Human Responders

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Lecture notes in this series are based on

- Ahmed Sabbir Arif. 2021. Statistical Grounding. *Intelligent Computing for Interactive System Design: Statistics, Digital Signal Processing, and Machine Learning in Practice*, ACM
- Ann Blandford, Dominic Furniss, Stephann Makri. 2016. Qualitative HCI Research: Going Behind the Scenes. Morgan & Claypool
- Jonathan Lazar, Jinjuan Feng, Harry Hochheiser. 2017. Research Methods in Human-Computer Interaction. Morgan Kaufmann
- I. Scott MacKenzie. 2013. Human-Computer Interaction: An Empirical Research Perspective, Morgan Kaufmann
- Interaction Design Foundation. 2022. Design Thinking
- Lecture notes of Amy Bruckman, Mark Dunlop, Niels Henze, I. Scott MacKenzie, Laura Moody, Albrecht Schmidt, Kami Vaniea

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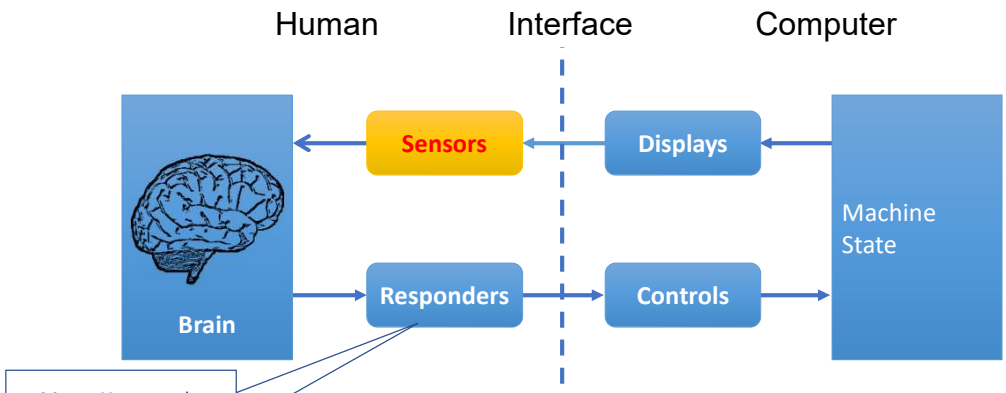
Human Factors Model



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Responders

- Humans control their environment through responders, e.g.
  - A finger to point
  - Feet to walk or run
  - Eyebrow to frown
  - Vocal chords to speak
  - Torso to lean

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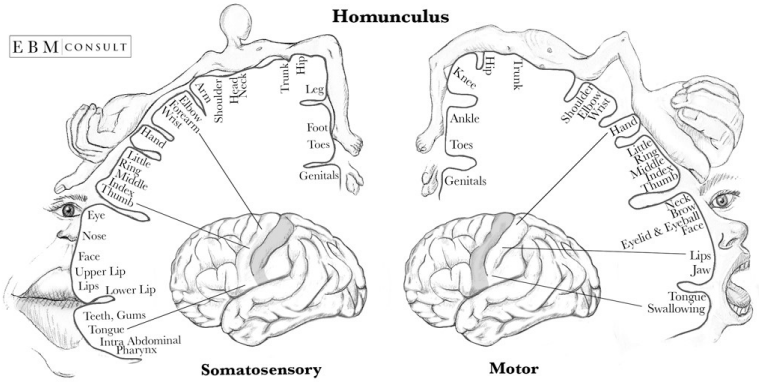
Motor Homunculus

- Motor homunculus shows human responders and the relative area of motor cortex dedicated to each



https://www.ebmconsult.com/articles/homunculus-sensory-motor-cortex

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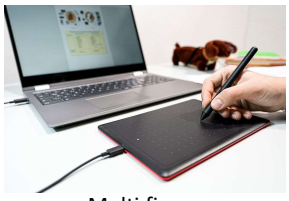
Responder Examples

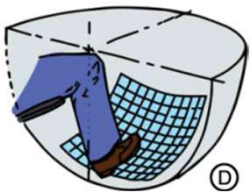

Bimanual


Index finger


Multi finger


Two thumbs


One thumb


One foot

Pearson & Weiser (1986)


Head tracking

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Handedness

- The dominant hand is a person's preferential use of the hand due to it being stronger, faster, or better in dexterity
  - Often defined by one's writing hand
- The non-dominant hand is weaker, less dexterous, or less subjectively preferred
- Right-handedness is more common
  - 90% of the population
- True ambidexterity (equal preference of either hand) is rare
- Handedness exists by degree
- Many devices are designed for right-handed people, thus difficult for left-handed people to use

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Edinburgh Inventory for Handedness

	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

Richard C. Oldfield. 1971. The Assessment and Analysis of Handedness: The Edinburgh Inventory. Neuropsychologia 9.1: 97-113.

