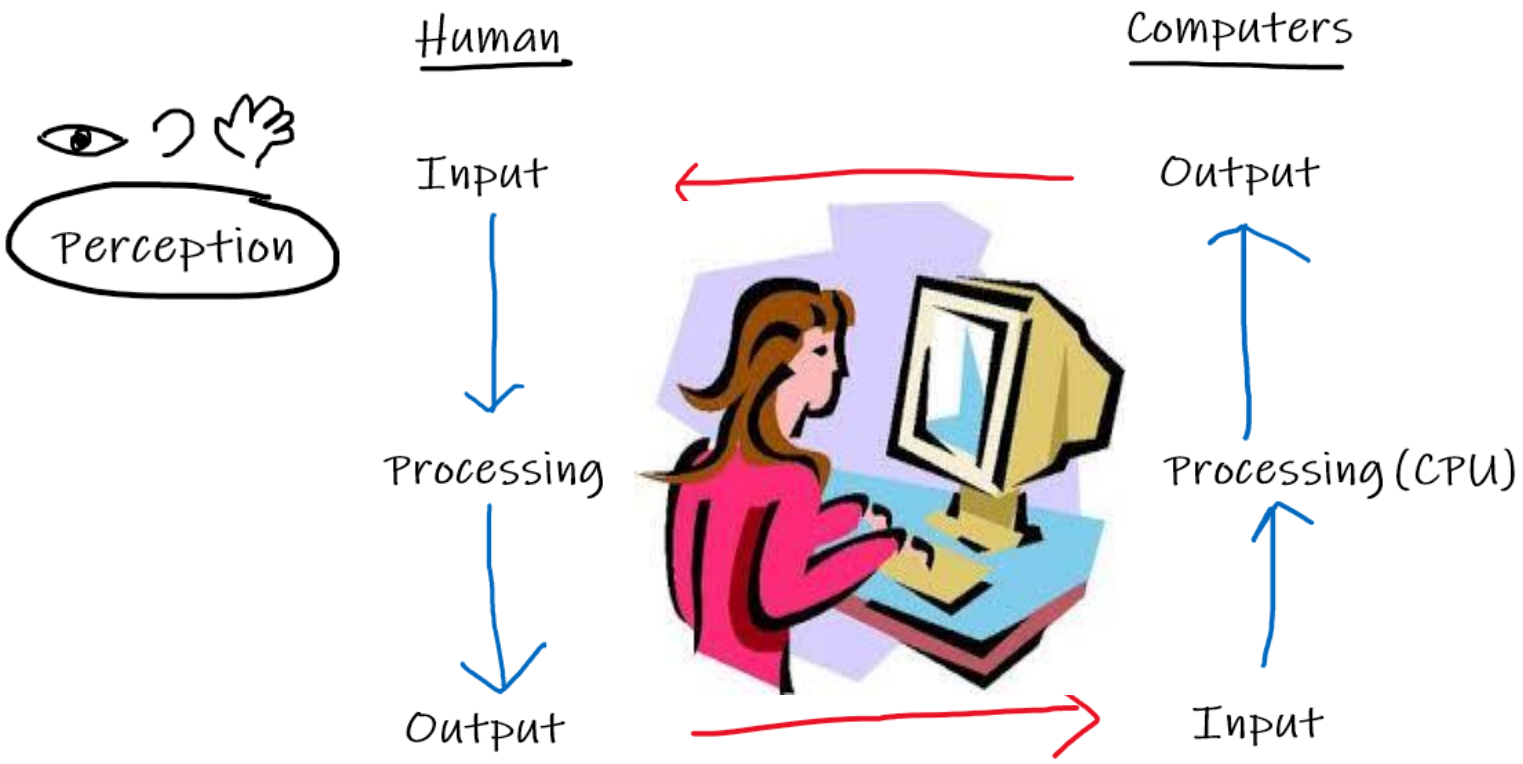


Image credit: http://www.clipartpanda.com/categories/using-the-computer-clipart

Auditory Perception

- Sound travels as pressure waves and picked up by our ears
- Physical structure of the ear amplify and direct these waves
- The range of human hearing is considered to be 20 Hz to 20 kHz
- But it is far more sensitive to sounds between 1 kHz and 4 kHz.

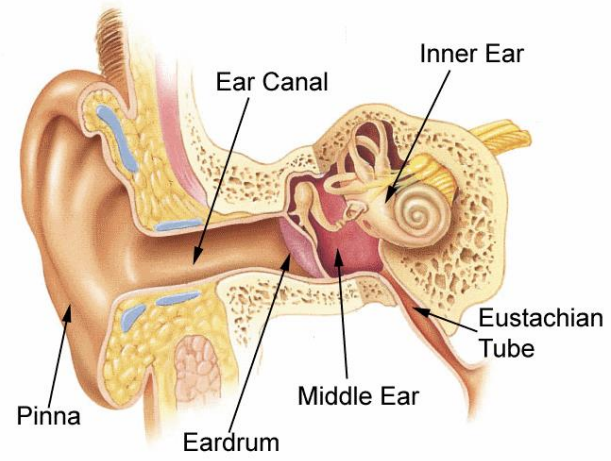
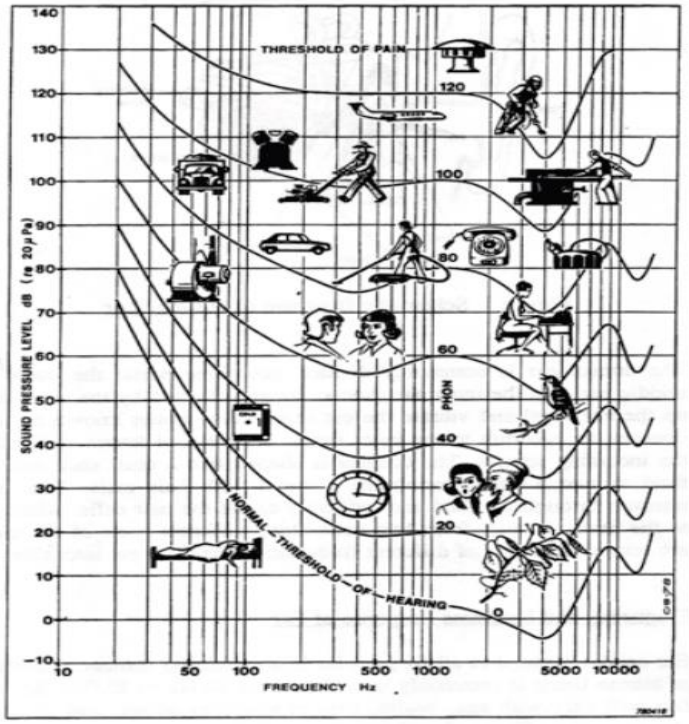


Image credit: http://www.soundintel.com/

Auditory Perception

- Intensity is perceived as loudness
  - Intensity measured in decibels (dB)
    - Whisper (15dB),
    - conversation (60 dB),
    - car horn (110 dB),
    - rock concert (120+ dB)
- Frequency is perceived as pitch
  - Frequency measured in Hz
- Timbre
  - Different instruments, different timbre



Activity

Do you have difficulty understanding the differences between each term?
Watch the wave examples here:

- https://www.animations.physics.unsw.edu.au/jw/sound-pitch-loudness-timbre.htm

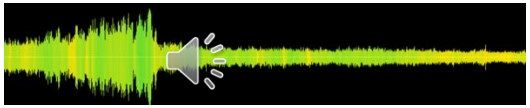
Types of Audio – Sound Alerts

- Alert user to abnormal or undesirable situations.
- Identify the sounds used for the following situations:
  A. Fire alarm
  B. Ambulance
  C. Car horn
  D. Car parking sensor

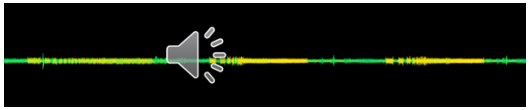
Credit: https://freesound.org/people/InspectorJ/sounds/402958/



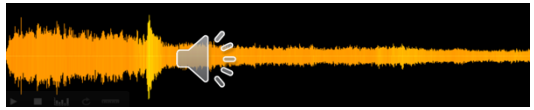
Credit: https://freesound.org/people/stereobrother/sounds/445344/



Credit: https://freesound.org/people/jeroenabel/sounds/178422/



Credit: https://freesound.org/people/RutgerMuller/sounds/436065/



Sound Alerts

Advantage

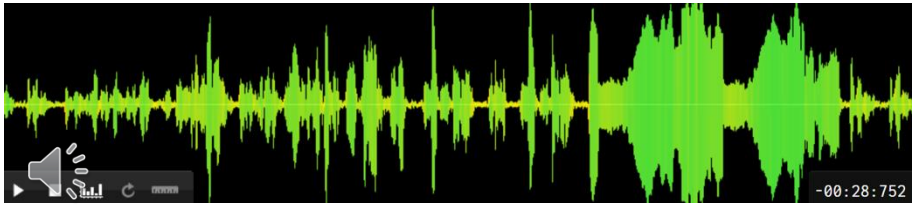
- Reduces demands on visual attention
  - Reduces the amount of information needed on the screen.
- Sound is attention grabbing.
  - Users can choose not to look at something, but it is harder to avoid hearing it.

