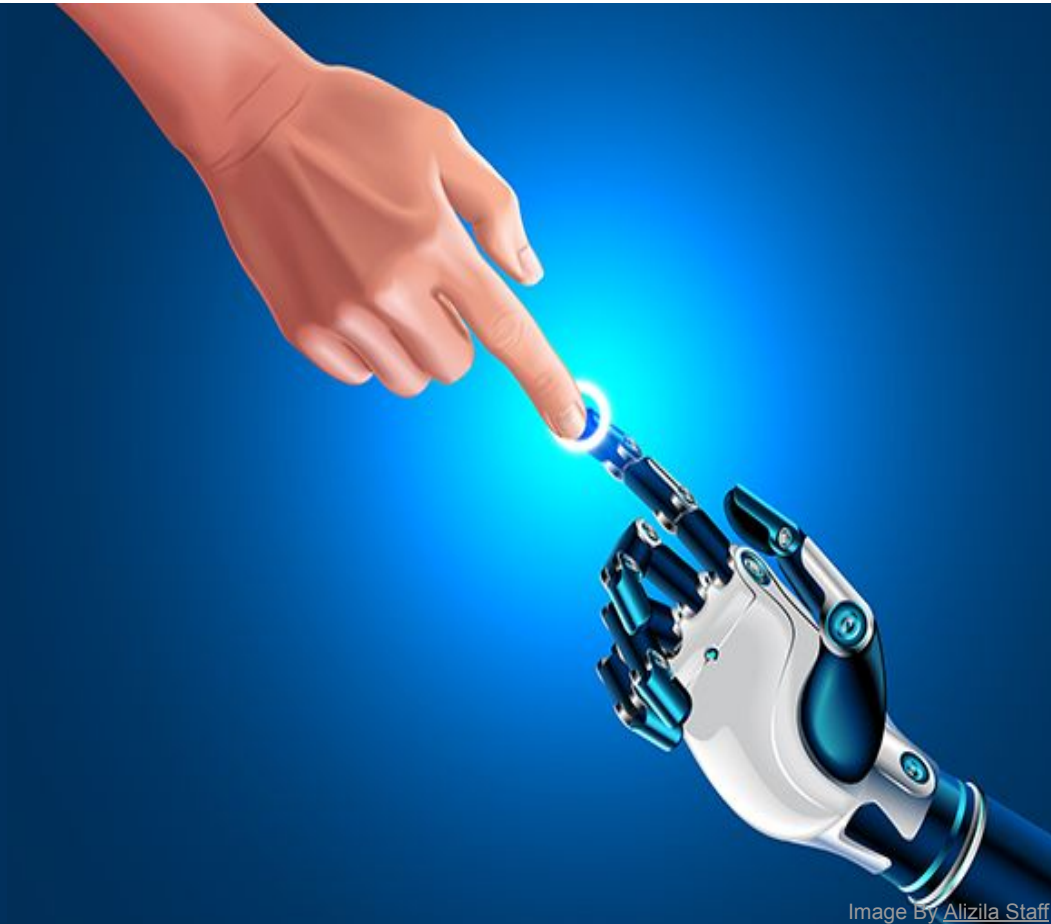
Lecture 3: Human

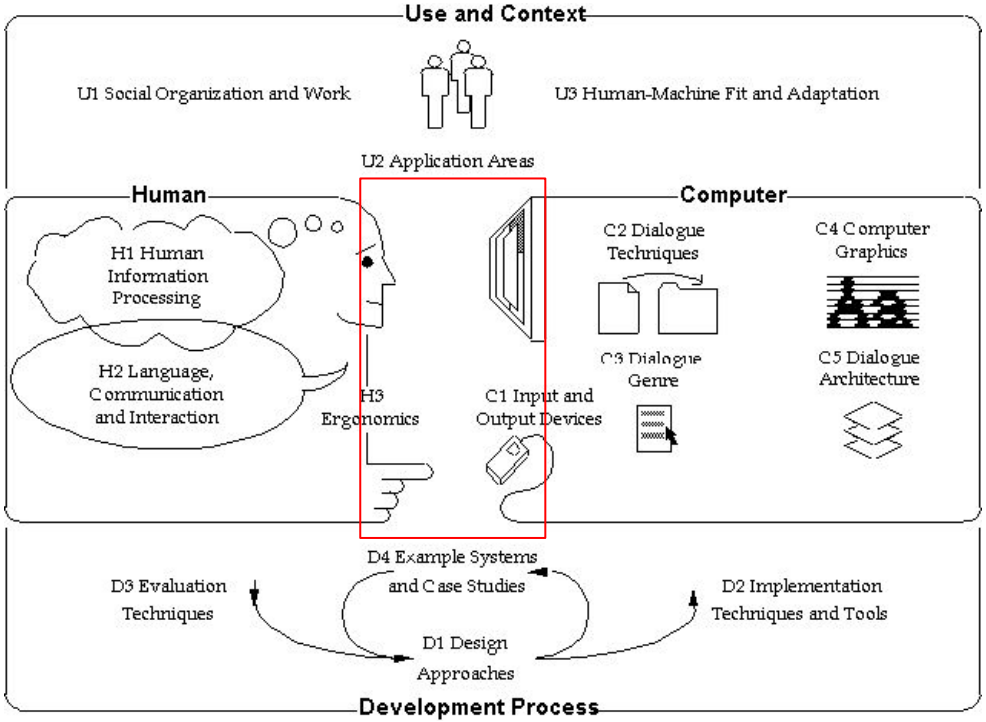


Amal Aboulhassan

Image By Alizila Staff

Last Lecture

- Design Heuristics and Principles

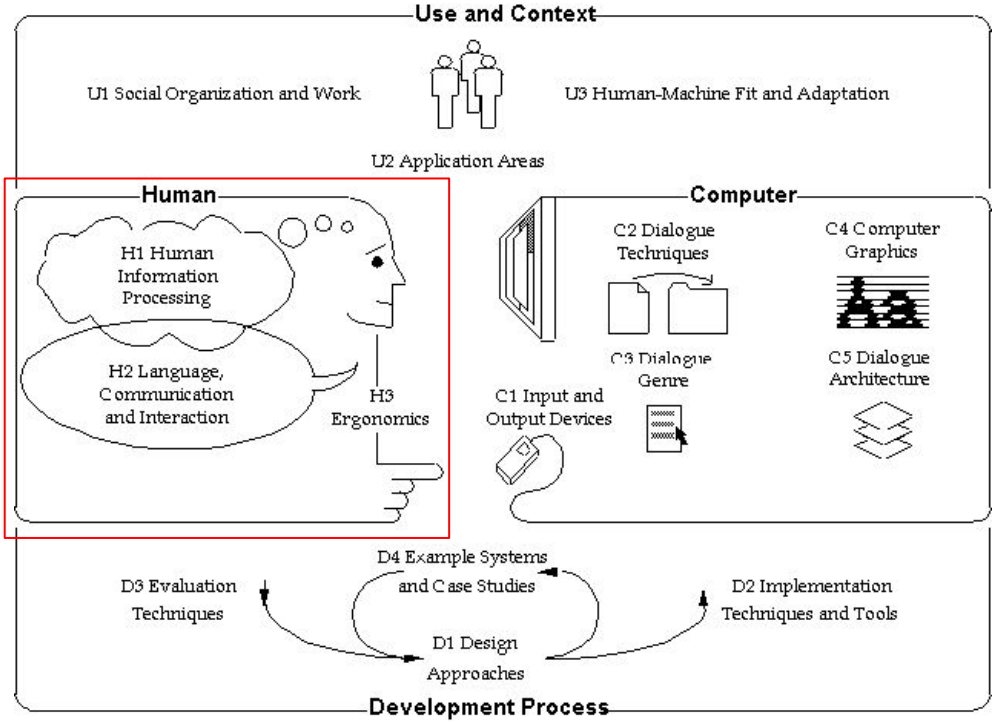


http://grouplab.cpsc.ucalgary.ca/saul/hci_topics/taxonomy.html

adapted from Section 2 of the ACM SIGCHI Curricula for HCI, ACM Press, 1992.