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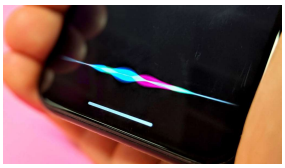
Human Voice

- Human vocal chords are responders
- Sounds created through 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
    - Frequency, loudness, duration, change direction, etc.

Speech Example

Amazon Alexa

Google Nest



Apple Siri

Pros

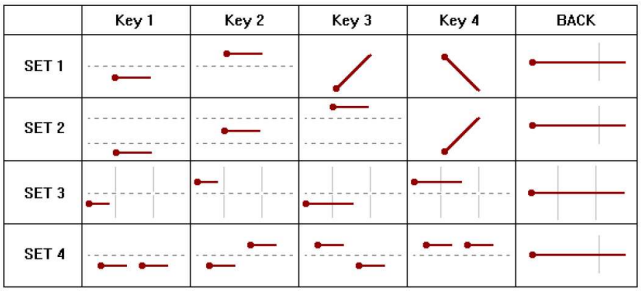
- More natural and intuitive
- High learnability
- High discoverability

Cons

- Low accuracy rate, especially in noisy places
- Invades privacy and security
  - Bystanders in public places
  - Always listening

Non-Speech Example

- Non-verbal voice interaction



- Amazon Alexa Guard with Alarm can detect broken glass

Adam J. Sporka, Torsten Felzer, Sri H. Kurniawan, Ondřej Poláček, Paul Haiduk, and I. Scott MacKenzie. 2011. CHANTI: Predictive Text Entry Using Non-verbal Vocal Input. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '11). ACM, NY, USA, 2463–2472.

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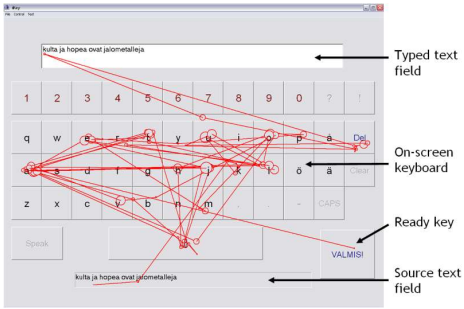
The Eye as a Responder

- 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



Text Entry with Eye Tracking (Päivi Majaranta et al., 2006)

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Eye Movement & Blinking

- Blinking can be used for computer control when other means of interactions are unavailable

- Not natural behavior
  - Can cause fatigue and irritation
  - Can increase cognitive load
  - Higher chance of accidental selection

Author Mia Austin who was left paralyzed from the neck down, known as the locked in syndrome, wrote a book "In the Blink of an Eye" using only her eyes.
The Independent (2018)
https://www.independent.co.uk/life-style/stroke-victim-paralysed-writes-book-eyes-mia-austin-locked-in-syndrome-a8321381.html

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Head Movement

- Head movement can also be used for computer control

- Not natural behavior
  - Can cause fatigue and irritation
  - Can increase cognitive load
  - Higher chance of accidental selection

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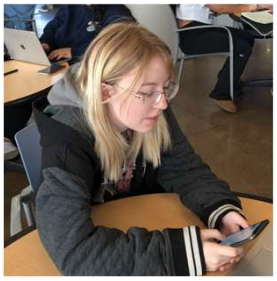
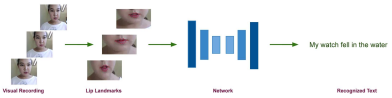
Lip Movement

- Lip movement can be used to control computers
  - Silent speed or mouth gestures
- Pros:
  - More private and secure than speech
  - No effect of noisy environment on recognition
- Cons:
  - Effects of lighting condition
  - Different accents, speaking abilities may impact performance
  - Current models are slower than speech





Laxmi Pandey, Ahmed Sabbir Arif. 2021. LipType: A Silent Speech Recognizer Augmented with an Independent Repair Model. In Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (CHI 2021). ACM, New York, NY, USA, Article 1, 1-19.

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