Disadvantage

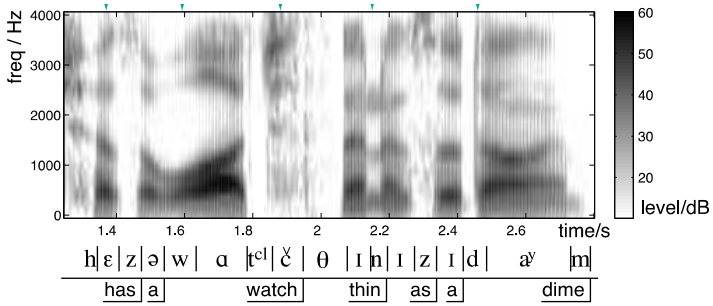
- Sound has low resolution
  - Can't covey high details of information.
- Presenting absolute data is difficult
  - Need to have two sounds or vibrations to tell if a value is going up or down
- Annoyance
  - To the user whose machine is making the noise
  - To others in the same environment who overhear the sound

Types of Audio – Speech

- Convey more information than plain sounds but requires more processing.
- Phonemes is the smallest unit of sound that distinguishes one word from another.
- Factors affect understanding:
  - Accent
  - Speed of speech



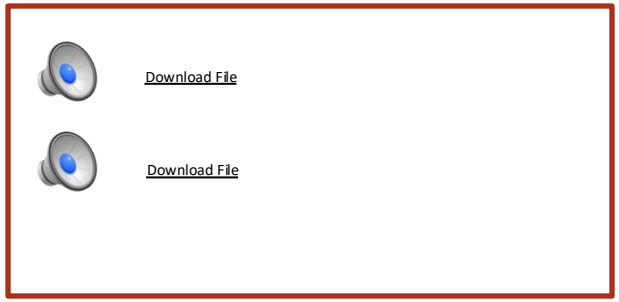
Credit: https://freesound.org/people/payattention/sounds/82797/



Elis & Mandel www.ee.columbia.edu

Phonemic restoration

- Perceptual Restoration of Missing Speech Sounds
  - Richard M. Warren (1970)
- People do not notice the missing parts
- Sine-wave speech
  - Remez, et al. (1981). Speech perception without traditional speech cues. Science
  - More info: https://www.mrc-cbu.cam.ac.uk/people/matt.davis/sine-wave-speech/





Sounds: Elis & Mandel www.ee.columbia.edu

Design Implications

- Sounds should be audible and distinguishable.
- Characteristics should be comfortable to the listener.
- Speech output should be intelligible.
- Accentuate the intonation of artificially generated speech voices as they are harder to understand than human voices.

Tactile Senses and Haptic Perception

- Haptic perception is the process of acquiring, interpreting, selecting, and organizing haptic sensory information.

- ISO9241-910:2011 – Framework for tactile and haptic interaction:
  - Haptics – sensory and/or motor activity based in the skin, muscles, joints and tendons. Covers two parts tactile and kinesthesia.
  - Tactile – connected to sense of touch.
  - Touch – sense based on receptors in the skin.
  - Kinaesthesis – sense and motor activity based in the muscles, joints and tendons (sense of self-movement and body position).



http://specialprojects.sciencemag.org/xxfiles/img/xxfiles_haptacv01.jpg

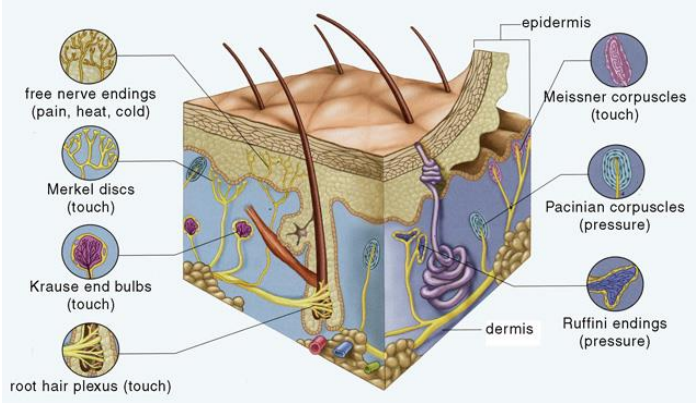
Tactile Senses and Haptic Perception

- A sensory system associated with the body.
- Three main modalities
  - Discriminative touch
    - Mechanoreceptor – receptors responsible for tactile sensation
    - Cutaneous – belonging to skin
  - Temperature & pain
    - Free nerve endings
  - The kinesthetic senses
    - Muscle and joint receptors
    - Proprioception

Tactile Senses and Haptic Perception

Mechanoreceptors

Receptor	Adaptation/ Type	Freq. (Hz)	Function
Merkel's disks	Slow I (SA1)	0-30	Pressure
Ruffini endings	Slow II (SA2)	0-15	Stretch, tension
Meissner's corpuscles	Rapid I (RA1)	10-60	Local vibration
Pacinian corpuscles	Rapid II (RA2)	80-400	Unlocalized vibration