In this lecture

- Human:
  - Senses
  - Cognitive Processes
    - Perception
    - Attention
    - Memory
    - Learning
    - Reading, speaking and listening
    - Problem-solving, planning, reasoning and decision-making



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Human Information Processing





see
hear
taste
touch
Smell

perception → cognition → action

Motor system

Human Senses

Why we need to study human senses

- To know the human capabilities and limitations and put this in mind in our design.
- This is relevant to Ergonomics
- Ergonomics in HCI (Human-Computer Interaction)
  - Involves designing computer systems and interfaces to optimize user comfort, efficiency, and safety.
  - It focuses on creating user-friendly designs that consider human capabilities, limitations, and preferences, ultimately enhancing the overall user experience.
  - Ergonomics aims to prevent discomfort and injury by designing interactions that fit the user's physical and cognitive capabilities

- The principles include:
  - Usability: how well users can use the system's functionality
  - Learnability: how easy is it to learn?
  - Efficiency: once learned, how quickly can it be used?
  - Safety: are errors few and recoverable?
  - Accessibility
  - Aesthetics, minimalism
  - Ergonomics
  - Expressivity, flexibility
  - Malleability, control

Senses

- Main senses that are involved in HCI system nowadays are: seeing, hearing, touching, and motor activities

Mainly, we need to be aware of

- The limitations of the human senses
- The possible exceptions, such as:
  - Color blindness
  - Deafness
  - Weak joints
  - Etc.

Seeing and Hearing

- Senses of humans are limited: only a range of wavelengths we can see and a range of Hz we can hear

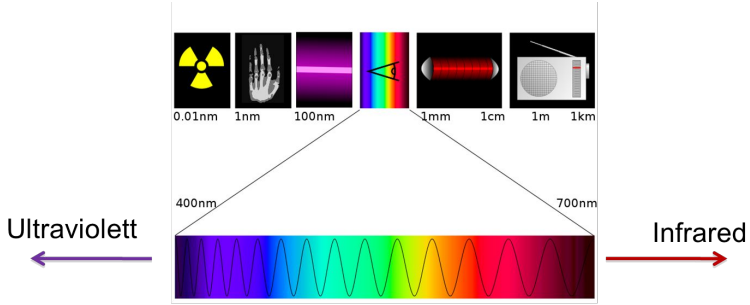


Image Source https://commons.wikimedia.org/wiki/File:Spectre.svg by Tatoute and Phrood

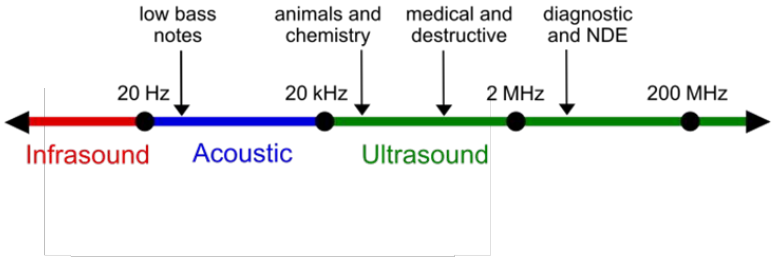
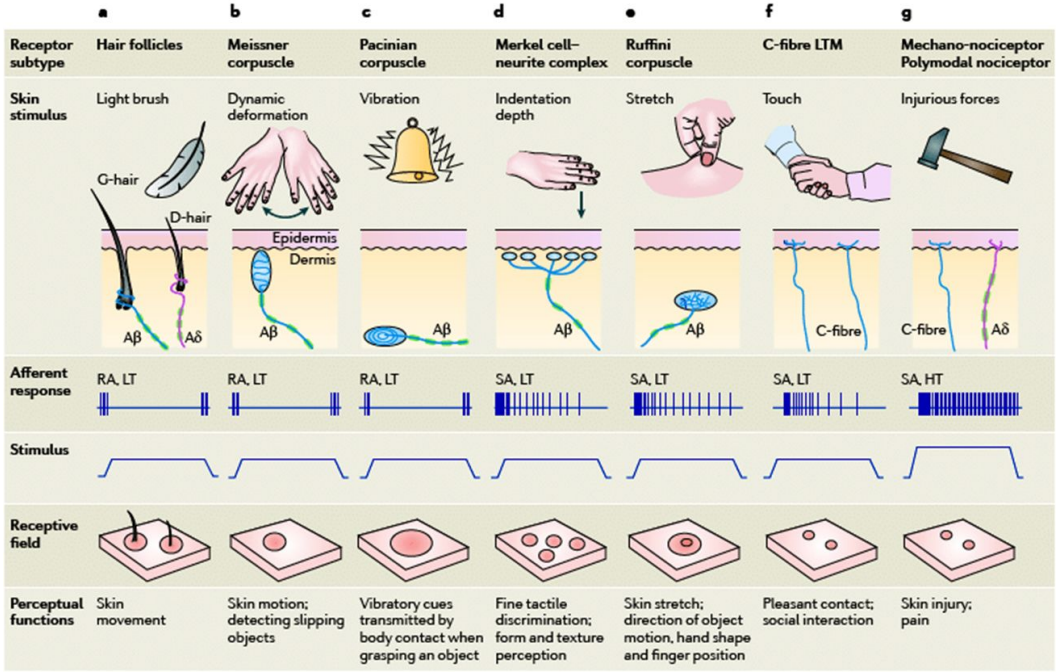


Image Source https://commons.wikimedia.org/wiki/File:Standing.gif by Daniel A. Russell & https://commons.wikimedia.org/wiki/File:Ultrasound_range_diagram.svg by Mikhail Ryazanov

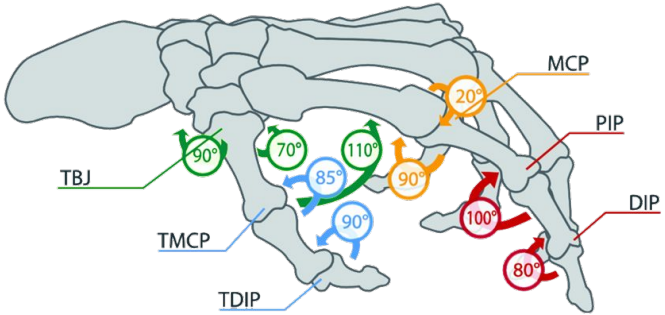
Haptics

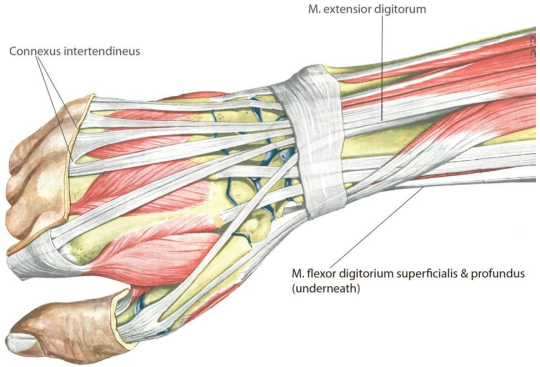
- Haptic perception: active exploration of surfaces and objects by a moving subject, as opposed to passive contact by a static subject during tactile perception.
- Haptic technology: creates an experience of touch by applying forces, vibrations, or motions to the user.

