Presentations & Demos of the "Curiosity Cloning" Project

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Presented at the Workshop on "Brain Machine Interfaces for Space Applications: Enhancing Astronaut Capabilities", European Space Agency, Noordwijk (The Netherlands)

Introduction

- **BCI rapidly expanding area**
- **Utilises specialist hardware**
- **Consumer (< $1000 USD) -> Professional ($50k+)**
- **DCU's focus:**

What can be achieved with approx $1000 USD hardware?

Overview

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- Apparatus
- Experimental Methodology
- Experimental Outcomes
- Conclusions

Apparatus

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- EEG Equipment:
- 'Pendant EEG' - http://www.pocket-neurobics.com/
- 2 Channel device, 254 Samples Per Second, 12-bit resolution. Operation is wireless, with USB receiver.
- 'Daisy-Chained' 2 devices together to create 4-node device, with joint mastoid reference.
- Custom written device driver.

Apparatus


Dev 2
Dev 1
Pendant EEG


Pendant EEG
Pocket-Neurobics.com
2-
2+
N
1-
1+
3. When green light appears depress the lever and open the door.
A red light needs staff assistance.
Please hand back to reception on check-out.

Experimental Methodology

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- For Oddball style experiments, subjects required to count number of oddballs observed.

- Subjects asked to look at fixation cross on screen, remain still and to refrain from blinking where comfortable.

- Expert advice: Node placements according to 10-20 system, at sites Pz, Cz, P3 and P4. Intention to capture most data from P3 ERP.

Experimental Methodology

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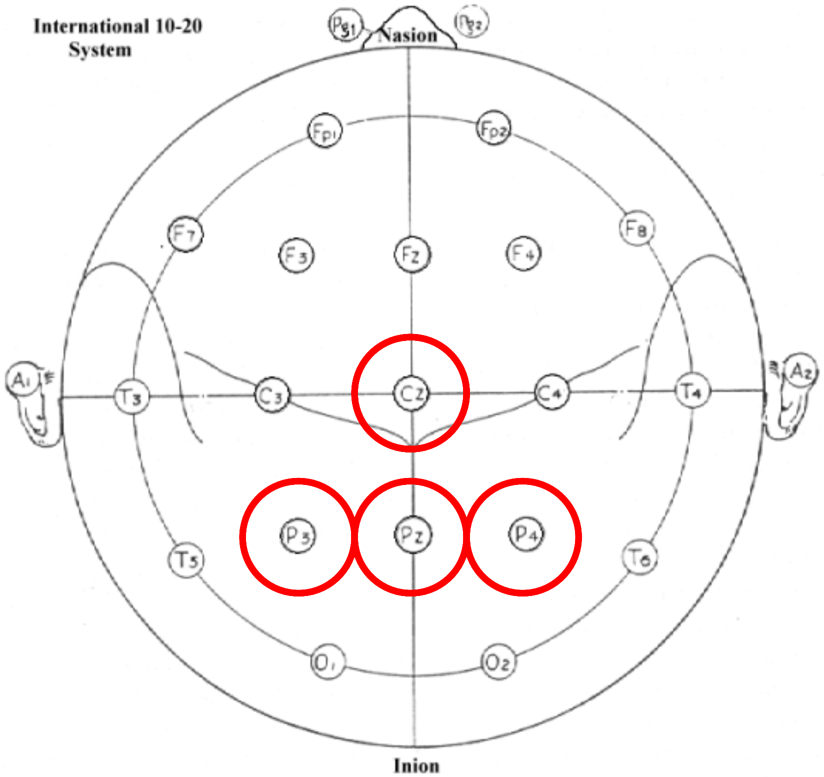

