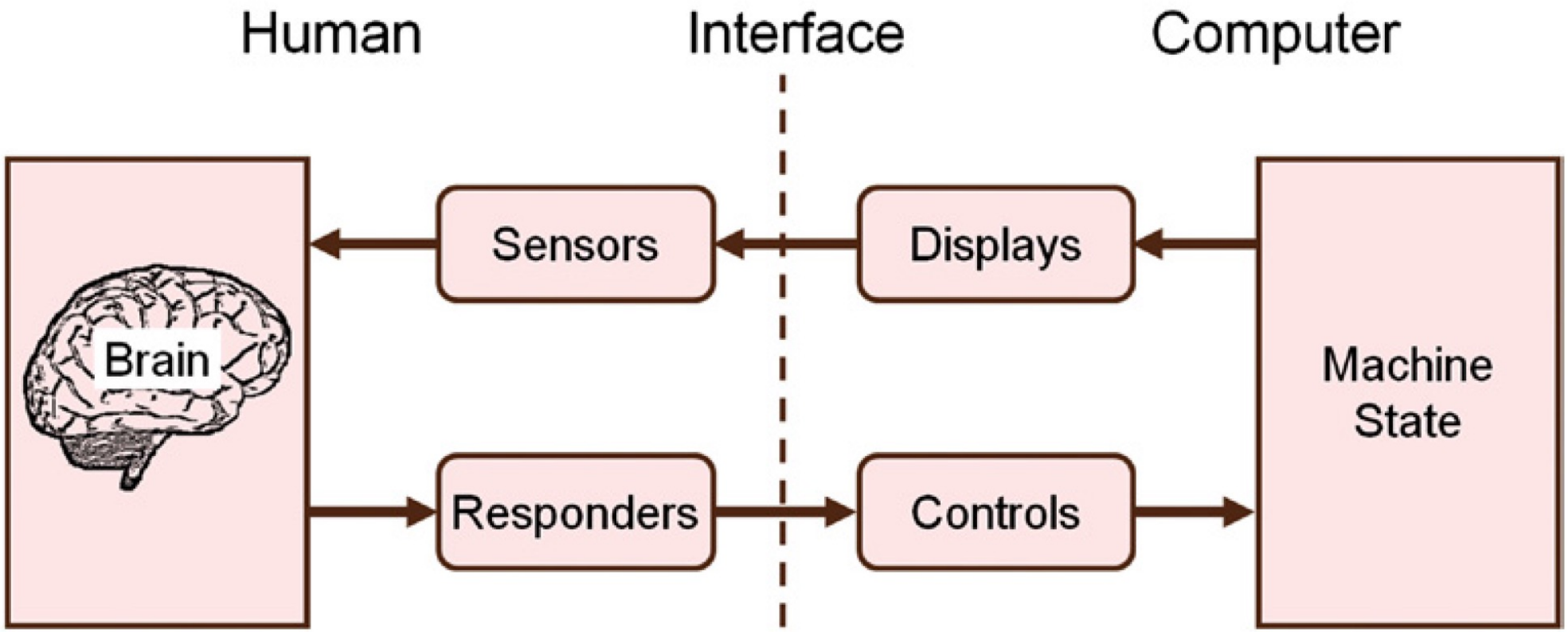
Human Factors 2

CSE333: Introduction to Human-Computer Interaction

Spring 2023

Jaeyeon Lee

Human Factors Model



Kantowitz, B. H., & Sorkin, R. D. (1983).
Human factors: Understanding People-System Relationships

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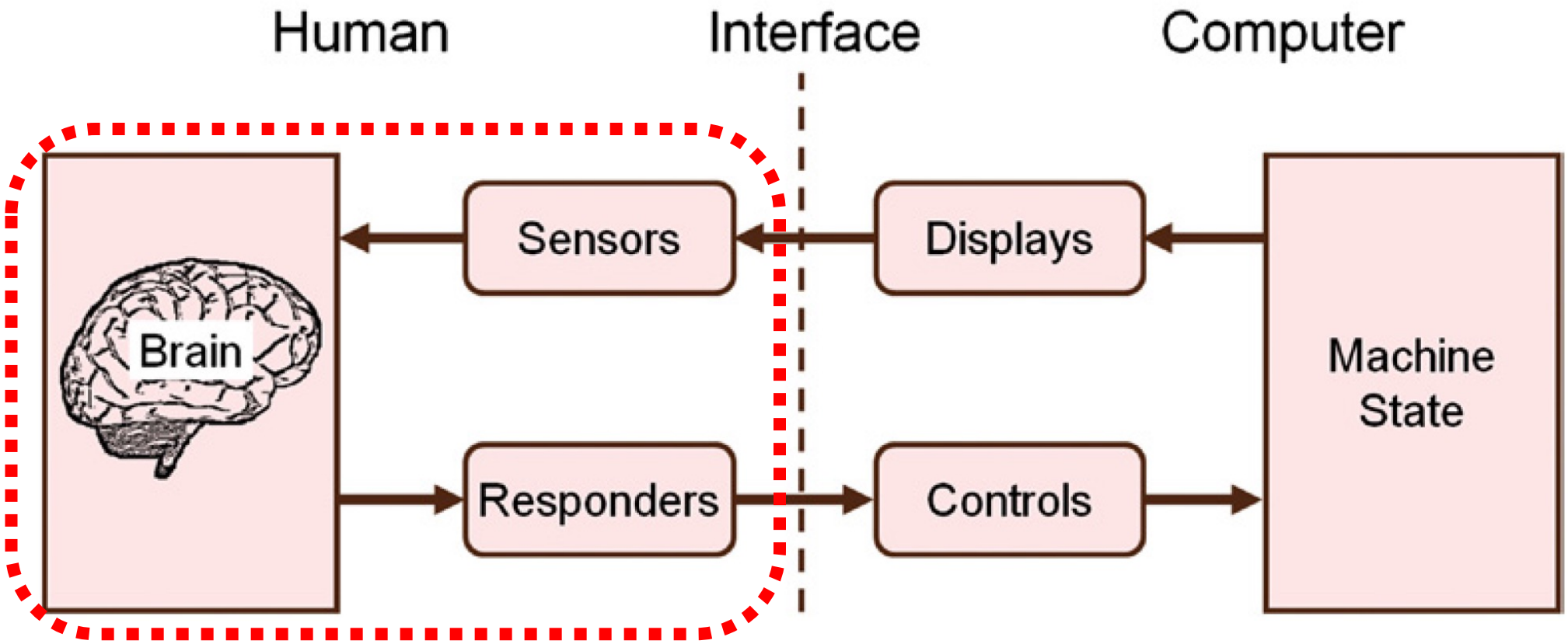