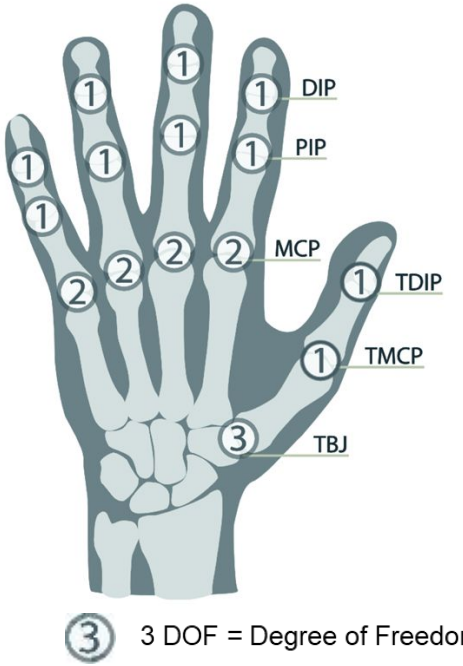


Suslak, Thomas. (2015). There and back again: a stretch receptor's tale. Thesis, https://www.researchgate.net/publication/292449835_There_and_back_again_a_stretch_receptor's_tale
Weber, E. H. (1851). Die Lehre vom Tastsinne und Gemeingefühle auf Versuche gegründet. Friedrich Vieweg und Sohn
Gabriel Robles-De-La-Torre. "International Society for Haptics: Haptic technology, an animated explanation". Isfh.org. Archived from the original on 2010-03-07. Retrieved

Motor System





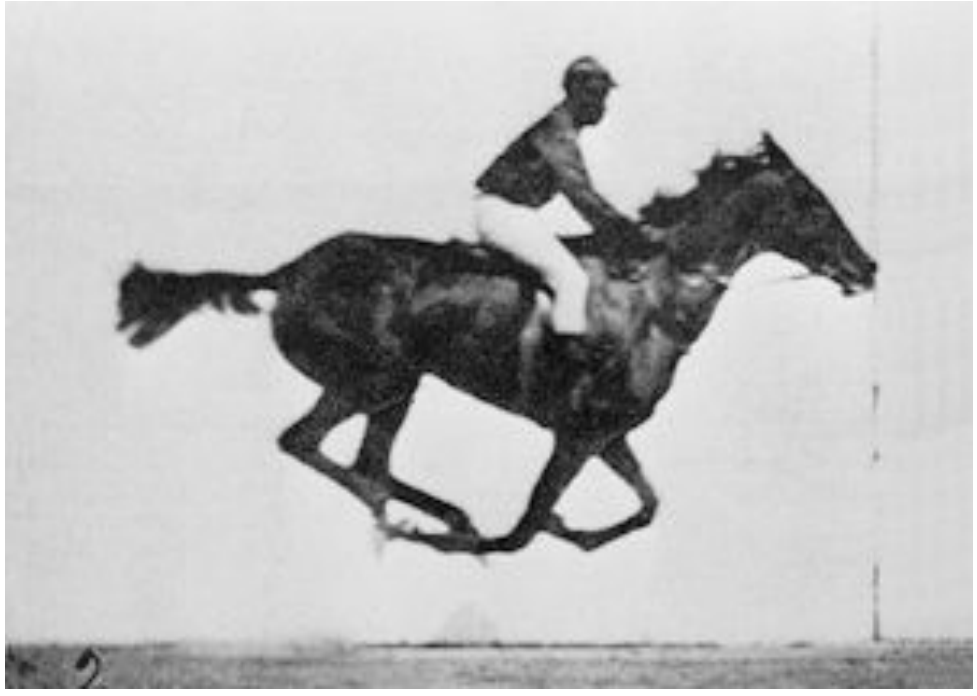


3 DOF = Degree of Freedom

Image Source Katrin Wolf, Markus Schneider, John Mercouris and Christopher-Eyk Hrabia: Biomechanics of Front- and Back-of-Tablet Pointing with Grasping Hands. International Journal of Mobile Human Computer Interaction

Sensory Perception: Motion Perception

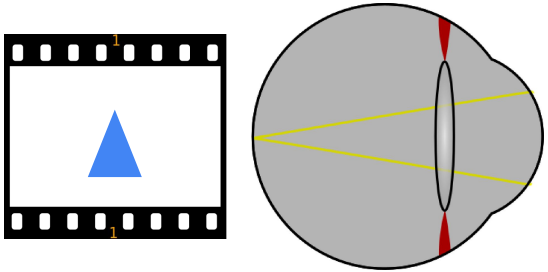
Motion perception is the ability of the nervous system to discern the distance and speed of a moving object in relation to the eye that is seeing the object.

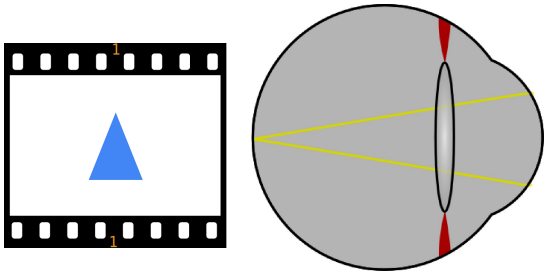


https://www.wondriumdaily.com/motion-perception/

https://en.wikipedia.org/wiki/Eadweard_Muybridge

Sensory Perception: Depth





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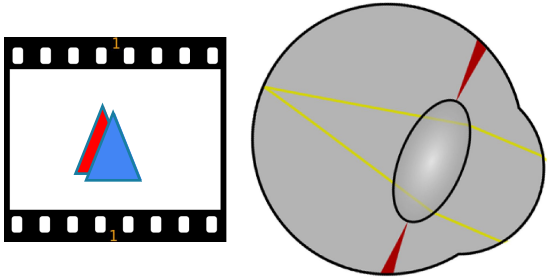
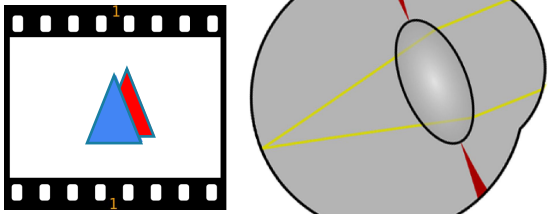
Sensory Perception: Depth





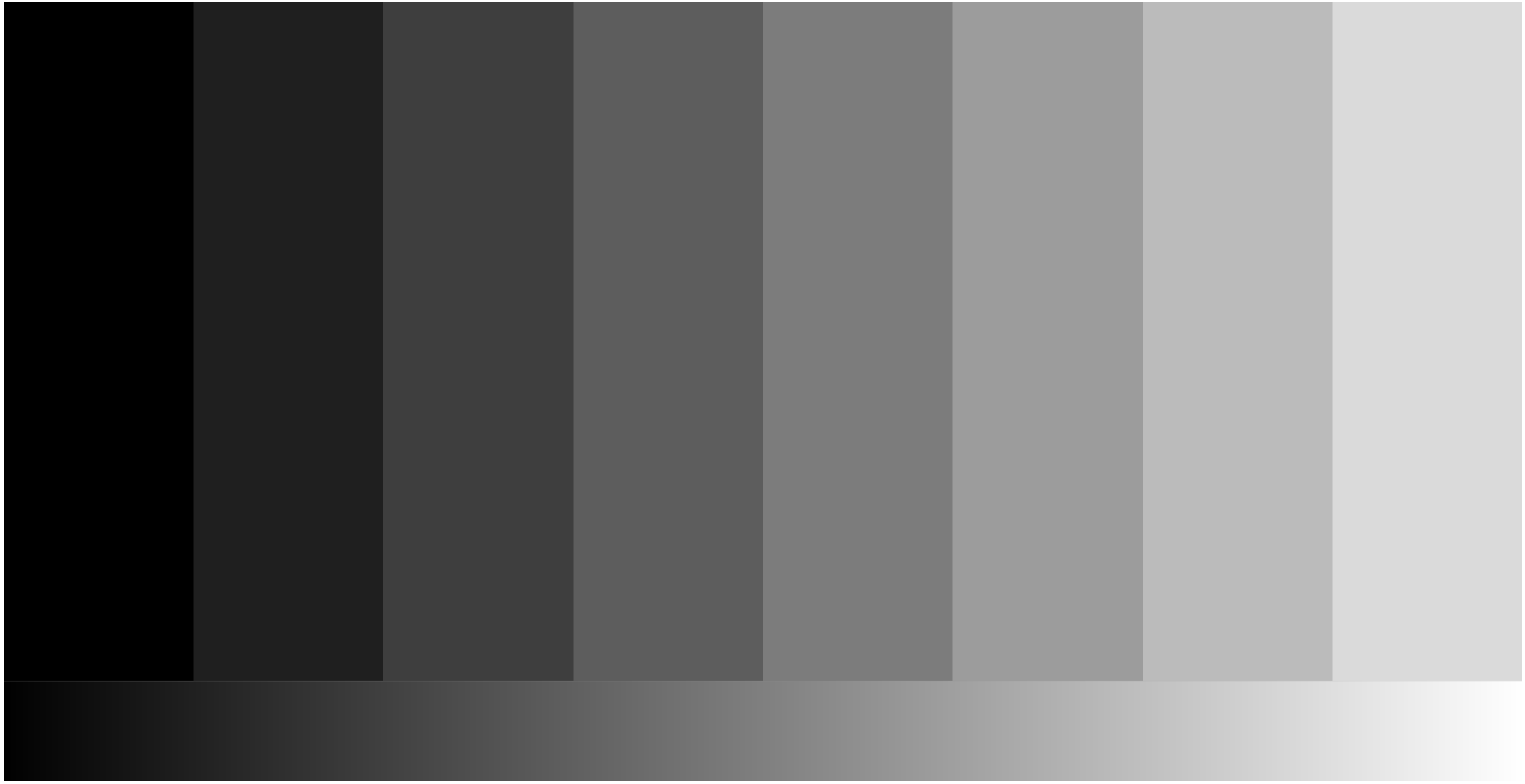
https://commons.wikimedia.org/wiki/File:Film_strip.svg