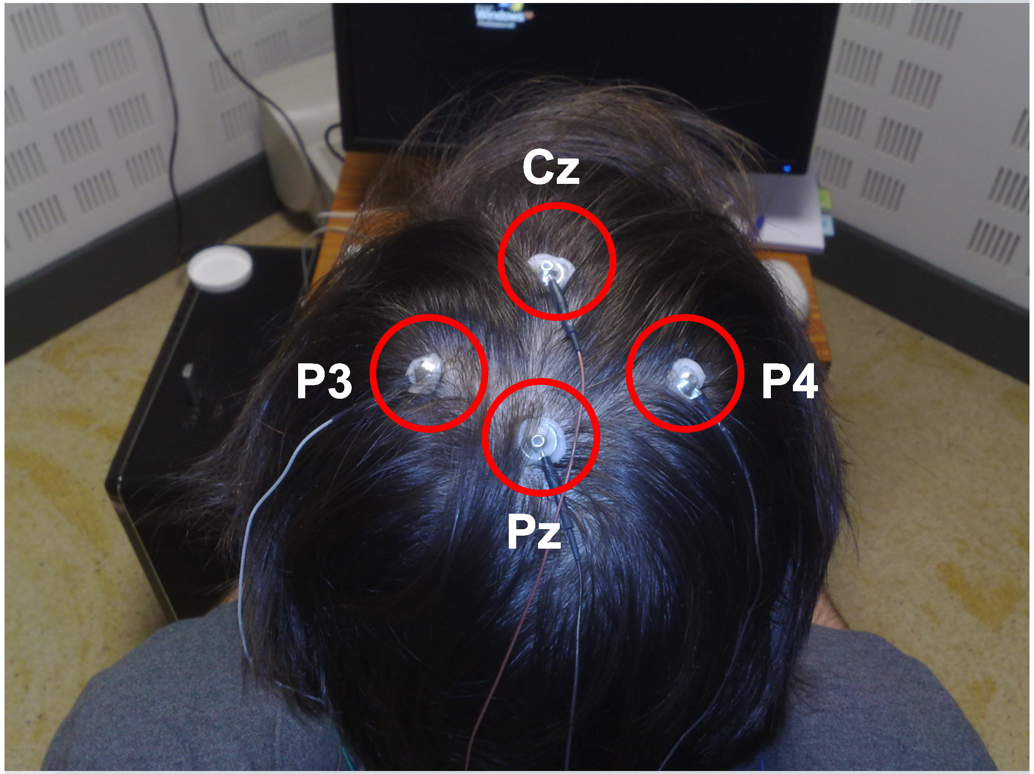

Experimental Methodology

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- Signal Processing (per channel), generalized approach for cross-subject application:

- Bandpassed 0hz-14hz, region 220ms-810ms, 14 samples.

- FFT from region 220ms-620ms, 5 features extracted in range 1hz-15hz, 3hz steps.

- Low frequency sampling in range 0hz-5hz for region 220ms – 1000ms, 5 features extracted.

- Total features per channel: 24. Total features: 96.

- Time offset is from stimulus presentation time.

Experiments

- **'Reliability vs. Speed'**

– See how far we can push a 4 node setup.
– Stimulus presentation rates 500ms -> 50ms.
– Dataset: ESTEC Rocks, Subjects: 4

- **'Expert vs. Non-Experts'**

– Determine if it was possible to detect 3 classes of image, oddball, non-obvious oddball, non-oddball.
– Dataset: Nanomaterials Images (similar visually to heatmap).
– Subjects: 6 (5 'non-expert', 1 'expert' (ACT-ESA)).

- **SenseCam**

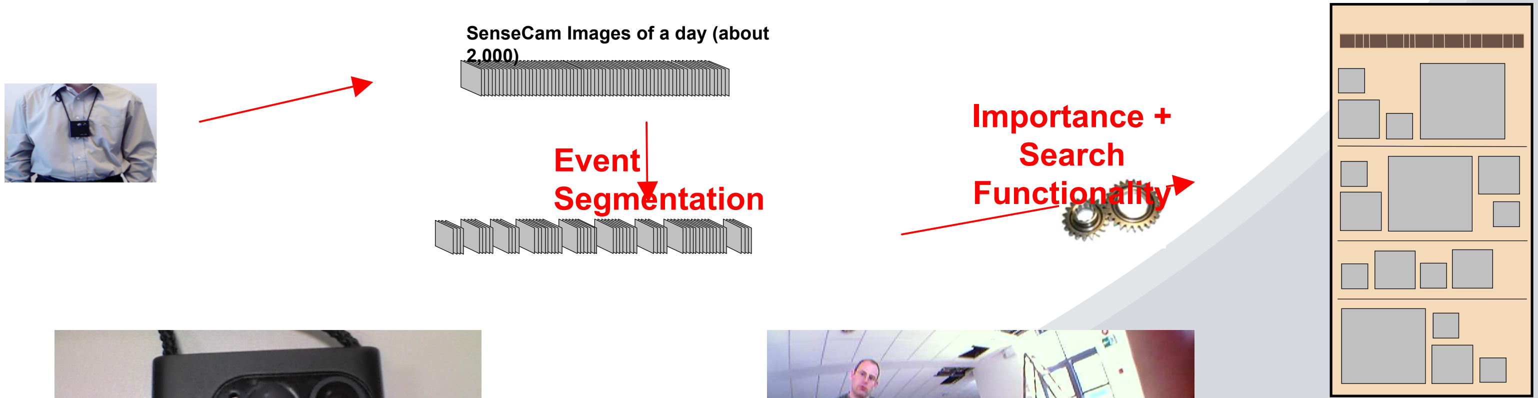
– Similar to previous, determine differences in detection between 'expert' & non-expert, but on natural images.
– Dataset: SenseCam images from one subject.
– Subjects: 5 (4 'non-expert', 1 'expert' (DCU)).

