Effect of Bimodal Sensory Integration on Reactionary Impulsivity

Brian-Kalani Headen, Biomedical Engineering
Mentor: Justin Tanner, PhD
School of Biological and Health Systems Engineering

Abstract

This research investigates the utilization of neural summation resulting from multisensory integration during action inhibition. Combining the race model inequality, which implies neural summation from bimodal stimuli, with the stop signal (SS) tasks, which infers inhibition performance, allows an investigation of psychophysics integrating to cognitive processes. At present, experimental design is finalized and the set-up is being implemented using Arduino components. Research into best practices for the SS task have provided specific goals, specifically the statistical benefit of a dynamic stop signal delay. Once participant data is collected, it is expected that bimodal stimuli will produce improved inhibition performance.

Background

During the tenure of the project I performed an individual test on five different participants using an Arduino circuit setup that used tactile, auditory, and visual stimuli in order to measure response inhibition. The basis of this research rested upon the question:

Can inter-sensory facilitation of visual and tactile stimuli influence response inhibition? By combining established psychophysics tasks, we can evaluate this by observing the "Stop Signal Delay" of different stimulus conditions.

Combining Two Tasks (The innovation behind the research)

- Race Model Violation indicates co-activation. Normal task is basically a "Go" process.
- Stop Signal Delay magnitude indicates inhibition via indirect "Stop" process observation.
- **By combining these two concepts, we can determine if the Stop Process can be shortened by inter-sensory facilitation of visual and tactile stimuli.**

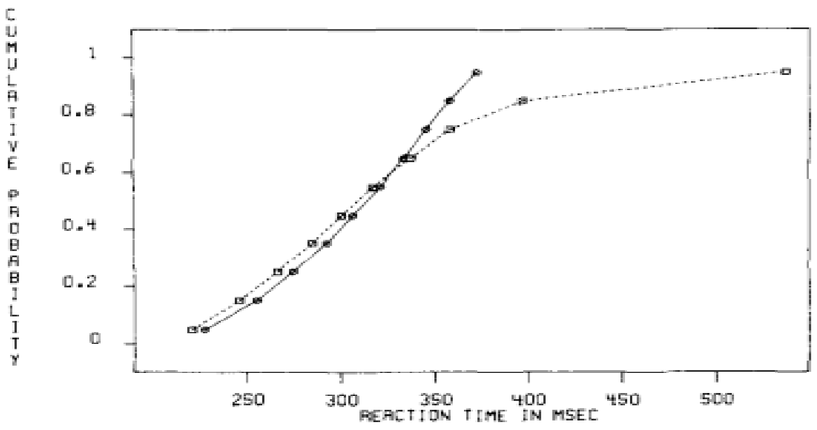

Figure 1: As the bimodal CDF is greater than the sum of the individual, the inequality is violated and there is evidence of co-activation. (Miller, 1982).

Experimental Methods

- Paradigm Decisions
  - 20-30 Participants
  - 4 Blocks of 192 Trials, in Random Order
  - 96 Go Trials (Audio Cue Only)
  - 32 Stop Signal Trials per Stop Signal Type
    - Visual (LED)
    - Tactile (delivered as electro tactile pulses to transcutaneous electrodes to the forearms)
    - Visual-Tactile (Bimodal)
  - Dynamic SSD to achieve 50% inhibited response. (Figure 3)
    - Participant Inhibits: increase SSD
    - Participant Fails to Inhibit: decrease SSD
- Trial Outline (Figure 2)
  - Auditory "Go" Signal (Always)
  - Stop Signal Trials
    - Wait SSD (ms)
    - Deliver Stop Signal
    - Wait for button press
  - Go Trials
    - Wait for button press
    - Store Reaction time
  - Independent Variable: SSD Values per Mode

