Brain Computer Interface (BCI)

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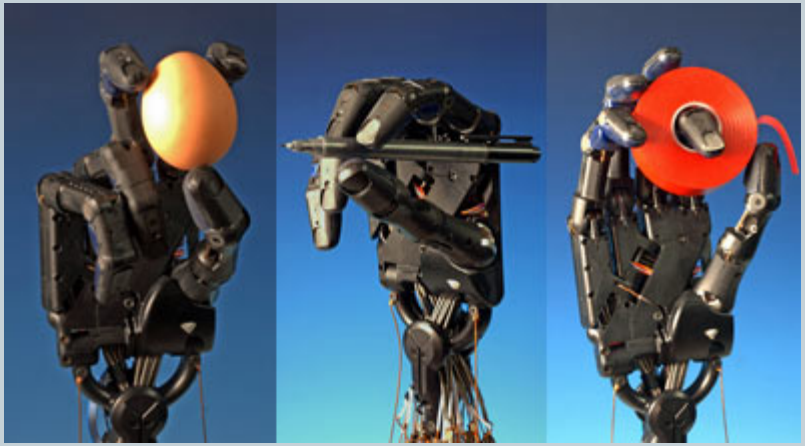
Overview

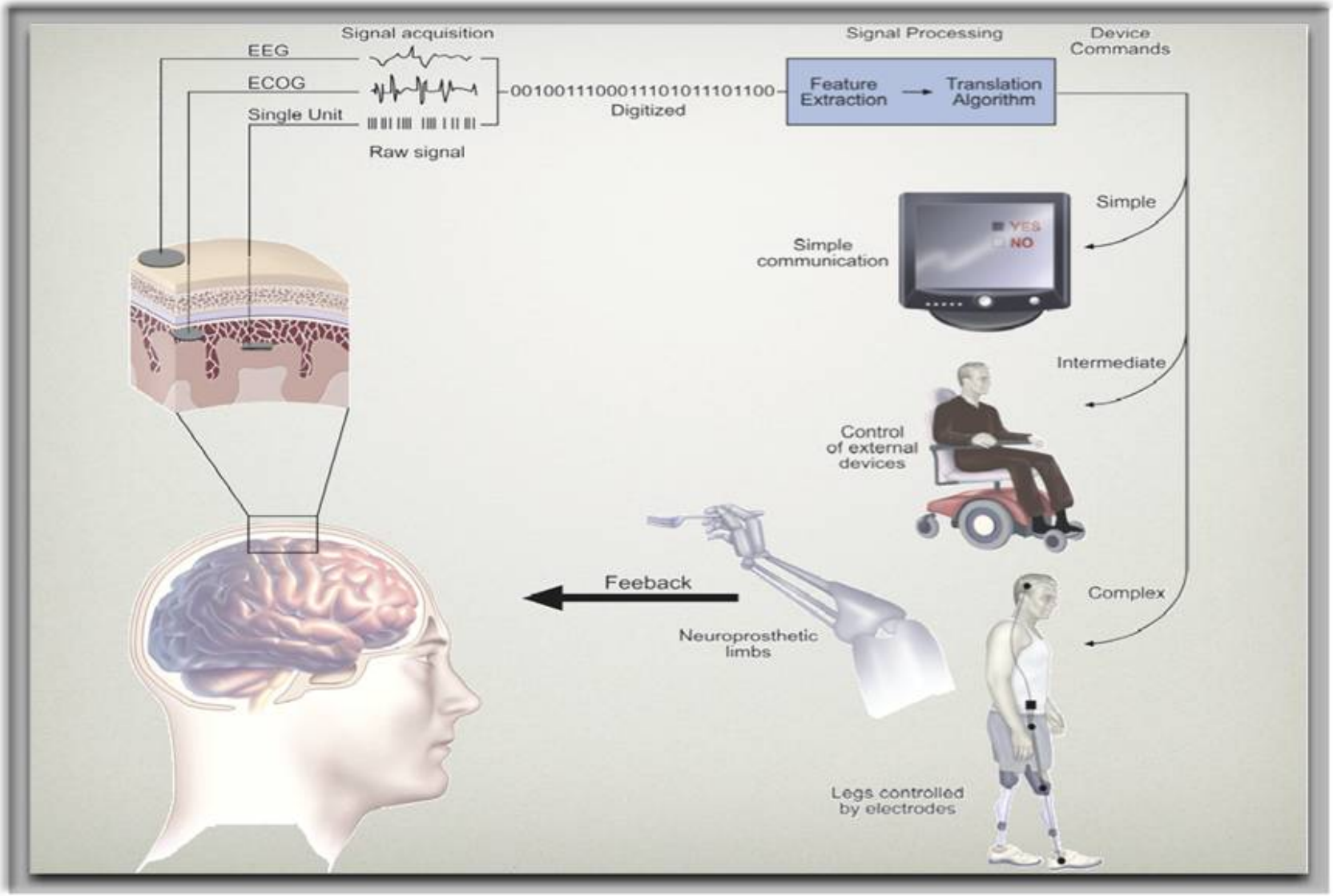
- Neuroprosthetics
- Paralysis/severe motor disabilities
  - Records neural activity from specific brain regions
  - Info converted for limb prosthetics
- Brain signals, processing methods, applications



