(2-F-56) Histogram of Gradient Orientations of Signal Plots applied to Brain Computer Interfaces

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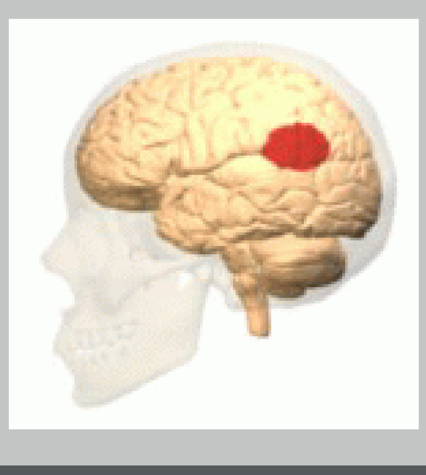
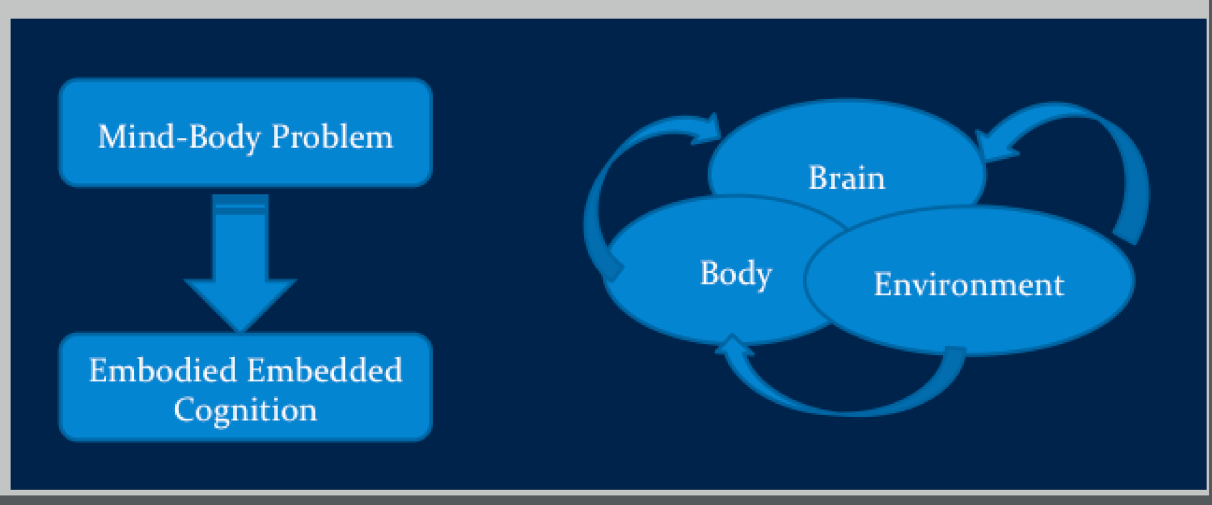
Introduction

- **Where are the waveforms?**
  - Through the last fifteen years, many successful projects have proved the feasibility to transfer information from the Central Nervous System to a computer, machine or robot.
- **BCIs are even now being considered an important branch of Human Computer Interaction.**
  - Games, Neuromarketing, Neuroergonomy, lie detection, biometric security, telepresence.
- Although, this widespread usage, the key aspect of BCI still lies in its support into **Assitive Technologies**.
  - However, there are many challenges ahead that need to be tackled: *"we yet have an impractical and inaccessible exotica for very specific user groups"*([5])
  - We need **New mental paradigms** and **to get out of the lab into the real world!**

Histogram of Gradient Orientations

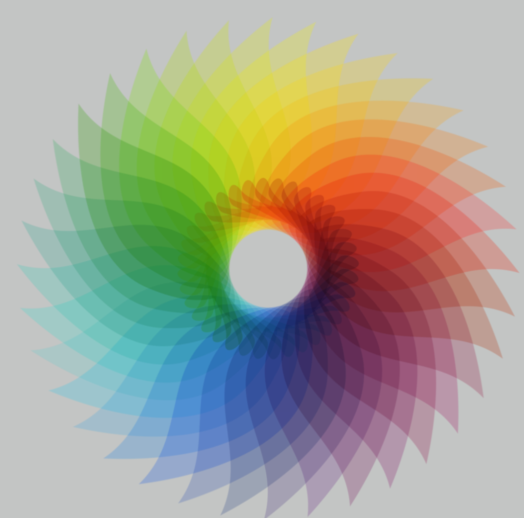
- Cognition is not strictly located within the physiological borders of the brain.
- Intelligent behaviour emerges out of the interplay between brain, body and world. Cognition is predominantly Active and Multisensorial [1,3]
- Spatial Localization: the Tempo Parietal Junction is involved in processes of self-localization, self-identification and is related to the situatedness of agents in their environments.
  - We want to verify that if cognition relies strongly on the interaction with the environment and the agent's sensorial loop, then there must be a noteworthy signal feature strong enough to be detected by non invasive EEG.
  - We also hypothesize that this signal could be modulated to effectively transmit volition.



