Cognition 2.0

Data-driven Ubiquitous Computing for Augmenting Human Cognition and Perception

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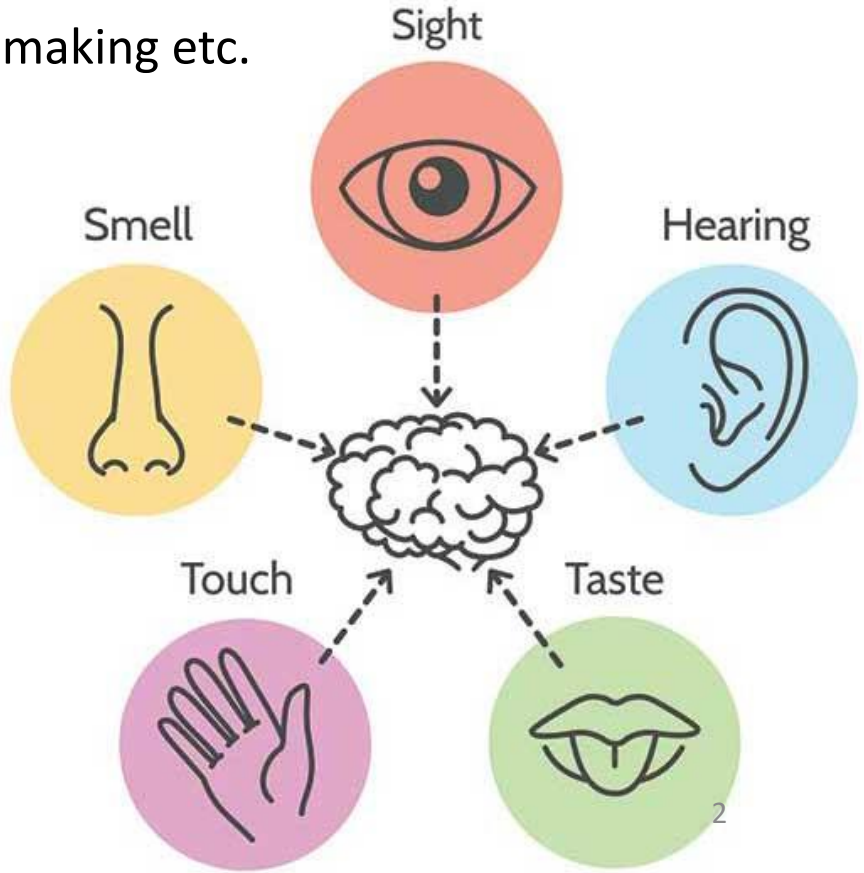
Human Cognition and Perception

- **Human Cognition**

  - thought processes
    - attention, **memory**, learning, problem solving, decision making etc.

- **Human Perception**

  - sensory input
    - 5 senses



Augmenting Human Perception on the Slopes

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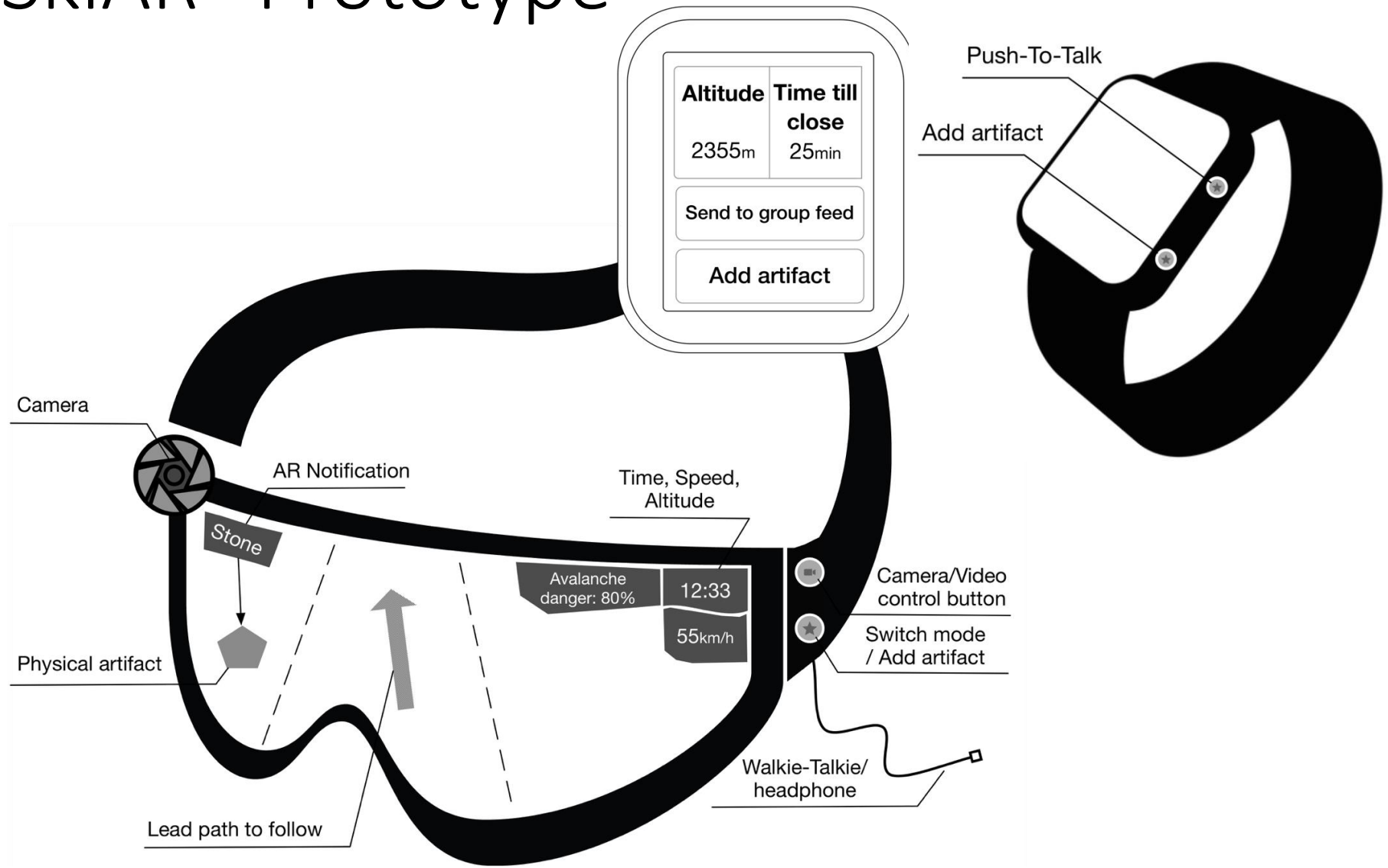
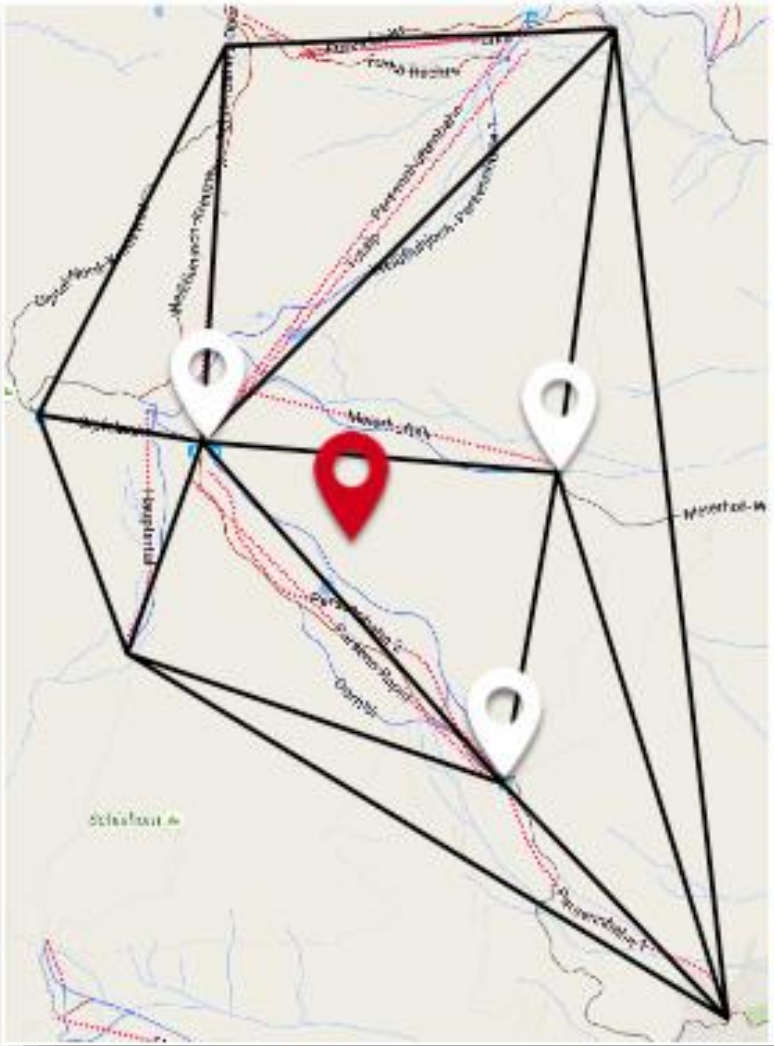
Sharing Personalized Content on the Slope