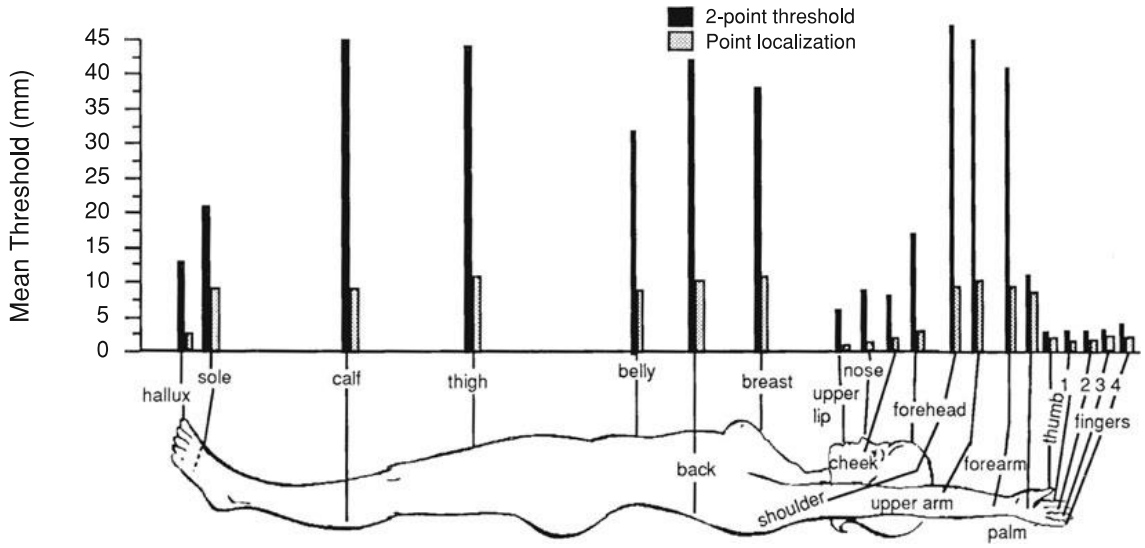


http://biologyboom.com/

Tactile Senses and Haptic Perception

Mechanoreceptors

- Spatial Acuity
  - On fingertip about 1-2mm

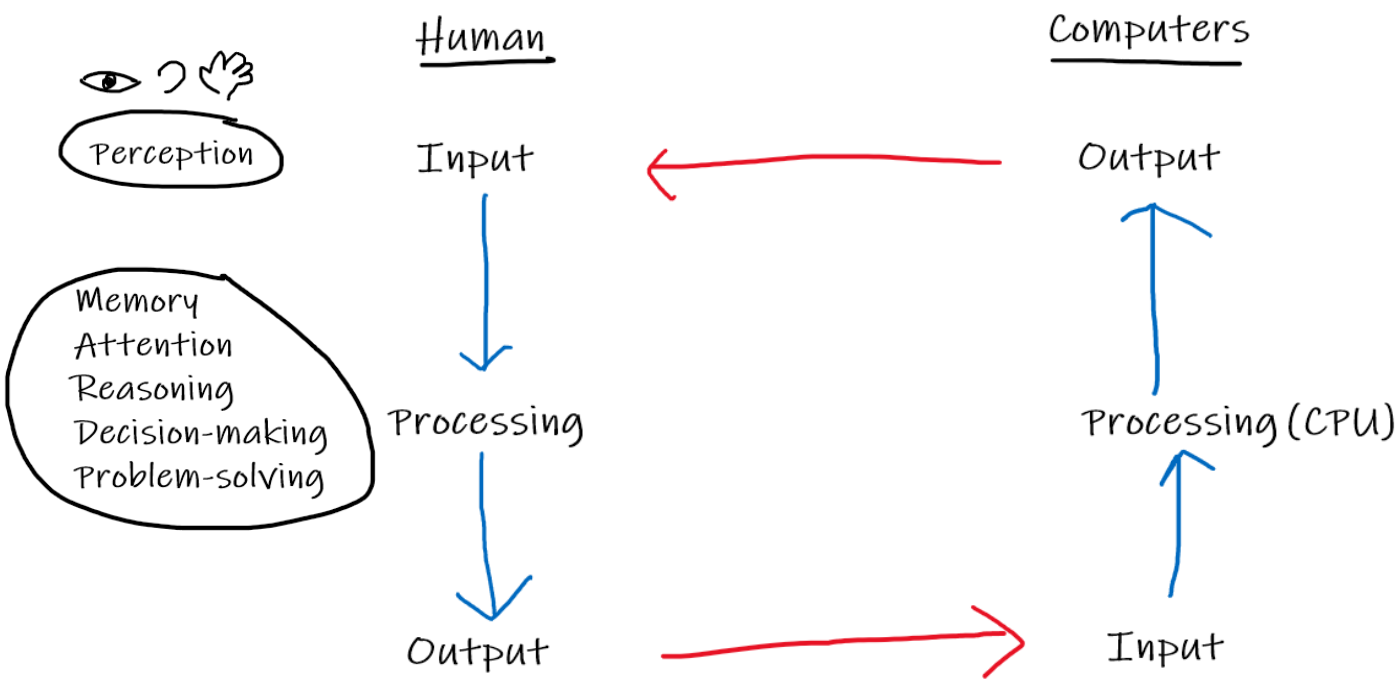


Lederman SJ, Klatzky RL. Haptic perception: A tutorial. Attention, Perception, & Psychophysics. 2009 Oct 1;71(7):1439-59.

2-point threshold:

- Take two pencils, held so their tips are about 12 mm apart.
- Touch the points to the skin.
- Observers are asked to decide whether they subjectively feel one or two points. If they can't, move the points a little further apart.
- When you can feel two points, measure the distance between them.

Human Information Processing Model



Memory Overview

- Sensory memory
  - Buffer for stimuli received through senses
  - Continuously overwritten
- Short-term memory or working memory
  - Scratch-pad for temporary recall
  - Rapid access: ~ 70ms
  - Rapid decay: ~ 200ms
  - Limited capacity: 7 ± 2 chunks
- Long-term memory
  - Repository for all our knowledge
  - Slow access: ~ 1/10 second
  - Slow decay, if any
  - Huge or unlimited capacity

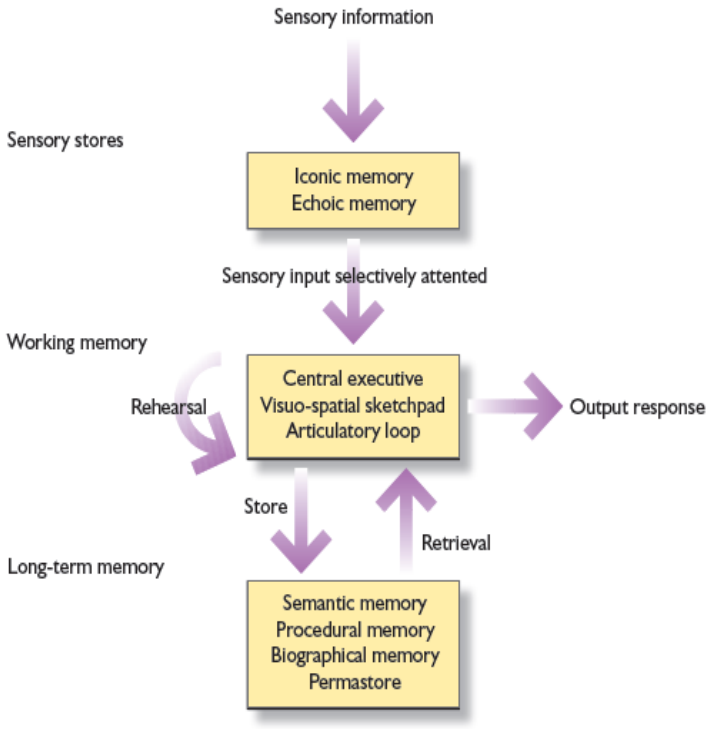


FIGURE 15-1 A schematic model of multi-store memory (*Source: after Atkinson and Shiffrin, 1968*)

Memory Test - Again

- Remember the following:

1300888333

1-800-793-864

town river corn string car shovel

what is the meaning of life

Working Memory

- Contents are transferred to working memory from sensory memory/stores in a fraction of a second.
- Working memory has three elements:
  - Central executive – decision making
  - Visuo-spatial sketchpad – holds visual information
  - Articulatory loop – holds auditory information
- Through rehearsals (refreshing of contents), information is retained
- Without rehearsal, contents will decay

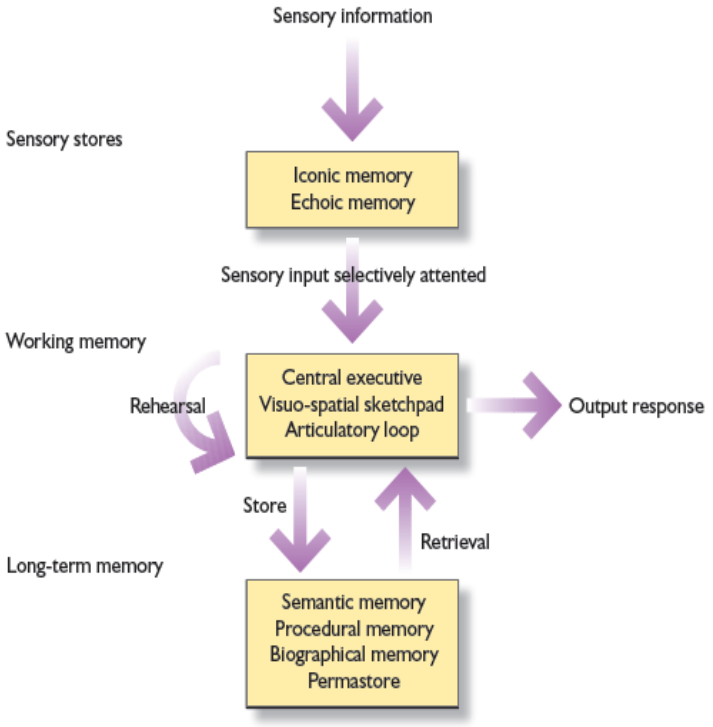


FIGURE 15-1 A schematic model of multi-store memory (*Source: after Atkinson and Shiffrin, 1968*)

Long Term Memory

- Four elements:
  - Semantic – hold information related to meaning
  - Procedural – stores knowledge on how to do things e.g. typing, driving
  - Episodic/Autobiographical – stores memories related to personal events or experiences such as birthdays, graduation, getting married.
  - Permastore – memories that lasts our lifetime.
- Process:
  - Storage/encoding – store into memory
  - Retrieval – means memories are recovered from storage
    - Recognition
    - Recall