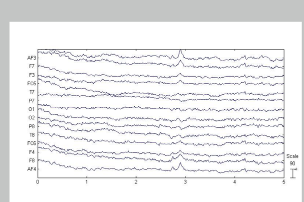


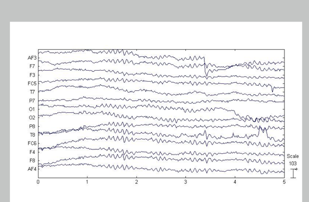
Visual Spatial Covert Attention and α waves

- Alpha (8-13 Hz) waves are an inhibitory signal and are stronger on cognitive idle states when there is an absence of interaction with the environment.
- Inside the practical bandwidth of EEG signals (0-40 Hz).
- Affordable in the terms of Cost, with Wearable Commercial Devices (i.e. EPOC Emotiv).



- **Protocol**
  Subject is instructed to count the number of flashes on the sides of an image. Gazing not allowed ! [4]
  Flickering light on both sides of the screen at random frequency rates (similar to Oddball paradigm). 16 trials, $T = 4s$ each.
  15 healthy voluntary subjects were recruited.
- **Analyze Method**
  EEGLAB, BCILAB, Matlab, fieltrip

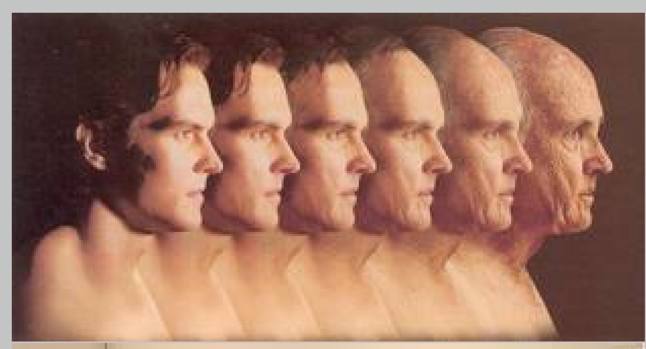




  - CSP, band-pass filter to 8-13 Hz.
  - PSD over each channel
  - Estimation of winner channel: Left or Right?
- **Current Results**
  - Estimating flickering side: very high error rate: 42 % !
  - Is the device accurate ? Next: gaze tracker, EOG detection, CSSD.
- Work in Progress !!!