Forbes.com

Goal: Improve speed & efficacy

Hope: Restore limb functions to paralyzed patients


Signal acquisition
EEG
ECOG
Single Unit
Raw signal
0010011100011101011101100
Digitized
Signal Processing
Feature Extraction
Translation Algorithm
Device Commands
Simple
Simple communication
YES
NO
Intermediate
Control of external devices
Complex
Feeback
Neuroprosthetic limbs
Legs controlled by electrodes

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EEG vs. ECoG

- Surface of scalp
- No surgery required
- High interference
  - Twitching, blinking
  - Alternating current (60 Hz) - Power lines

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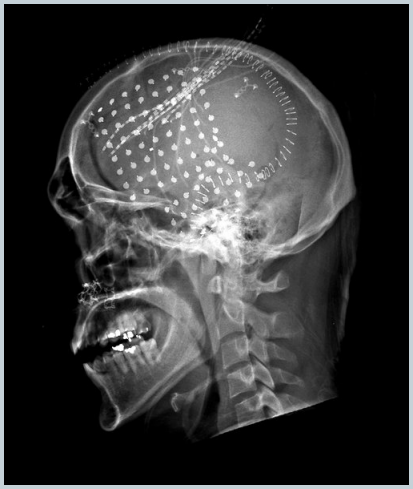
- Surface of brain
- Detect smaller neuron regions
- Invasive