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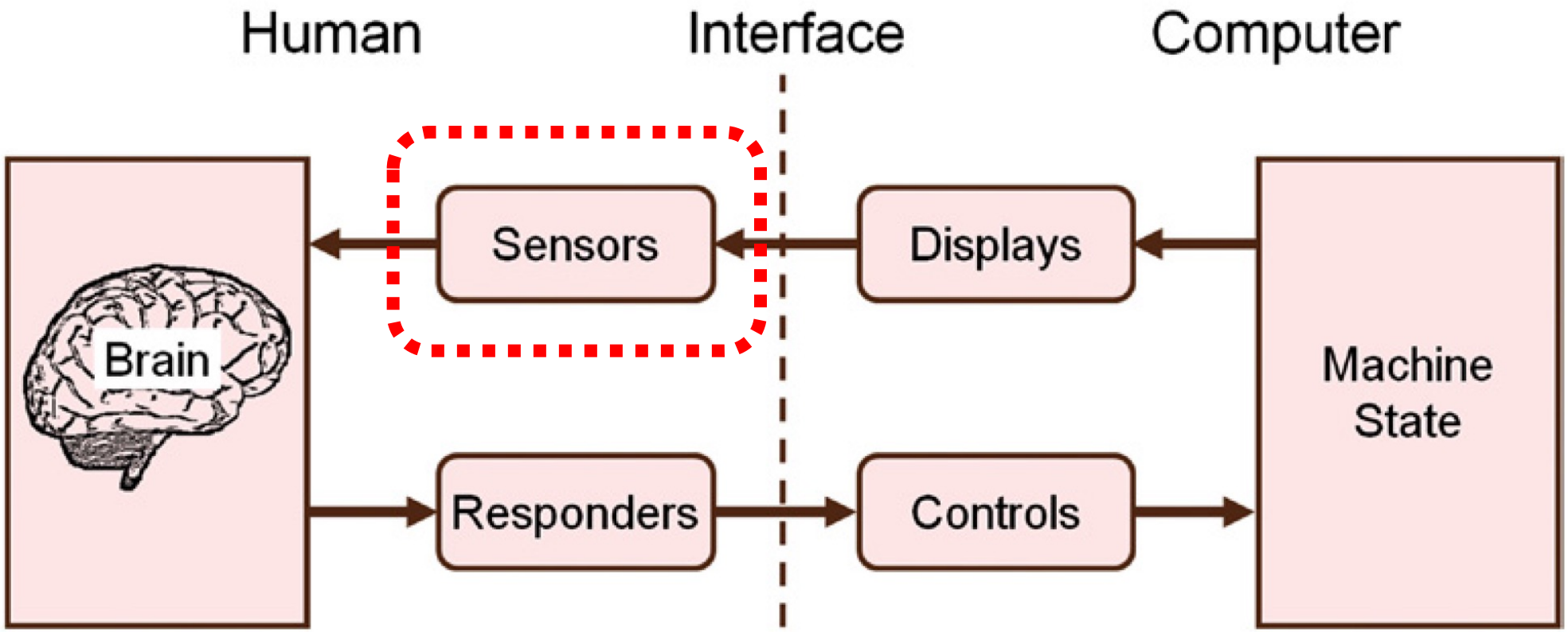

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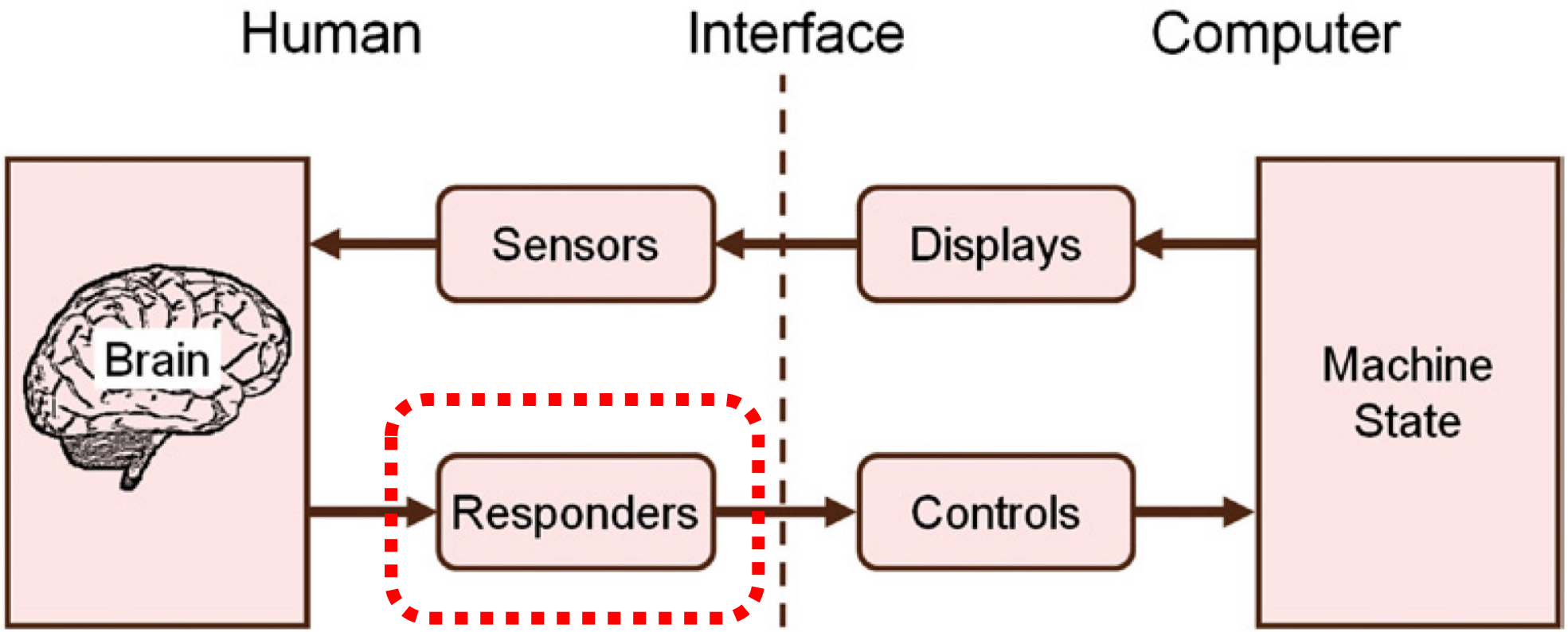
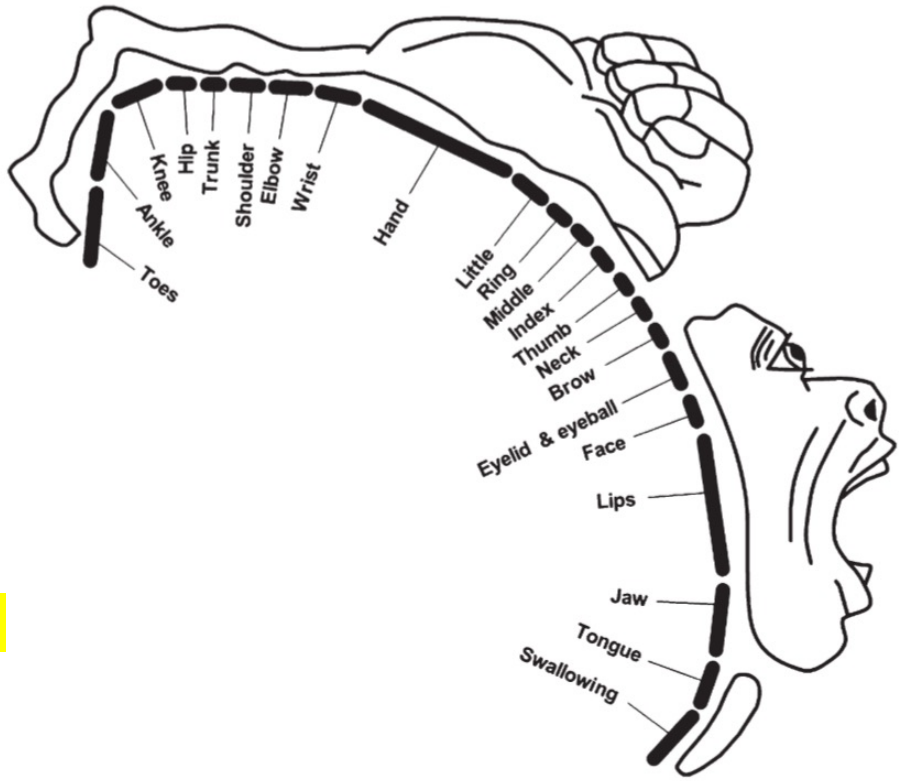