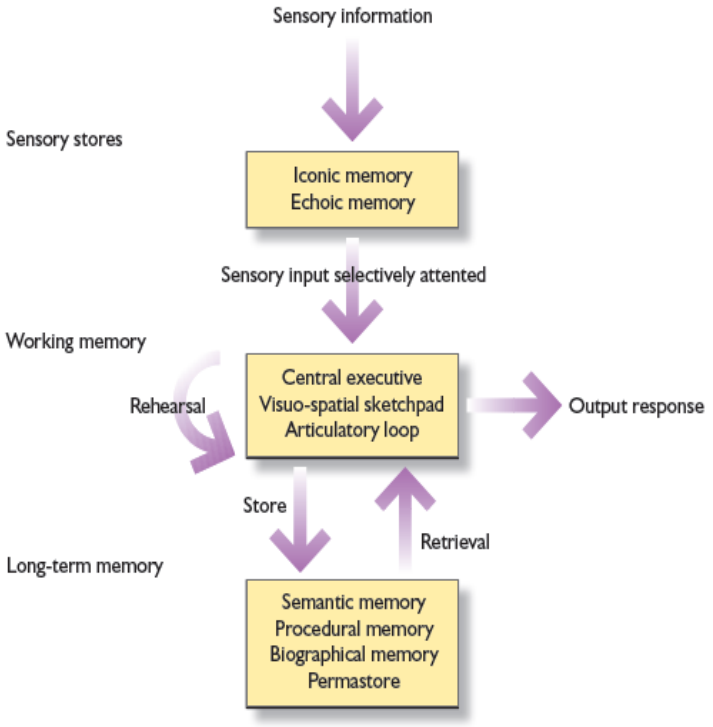
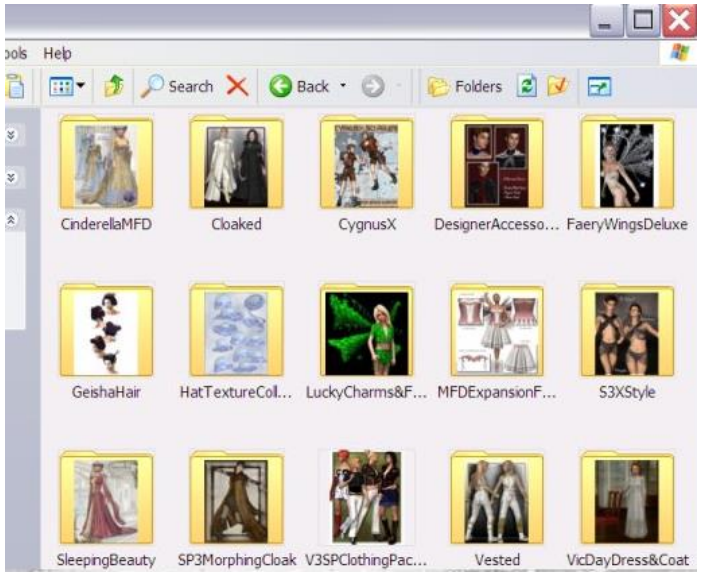


FIGURE 15-1 A schematic model of multi-store memory (*Source: after Atkinson and Shiffrin, 1968*)

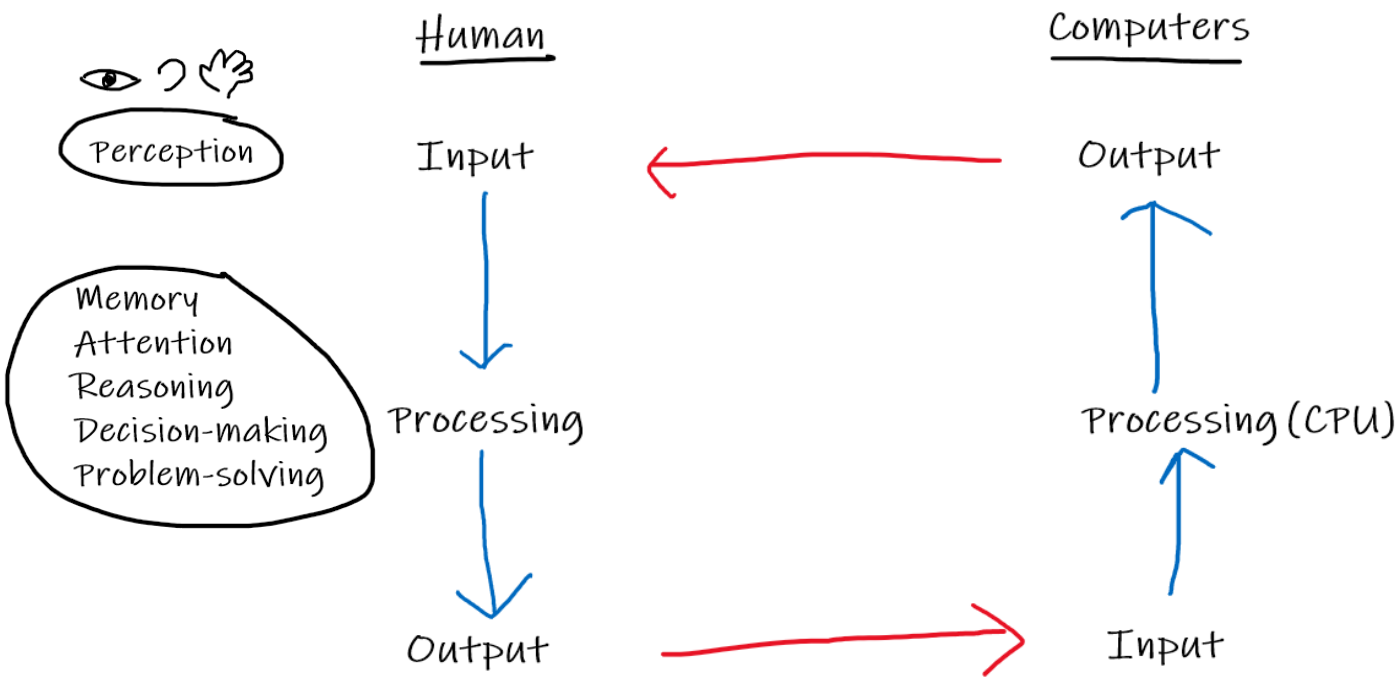
Design Implications

- Reduce cognitive load by avoiding long and complicated procedures for carrying out tasks.
- Design interfaces to promote recognition than recall using familiar interaction patterns, menus, icons and consistently placed objects.
- Provide users with a variety of ways of labelling digital information to help them identify it again.



Credit: http://www.caryb.co.uk/Computer07-Thumbnails.html

Human Information Processing Model



Attention

- Selecting things to concentrate on at a point in time from the mass of stimuli around us
- Allows us to focus on information that is relevant to what we are doing
- The extent to which this process is easy or difficult depends on:
  - **Our Goals**
  - **Information Presentation**
- Enables us to be selective in terms of the mass of competing stimuli but limits our ability to keep track of all events



Activity 1 – Information Presentation

Find the price of a **double room** at the **Quality Inn** in **Columbia**.

South Carolina

City	Motel/Hotel	Area code	Phone	Rates Single	Rates Double
Charleston	Best Western	803	747-0961	$126	$130
Charleston	Days Inn	803	881-1000	$118	$124
Charleston	Holiday Inn N	803	744-1621	$136	$146
Charleston	Holiday Inn SW	803	556-7100	$133	$147
Charleston	Howard Johnsons	803	524-4148	$131	$136
Charleston	Ramada Inn	803	774-8281	$133	$140
Charleston	Sheraton Inn	803	744-2401	$134	$142
Columbia	Best Western	803	796-9400	$129	$134
Columbia	Carolina Inn	803	799-8200	$142	$148
Columbia	Days Inn	803	736-0000	$123	$127
Columbia	Holiday Inn NW	803	794-9440	$132	$139
Columbia	Howard Johnsons	803	772-7200	$125	$127
Columbia	Quality Inn	803	772-0270	$134	$141
Columbia	Ramada Inn	803	796-2700	$136	$144
Columbia	Vagabond Inn	803	796-6240	$127	$130

Activity 2 – Information Presentation

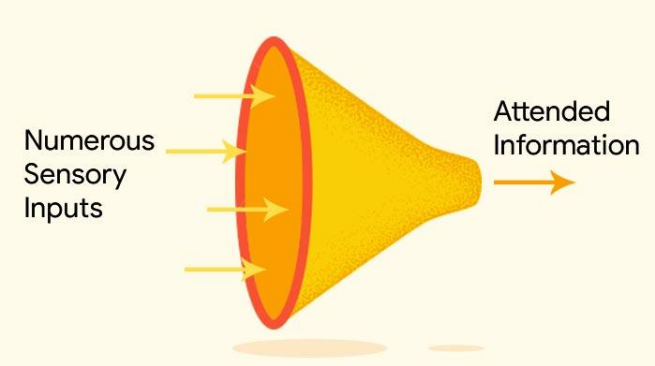
Find the price of a **double room** at the **Holiday Inn** in **Bradley**, **Pennsylvania**.



Attention

- Two forms of attention:
- 1. Selective attention
  - Awareness of sensory information
  - Broadbent's early selection model
- 2. Divided attention (Multi-tasking)
  - Consciously divide mental resources between tasks being performed
  - Kahneman's capacity allocation model

*Read Benyon(2019) Chapter 21.3, pp 513-515





Stroop Effect

- Stroop Effect Experiment
  - https://faculty.washington.edu/chudler/java/ready.html
- What does the Stroop Effect tell you about how we process information?