Cognitive Processes: Perception

Sensory and Cognitive Perception

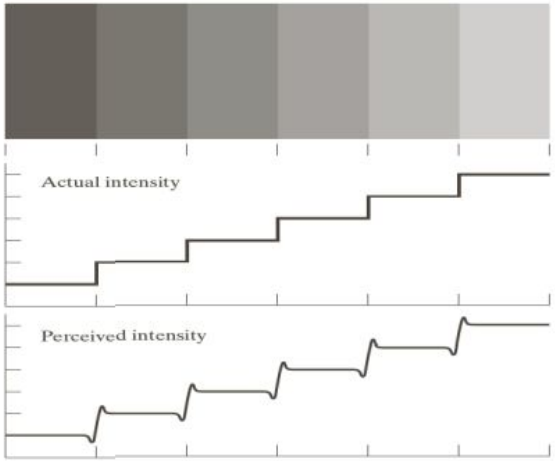
- While sensory perception is more relevant to the biology of the human, cognitive perception is relevant to the brain part.

Exercise: The rectangles are curvy or flat?



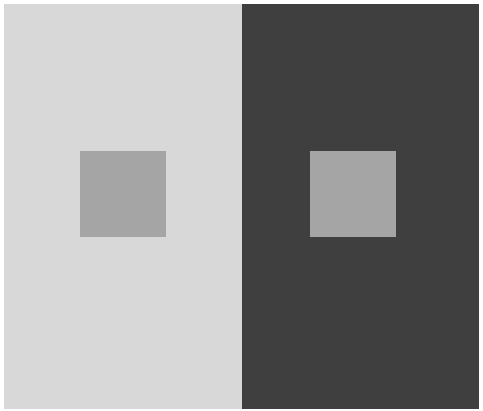
Edge intensification: Mach Band Effect

- Stimuli are pre-processed in the neuronal networks of the retina
- Example: edge intensification shown in Mach's bands



https://cs.stackexchange.com/questions/117497/mach-band-effect

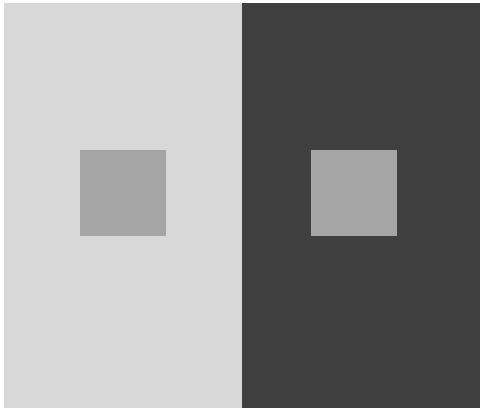
Exercise: Which small rectangle is darker?



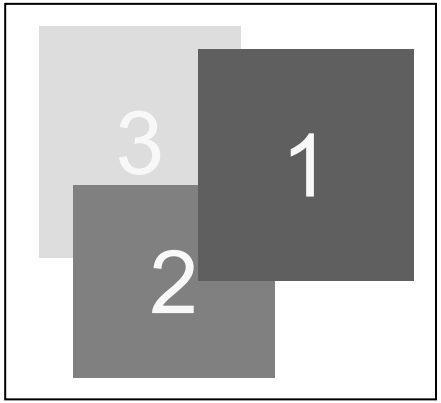
Exercise: Which small rectangle is darker?

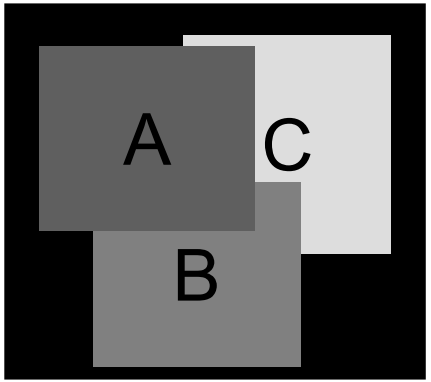
Edge Detection through Contrast Intensification

- Simultaneous contrast:
  - Two colors, side by side, interact with one another and change our perception accordingly.
  - The effect of this interaction is called simultaneous contrast
  - Since we rarely see colors in isolation, simultaneous contrast affects our sense of the color that we see