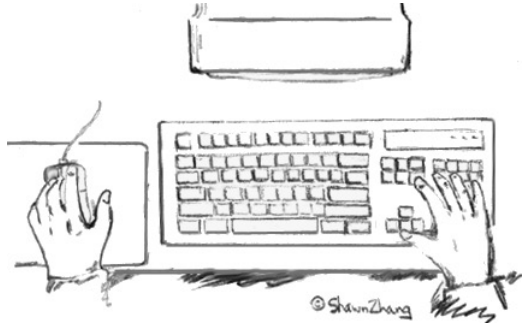
Penfield's Motor Homunculus

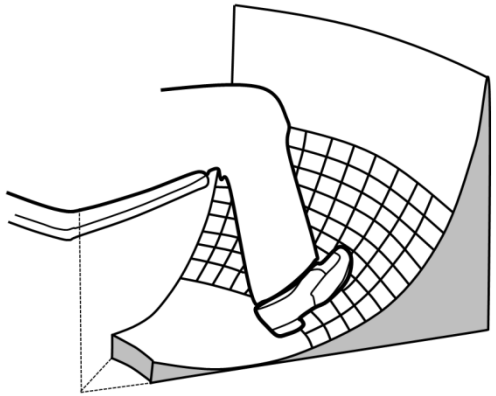
- Relative area of motor cortex dedicated to each human responder



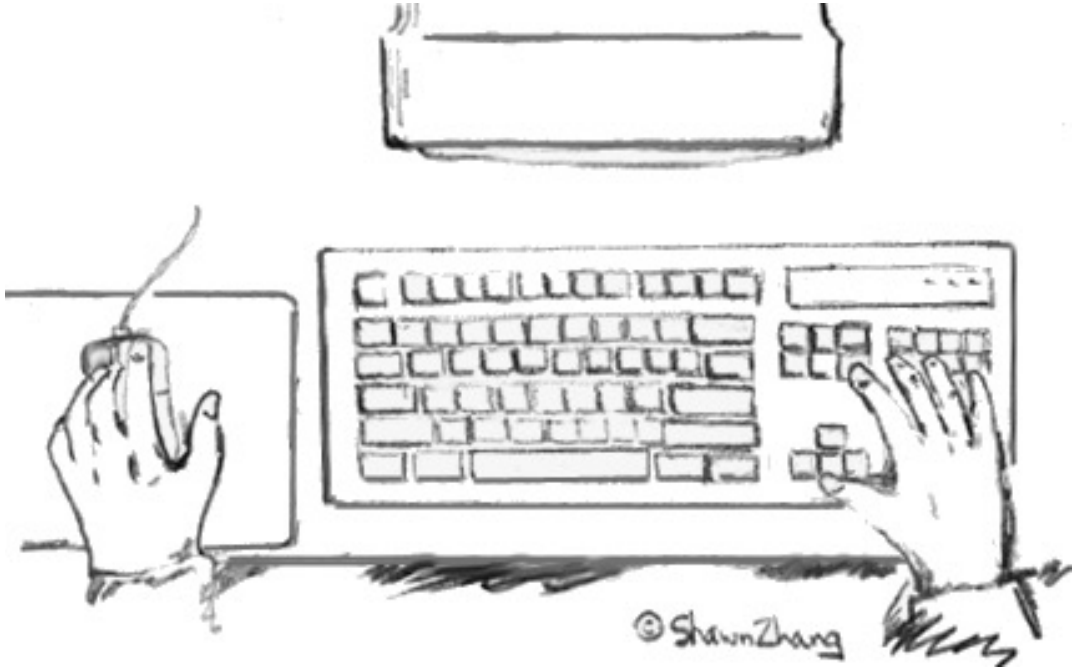
"those groups of muscles having a large area devoted to them are heuristically promising places to connect with input device transducers if we desire high performance"
-Card et al., 1991

Responder Examples





Left-handed? Right-handed?



Edinburgh Handedness Inventory (EHI)

	Left	Right
1. Writing	☐☐	☐☐
2. Drawing	☐☐	☐☐
3. Throwing	☐☐	☐☐
4. Scissors	☐☐	☐☐
5. Toothbrush	☐☐	☐☐
6. Knife (without fork)	☐☐	☐☐
7. Spoon	☐☐	☐☐
8. Broom (upper hand)	☐☐	☐☐
9. Striking a match	☐☐	☐☐
10. Opening box (lid)	☐☐	☐☐
Total (count checks)	☐	☐

Difference	Cumulative Total	**RESULT**
☐	☐	☐

Instructions

Mark boxes as follows:

x	preference
xx	strong preference
blank	no preference

Scoring

Add up the number of checks in the "Left" and "Right" columns and enter in the "Total" row for each column. Add the left total and the right total and enter in the "Cumulative Total" cell. Subtract the left total from the right total and enter in the "Difference" cell. Divide the "Difference" cell by the "Cumulative Total" cell (round to 2 digits if necessary) and multiply by 100. Enter the result in the "RESULT" cell.