Word Set #2

RED	GREEN	BLUE	YELLOW	PINK
ORANGE	BLUE	GREEN	BLUE	WHITE
GREEN	YELLOW	ORANGE	BLUE	WHITE
BROWN	RED	BLUE	YELLOW	GREEN
PINK	YELLOW	GREEN	BLUE	RED

Activity: Problem-solving and Decision-making

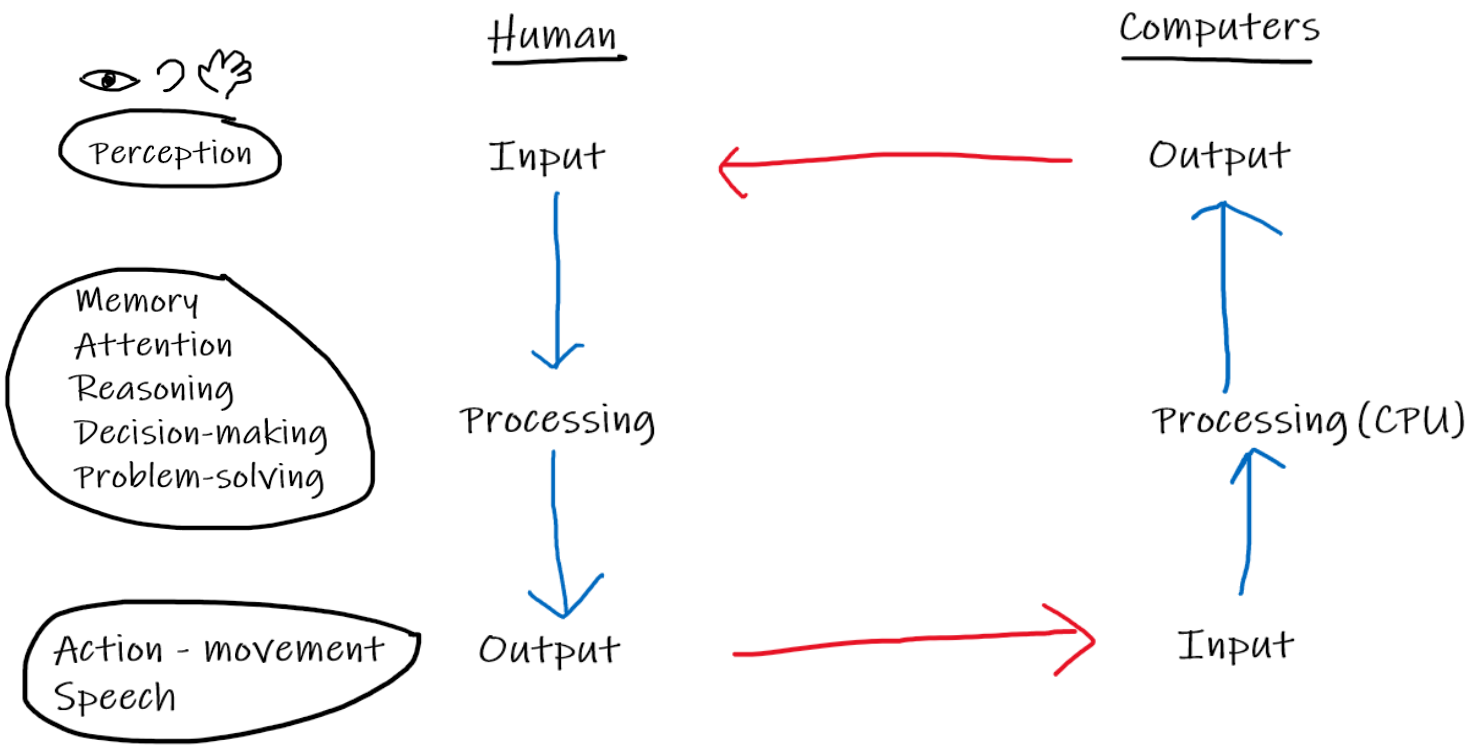
- Try this game: https://www.mathsisfun.com/games/allout.html
- How did you find the game?
- How long would you continue to play the game?
- How do you make decisions?

Reasoning, Decision-making, Problem-solving

- Processes that involve reflective cognition – what to do, the available options and consequences of doing the action.

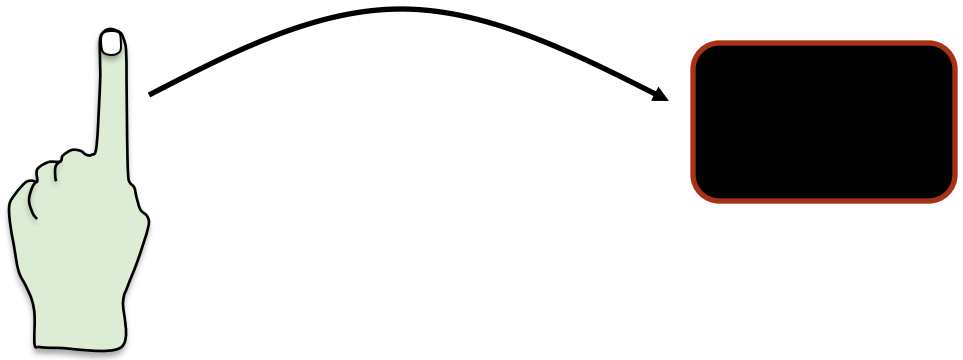
- Design implications:
  - Provide information and help pages that are easy to access for people who want to understand more about the how to carry out an activity.
  - Enable users to set or save their own criteria or preferences.

Human Information Processing Model



Movement

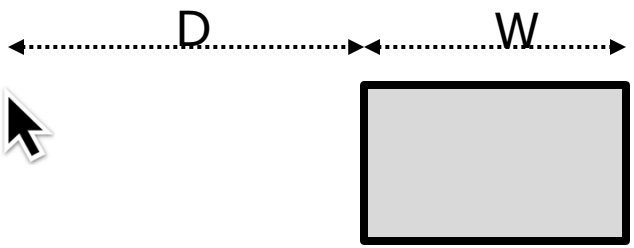
- Time taken to respond to stimulus = reaction time + movement time
- Movement time dependent on age, fitness etc.
- Fitts' Law is a model that predicts the time required for a targeted motor movement:



Fitts' Law

- Time to select a target is a function of the distance and width (size) of the target.
  - It also depends on some device-specific constants.

$$t = a + b\ log_2\left(\frac{D}{W} + 1\right)$$



D = the distance between the target and pointer (the distance user moves)

W = the width (or size) of the target

a = time required to start/stop moving (device specific)

b = the inherent speed of the device (device specific)

Summary: Human Capabilities and Limitations

1. Our vision is optimized to see structure.
2. Our peripheral vision is poor and colour vision limited.
3. Our attention is limited, our memory is imperfect.
4. Recognition is easy; recall is hard.
5. Performing learned actions are easy but problem-solving and calculations are hard.
6. Our hand-eye coordination follows laws e.g. Fitts Law

Robocop

- A combination of man and machine.
- Human abilities
  - Make judgements
  - Limited memory
- Machine
  - Strength and speed

- https://youtu.be/d-SLhDmaTqI

Food for thought:

Are you making your own decisions if you follow suggestions by recommender systems?

Can machines have feelings?



Image credit: http://umich.edu/~engb415/film/robocop.html

Motivation

- How do we get people do things that they don't like to do?