Simultaneous contrast

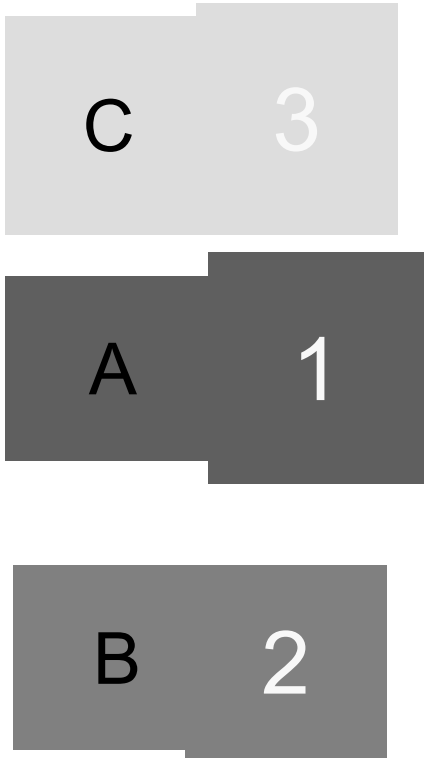




Adapted from Katrin Wolf slides

Simultaneous contrast

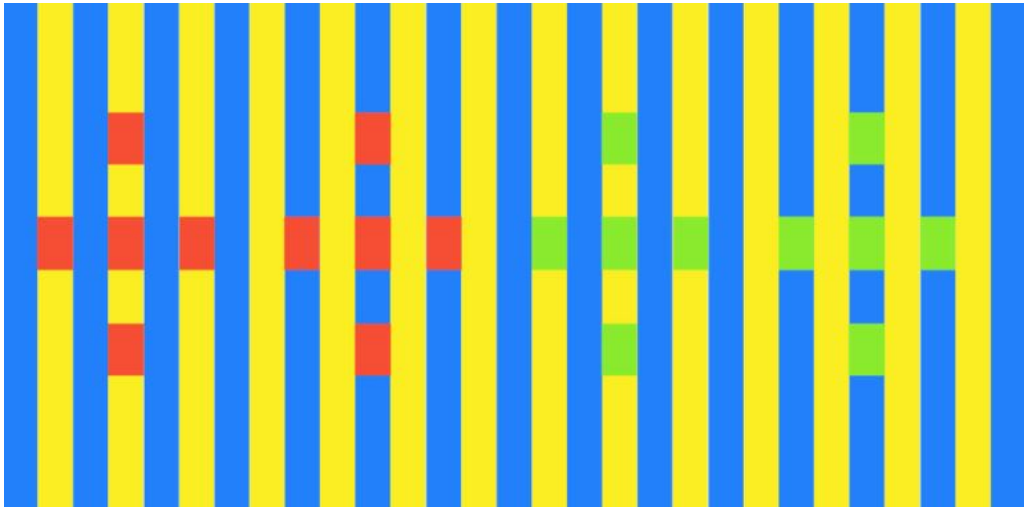
- Also simultaneous contrast



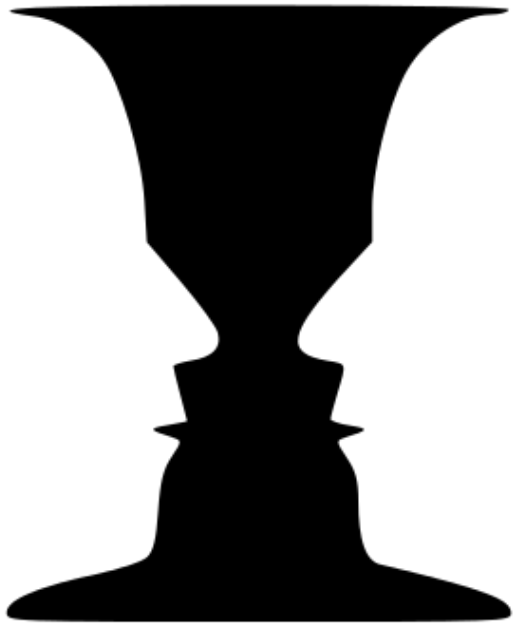
Simultaneous contrast: Also in Colors

All Reds are same

All greens are same

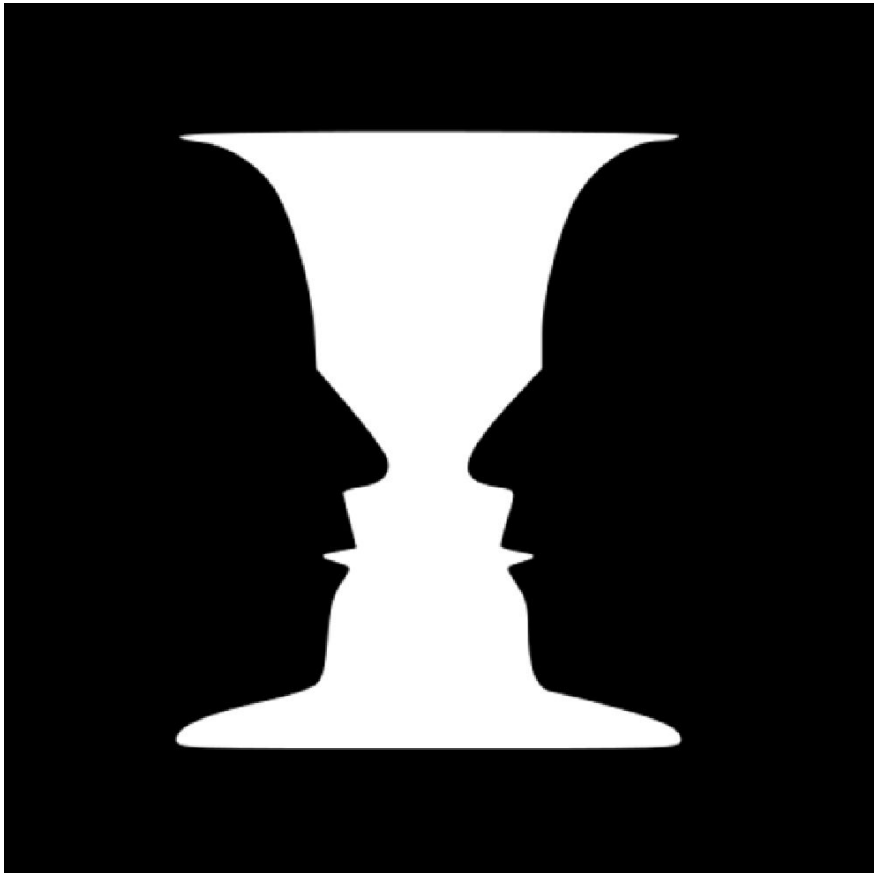


Exercise: Explain the object you see in this figure



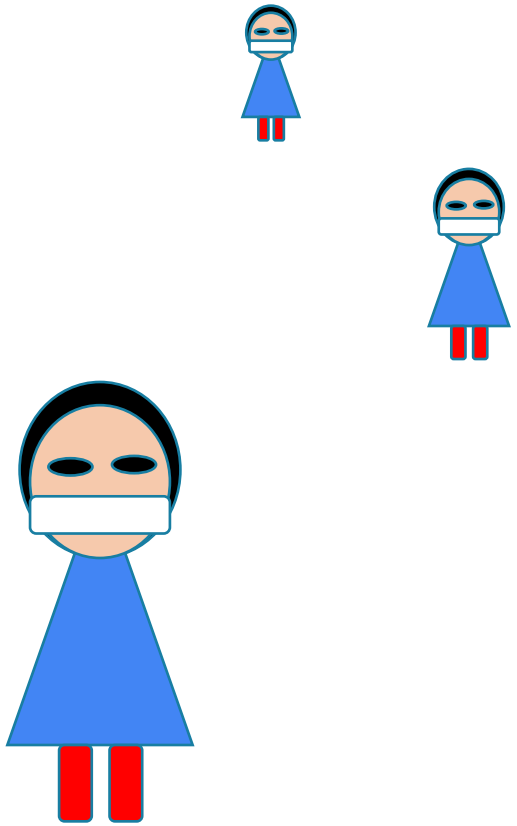
Background/Foreground

- Every human either perceives the photo based on the foreground, background, or both.



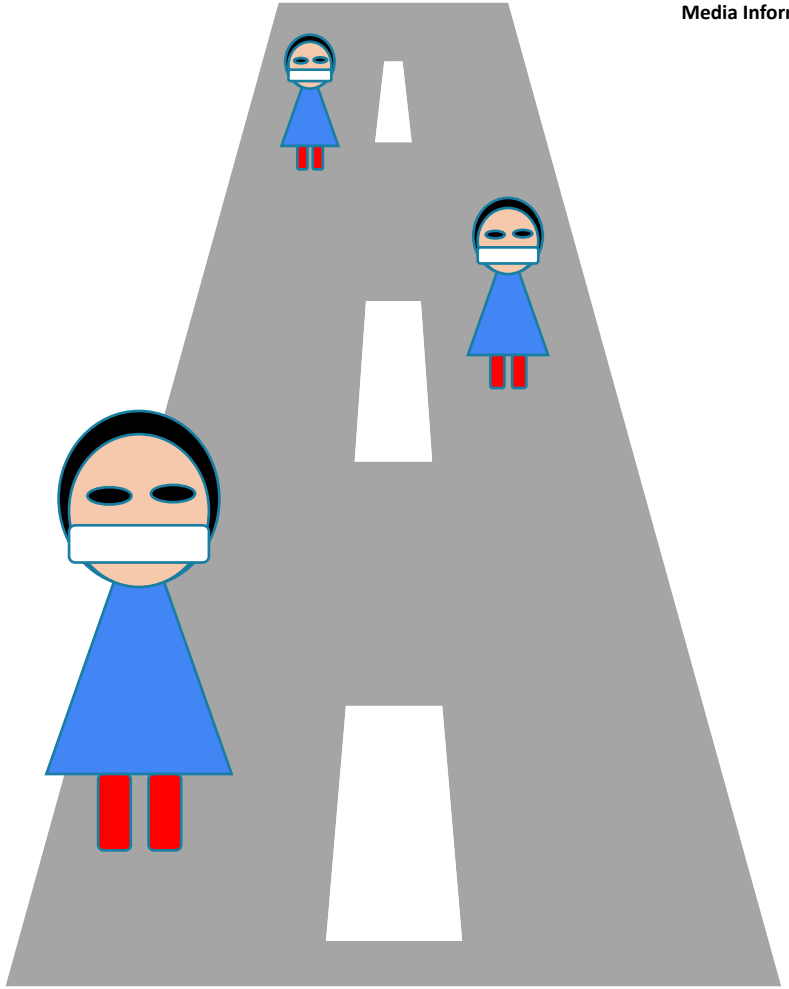
Exercise

- Let’s see how we can design different backgrounds for this figure to allow the perception of different cues
- Describe the figure