Interpretation of RESULT

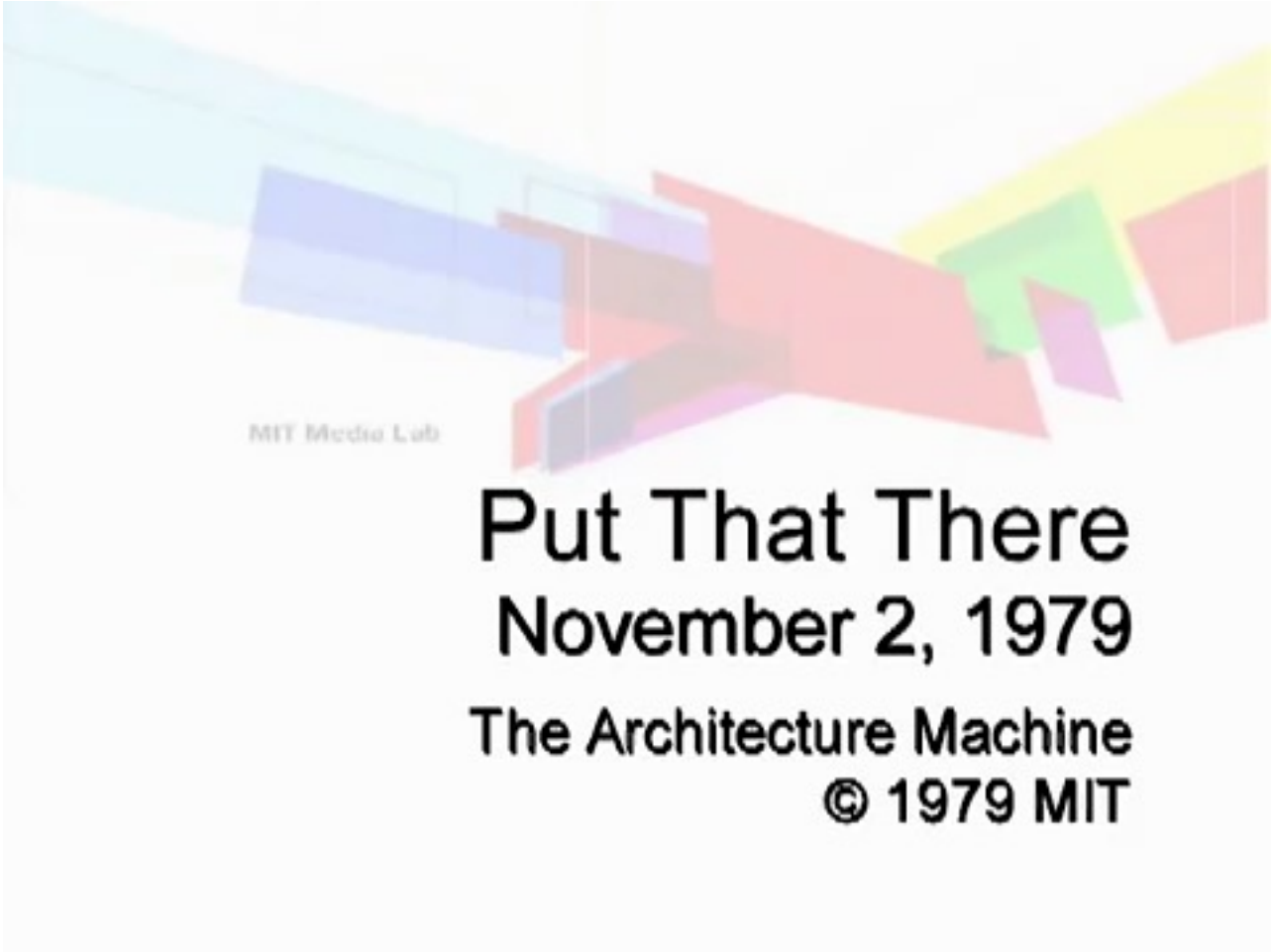
-100 to -40	left-handed
-40 to +40	ambidextrous
+40 to 100	right-handed

Oldfield, R. C. (1971). The assessment and analysis of handedness: The Edinburgh inventory. *Neuropsycholologia, 9*, 97-113.

Human Voice

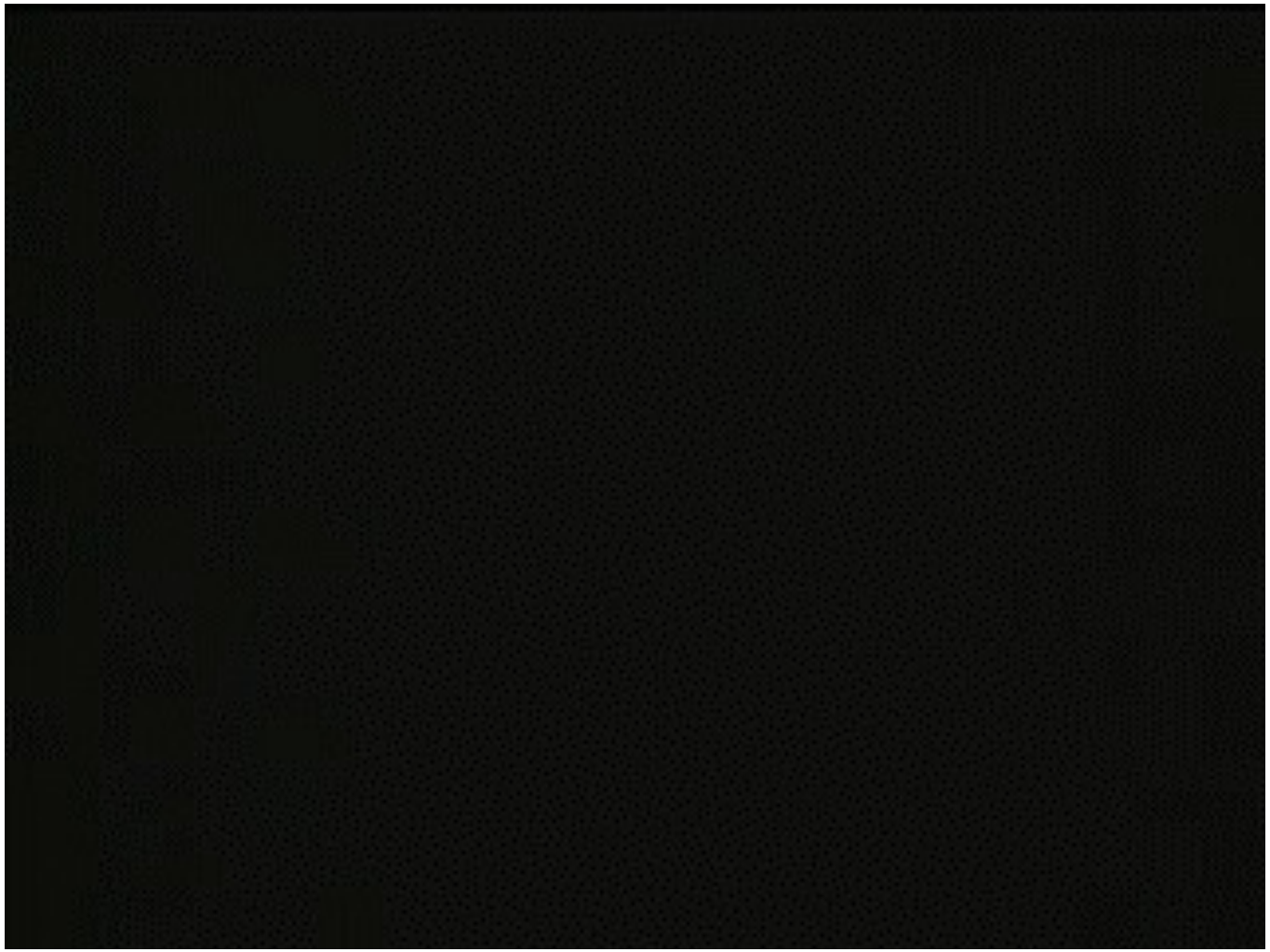
- Human vocal cords are responders
- Sounds created through a combination of…
  - Movement in the larynx
  - Pulmonary pressure in the lungs
- Two kinds of vocalized sounds:
  1. Speech
  2. Non-speech
- Both with potential for computer control
  - Speech + speech recognition
  - Non-speech + signal detection (e.g., frequency, loudness, duration, change direction, etc.)