Results

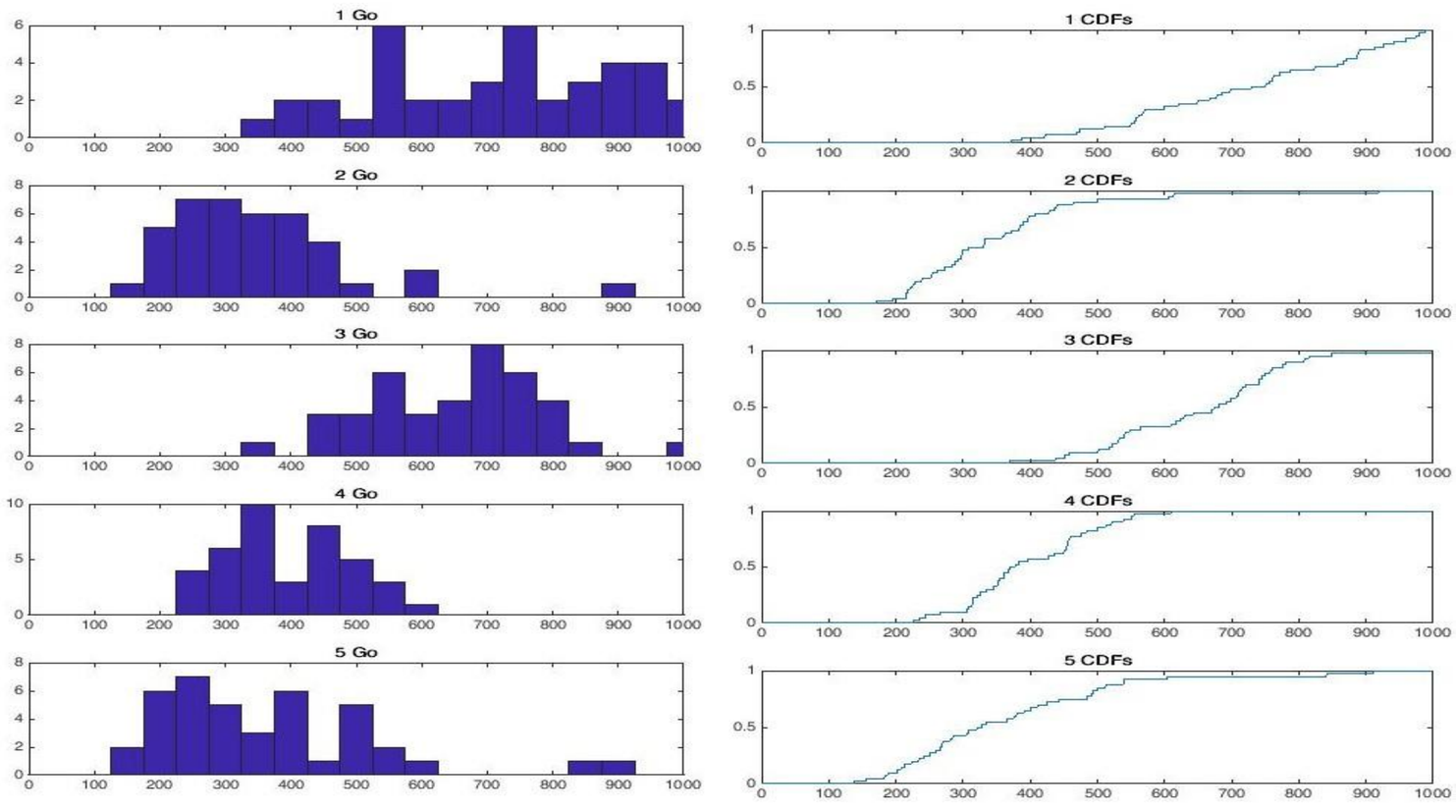

Figure 2: Cumulative RT distributions and histogram charts for signal-respond and no-stop-signal trials predicted by the race model. For signal-respond trials, different distributions are predicted for various SSDs (short, central, or long). The CDFs for results 2-4 show us failure to inhibit and/or failure to stop button press.