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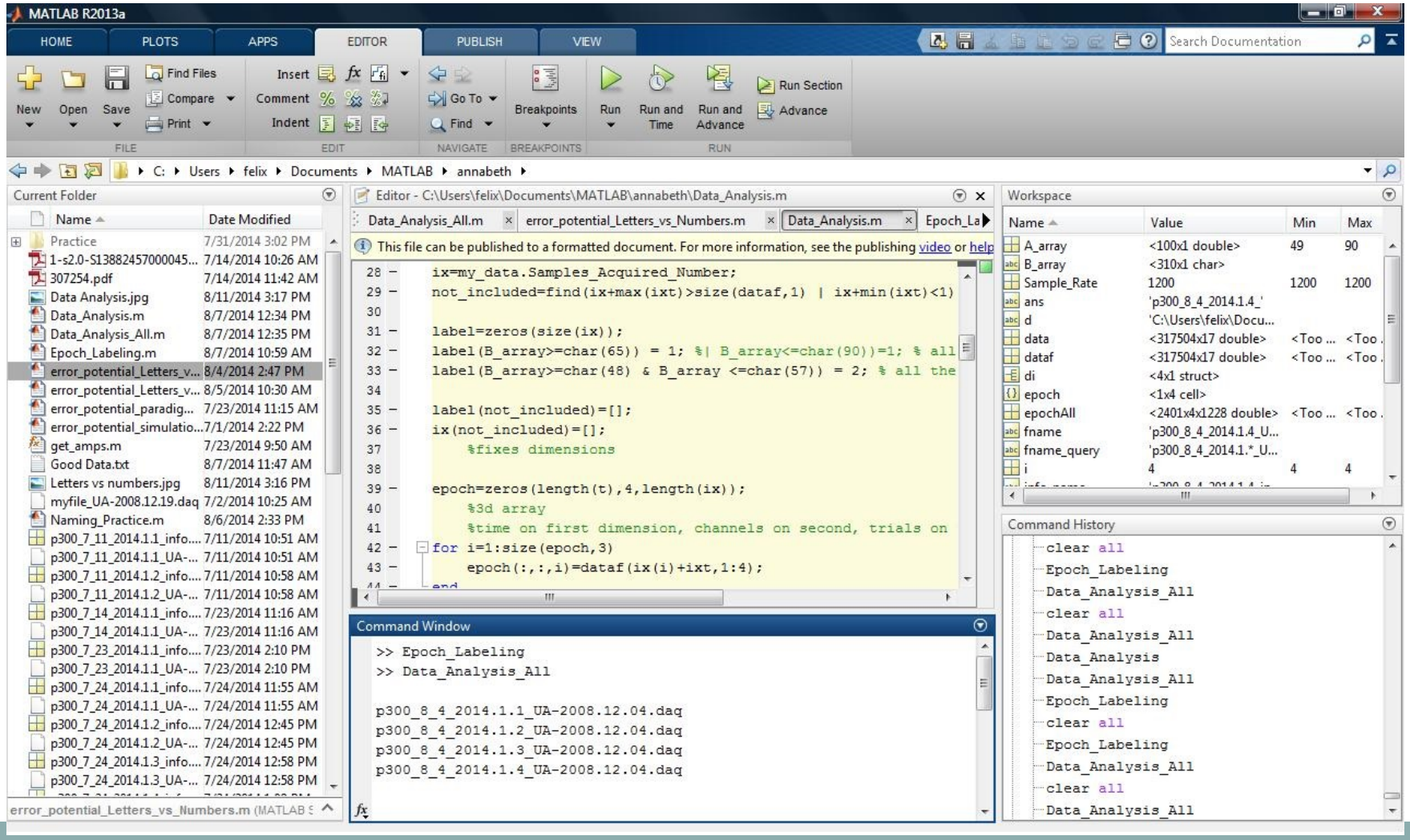
MATLAB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p300_7_24_2014.1.3_UA-... 7/24/2014 12:58 PM
error_potential_Letters_vs_Numbers.m (MATLAB
Editor - C:\Users\felix\Documents\MATLAB\annabeth\Data_Analysis.m
Data_Analysis_All.m
error_potential_Letters_vs_Numbers.m
Data_Analysis.m
Epoch_La
This file can be published to a formatted document. For more information, see the publishing video or help
28 ix=my_data.Samples_Acquired_Number;
29 not_included=find(ix+max(ixt)>size(dataf,1) | ix+min(ixt)<1)
30
31 label=zeros(size(ix));
32 label(B_array>=char(65)) = 1; %| B_array<=char(90))=1; % all
33 label(B_array>=char(48) & B_array <=char(57)) = 2; % all the
34
35 label(not_included)=[];
36 ix(not_included)=[];
37 %fixes dimensions
38
39 epoch=zeros(length(t),4,length(ix));
40 %3d array
41 %time on first dimension, channels on second, trials on
42 for i=1:size(epoch,3)
43 epoch(:,:,i)=dataf(ix(i)+ixt,1:4);
44 end
Command Window
>> Epoch_Labeling
>> Data_Analysis_All
p300_8_4_2014.1.1_UA-2008.12.04.daq
p300_8_4_2014.1.2_UA-2008.12.04.daq
p300_8_4_2014.1.3_UA-2008.12.04.daq
p300_8_4_2014.1.4_UA-2008.12.04.daq
Workspace
Name
Value
Min
Max
A_array <100x1 double> 49 90
B_array <310x1 char>
Sample_Rate 1200 1200 1200
ans 'p300_8_4_2014.1.4_'
d 'C:\Users\felix\Docu...
data <317504x17 double> <Too ... <Too
dataf <317504x17 double> <Too ... <Too
di <4x1 struct>
epoch <1x4 cell>
epochAll <2401x4x1228 double> <Too ... <Too
fname 'p300_8_4_2014.1.4_U...
fname_query 'p300_8_4_2014.1.*_U...
i 4 4 4
Command History
clear all
Epoch_Labeling
Data_Analysis_All
clear all
Data_Analysis_All
Data_Analysis
Data_Analysis_All
Epoch_Labeling
clear all
Epoch_Labeling
Data_Analysis_All
clear all
Data_Analysis_All

Preparation

- MATLAB
  - Error Potential Letters vs. Numbers paradigm
    - Flashes letters/numbers
    - 400 trials (appx. 20 minutes)
  - Data Analysis
    - Analyzes & Graphs data
- Preparing for EEG
  - Cap & Electrodes
  - NuPrep – Skin Prep Gel & cleans scalp
  - Elefix – Conductive Paste & lowers impedance levels
  - Amplifier