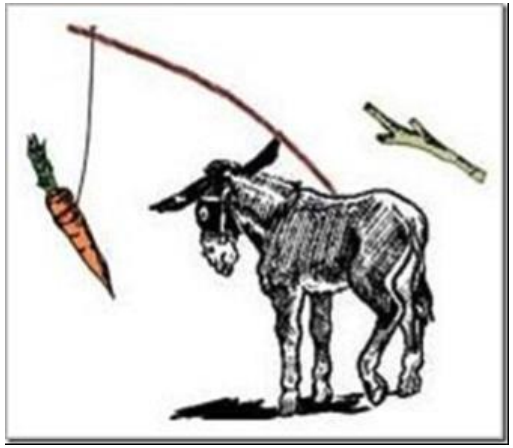
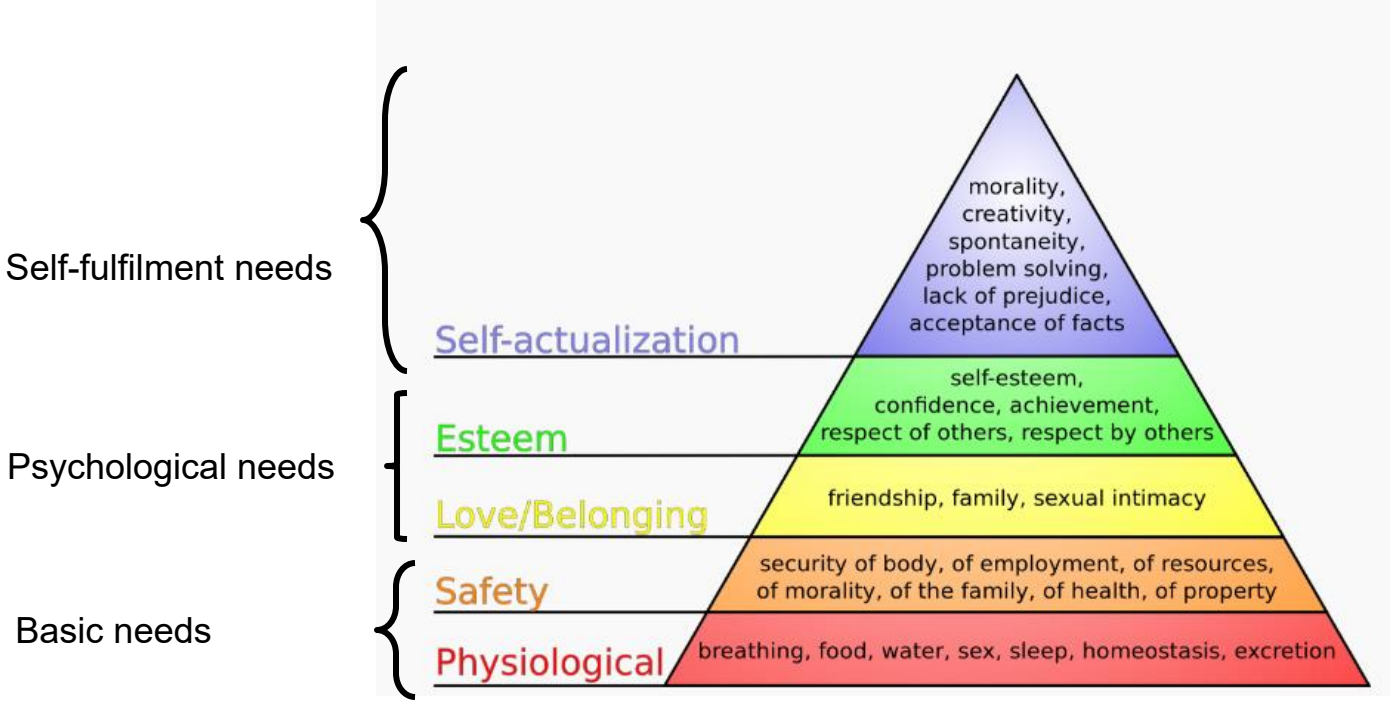
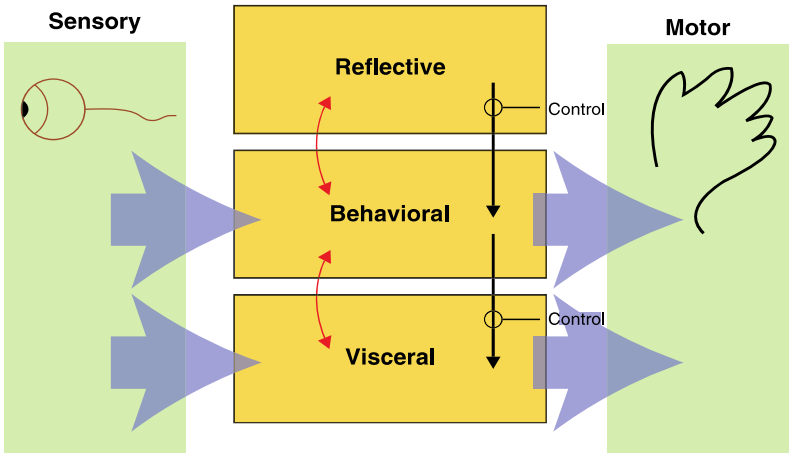


Image credit: https://www.kidsinthehouse.com/blogs/patrick-madden-ma-lep/the-carrot-and-the-stick-are-now-old-hat

Maslow's Hierarchical Theory



Modeling Emotions and Reaction



Ortony et al. (2005) model of emotional design

- Visceral design refers to making products look, feel, and sound good
- Behavioral design is about use, and it equates with traditional values of usability
- Reflective design is about considering the meaning and personal value of a product

Discussion - MoonSwatch Frenzy



https://www.news.com.au/finance/business/retail/hundreds-of-people-descend-on-westfield-for-omega-x-swatch-moonswatch-release/news-story/66607d997272d300b93cfbd5e5c1f856

- Would you queue overnight for a product?

Human Emotions

- How do we express emotions when we are online?

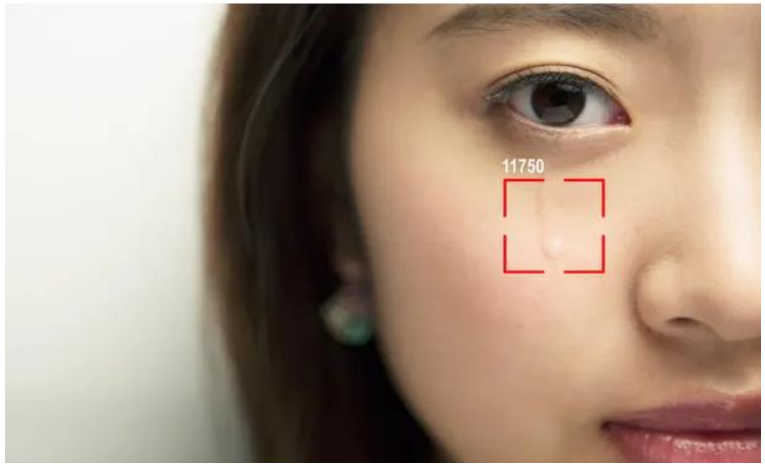






Affective Computing

– Can we teach computers to recognize emotions?



Credit: https://www.theguardian.com/technology/2019/mar/06/facial-recognition-software-emotional-science

Emotions and Technology

- Gloves that glow when you are excited by measuring the changes in skin conductance.

- More information:

https://youtu.be/ujxriwApPP4



Image credit: https://www.media.mit.edu/galvactivator/faq.html

In-class quiz

- Very easy in-class quiz
- 4 questions, randomly taken from the pool of questions to maximise the fairness
- Access code is required, will change after the quiz
- Multiple attempts not allowed
- For those who missed it, please email your tutors valid reasons and we will allow to retake the quiz
- Time is limited – 5 mins

Cognitive frameworks

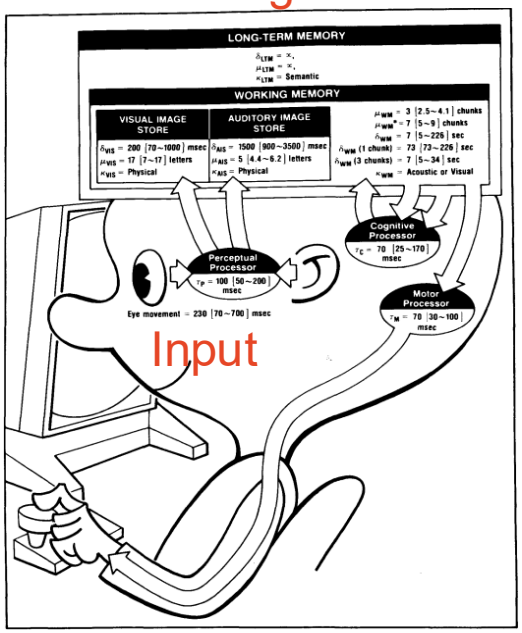
- Can be used to explain and predict user behavior at the interface
  - Based on theories of behavior
  - Focus is on mental processes that take place
  - Also use of artifacts and representations
- Internal frameworks
  - Human Information Processing Model
  - Mental models
  - Gulfs of execution and evaluation
- External frameworks
  - Distributed cognition
  - External Cognition

Internal Cognitive Frameworks

- Human Information Processing
- Mental Models
- Gulf of execution and gulf of evaluation