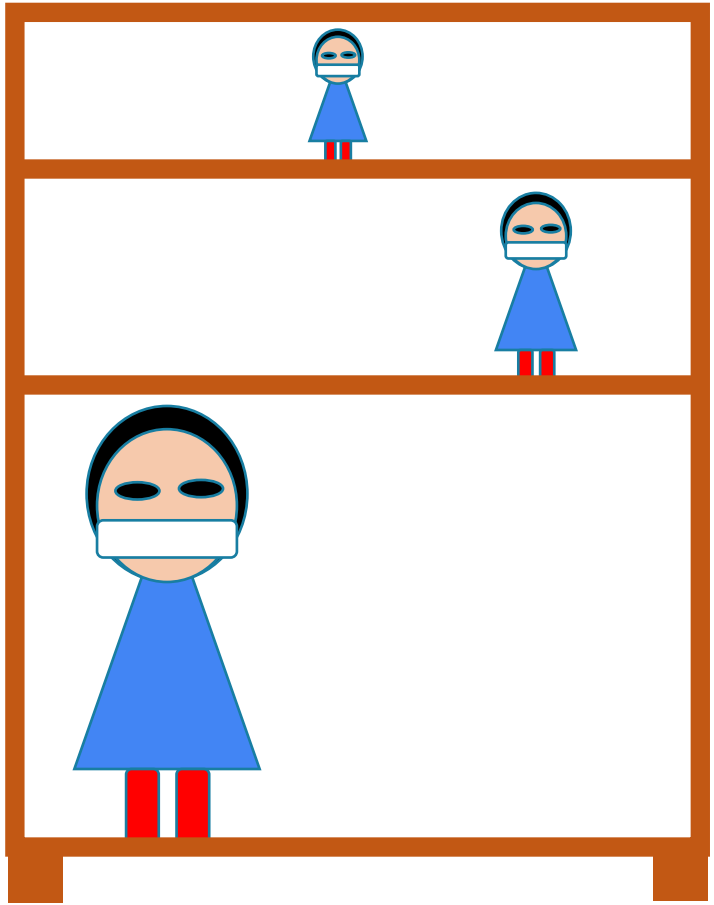
Exercise

- Let’s see how we can design different backgrounds for this figure to allow the perception of different cues
- Describe the figure
- We added “Depth”



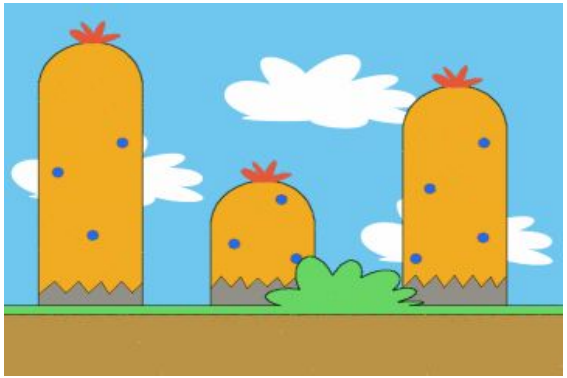
Exercise

- Let’s see how we can design different backgrounds for this figure to allow the perception of different cues
- Describe the figure
- We added some order



Exercise

- Which objects are in the front and which are in the back?
- Why?



//www.flickr.com/photos/cadampol/2297308960

Check this design example

- Applying Parallax in web and mobile applications to give a sense of depth for the foreground/background. Examples
  - https://www.wix.com/studio/blog/parallax-scrolling?utm_source=google&utm_medium=cpc&utm_campaign=20954991241^160638040049^search%20-%20us&experiment_id=^^689640761926^&gad_source=1&gclid=Cj0KCQjw3vO3BhCqARIsAEWblcCng0jBvjpQKdlXdylW4OBaGjmpAqOOX8sBdkBAlboHhEkC4KQnwCsaAhnuEALw_wcB

Depth Perception Vs. Depth Cues

- Depth perception (from the eye and the brain)
  - Binocular disparity:
    - refers to the difference in image location of an object seen by the left and right eyes, resulting from the eyes' horizontal separation (parallax)
  - Vergence:
    - the simultaneous movement of both eyes in opposite directions to obtain or maintain single binocular vision.
  - Accommodation:
    - Accommodation refers to the ability of the eye to adjust its optical power to keep an object in focus as the object moves various distances from the eye

- Depth cues (from the environment and physics around)
  - Occlusion
  - Increased size over distance
  - Shadows
  - Atmospheric Lightning
  - Perspectives
  - Texture gradient (distortion over distance)
  - Motion parallax

Design Implications for Perception

- Icons should enable users to distinguish their meaning readily
- Bordering and spacing are effective visual ways of grouping information
- Sounds should be audible and distinguishable
- Research proper color contrast techniques when designing an interface:
- Yellow on black or blue is fine
- Yellow on green or white is a no-no
- Haptic feedback should be used judiciously

Cognitive Processes: Memory

Attention

- Helps us to select things on which to concentrate 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
- Enables us to be selective in terms of the mass of competing stimuli, but limits our ability to keep track of all events
- In design, to enhance attention, we need to:
  - Involves audio and/or visual senses
  - Understand Focused and divided attention
  - Structure Information at the interface to capture users' attention, for example, use perceptual boundaries (windows), color, reverse video, sound, and flashing lights
- What else?

Exercise

- Let's start a stopwatch
- Find the price for a double room at the Quality Inn in Pennsylvania
- How many seconds?

Pennsylvania
Bedford Motel/Hotel: Crinaline Courts
(814) 623-9511 S: $118 D: $120
Bedford Motel/Hotel: Holiday Inn
(814) 623-9006 S: $129 D: $136
Bedford Motel/Hotel: Midway
(814) 623-8107 S: $121 D: $126
Bedford Motel/Hotel: Penn Manor
(814) 623-8177 S: $119 D: $125
Bedford Motel/Hotel: Quality Inn
(814) 623-5189 S: $123 D: $128
Bedford Motel/Hotel: Terrace
(814) 623-5111 S: $122 D: $124
Bradley Motel/Hotel: De Soto
(814) 362-3567 S: $120 D: $124
Bradley Motel/Hotel: Holiday House
(814) 362-4511 S: $122 D: $125
Bradley Motel/Hotel: Holiday Inn
(814) 362-4501 S: $132 D: $140
Breezewood Motel/Hotel: Best Western Plaza
(814) 735-4352 S: $120 D: $127
Breezewood Motel/Hotel: Motel 70
(814) 735-4385 S: $116 D: $118

Exercise

- Let's start a stopwatch
- Find the price for a double room at the Quality Inn in Pennsylvania
- How many seconds?

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

Spacing and Grouping enhances the Attention

- Spacing (for the same screen density)
  - In the 1st screen, the information is bunched up together, making it hard to search
  - In the 2nd screen, the characters are grouped into vertical categories of information making it easier
- Tullis (1987) found that the two screens produced quite different results
  - 1st screen: Took an average of 5.5 seconds to search
  - 2nd screen: Took 3.2 seconds to search

How about Multitasking?