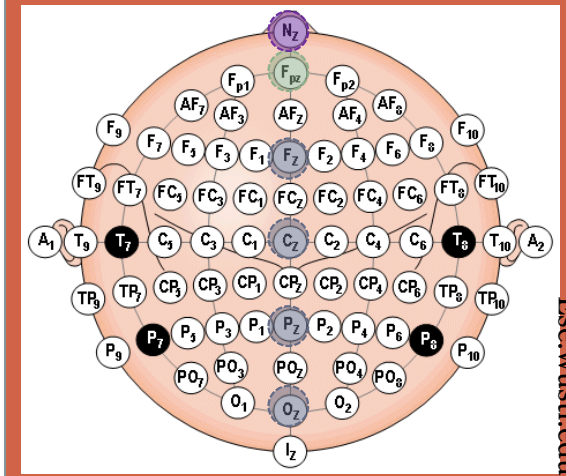
Uark.edu

Experiment

- Compare needle to surface electrodes
  - Improve signal-to-noise ratio
  - Subject must track numbers
- Evoked Visual Potential
  - Response to stimuli
- Error Potentials
  - Subject's response to unexpected result
  - Machine acts differently than user's intent
  - Occurs 400-800 ms after stimuli

Surface Electrodes

- Ground & Reference in front center
- 4 electrodes
- Impedance levels: 7-23 kOhms