Put That There – Speech Input



Richard A. Bolt, “Put-that-there”: Voice and gesture at the graphics interface. *Siggraph 1980*

Non-Speech Input

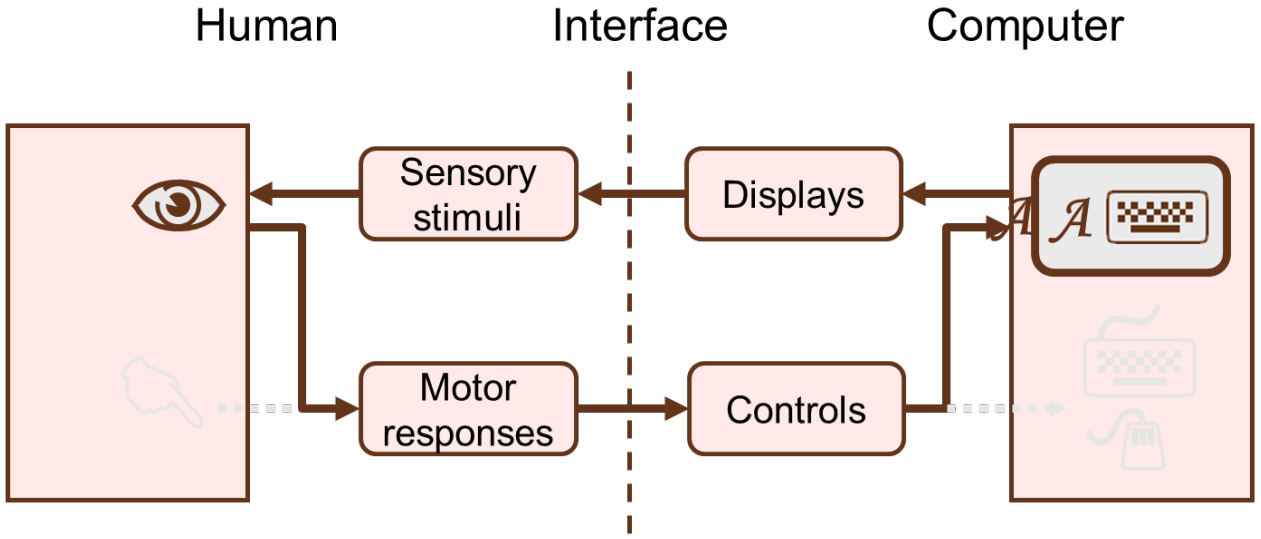


Igarashi, T., & Hughes, J. F. Voice as sound: using non-verbal voice input for interactive control. *UIST 2001*

Degraen, Donald, et al. Weirding Haptics: In-Situ Prototyping of Vibrotactile Feedback in Virtual Reality through Vocalization. UIST 2021

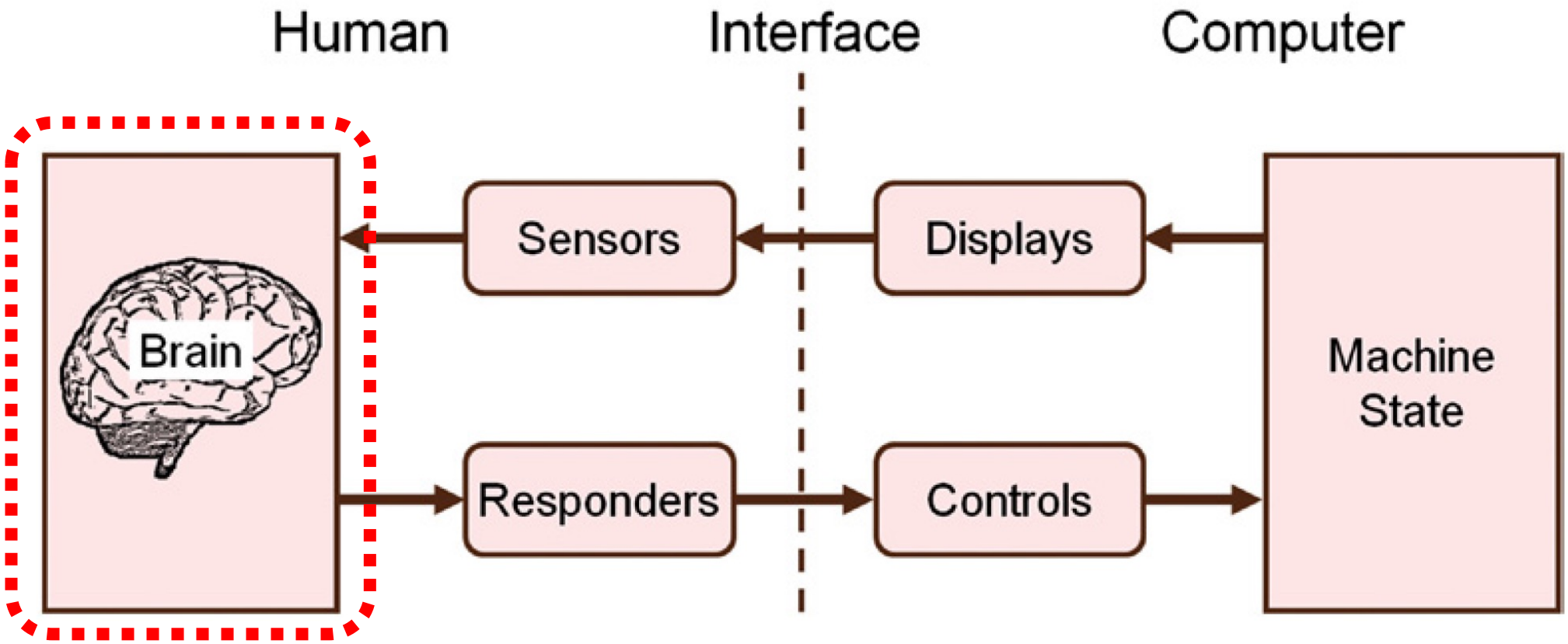
The Eye as a Responder

- As a responder, the eye is called upon to do “double duty”
  1. Sense and perceive the environment/computer
  2. Act as a controller via saccades and fixations



[1] MacKenzie, I. S. (2012). Evaluating eye tracking systems for computer input. In Majaranta, P., Aoki, H., Donegan, M., Hansen, D. W., Hansen, J. P., Hyrskykari, A., & Räihä, K.-J. (Eds.) *Gaze interaction and applications of eye tracking: Advances in assistive technologies*, pp. 205-225. Hershey, PA: IGI Global.

Human Factors Model



The Brain

- Most complex biological structure known
- Sensors (human inputs) and responders (human outputs) are nicely mirrored, but it is the brain that connects them

- Three core functions:
  - Perception
  - Cognition
  - Memory

Perception

- 1st stage of processing for sensory input
- Interpretation of sensory signals
  - Auditory stimulus → harmonious, discordant
  - Visual stimulus → familiar, strange
  - Tactile stimulus → warm, hot
  - Smell stimulus → pleasurable, abhorrent
  - Taste stimulus → sweet, sour

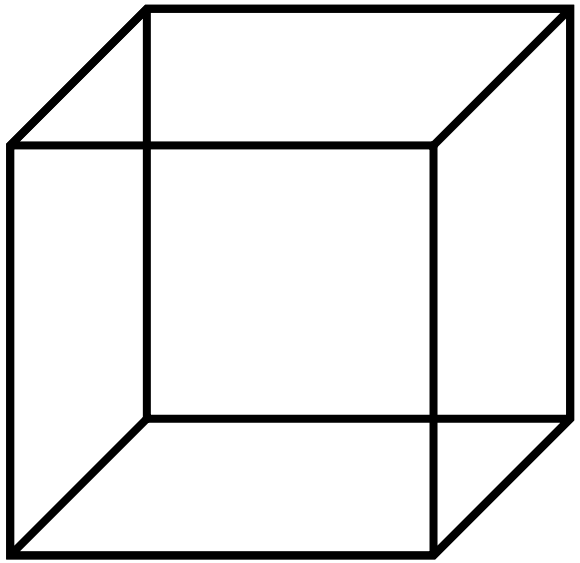
Psychophysics

- Branch of experimental psychology
- Since 19th century
- Relationship between human perception and physical phenomena
- Experimental method
  - Hearing test (left or right?)
  - Two-point discrimination (one point or two?)