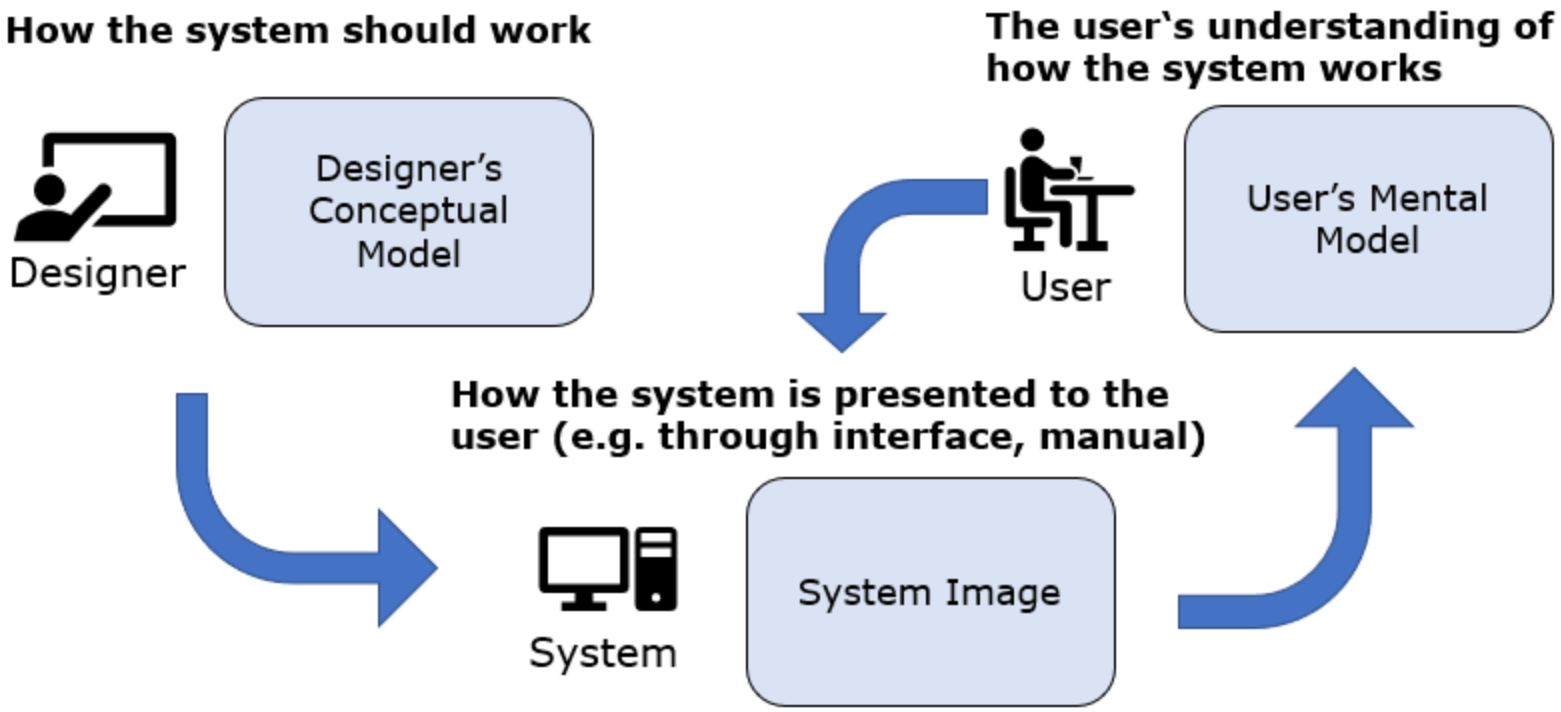
Human Processor Model

- One of the first HCI models to be derived from the information processing theory.
- **Application:** Model-based evaluation



Card, S., MORAN, T., & Newell, A. (1986). The model human processor- An engineering model of human performance. *Handbook of perception and human performance.*, *2*(45–1).

Mental models



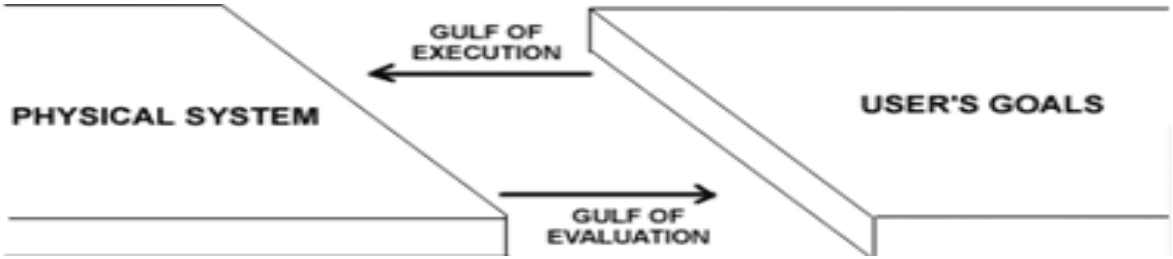
Don Norman, Design of Everyday Things


CAN'T YOU DO ANYTHING RIGHT?

Norman's Gulfs



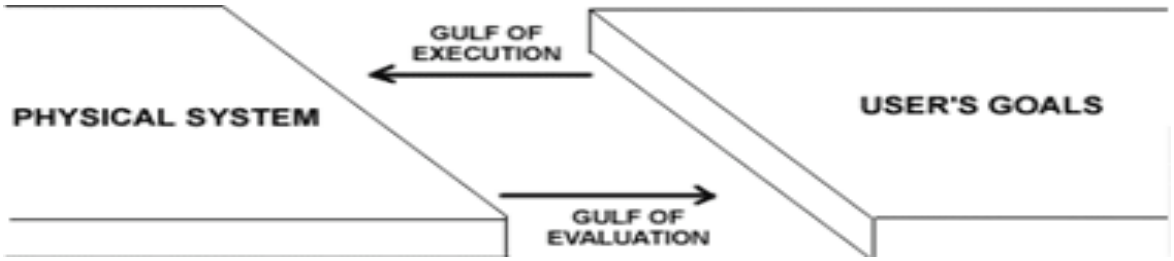
Gulf of Execution



Gulf of execution….distance between the user's goals and the means of achieving them through the system

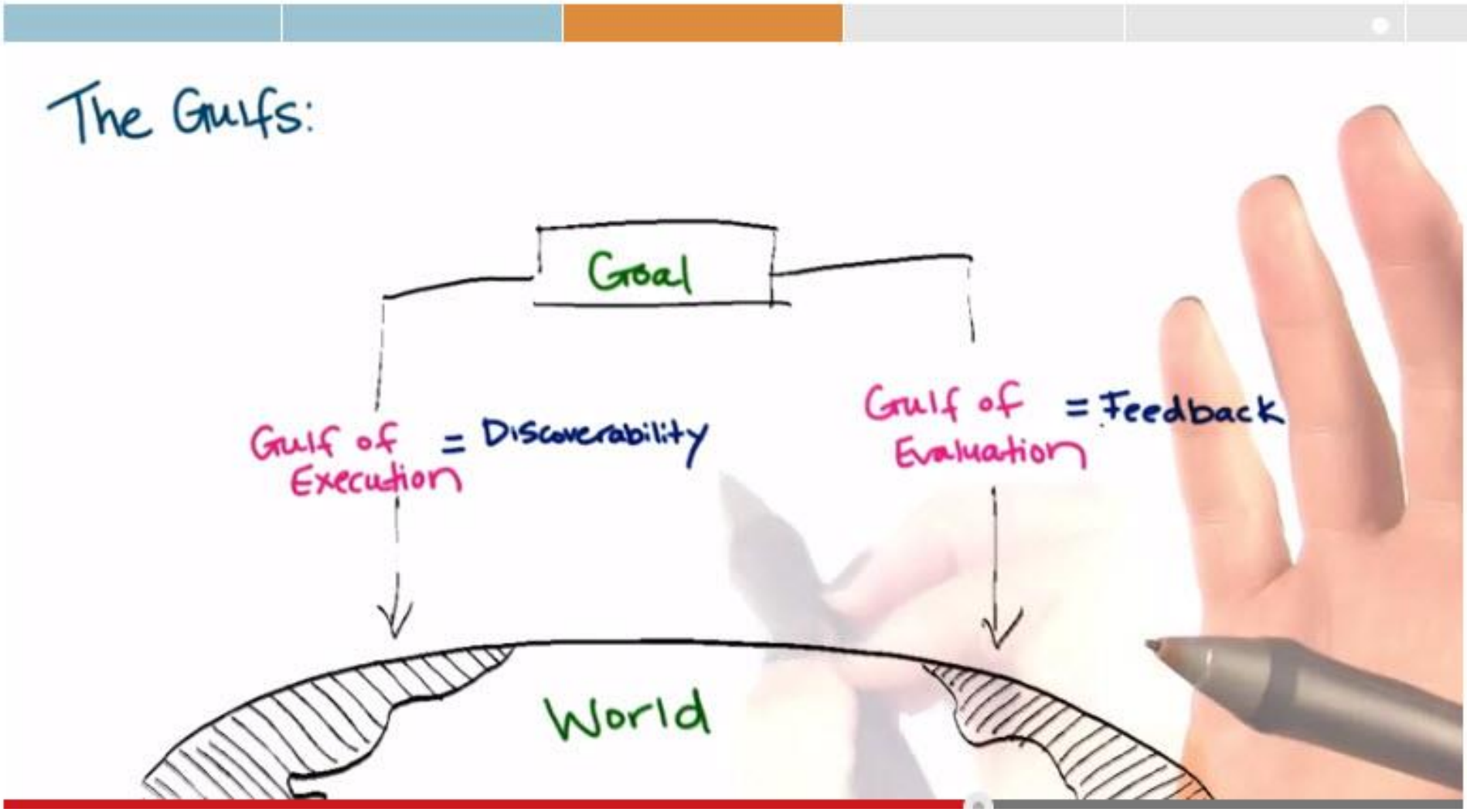
Some examples:
"What do I do now?"
"How do I [...]?"
"I wanted to [...], but I can't see how I would do that?"
"Do I press this?"
"Do I type this in here?"
"I'm looking for [...] but I can't find it"