SenseCam

SenseCam

– SenseCam personal wearable camera, capturing up to 3000 personal images per day.

– Presents information management research challenges, involving event segmentation, indexing and retrieval



Evaluation

Two fold evaluation criteria:

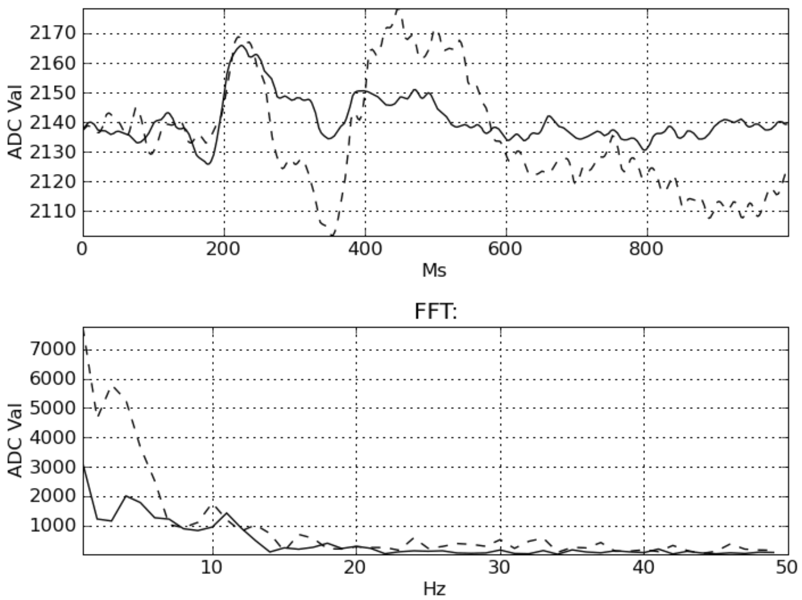
1. Creation of 'Grand Average' ERP signatures, to determine if we are capturing responses to different stimulus.

2. Creation of discriminative classifiers (SVM) to determine if signals can be captured and classified on 4 node setup. Evaluation metrics AUC & ROC.

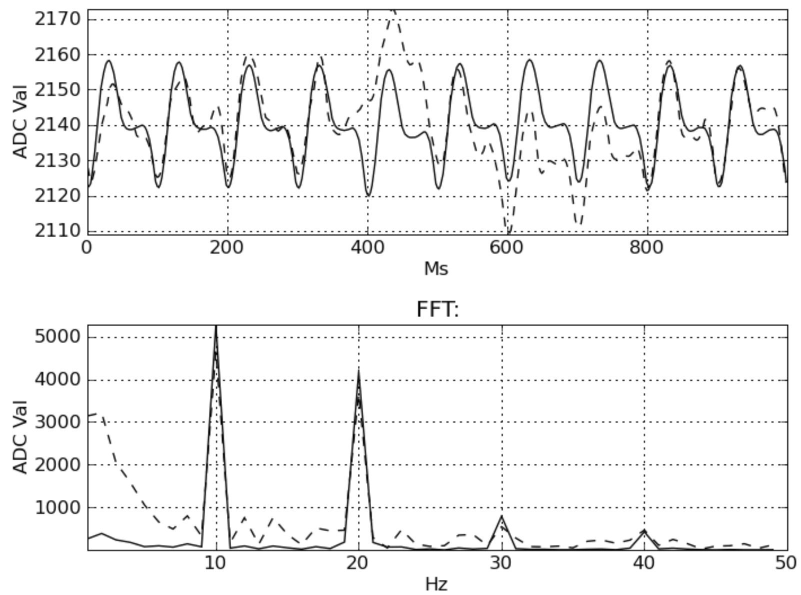
Results

Reliability vs. Speed:

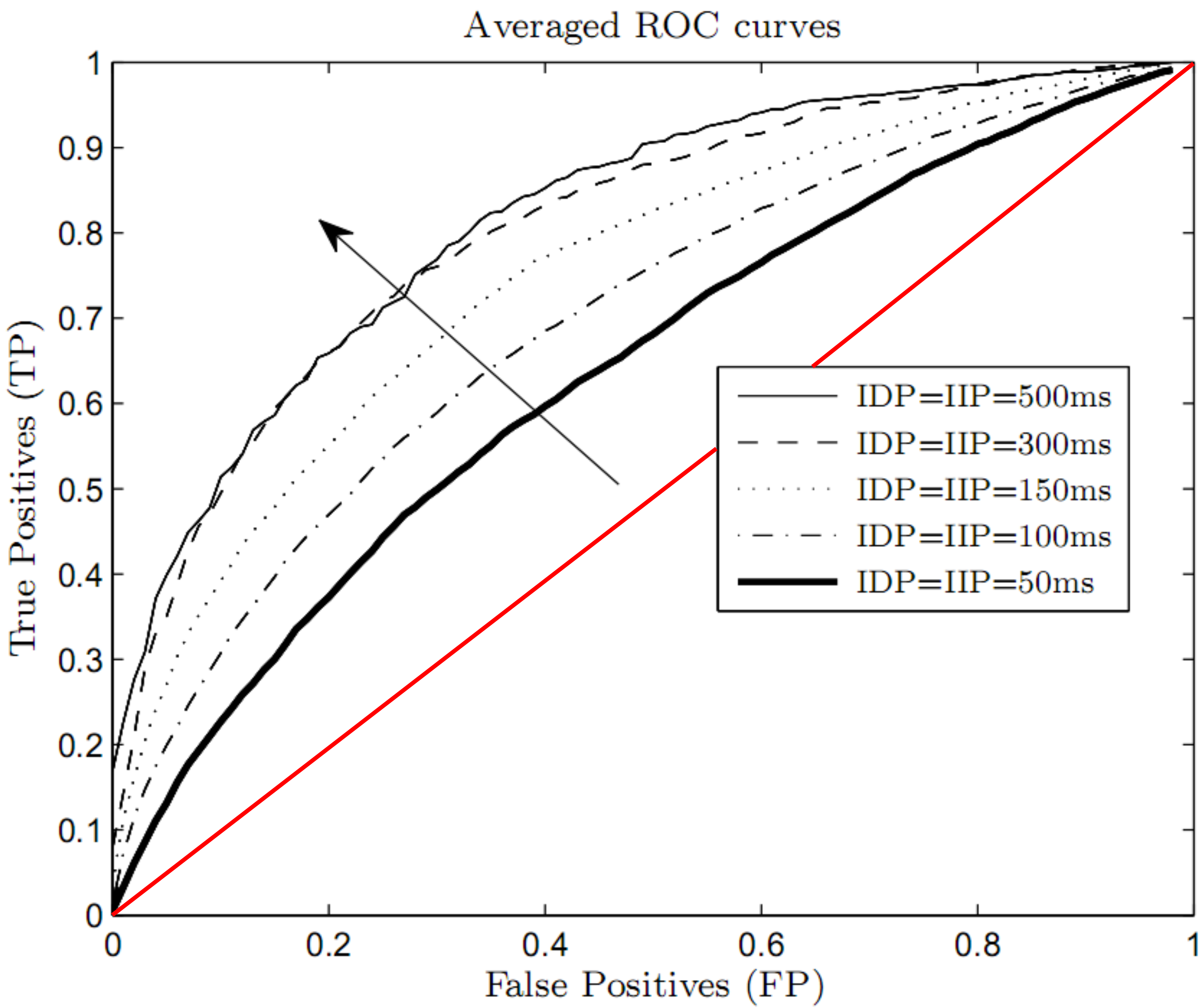
Grand Averages – dashed line = oddball stimulus.