- Is it possible to perform multiple tasks without one or more of them being detrimentally affected?
- Multitasking can cause people to lose their train of thought, make errors, and need to start over
- Ophir et al. (2009) compared heavy vs light multitaskers
  - Heavy multitaskers were more prone to being distracted than those who infrequently multitask
  - Heavy multitaskers are easily distracted and find it difficult to filter irrelevant information

Exercise

- Is it OK to use phones while driving?

https://www.lawyernc.com/blog/is-it-illegal-to-talk-on-the-phone-while-driving-in-north-carolina/

Exercise

- Is it OK to use phones while driving?
- NO!

https://www.lawyernc.com/blog/is-it-illegal-to-talk-on-the-phone-while-driving-in-north-carolina/

Exercise

- Driving is very demanding
- Drivers are prone to being distracted
- Drivers' reaction times are longer to external events when talking on the phone in a car (Caird et al., 2018)
- Drivers using their phones rely more on their expectations about what is likely to happen next as conducting a conversation takes up their attention
- Response time is slower to unexpected events (Briggs et al., 2018)
- Drivers often try to imagine what the other person's face is like− the person to whom they are speaking
- Doing so competes with the processing resources needed to enable them to notice and react to what is in front of them

https://www.lawyernc.com/blog/is-it-illegal-to-talk-on-the-phone-while-driving-in-north-carolina/

Exercise

- Are hands-free phones safer to use when driving?

https://www.independent.co.ug/wp-content/uploads/2018/02/MOTORING-1.jpg

Exercise

- No, as same type of cognitive processing is happening when talking
- The same thing happens when talking with front seat passenger
  - But both can stop in mid-sentence if a hazard is spotted allowing the driver to switch immediately to the road
  - So, it's less dangerous talking to a front seat passenger than a remote person
  - A remote person on the end of a phone is not privy to what the driver is seeing and will carry on the conversation when there is a hazard
  - This makes it difficult for the driver to switch all their attention to the road

https://www.independent.co.ug/wp-content/uploads/2018/02/MOTORING-1.jpg

We cannot avoid multitasking in our design

- It is increasingly common for workers to multitask
- For example, hospital workers have to attend to multiple screens in an operating room that provide new kinds of real-time information
- This requires clinician's constant attention to check if any data is unusual or anomalous
- Need to develop new attention and scanning strategies

Design Implications for Attention

- Context:
  - Make information salient when it needs to be attended to at a given stage of a task
  - For example, color, ordering, spacing, underlining, sequencing, and animation
- Avoid cluttering visual interfaces with too much information
- Consider designing different ways to support effective switching and returning to an interface

Cognitive Processes: Memory

Exercise

- Try to remember the dates of your grandparents' birthday
- Try to remember the cover of the last two books you read
- Which was easiest? Why?

Recall Vs. Recognition

- People are very good at remembering visual cues about things
- For instance, the color of items, the location of objects and marks on an object
- They find it more difficult to learn and remember arbitrary material
- For example, birthdays and phone numbers

Recall Vs. Recognition

- Command-based interfaces require users to recall from memory a name from a possible set of 100s of names
- Graphical interfaces provide visually-based options (menus, icons) that users need only browse through until they recognize one
- Web browsers provide tabs and history lists of visited URLs that support recognition memory

Problem 1: Personal Information management

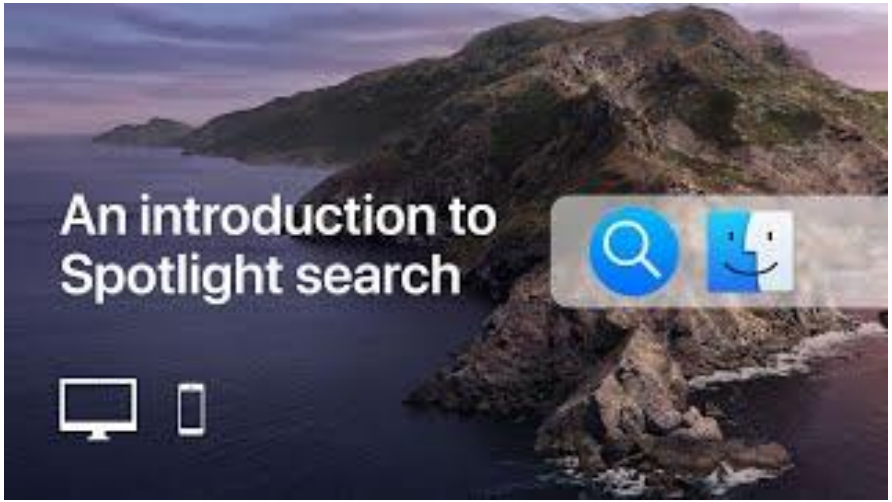
- Is a growing problem for many users:
  - They accumulate a vast numbers of documents, images, music files, video clips, emails, attachments, bookmarks, and so forth
- User challenges:
  - Where and how to save them all; then remembering what they were called and where to find them again
  - Naming most common means of encoding them. But can be difficult to remember, especially when you have 10,000s
- How might such a process be facilitated taking into account people's memory abilities?

Problem 1: Personal Information management

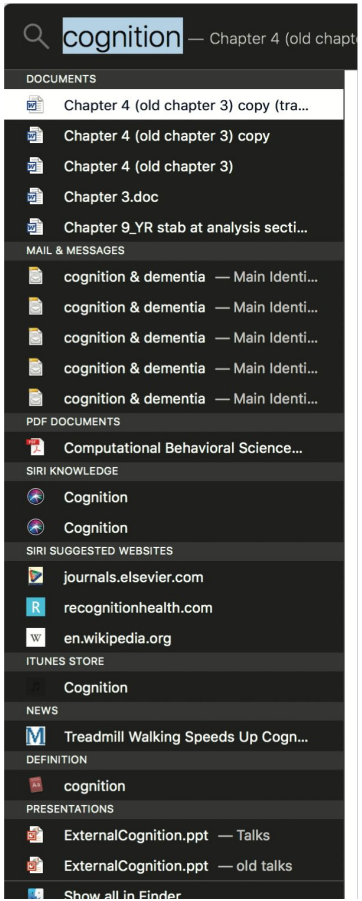
- Bergman and Whittaker, three interdependent processes model (2016) to help people manage their stuff:
  - How to decide what stuff to keep
  - How to organize it when storing
  - Which strategies to use to retrieve it later
- Methods:
  - Folders and naming
  - Scanning across and within folders when looking for something
  - Search engines only helpful if you know the name of the file
  - Smart search engines help with listing relevant files for partial name or when type in first letter

Personal Information management: Case Study

- Example:
  - Apple's Spotlight search tool



https://youtu.be/Hb-v9h28ybg



Case Study: Problem for people who suffer from Dementia

- SenseCam:
  - developed by Microsoft Research Labs (now Autographer)
- A wearable device that intermittently takes photos without any user intervention while worn
- Digital images taken are stored and revisited using special software
- Has been found to improve people's memory, especially those suffering from dementia
- Other aids include RemArc, which triggers long-term memory using old BBC materials

https://youtu.be/fSgPHcRZHwE

Case Study: Problem for people who suffer from Dementia

- This device is nice to allow people to remember using visual aids. But what do you think other limitations that can worsen the user experience?

Case Study: Problem for people who suffer from Dementia

- Browsing:
  - Huge of captured images
  - On solution, navigate using a slide bar and a speed scroller but not a good solution
- Privacy of other people around
- Storage
- Better solutions:
  - Using AI: classification
  - Try this: classification by face in your mobile

Design Implications for Memory

- Reduce cognitive load by avoiding long and complicated procedures for carrying out tasks
- Design interfaces that promote recognition rather than recall
- Provide users with various ways of labelling digital information to help them easily identify it again
    - For example, folders, categories, color, flagging, and time stamping

Class Activity

- In the diamond painting kit:
  - Why they are doing coding for the colors? They did not let the user search by color?
  - Why there are different coding schemes for the colors? (Numbers and Letters)?
  - Why the color coding panel is repeated twice?
  - Can you spot one potential problem for the current color coding?

Cognitive Frameworks

Cognitive Frameworks

- These are 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
- Most well known are:

  1- Mental models

  2- Gulfs of execution and evaluation

  3- Distributed cognition

  4- External and embodied cognition

1- Mental Models

- Lots of people hit the button for elevators and pedestrian crossings at least twice
  - Why? Think it will make the lights change faster or ensure that the elevator arrives!

1- Mental Models

- Users develop an understanding of a system through learning and inferences
- In the previous example, they are following the “more is more” mental model. Which is not always correct
- Most of us have erroneous mental models (Kempton, 1996)
- Mental models users have for understanding are usually:
  - Poor, often incomplete, easily confusable, based on inappropriate analogies and superstition (Norman, 1983)

Mental Models: Example

1. You arrive home on a cold winter's night to a cold house. How do you get the house to warm up as quickly as possible? Set the thermostat to be at its highest or to the desired temperature?
2. You arrive home starving hungry. You look in the fridge and find all that is left is an uncooked pizza. You have an electric oven. Do you warm it up to 375 degrees first and then put it in (as specified by the instructions) or turn the oven up higher to try to warm it up quicker?