Illusions

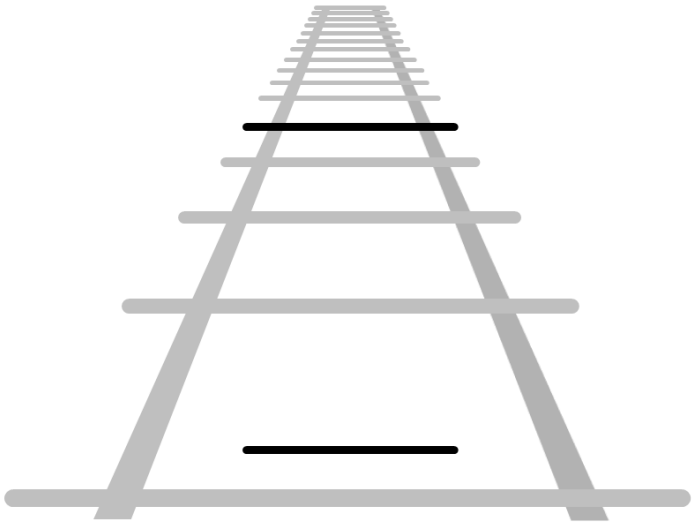
- Interpretation can be difficult and ambiguous – leading to illusions

Necker cube



Which surface is at the front?

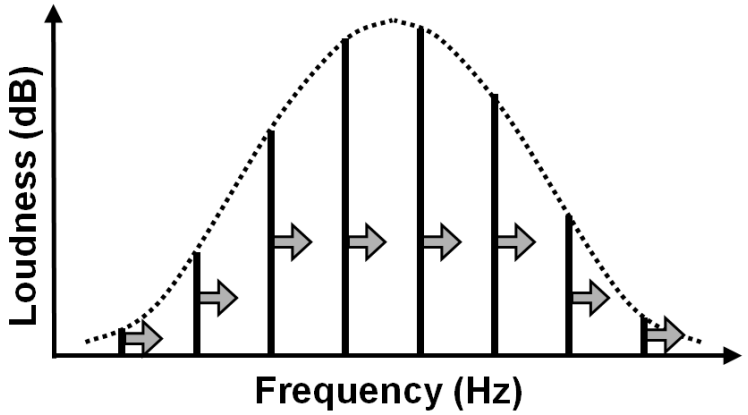
Ponzo lines



Which black line is longer?

Illusion – Other Senses

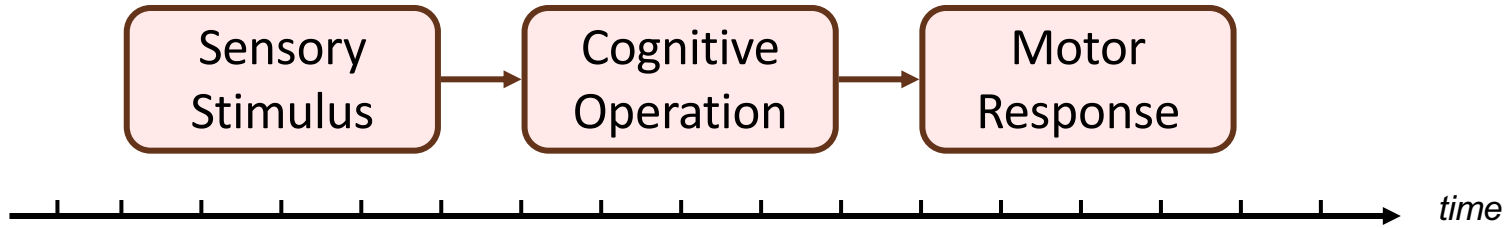
- If illusion is possible for the visual sense, the same should be true for the other senses
- Tactile illusion: Sensory Saltation
  - Also called cutaneous rabbit illusion
- Auditory illusion: Sheppard-Risset glissando



https://www.youtube.com/watch?v=MShclPy4Kvc

Cognition

- Human process of conscious intellectual activity
- Thinking, reasoning, deciding, etc.



Operation	Typical time (ms)
Sensory reception	1 – 38
Neural transmission to brain	2 – 100
Cognitive processing	70 – 300
Neural transmission to muscle	10 – 20
Muscle latency and activation	30 –70
Total:	113 - 528

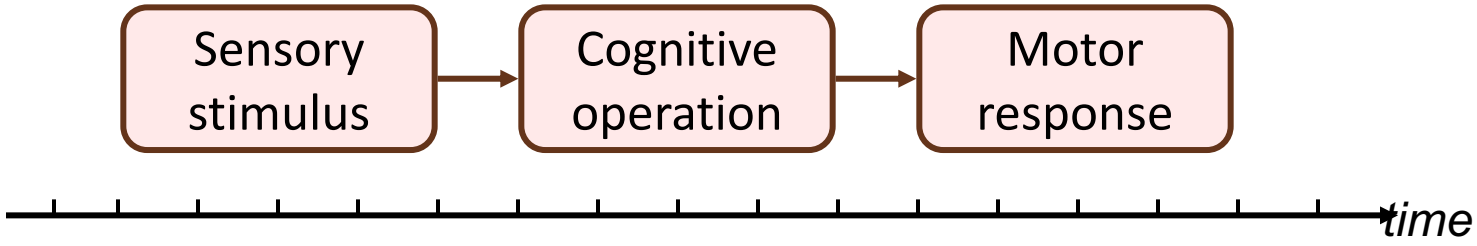
“Making a Decision”

- Not possible to directly measure the time for a human to “make a decision”

- When does the measurement begin and end?
- Where is it measured?
- On what input is the human deciding?
- Through what output is the decision conveyed?

- There is a sensory stimulus and motor response that bracket the decision

Making a Decision – in Parts



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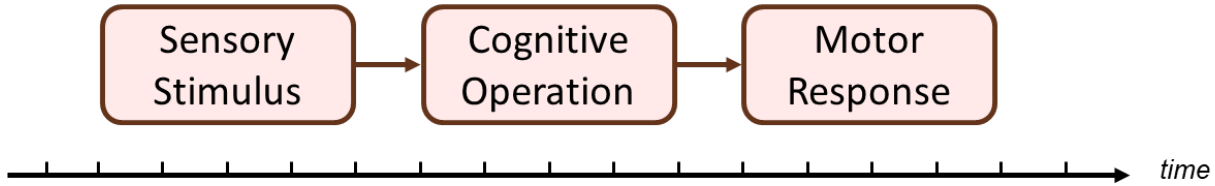
Large variation!

