The Design, Development, and Testing of a Choice/Serial Reaction Time Apparatus for EEG Data Collection & Analyses

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Background/Motivation

Project Goals

- Improve/de-bug and rebuild the Choice Reaction Time (CRT) and Serial Reaction Time (SRT) Apparatus.
- Program SRT Capabilities using Arduino IDE
- Apparatus will take input from the push-buttons to digital interface.
- Improve current capabilities.
- Conduct a CRT/SRT study using the improved apparatus along with EEG and EMG data.

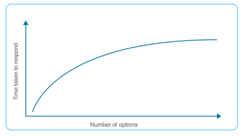
Motivation

- Examine how motor control, learning, and memory processes are affected by age, neurogenic pathologies, and learning through a research study.
- Provides a pathway for the student to enhance their skills in microcontroller programming.
- Engage in a publishable research study .
- Work on a practical application with medical instrumentation.

Choice Reaction Time (CRT)

In the choice reaction time experiments, the user must give a response that corresponds to our cue light stimulus.

Hicks Law



Hick's Law states as more choices are added, reaction time will decrease.

Serial Reaction Time (SRT)

Serial reaction time is a variant of choice reaction time in which the order of stimulus types is not random.

Implicit Learning

Implicit learning is the process of acquiring info about the structure of the environment without conscious awareness.

Electroencephalogram (EEG)

The EEG will record and detect the electrical activity of the brain. This will be used for testing the reaction time of subjects in CRT tasks and implicit learning for SRT tasks.

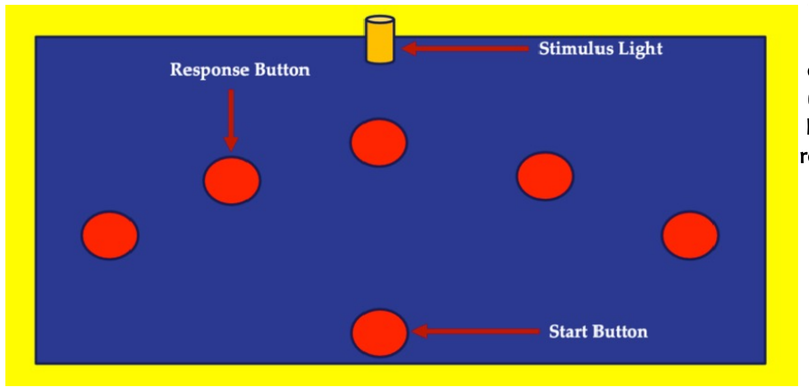
Electromyography (EMG)

The EMG measures muscle response or electrical activity in response to a nerve's stimulation of the muscle. This will be used to measure movement time (MT) as well as the other time-based parameters.