Subject ‘a’: 1000ms



Subject ‘b’: 50ms


Averaged ROC curves
True Positives (TP)
False Positives (FP)
IDP=IIP=500ms
IDP=IIP=300ms
IDP=IIP=150ms
IDP=IIP=100ms
IDP=IIP=50ms
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
0.2
0.4
0.6
0.8
1

Results

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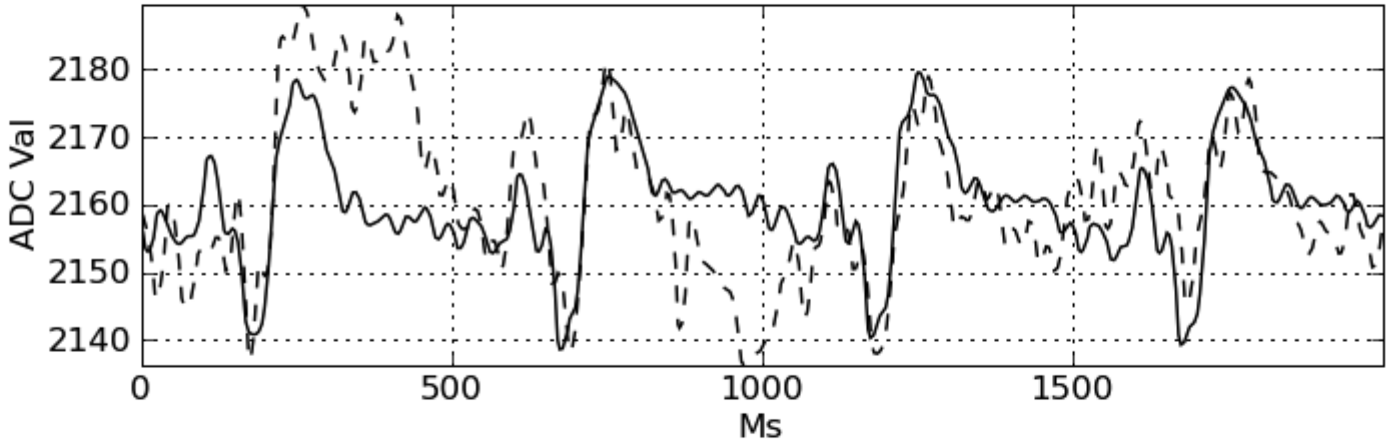
‘Expert vs. Non-Experts’

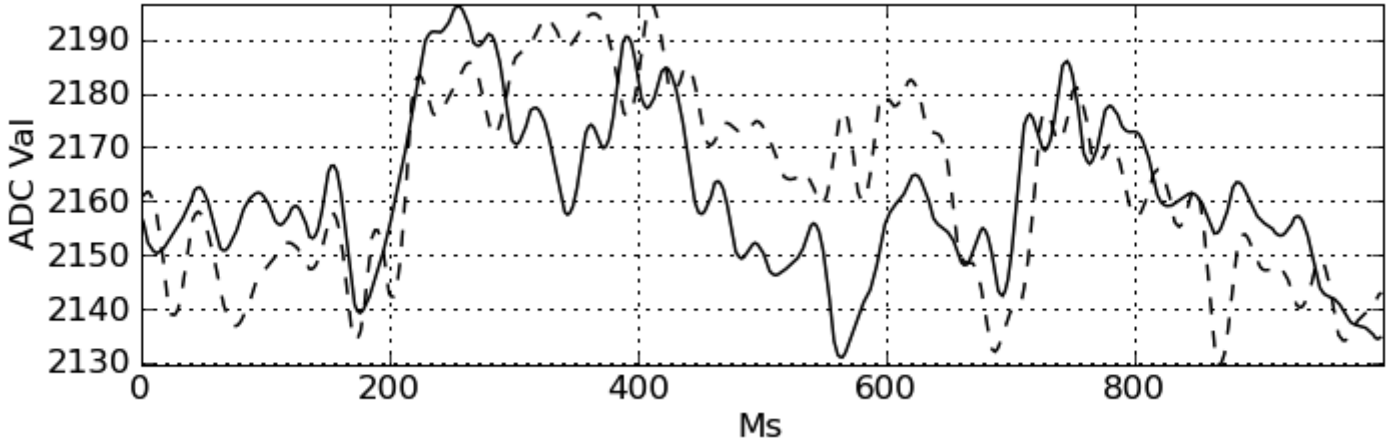
• 3 Classes of stimulus, oddball, non-obvious oddball, non-oddball.

• Of 6 subjects, the expert & 2 non-experts able to distinguish 3 classes, based upon grand averages.