The ”SkiAR” Prototype



From Topological to Panoramic Map

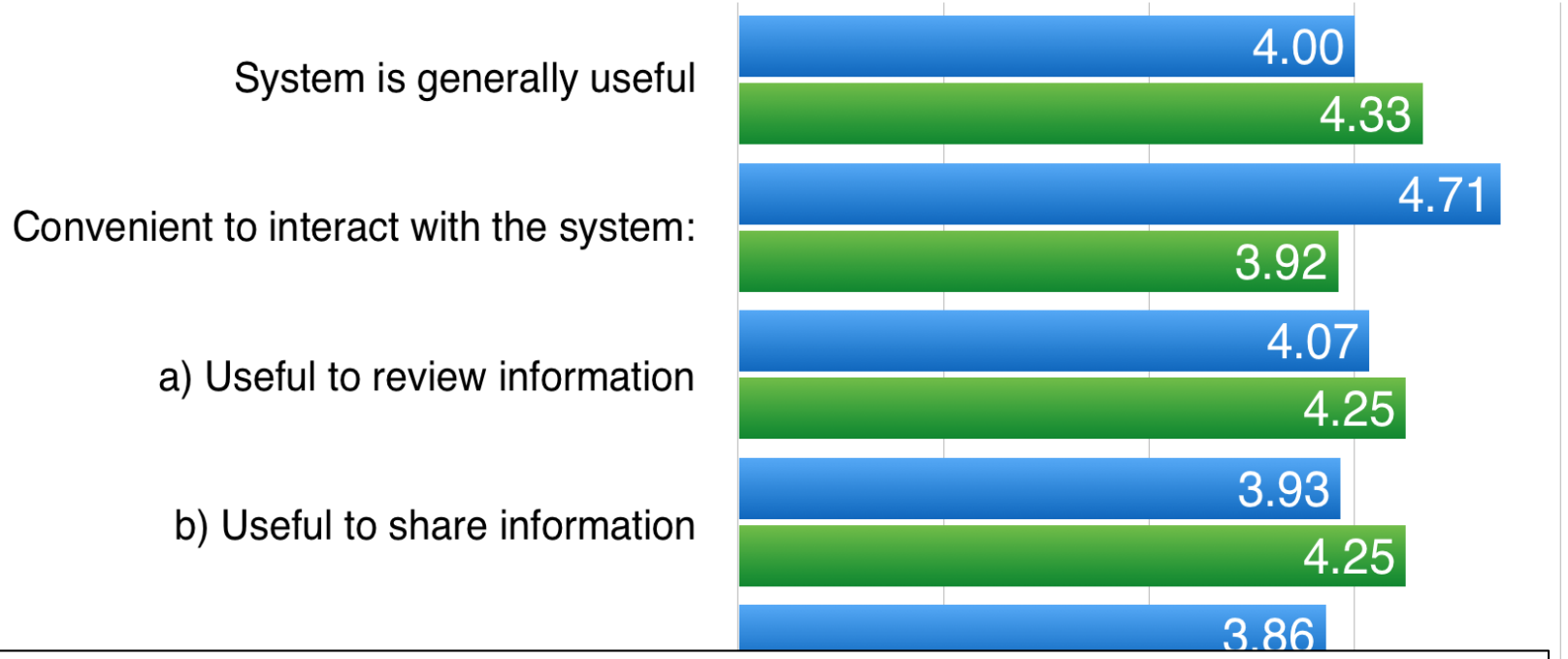


Delaunay Triangulation

Trials on the Slopes

Take-away Points

- Supports decision making
- Coordination with peers
- Enables storytelling
- Better on-slope awareness



