IOWA STATE UNIVERSITY
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Honors Poster Presentation
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Investigation of cognitive activity while touching textured surfaces

Background

The most popular method for quantifying skin to surface interactions is by evaluating the coefficient of friction. However, this metric doesn't give any insight into how these interactions are perceived by a human being. Researchers are turning towards EEG to understand how surfaces affect cognitive activity. Currently, researchers use electrical or mechanical pulses to stimulate the skin. The purpose of this study is to design an experiment that allows us to analyze skin to surface interactions that more closely emulate how the body interacts with the world on a daily basis, with a texture gradient instead of with pulses.

- **Electroencephalogram (EEG) -** a test that records brain wave activity by measuring the electric potential differences between neurons.
- **Event Related Potential (ERP) -** method of analyzing EEG data by isolating a stimuli and analyzing the data immediately before and after it to determine the effect of the stimuli.

Objectives

- Determine if significant cognitive activity is present in response to tactile stimulation
- Design an experiment to test whether EEG is a viable way to measure neural activity during tactile stimulation
- Decode EEG signal analysis to facilitate communication across disciplines

Methodology

- Explore EEG's signal analysis process to understand the computational methods used on the raw data
- Find material that is easily surfaced, non-conductive, with high shear strength
- Design a non-contact trigger system
- Find surfacing technique that creates a fairly rough surface without compromising material integrity
- Develop optimal sensor, surfacing and electrical layout to reduce outside EMF influence
- Create gradual but short transition zone between two surfaces

Results

Challenges:

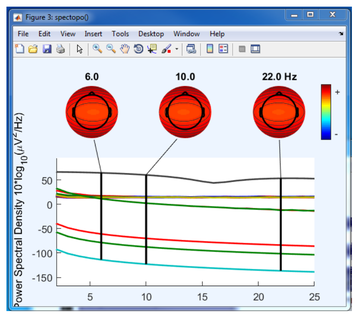
- Determining the correct reference node in EEGLab
- Balancing sensor contact area and EMF interference
  - Small area = more precise triggering but increased EMF interference
- Distinct surfacing technique that could be applied directly to the acrylic
  - Sandblasting vs. sandpaper vs. textured spray paint

Table 1. Factorial table to evaluate effects of two design variables: the sensor connection type (soldered vs. unsoldered) and depth of sensor in acrylic (notched vs. unnotched).

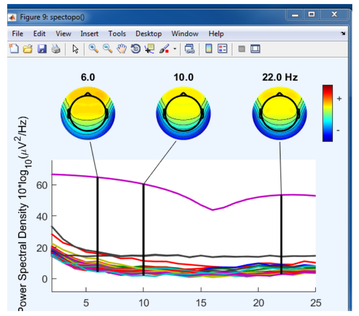
Test parameters	Number of sensor trips		
	Trial 1	Trial 2	Trial 3
Soldered, notched	10	10	10
Soldered, unnotched	0	0	0
Unsoldered, notched	10	10	10
Unsoldered, unnotched	0	0	0

Final parameters:

- **Material**: Acrylic
- **Surfacing Technique**: Textured spray paint with no prior surfacing
- **Sensor Setup**: Notched acrylic with soldered connections
- **Transition Zone**: Sandpaper spot treatment



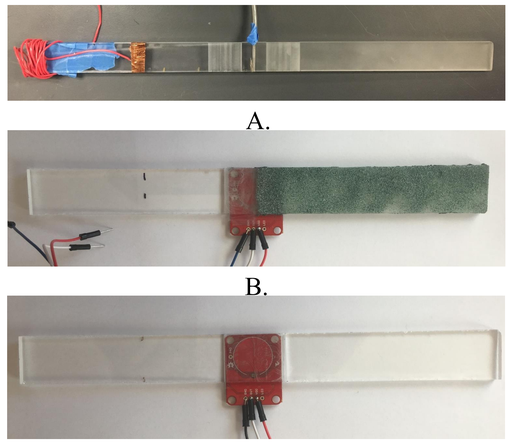
A.



B.

Figure 1. EEG data evaluated using the incorrect (A) and correct (B) reference nodes. The reference electrode is placed behind the ear and is channel 260 in EEGLab.

Tactile Sensors:



A.

B.

C.

Figure 2. The first prototype (A) used a copper wire as the sensor, included an electrical sink, and was surfaced by sandblasting the right half . The final prototypes used a capacitive sensor with the test strip surfaced with textured spray paint (B) and the control strip being smooth acrylic (C).

Conclusions

- Developed a working experiment that is ready to collect data
- An effective transition zone is extremely important to maintain purity of data. A rough transition will cause an unintended tactile stimulus which will generate premature neural responses.
- ERP analysis looks at one electrode and averages the amplitudes across all the trails to create the general trend in response to a stimuli.
- The selection of the reference node is integral for accurate signal analysis in EEGLab.

Further Questions:

1. Are significant neural responses produced while touching a texture?
2. If so, can these responses be used to objectively measure the effectiveness of different Braille styles?

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