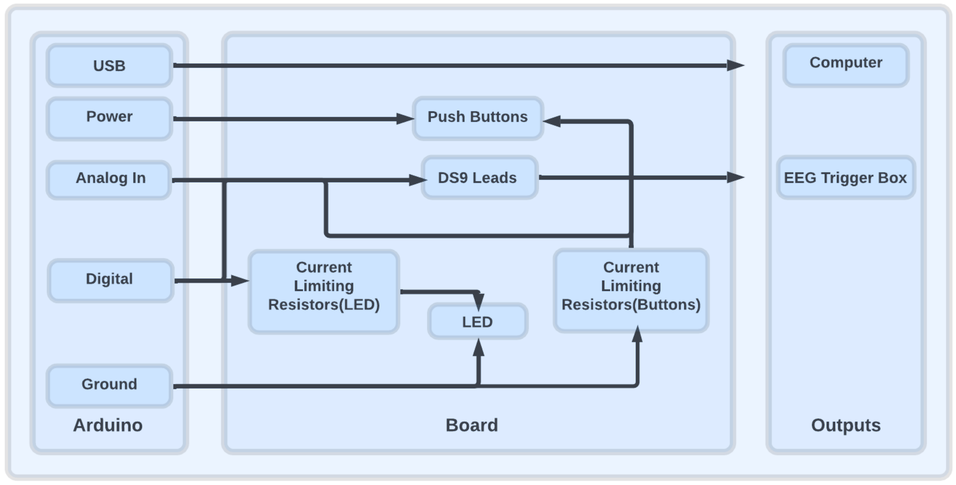
Design

Hardware

Apparatus User Interface

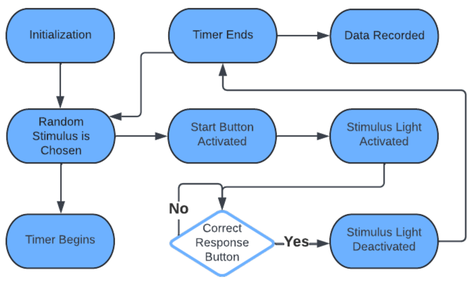


Hardware Circuit Block Diagram

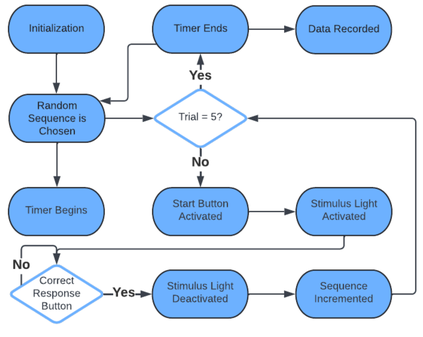


Software

Choice Reaction Code Flow Chart



Serial Reaction Code Flow Chart

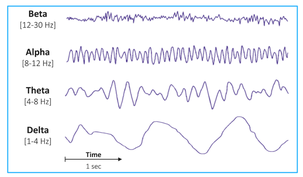


Results/Discussion

Results

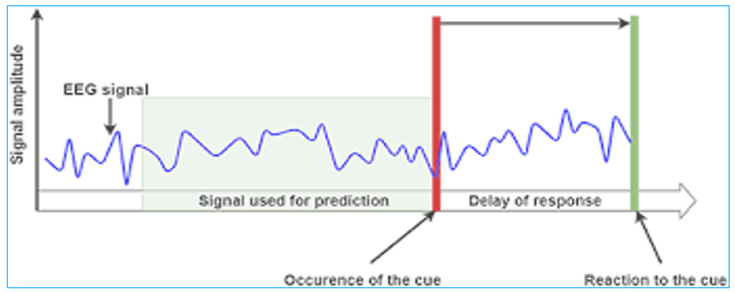
Recorded Time

Timing data was recorded with the Arduino and exported to Excel. This was used for comparison to the EEG Trigger Box measured response time. This was used to verify our measured findings.



EEG Trigger Data

The EEG trigger box was used to create a timing layout like what we see below. Setting a trigger when the stimulus is activated and when the correct response is chosen, allowed us to measure reaction time.



Discussion

Choice Reaction Time

- In our CRT experiment, the ideas of Hicks's laws were recorded. In the 1-choice experiment , reaction times were at their highest with little distraction to the user. In the 3-choice experiment we saw a slight decrease in reaction time as more options were introduced to the experiment. Lastly, in the 5-choice experiment reaction time decreases further and supports the ideas of Hick's law that we discussed earlier.
- Experiment will be repeated with new variables including distractions to user, fatigue, and demographic changes.

Serial Reaction Time

- For the SRT, experiment, we observed two important findings. By programming an infinite number of sequences for the user to experience, the ideas of implicit learning could be observed in a more controlled environment because the user was highly likely to experience the same sequence twice.
- Each time the sequence was reiterated, the reaction time was slightly increased as the user began to learn the combination. When 5 iterations was reached, the sequence was changed resetting the process.

References

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- Sabzi, A. H. (2012). The Effect of Different Fatigue Protocols on Choice Reaction Time.
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