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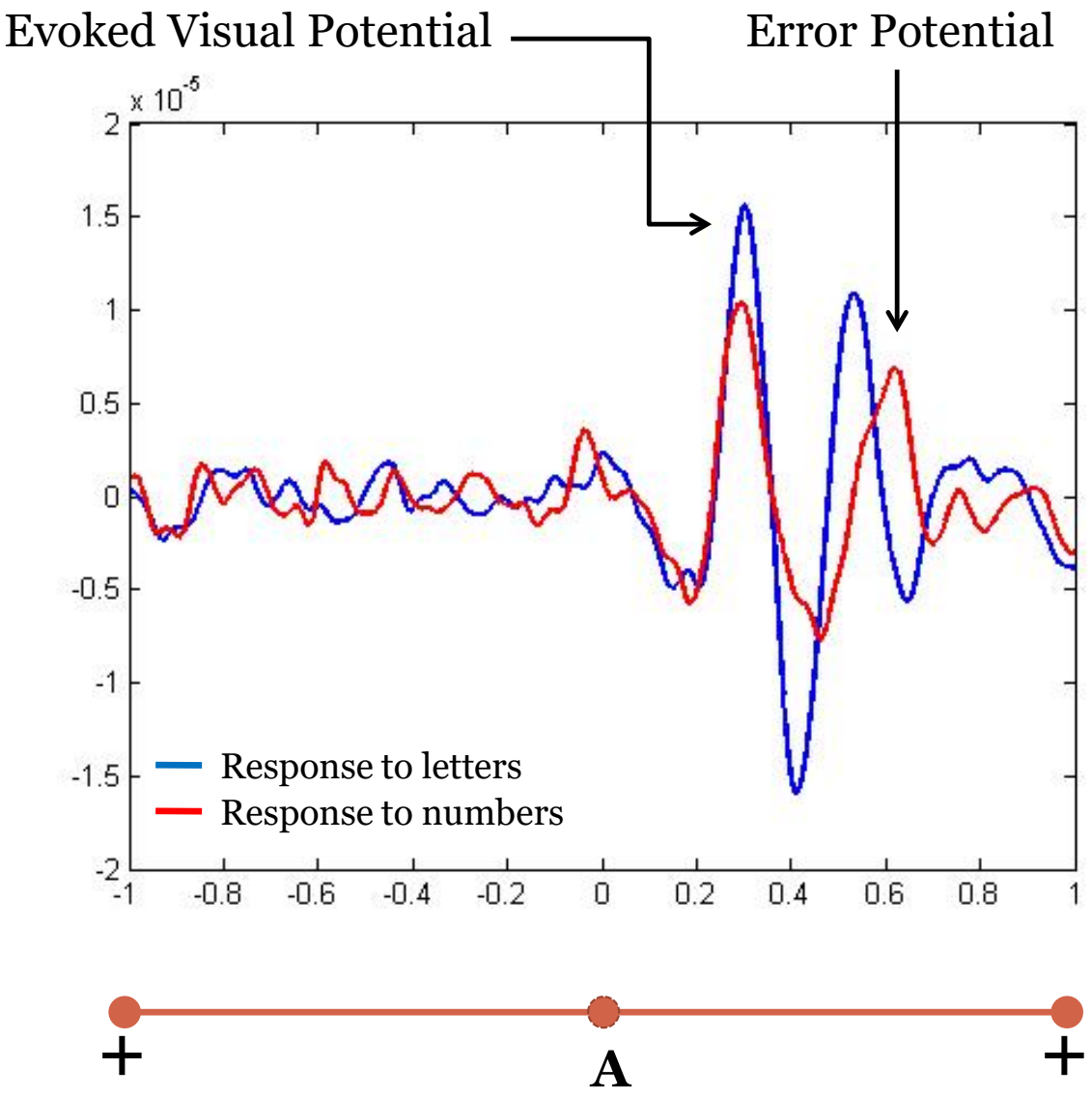
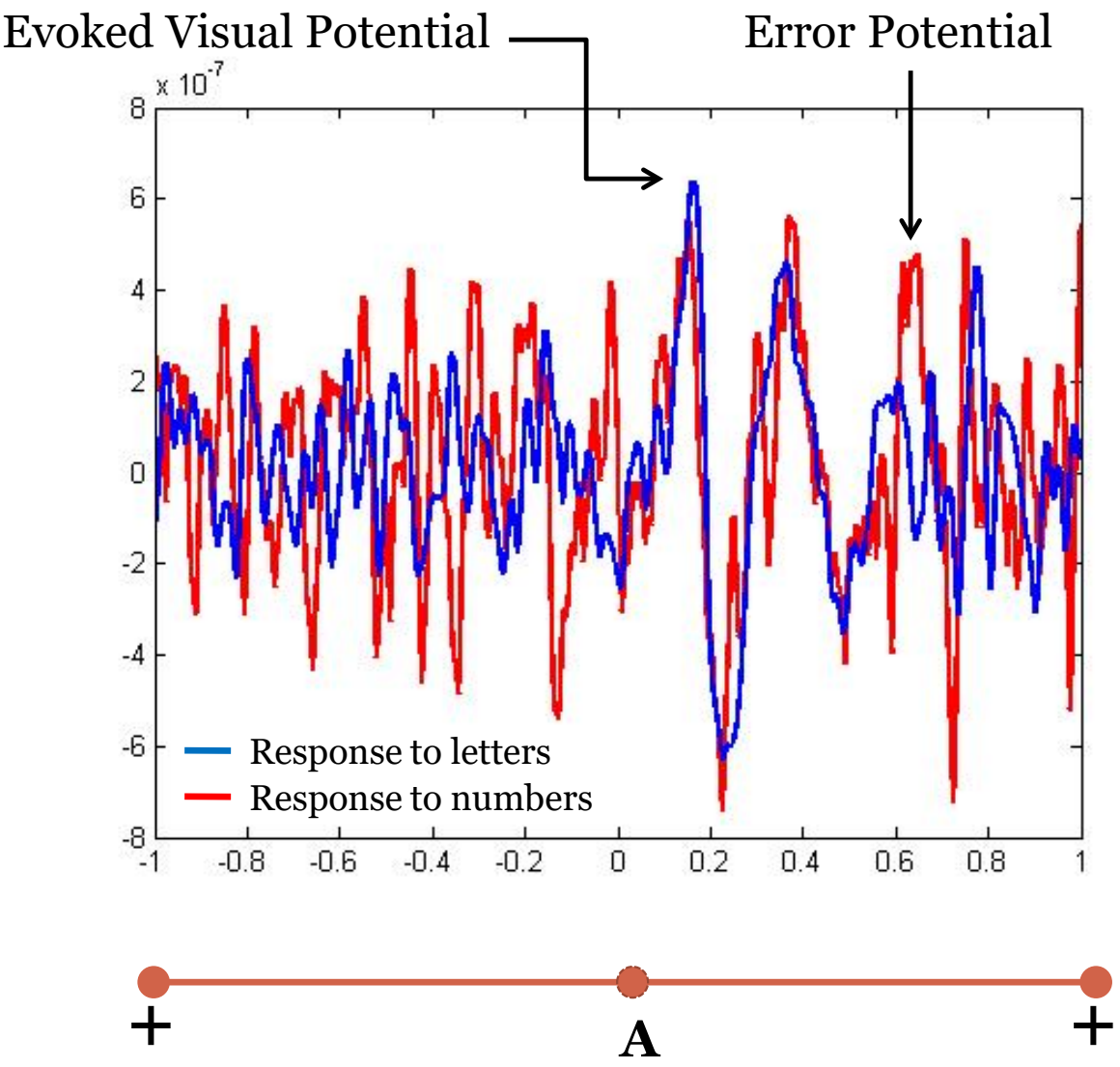


Needle Electrodes

- Ground & Reference in front center
- 9 needle electrodes
  - Grid pattern
  - Left side of head
- Impedance: 17-31 kOhms



Conclusion

- Needles collect stronger error potential
- Error potentials
  - Error recognized/avoided
  - Improve accuracy & rate of EEG communication
  - Self-correcting code for BCI
- Need more data for further conclusions