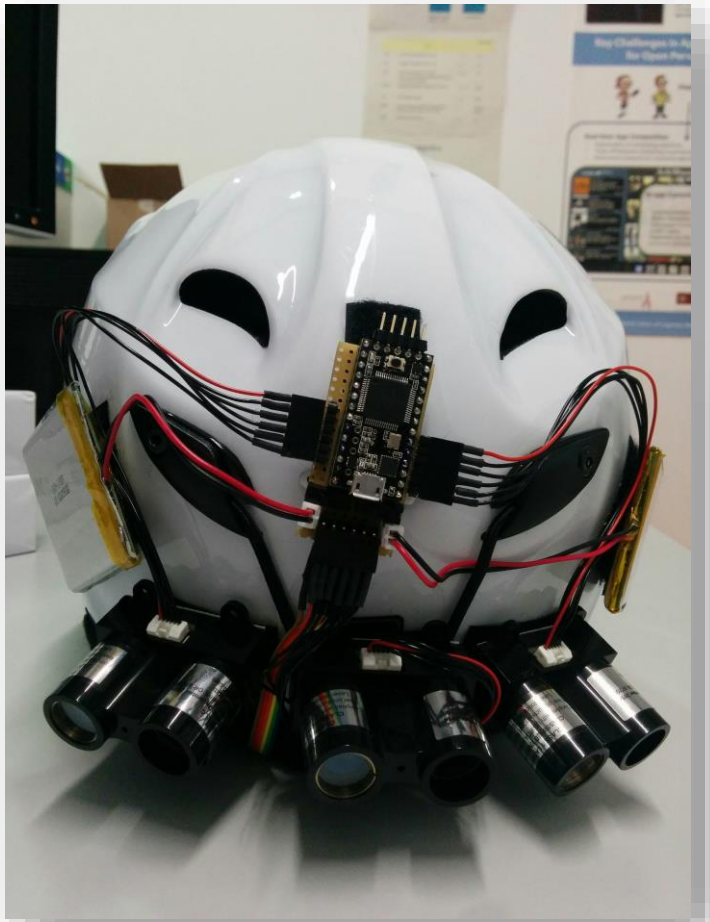
Fedosov, A., **Niforatos, E.,** Elhart, I., Schneider, T., Anisimov, D. and Langheinrich, M., (2016, December). Design and evaluation of a wearable AR system for sharing personalized content on ski resort maps. In *Proceedings of the 15th International Conference on Mobile and Ubiquitous Multimedia* (pp. 141-152). ACM. (*honorable mention*)

Fedosov, A., Elhart, I., **Niforatos, E.,** North, A., & Langheinrich, M. (2016, February). SkiAR: Wearable augmented reality system for sharing personalized content on ski resort maps. In *Proceedings of the 7th Augmented Human International Conference 2016* (p. 46). ACM.

Ski Helmet Use

- Helmets mandatory for skiers < 16 years old in Austria [Ruedl et al. 2014]
- Head injuries 3-15 % of total ski injuries but are increasing [Vanat 2015]
- **Some still abstain due to:**
  - Style, habit, ease, price…
  - Helmet wearers often perceived as reckless skiers [Ruedl et al. 2012]
  - Impaired hearing and sound source localization Helmet [Ruedl et al. 2014]
    - Ear plugs / built-in audio