Gulf of Evaluation



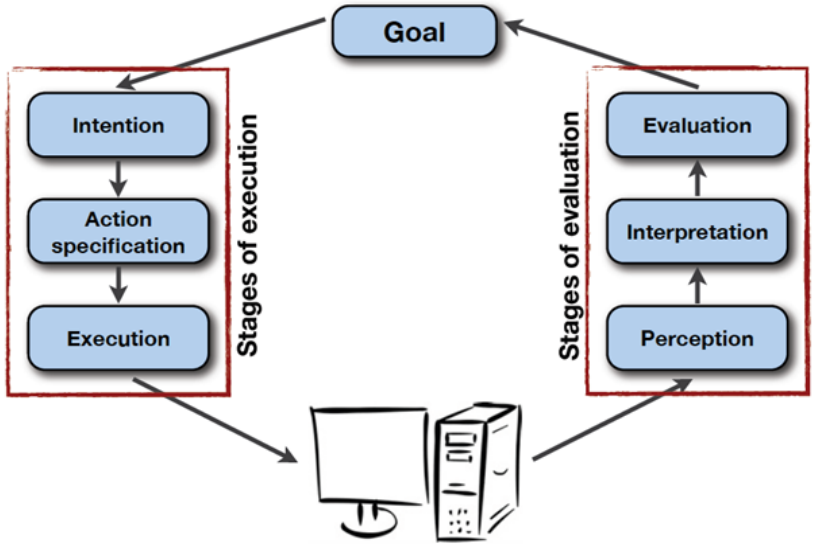
Gulf of evaluation: the amount of effort required to determine the system state

When problems occur in the evaluation phase, the "gulf of execution" widens
Some examples
"What happened then?"
"What did I do wrong"
User repeats the action (e.g. clicks the NEXT or SUBMIT button)


The Gulfs:
Goal
Gulf of Execution = Discoverability
Gulf of Evaluation = Feedback
World

Gulf of Execution and Gulf of Evaluation

- Transform goals into intentions and operating actions as easy as possible
- Possible actions are determinable in each situations
- Actions can be executed easily and robustly



- The reaction of the system and its state are
  - recognizable at all times
  - easily interpretable
- A displayed or indicated new state is easily comparable with the goals of the user

External Cognitive Frameworks

- Distributed Cognition
  - Visualize propagation across representational states
- External Cognition
  - Tools to aid our limited cognition

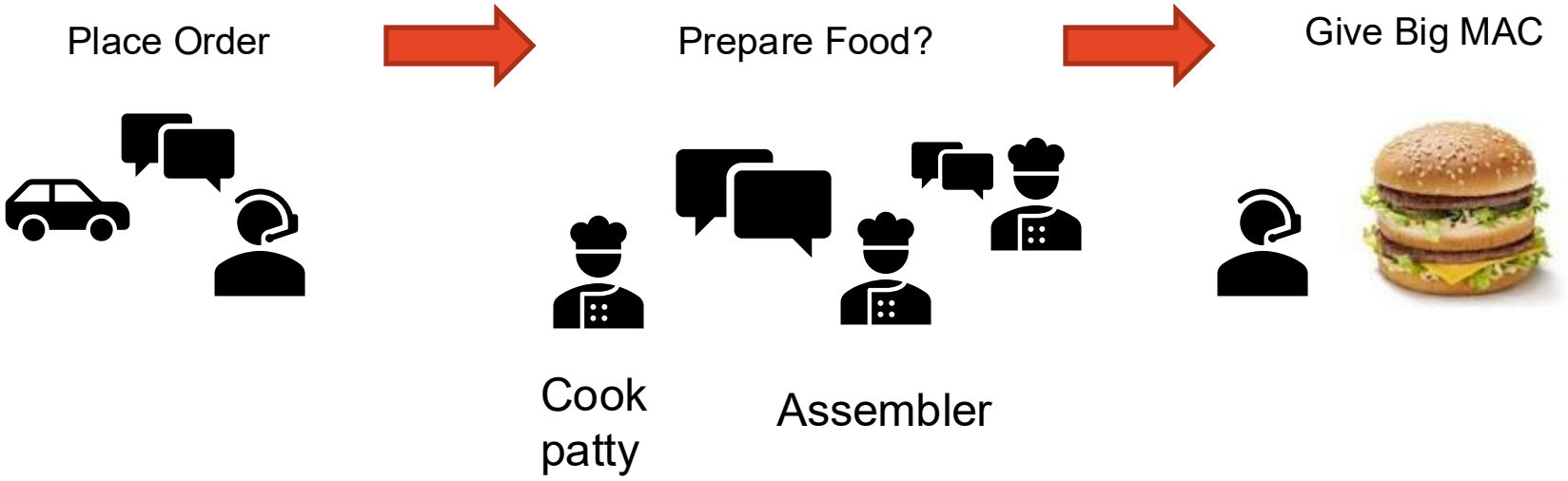
Distributed Cognition

– What do you think happens inside Mc Donald's when you place an order for a BIG MAC using the Drive Thru?

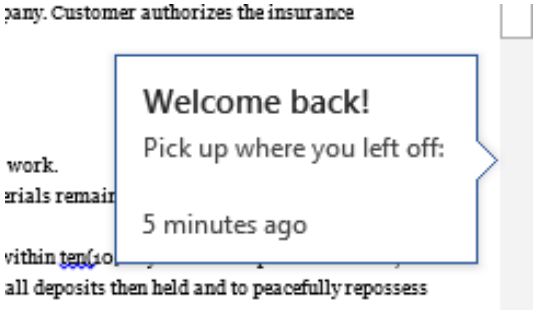


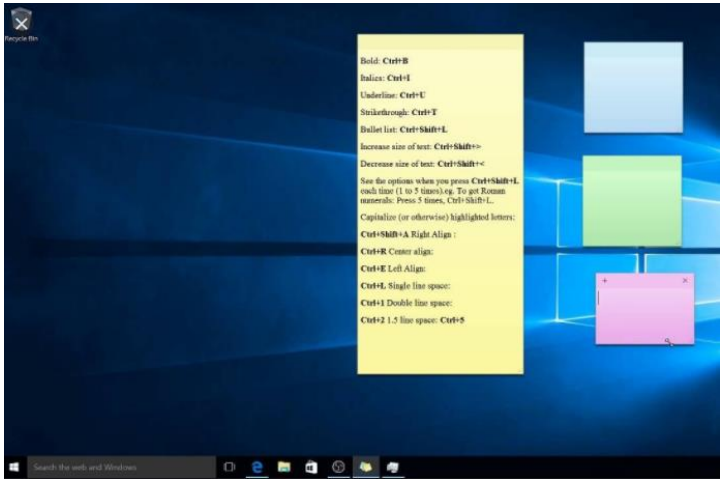


Distributed Cognition



Examples: External Cognition





Summary

- Human Perceptions
  - Visual
  - Auditory
  - Tactile
- Memory
- Attention
- Emotions
- Mental models
- Norman's Gulfs: Gulf of Execution and Gulf of Evaluation
- Cognition

Required Reading

- Preece, Rogers, Y., & Sharp, H. (2019). Interaction Design: Beyond Human-Computer Interaction. Wiley-Blackwell. Chapter 4 and Chapter 6

- Johnson, J. (2020). Designing With the Mind in Mind: Simple Guide to Understanding User Interface Design Guidelines. Morgan Kaufmann.