Four Hospitals, One Trust, One vision

Oxford University Hospitals NHS
NHS Trust

The Power of Thought

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Presentation summary

- Rob Lievesley
  - Overview of BCIs
  - Achievements of and developments of BCIs
  - Suitability of BCIs for AT
- Emlyn Clay – OpenVivo
  - Demonstration of intendiX

Section 1: Overview of BCIs

- What is a BCI
- How detect intentions at the brain
- EEG

What is a BCI?

- Brain Computer Interface

BCI

What is a BCI?

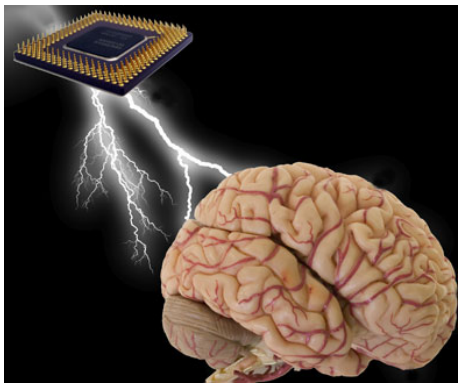
- Brain
  - We make conscious decisions
  - Intentions sent via nerves
  - Movements made with muscles
- If something goes wrong
  - Brain functions perfectly
  - Unable to control movements
  - Locked in
- Detect intentions at brain
  - Send to computer
  - From there
    - Wheelchairs, environmental controls, communication, prosthetic arms…

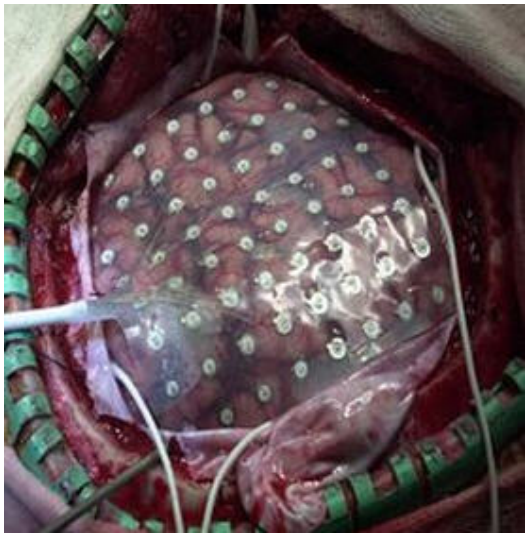
How detect intentions at brain?

- 100 billion neurones in brain
- Electrical signal when each fires
- EEG (ElectroEncephaloGraphy)
  - Invasive
  - Non-invasive

Invasive detection

- Electrode array implanted directly on brain
  - More precise understanding of what happens at brain
  - Requires brain surgery





Non-invasive detection

- Surface EEG

Surface EEG

- Electrodes on scalp
  - Each electrode detects electrical signal from billions of neurones
  - Electrical signal is very small at scalp

Summary of Section 1

- BCIs (Brain Computer Interfaces) aim to
  - Detect intentions at the brain
  - Send them to computer
  - Use to control AT devices
- Most suitable method is currently Surface EEG

Section 2: Achievements and developments of BCIs

- Methods of interpreting EEG signal
  - Sensorimotor Rhythms
  - P300 signals
- Control of AT devices
- Commercial developments

Sensorimotor Rhythms

- Recorded near motor and sensory areas of brain
- Relies on visual imagery
- Requires training

Sensorimotor Rhythms

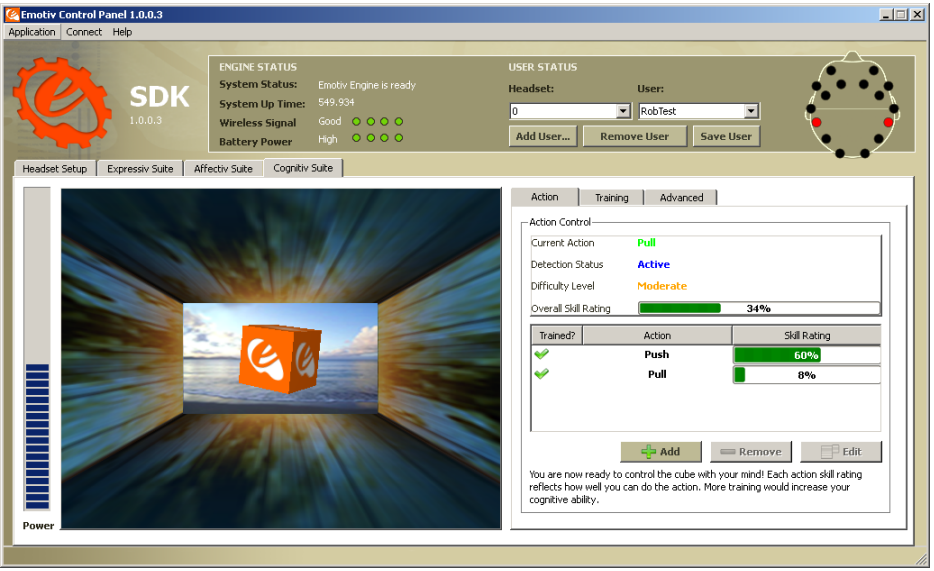
- Toyota / Rikken group video

Sensorimotor Rhythms

- Users think “left” or “right” 100 times each
- BCI system learns to distinguish between these two thoughts
- 6 healthy subjects drive wheelchair to endpoint on left or right
- 80% success

Tanaka K, Matsunaga K, Wang H (2005) *Electroencephalogram based control of an electric wheelchair*, IEEE Transactions on Robotics, 21(4) p762-6.

Sensorimotor Rhythms



Sensorimotor Rhythms

- EPOC Neuroheadset (Emotiv, USA)
- $299
- MSc project
  - 3 non-impaired subjects had 95% success in choosing between “push” and “neutral” after 1 week

P300 Evoked Potentials

- Peak in EEG signal
- 300 ms after stimulus presented
- Signal evoked automatically - no training required

P300 Evoked Potentials

Section 2 Summary

- There are methods of determining intent from EEG signal
- Demonstrated ability to:
  - Spell
  - Drive wheelchair
- Commercial products are appearing
  - Often cost effective

Section 3: Suitability of BCIs for AT

- Negatives
- Positives

Negatives

- Difficult to set up
- Slow to make a selection
- Relatively unreliable
- Relatively slow progress
  - 25 years old
  - Moore's law – computer processor power doubles every 2 years

Negatives

- Target audience – locked in syndrome?
  - Eye gaze
  - Switch access / eye blink
- Sensorimotor – locked in syndrome
  - Motor imagery difficult?
  - Training effort difficult?

Positives

- Popular equipment
  - Starting to come out of research labs
  - Mass production reduces costs
- European projects
  - TOBI – (Tools for Brain Computer Interaction)
    - P300 Brain painting
    - Document browsing
  - DECODER
    - Detect consciousness
    - Provide Yes / No response

Positives

- Auditory P300
- Enormous potential
  - Prosthetic arm
  - Human trials
  - Word detection

intendiX demo