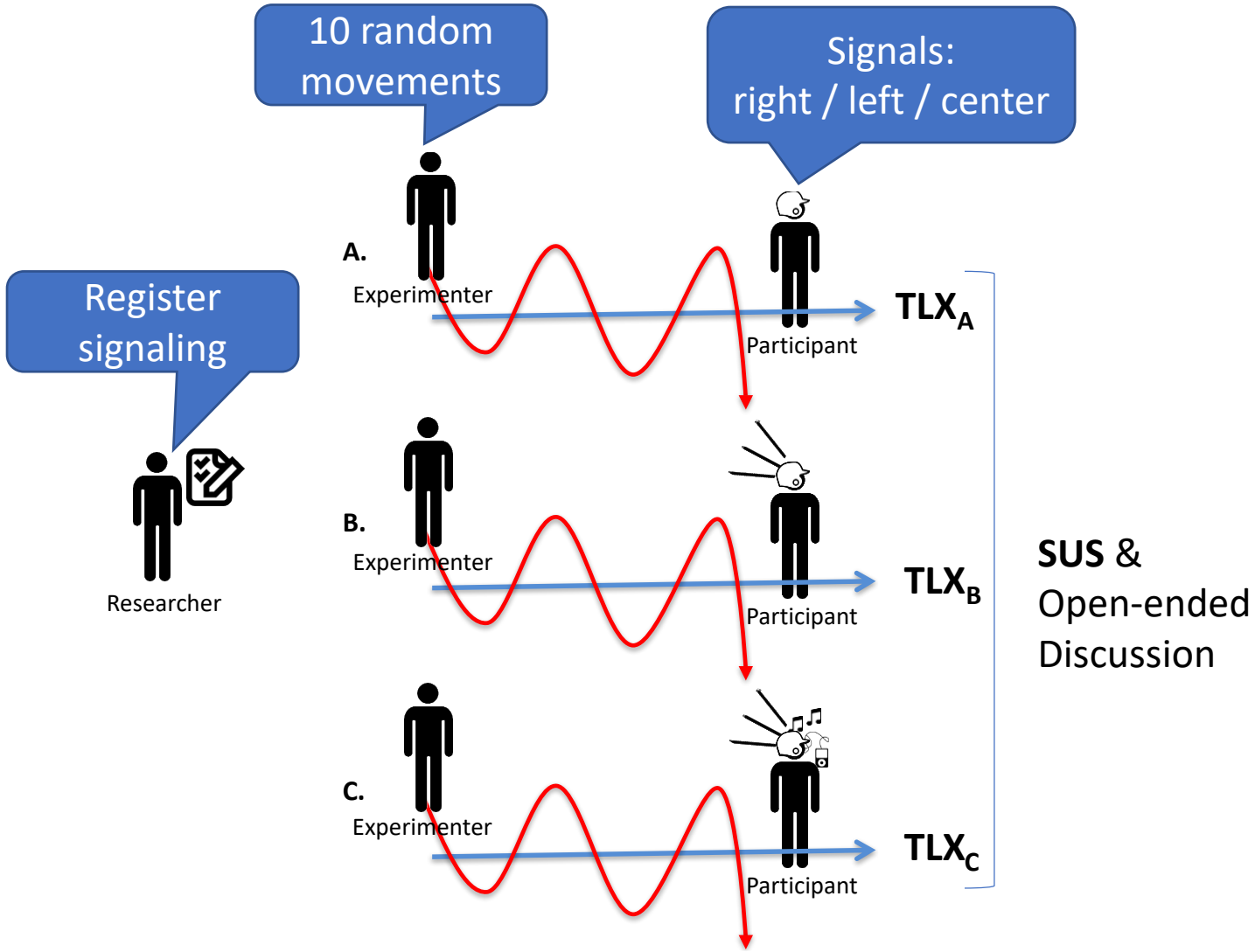
”Smart” Ski Helmet (S-SH) Prototype



Detecting skiers behind the wearer

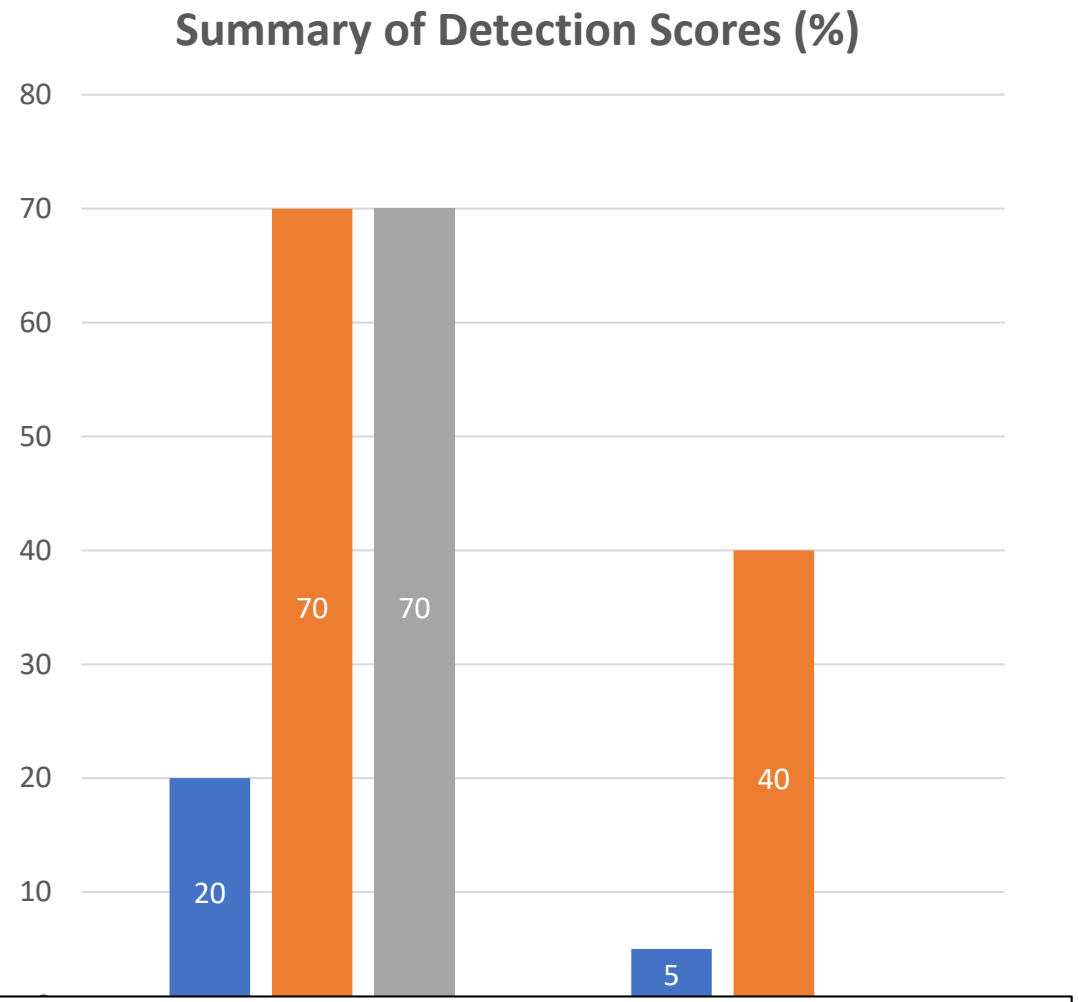
Procedure

- Participants were advised:
  - Look forward
  - Use any contextual detail (e.g., sound, shadow etc.) in addition to LEDs
- On-slope only A and B conditions



Take-away Points

- Participants perceived the movement direction of the person behind them
- TLX (~33 %) and SUS (~67) scores did not differ significantly between off- and on-slope
- Participants reported important usability flaws mainly about the LEDs' placement
  - Perhaps due to the use of large helmet (60-62 cm)

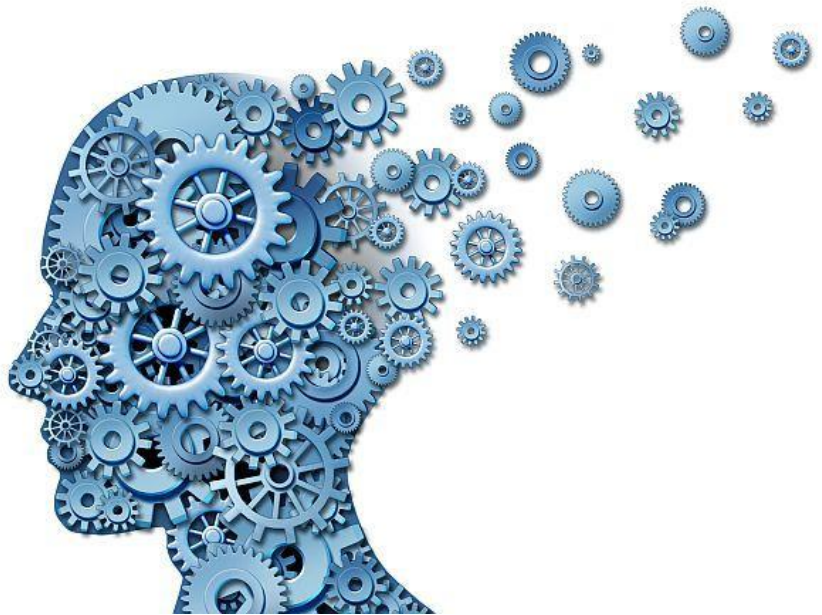


Niforatos, E., Fedosov, A., Elhart, I., & Langheinrich, M. (2017, September). Augmenting Skiers' Peripheral Perception. In *Proceedings of the 2017 ACM International Symposium on Wearable Computers* (pp. 114-121). ACM.

Niforatos, E., Elhart, I., Fedosov, A., & Langheinrich, M. (2016, February). s-Helmet: A Ski Helmet for Augmenting Peripheral Perception. In *Proceedings of the 7th Augmented Human International Conference 2016* (p. 45). ACM.