Examples of Simple Decisions

- Driving a car → decision to depress the brake pedal in response to a changing signal light
- Using a mobile phone → decision to press REJECT-CALL in response to an incoming call
- Reading news online → decision to click the CLOSE button on a popup ad

Information Processing Models

- Models the information processes of user interacting with a computer
- Predicts which cognitive processes are involved
- Enables calculations to be made of how long tasks will take



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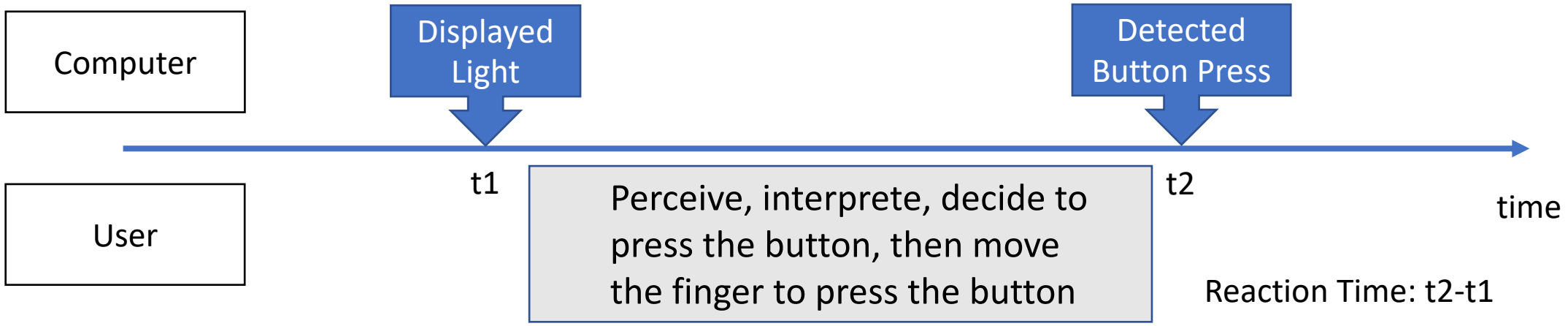
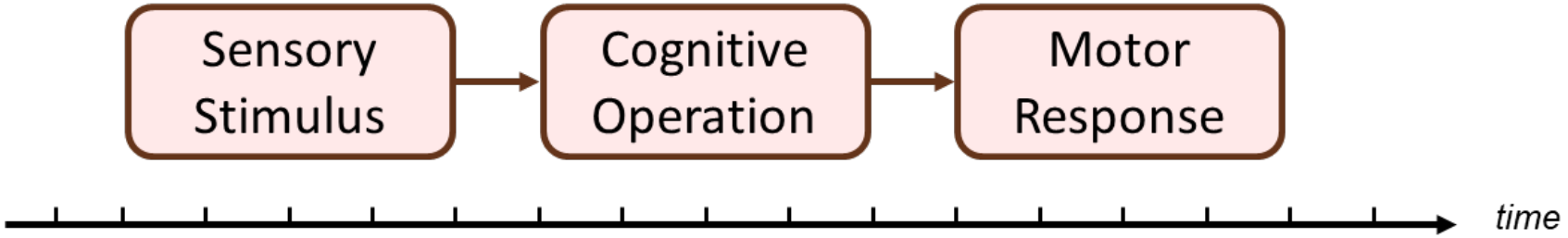
Reaction Time

- One of the most primitive manifestations of human performance is simple reaction time
- Definition: The delay between the occurrence of a single fixed stimulus and the initiation of a response assigned to it
- Example: Pressing a button in response to a stimulus light



Comparing Cognitive Load



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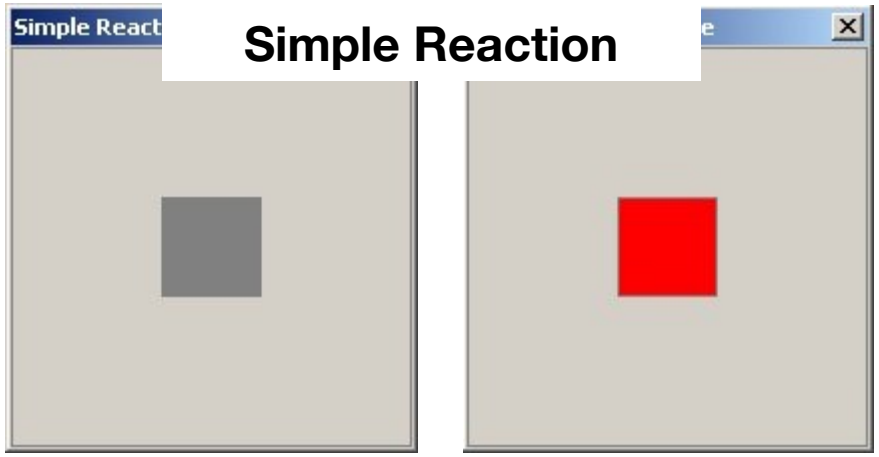
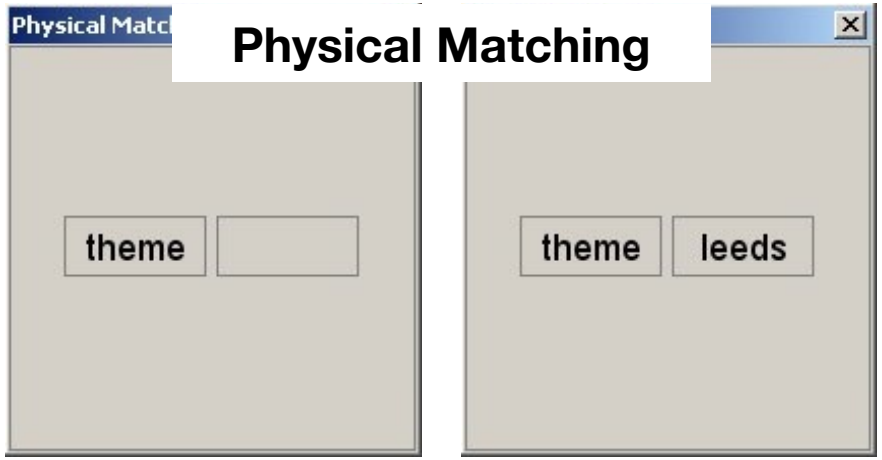
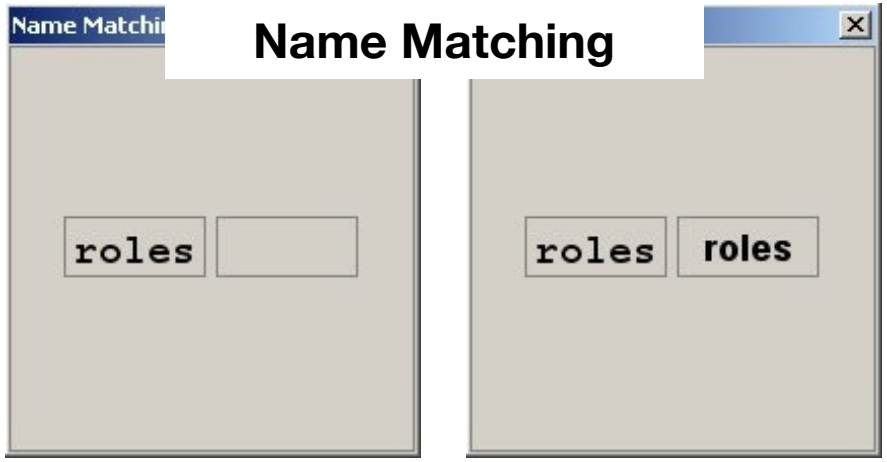
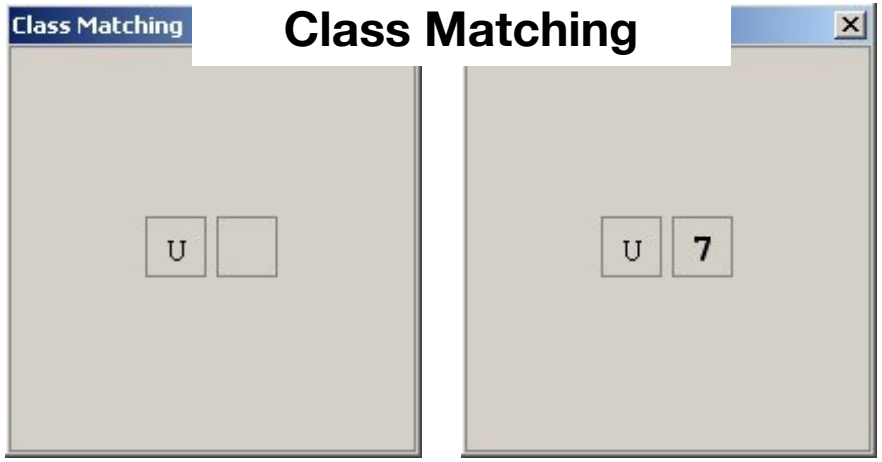
Reaction Time Experiment