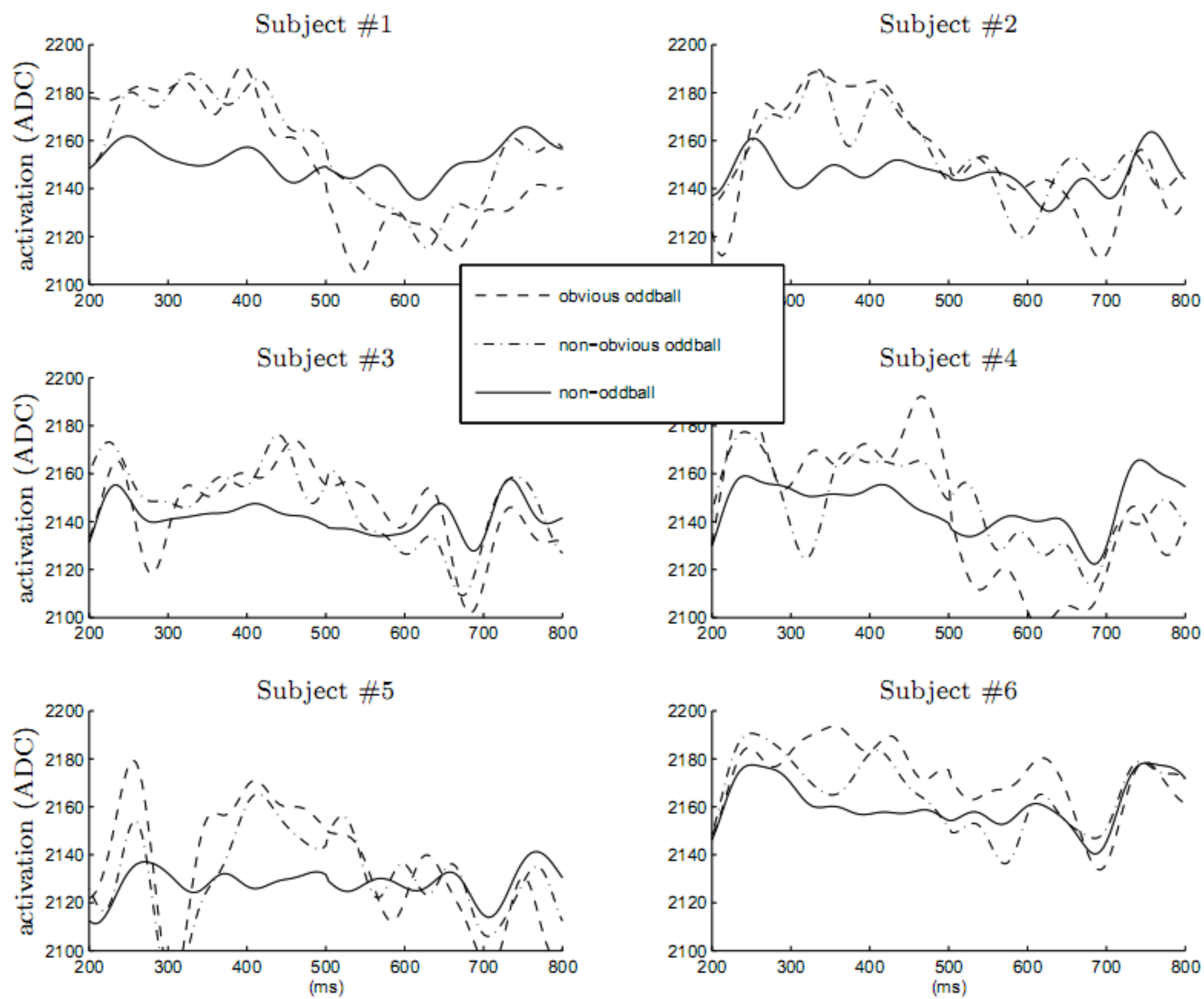
• Classification accuracy for these 3 subjects around 0.61-0.64 AUC – for remaining 3 performance close to random.



Expert Subject: Oddball vs. Non-Oddball



Expert Subject: Oddball vs. Non-Obvious Oddball


Subject #1
Subject #2
Subject #3
Subject #4
Subject #5
Subject #6
activation (ADC)
(ms)
obvious oddball
non-obvious oddball
non-oddball

Results

SenseCam Experiments:

- More difficult than anticipated.

- Generation of multiple ERP's such as N170 generated in response to faces, hampered classification as could be detecting different ERP's.

- More careful selection of dataset.

- Resolution of more nodes would be useful.

Conclusions

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- 4 Node setup is capable of capturing 'Oddball' stimulus events, ideally around 300ms.

- Generation of data for classification requires careful experimental parameter selection.

- Is theoretically possible to capture the differences between subjects as to what is of interest, aka 'curiosity cloning', however is dependent on dataset.

- Great variability between subject – long term goal to create generalized classifier.