The Role of Context in Augmenting Human Memory

(my phd topic)



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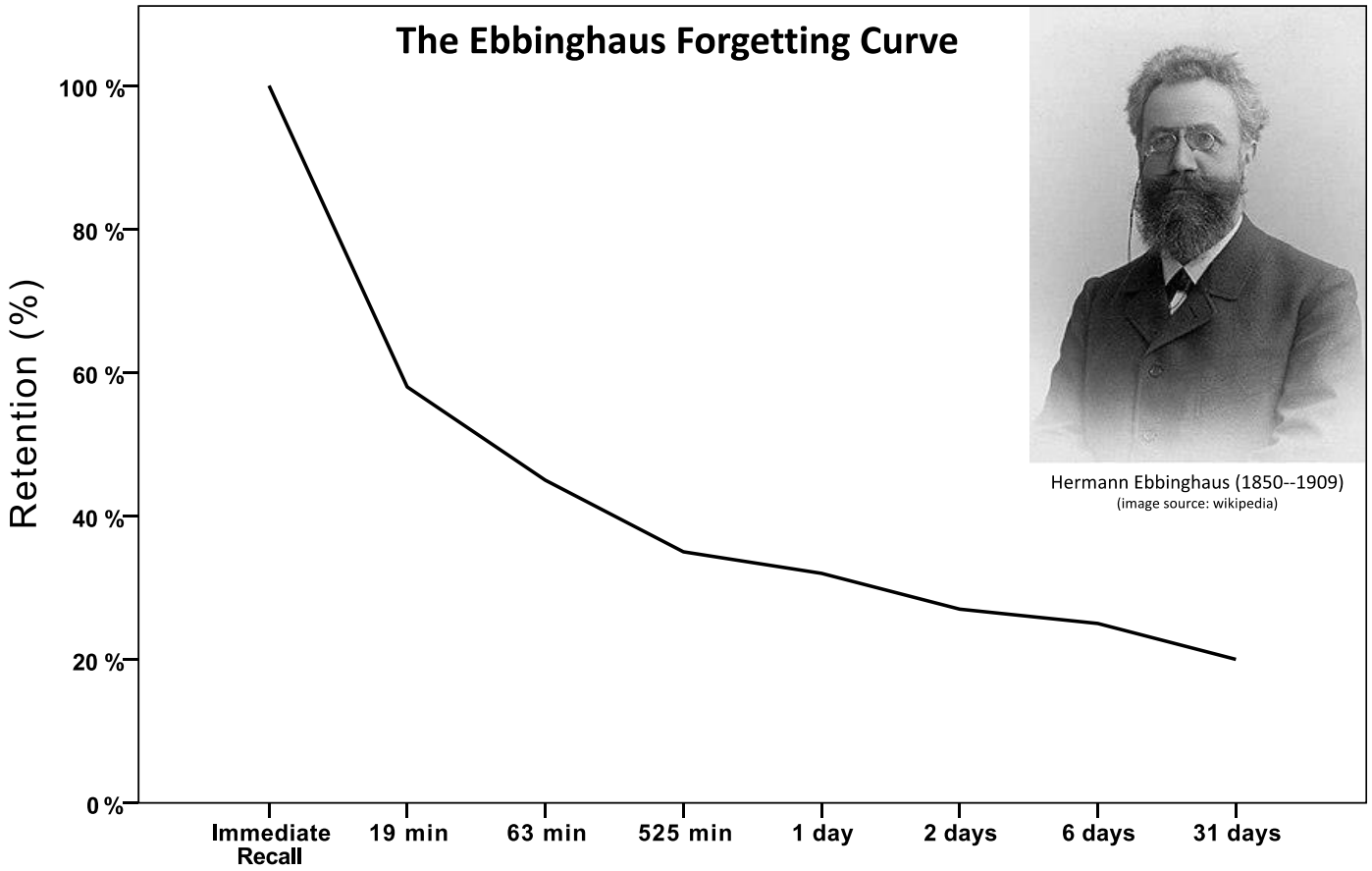
recall

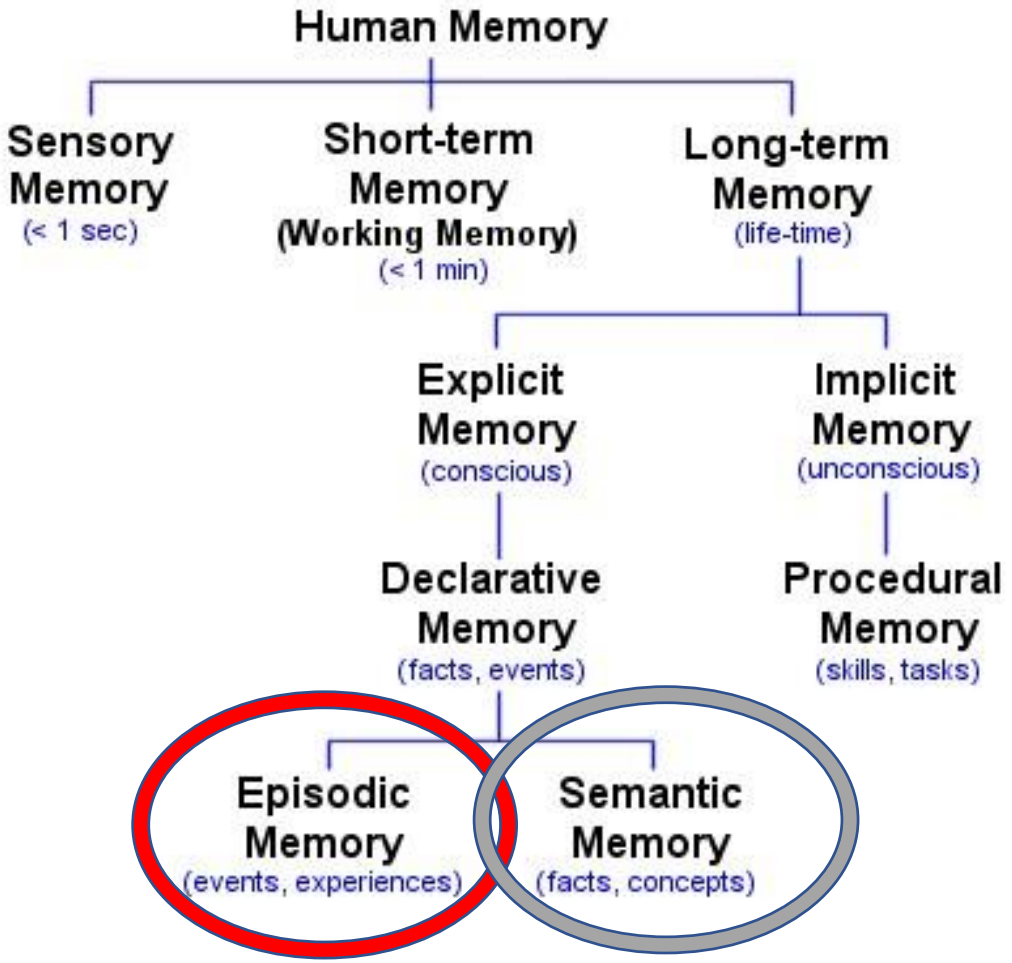
People forget

- due to…
  - hectic lifestyle (segmented attention span, sleep deprivation, lack of exercise etc.)
  - chronic stress
  - depression
  - Alzheimer, dementia etc.
  - aging
  - nature (need to forget)
  - modern technology (”Google effect”)
- But can technology help us remember better past experiences?