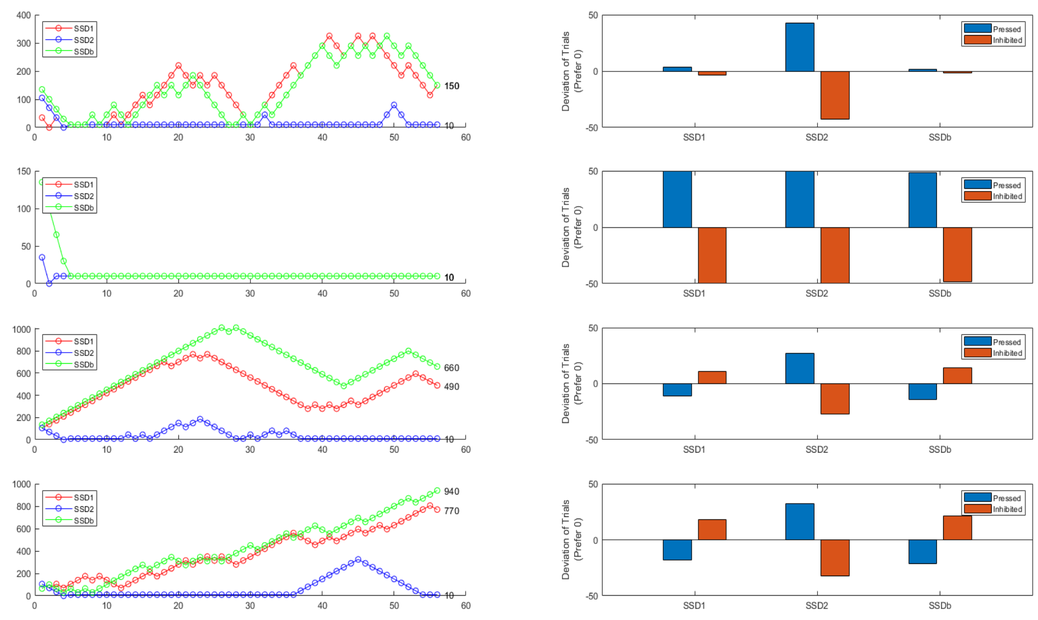

Figure 3: These data graphs extracted from a MATLAB code for data analysis shows us the participants ability to perform the given tasks. Results 2-4 indicate failure in understanding due to the large bias in button press vs inhibition as the original goal was for them to look similar to participant one was approximately 50/50 except for the SSD2. Showing that instructions may have not been clear in terms of actions taken.

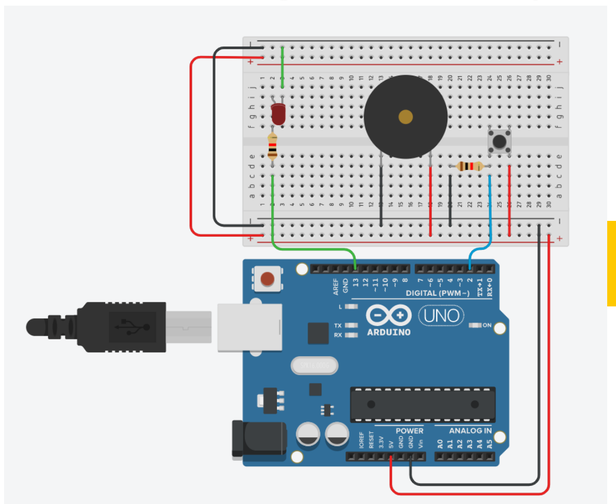

Figure 4. Present design of Arduino circuit. Includes auditory "Go" Signal speaker, visual "Stop" Signal LED, and response button. Not included: pulse output to Stimulator for electro tactile stimulation. The data is collected through a self sustaining Arduino code and is then analyzed by a code in MATLAB.

Future Work

The data shows us that the task can provide useful results. However, after seeing the undesired data results I will be able to do the following:

- Refine the software code
- Collect more participants for a better data spread
- Perform data analysis on the SSD values

Special Thanks

Thank you to all who participated in my research and a special thanks to my P.I, Dr. Justin Tanner.

Discussion & Conclusion

The experimental design consisted of having the participants press the button on an auditory cue (the go signal) and to inhibit/stop their responses on a visual (red light) or tactile (electrode stimulation) stimulus. The experiment met some difficulty as the participants had trouble fully understanding how to perform the tasks set before them. This was indicative by the data collected that showed the data was not conclusive of what was intended (see Figure 3). This was also indicated by the code created to collect the data which had base values of 70,70, and 100 for SSD1,SSD2, and SSDb respectively. The data collected from the participants showed values ranging from 150-940. To account for any errors the values would be adjusted to their ending values in order to fix and account for any bias in the execution of the tasks. This data will help to refine the task further.

References

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Ira A. Fulton Schools of Engineering
Arizona State University