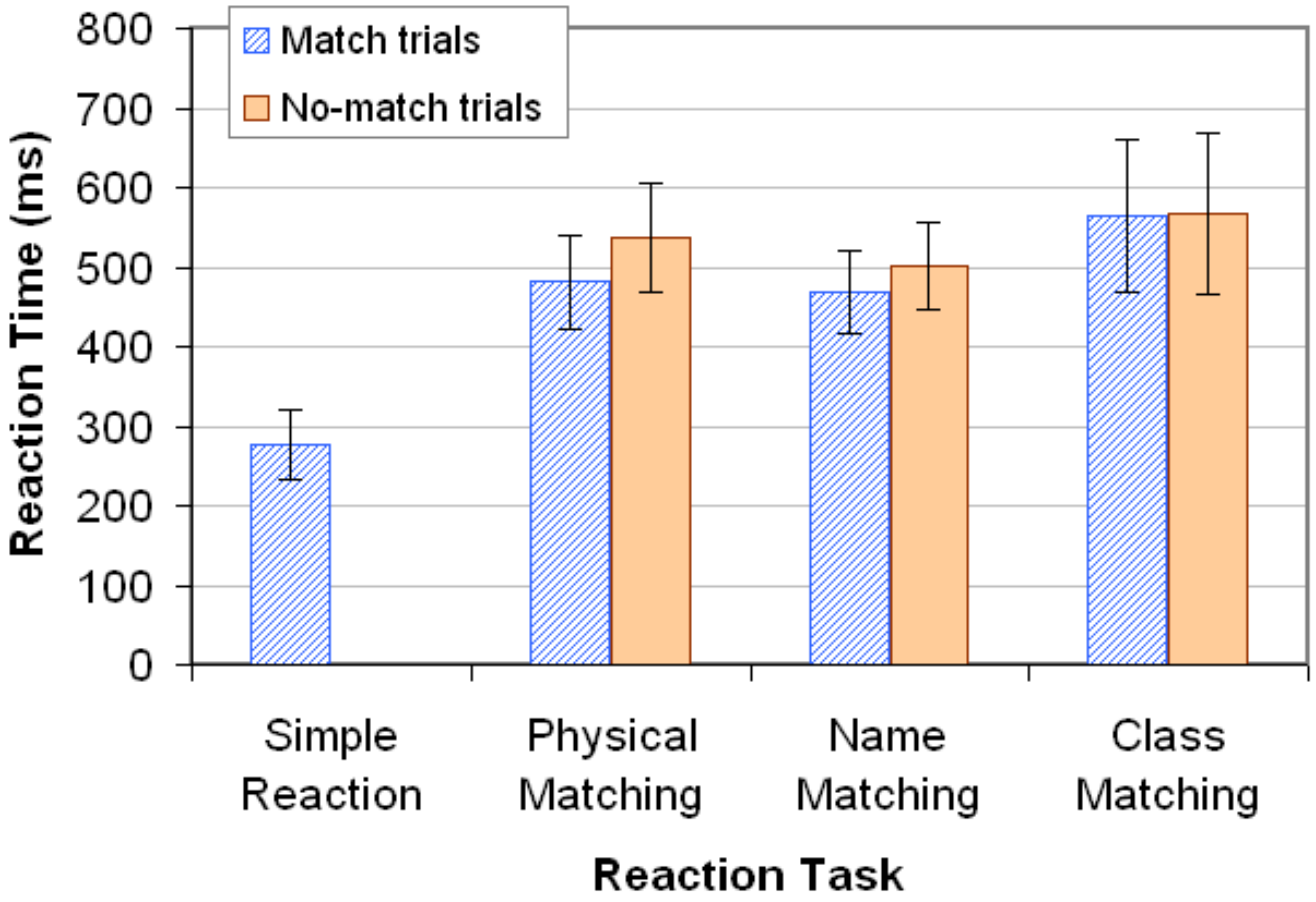






http://www.yorku.ca/mack/HCIbook/

Experiment Results

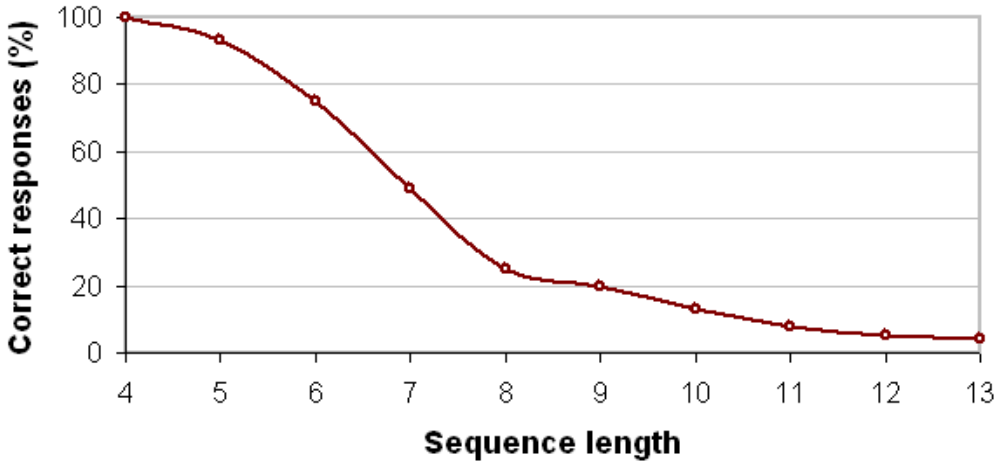


Sensory Stimuli and Reaction Time

- Delay time varies by type of sensory stimuli
- Approximate values
  - Auditory → 150 ms
  - Visual → 200 ms
  - Smell → 300 ms
  - Pain → 700 ms

Memory

- Human ability to store, retain, and recall information
- Long-term memory: Large storage of past events
- Short-term memory: active and readily available *working memory*
  - Miller's Law: Humans can remember about 7 (±2) items.



[1] Miller, G. A. (1956). The magical number seven plus or minus two: Some limits on our capacity for processing information. *Psychological Review, 63*, 81-97.

Chunking

- Units in short term memory may be recoded as a chunk
- Expands capacity of short term memory
- E.g., Commit to memory and recall…

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vs

82 52 217 2281

Upcoming

- 3/23 (Thu) Quiz 2 on Human Factors, Lecture on Control and Displays
- 3/27 (Mon) Pre-proposal Submission Deadline 23:59 on BB
  - On usability problem, proposed solution, prototyping plan
- 3/28-3/30 Pre-proposal Meeting with Instructor (no class)
  - I will review the submissions and contact teams that need further iterations.