[Ebbinghaus 1885]

Human Memory



Atkinson and Schiffrin (1968) Multi Store Human Memory Model

Episodic and Semantic Memory Interplay

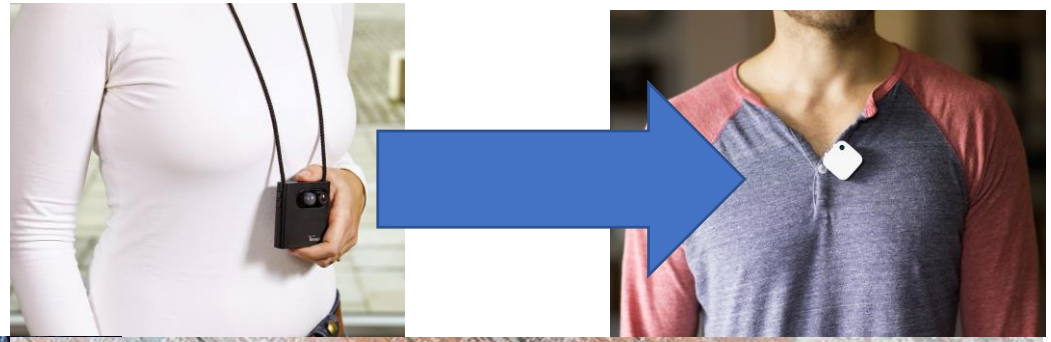
- Episodic (autobiographical)
  - summary our daily life records
  - different activation patterns
  - dominated by visual imagery
  - ”field” or an ”observer” perspective
  - in temporal order
- Semantic (factual)
  - facts, events, and concepts
  - learning and performance
  - in tandem with episodic
  - episodic → semantic over time

Memory Cues

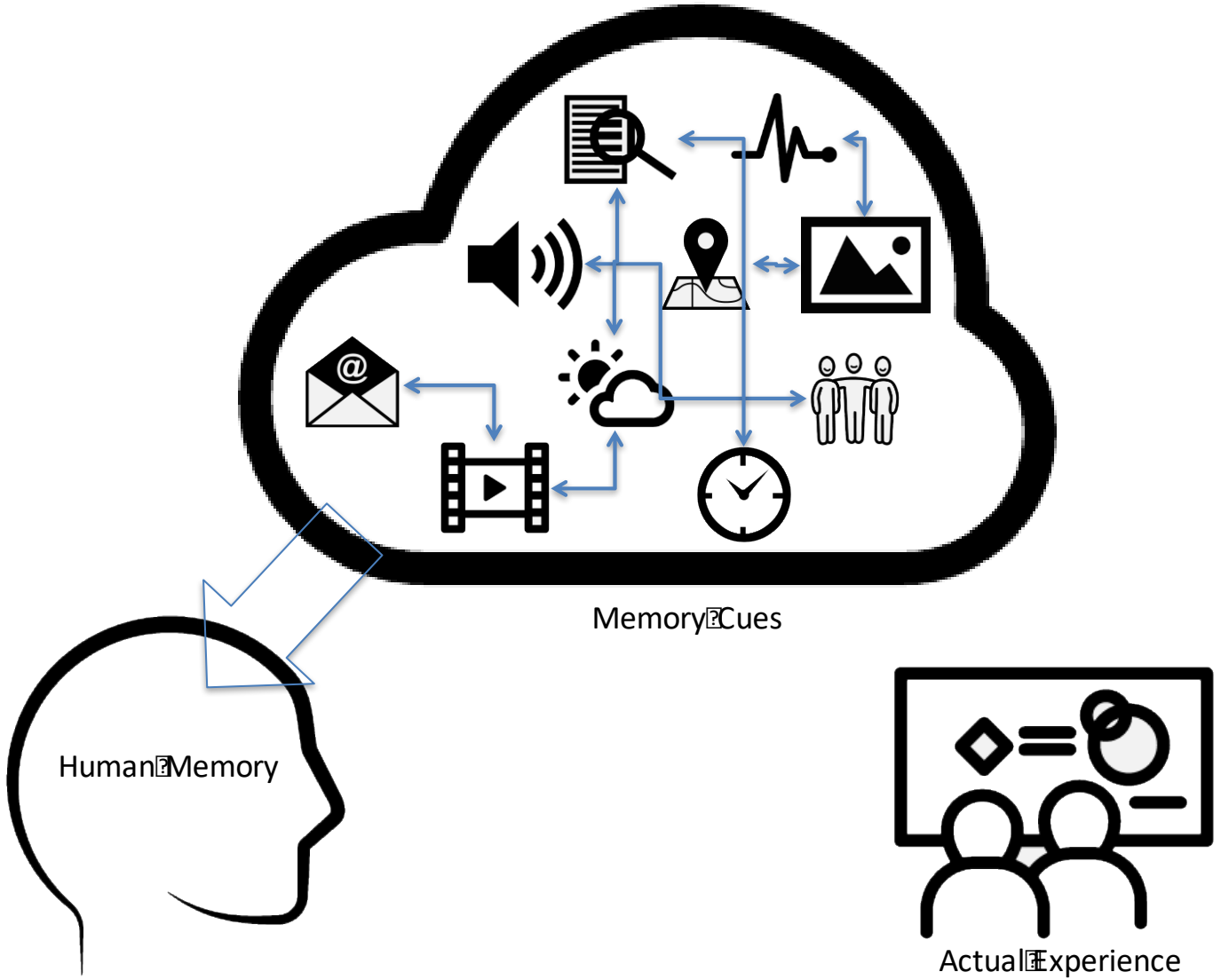
- Specks of personal experiences (personal context)
- Help trigger (episodic & semantic) memories
- Great variety
  - Visual (pictures, videos, text etc.)
  - Audible (sounds, songs etc.)
  - Olfactory (a smell)
  - Tactile (a touch)
  - Time (a date)
- Technology generates new types of cues
  - Location (GPS)
  - Logs (Facebook posts, e-mails, app usage etc.)
  - Social context and co-presence (Facebook check-ins)
  - Activity type (running, skiing etc.)
- Can synergistically support (episodic) memory recall