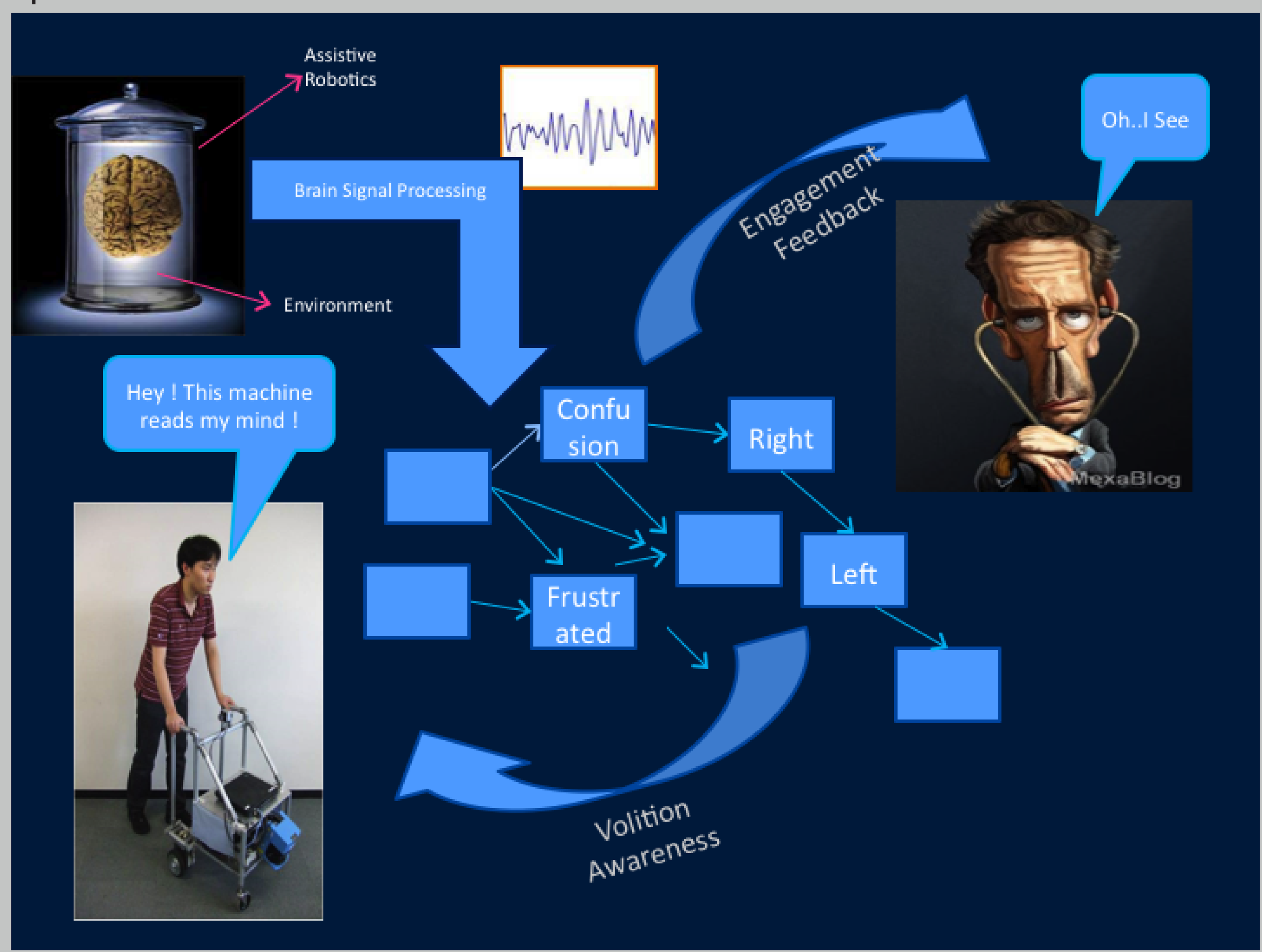
Motivations

- Aging Societies
  - Estimated for 2025, 800 millions people will be over 65 old.
  - 2/3 of them on "developing" countries.
  - Increased tendency to develop diseases that affect motor pathways.
- Through technology, provide a better quality of life for more people.
  - Specially for those affected by diseases or disabilities.
- Active lifestyle: enhance mobility.
  - Ability to walk independently is a key indicator of psychological and physical health.
- Digital World demands more methods of interactions.
  - We need more mechanisms to interpret our surrounding world and to translate our intentions through our digital gadgets.



Cognitive Monitoring BCI application for Assitive Robotics

- **Objectives**
  - Develop a Cognitive Monitoring Non-invasive BCI mobile device.
  - Real Time, Online, Single Trial, Active, Wearable,
  - It will assist both, subjects with limited but remanent walking abilities, and their therapists, by providing valuable feedback in rehabilitation procedures.



- **Research Questions: Work in progress**
  - Does an Active BCI-powered assistive device allows better controllability and maneuverability?
  - Is it possible to use Passive BCI (e.g. without user awareness) to enhance the safety of an assistive walking device ?
  - Rehabilitation procedures are improved by using a Cognitive Monitoring BCI device ?
  - Is it possible to achieve an improved BCI device in terms of Cost, Throughput, Utility, Integration and Appearance ? [6]

References and Previous Works

1 Clark, Andy. Supersizing the Mind: Embodiment, Action, and Cognitive Extension: Embodiment, Action, and Cognitive Extension. Oxford University Press, 2008.
2 A. Cherubini, G. Oriolo, F. Macri, F. Aloise, F. Babiloni, F. Cincotti, and D. Mattia. Development of a multimode navigation system for an assistive robotics project. *Proceedings 2007 IEEE International Conference on Robotics and Automation*, pages 2336–2342, April 2007.
3 Ionta, Silvio, Roger Gassert, and Olaf Blanke. Multi-sensory and sensorimotor foundation of bodily self-consciousness–an interdisciplinary approach. *Frontiers in psychology 2 (2011).*
4 Bahramisharif, Ali, et al. "Lateralized responses during covert attention are modulated by target eccentricity." *Neuroscience letters* 491.1 (2011): 35-39.
5 Tan Desney S. (Editor), Nijholt Anton (Editor) et al, *Brain-Computer Interfaces: Applying our minds to Human-Computer Interaction*,2010, Springer
6 Allison, Brendan Z. "Toward ubiquitous bcis." Brain-Computer Interfaces. Springer Berlin Heidelberg, 2010. 357-387.