Exercise

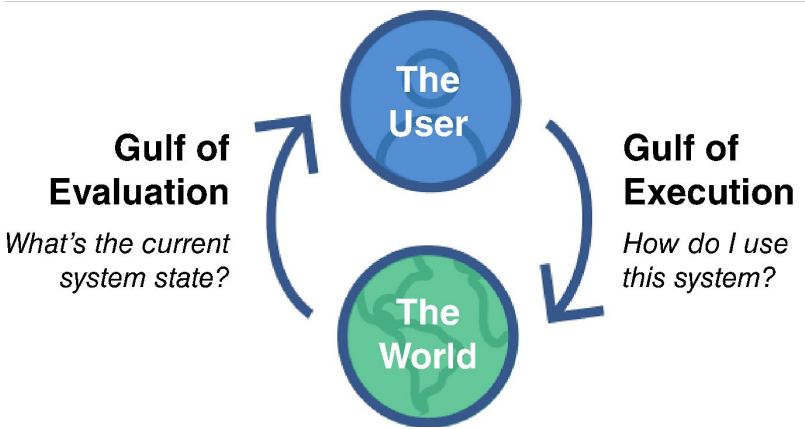
- Many people when asked (1) choose the first option
- Why?
  - They think it will heat the room up quicker
  - General valve theory, where ‘more is more’ principle is generalized to different settings (for instance, gas pedal, gas cooker, tap, radio volume)
  - But it is a wrong mental model for thermostats based on on-off switch model
- Many people when asked (2) choose the first option
  - Electric ovens work on the same principle as thermostats
- Most of us have erroneous mental models (Kempton, 1996)

How can UX be designed to help people build better mental models?

- Clear and easy to use instructions
- Appropriate tutorials and contextual sensitive guidance
- Provide online videos and chatbot windows when needing help
- Transparency: to make interfaces intuitive to use
- Affordances of what actions an interface allows
- For example, swiping, clicking, or selecting

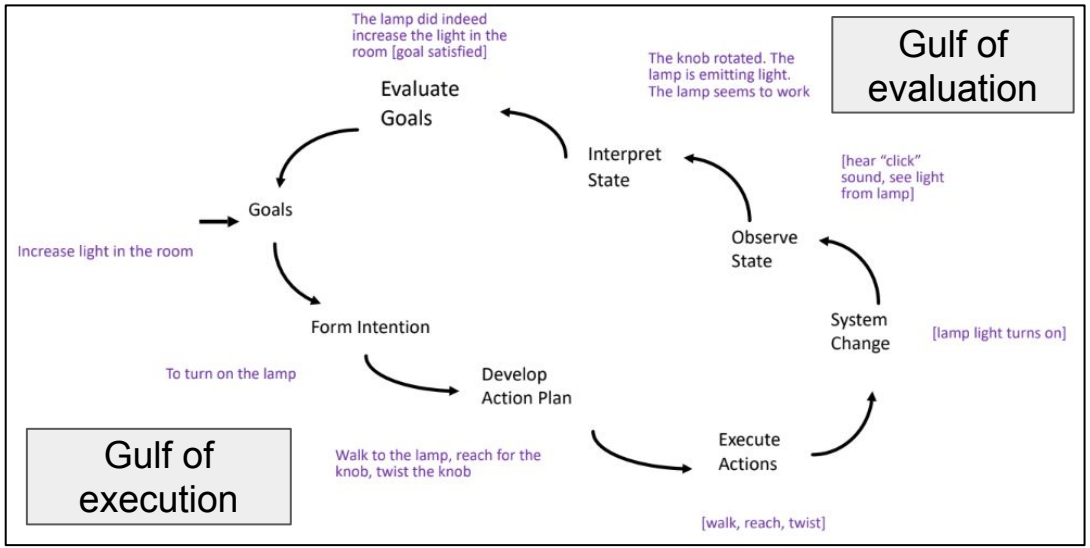
2- Gulfs of Execution and Evaluation

- The ‘gulfs’ explicate the gaps that exist between the user and the interface
- The gulf of execution
  - The distance from the user to the physical system
- The gulf of evaluation
  - The distance from the physical system to the user
- Bridging the gulfs can reduce cognitive effort required to perform tasks
- Can reveal whether interface increases or decreases cognitive load and whether it is obvious what to do next (Norman, 1986; Hutchins et al, 1986)



2- Gulfs of Execution and Evaluation

- Think of a scenario where gulf of execution and gulf of evaluation gap is big
  - For example taking a selfie.
  - If after clicking nothing happens: this means there is a big gap between execution and evaluation

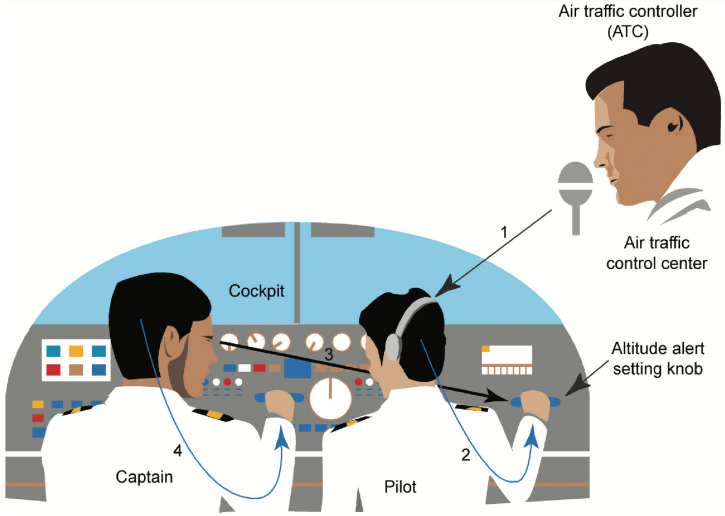


3- Distributed Cognition

- Concerned with the nature of cognitive phenomena across individuals, artifacts, and internal and external representations (Hutchins, 1995)
- Describes these in terms of propagation across representational state
- Information is transformed through different media (computers, displays, paper, heads)

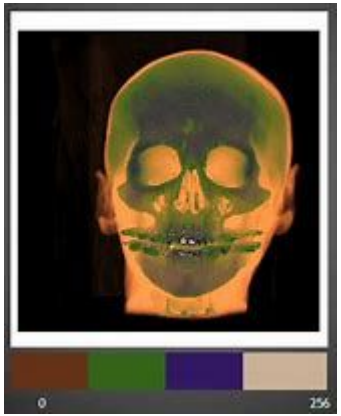
Distributed Cognition: Case Study

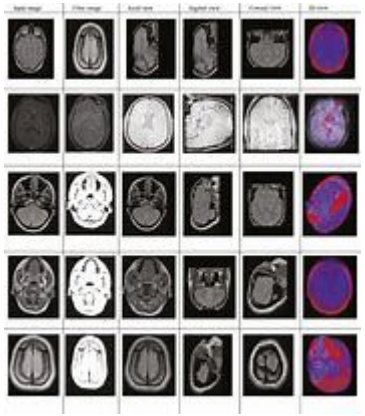
- A cognitive system for ATC
- The flight crew actions, gestures, dialogues, etc.
- What is involved:
  - The distributed problem-solving that takes place
  - The role of verbal and non-verbal behavior
  - The various coordinating mechanisms that are used (for example, rules and procedures)
  - The communication that takes place as the collaborative activity progresses
  - How knowledge is shared and accessed



4- External cognition

- Concerned with explaining how we interact with external representations (such as maps, notes, and diagrams)
- What are the cognitive benefits and what processes involved
- How they extend cognition
- What technologies can we develop to help people carry out complex tasks (for example, learning, problem solving, and decision-making)?
    - One technology: visualization





Some Course Logistics

Grading

- Final Exam: 30%
- Mid-Term: 20%
- Assignments: 20%
  - Theoretical Assignments (Quizzes)
  - Practical Assignments
- Project: 30%

Thank you!

Some Slides adapted from:
www.id-book.com and
Amy Zhang,Paul G. Allen School of Computer Science & Engineering