Lifelogging

- Continuous capture of data that characterizes a life experience
- ”Quantified self” movement
- Immense volume of data
- Highly heterogeneous data
- Great source of memory cues

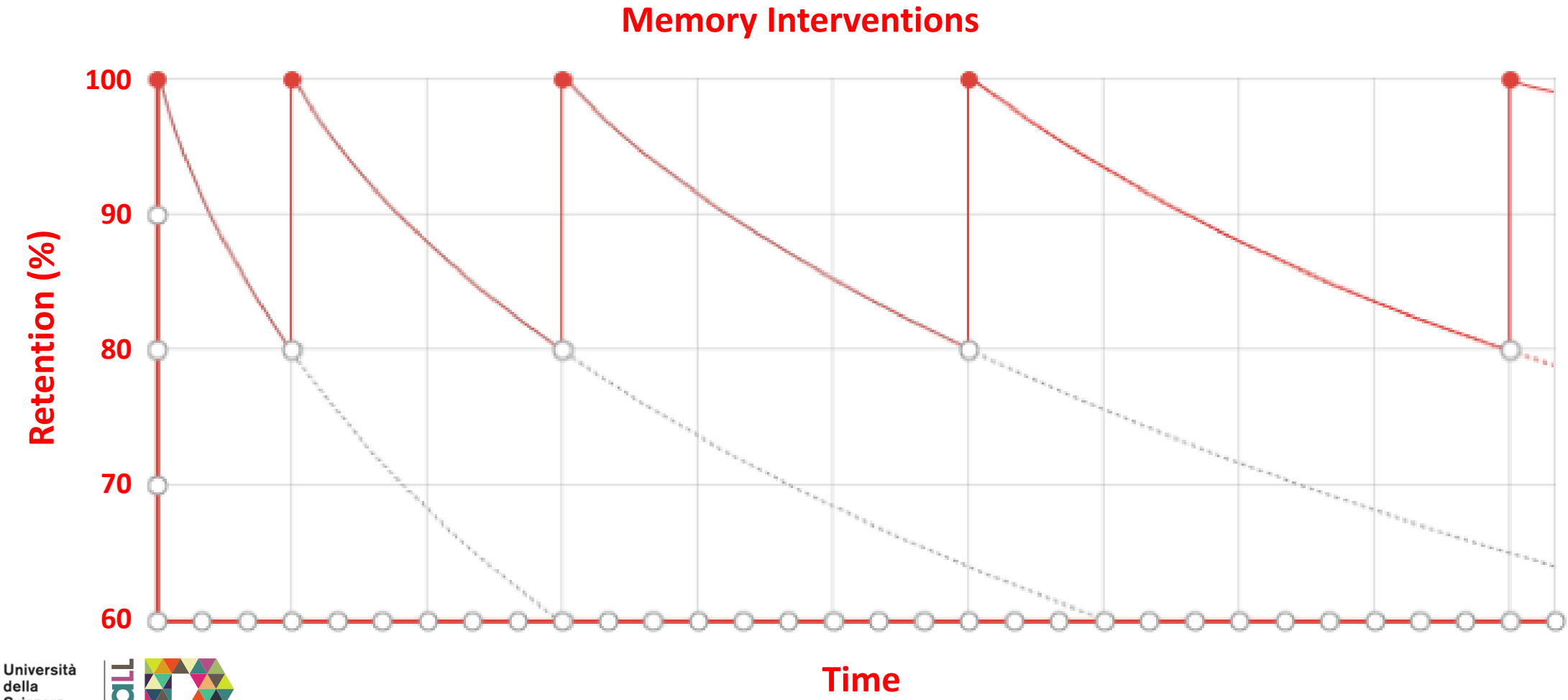


Method: Cued Recall



icons: thenounproject

Impact on Memory



Augmenting Human Cognition

”Bridging the Cognitive Gap between Human and Machine”

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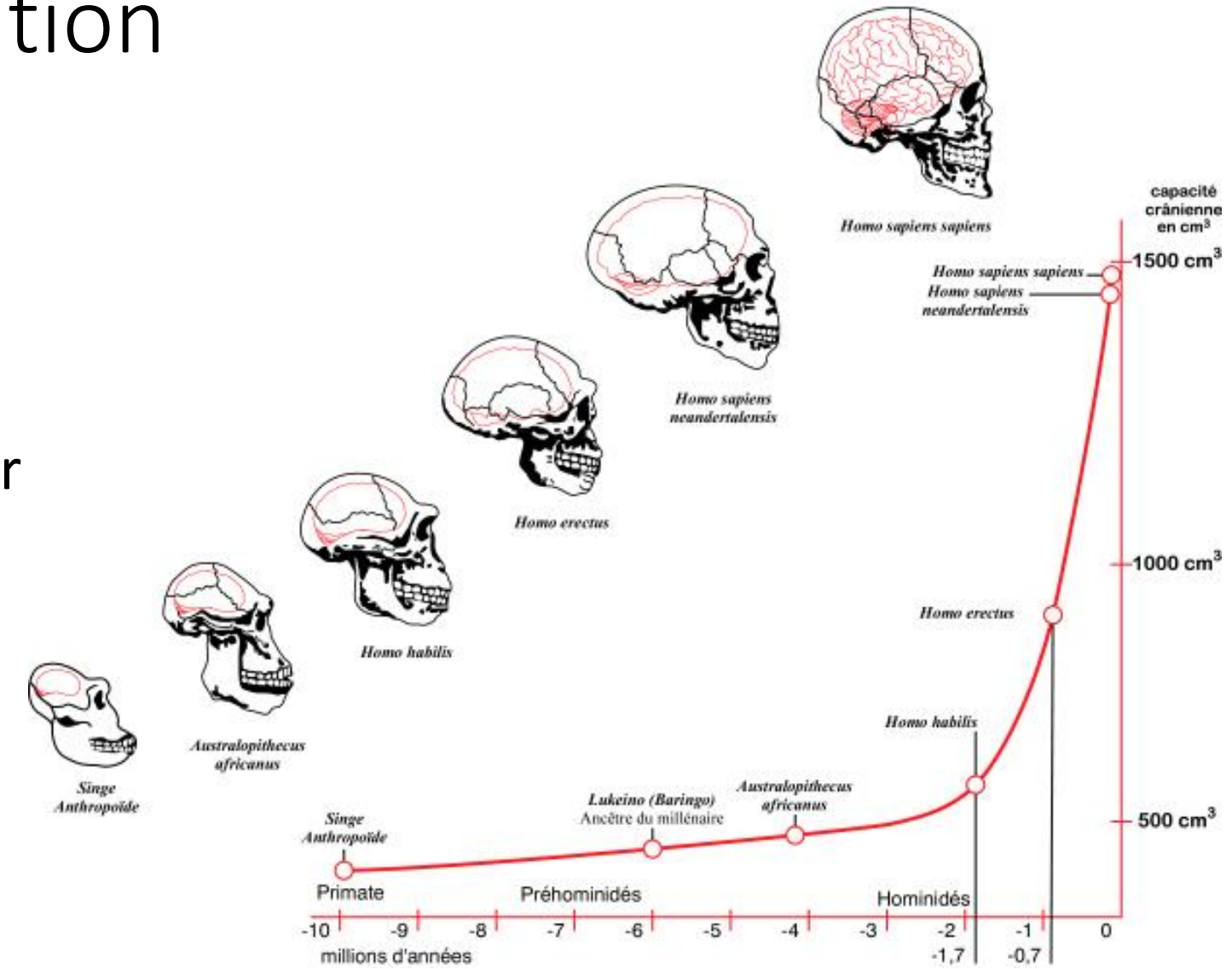
Human Brain Evolution

- Human brain evolved for collecting (perception) and processing (cognition) information
- Significant larger and denser brains over time
- Further human brain evolution will face limits imposed by Physics and diminishing returns
- Takes loooot's of time



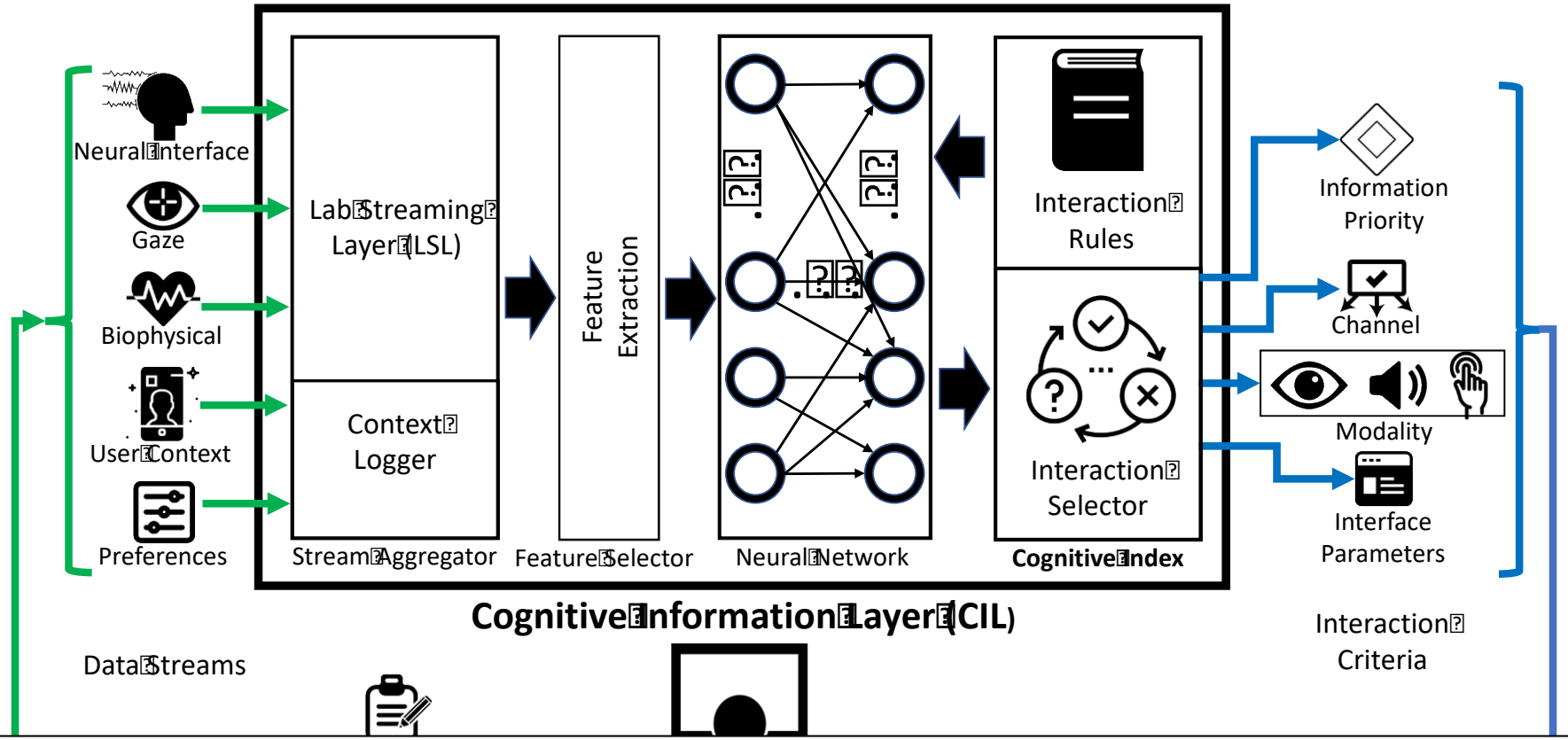
source: exposingtruth.com

The ”Cognitive Gap”

- Human brain (i.e., perception & cognition) cannot follow up with modern technologies
- Information overload with many negative effects
  - Attention deficit disorders
  - Multi-tasking illusion
  - Learning difficulties
  - Weak memory
  - Chronic stress
  - …
- Why? Due to the ”Cognitive Gap”:
  - The machine side has no clue about the user’s current cognitive state (i.e., state of cognitive processes)
- Can we bridge the ”Cognitive Gap”?

icons: thenounproject.com

The envisioned Cognitive Information Layer (CIL) architecture



Niforatos, E., Vourvopoulos, A., & Langheinrich, M. (2017, September). Amplifying human cognition: bridging the cognitive gap between human and machine. In *Proceedings of the 2017 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2017 ACM International Symposium on Wearable Computers* (pp. 673-680). ACM.

icons: thenounproject.com

Challenges

- Technical
  - Heterogeneous stream synchronization
  - Accurate cognitive state classification
  - Suitable interaction criteria for each cognitive state
  - Typical everyday applications need to become ”cognition-aware”
- Major reform in software design and development
- Sensory hardware still expensive and socially unacceptable (e.g., EEG)
- Privacy issues
- Policies for designing and developing cognition-aware applications

Epilogue

- Human brain evolution has reached its apex and cannot keep up with technology
- Human-machine convergence may be the only way forward
- Wearable sensing technologies become more pervasive
- OS integration is highly probable in the future
- A framework for supporting cognition-aware applications
- CIL for rectifying the competition of applications over our cognitive capacities

Thank you!

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