Rate of startle response in a direct movement context

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Introduction

During a simple reaction time (RT) task, the brain prepares by selecting an appropriate motor program prior to the "go" signal. A startling acoustic stimulus (SAS) can be used to elicit a startle response, which involuntarily initiates the prepared motor program, resulting in faster response times. As task complexity increases, levels of preparation typically decrease due to increased cognitive demands. Recent evidence from our lab showed low levels of preparation and very little startle response in the context of a visuomotor mental rotation (VMR) task, in which participants were required to mentally rotate a visual cue before responding for some trials. These trials required indirect movements. Surprisingly, low startle responses were also found during direct movement trials where no mental rotation was required. This study aims to reproduce the direct movements of the previous VMR experiment without any mental rotation trials to measure the rate of startle response. The hypothesis is that the startle response will be higher in a direct movement context than in the context of the VMR task.

Visuomotor rotation (VMR) task

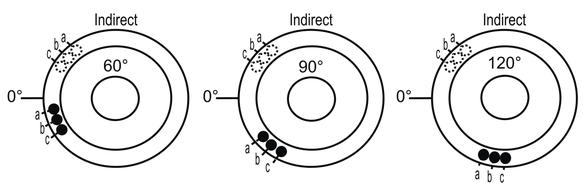

Figure 1. Visual cues and rotated target in VMR task.

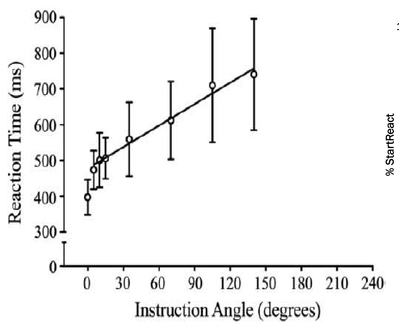

Figure 2. Reaction time for various instruction angles.

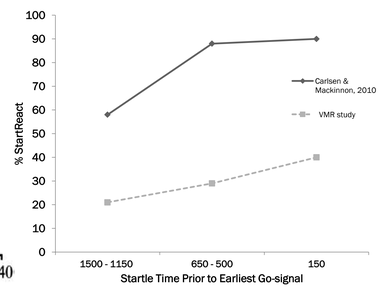

Figure 3. Expected startle response rates vs. startle response rates found in the VMR task.

Results

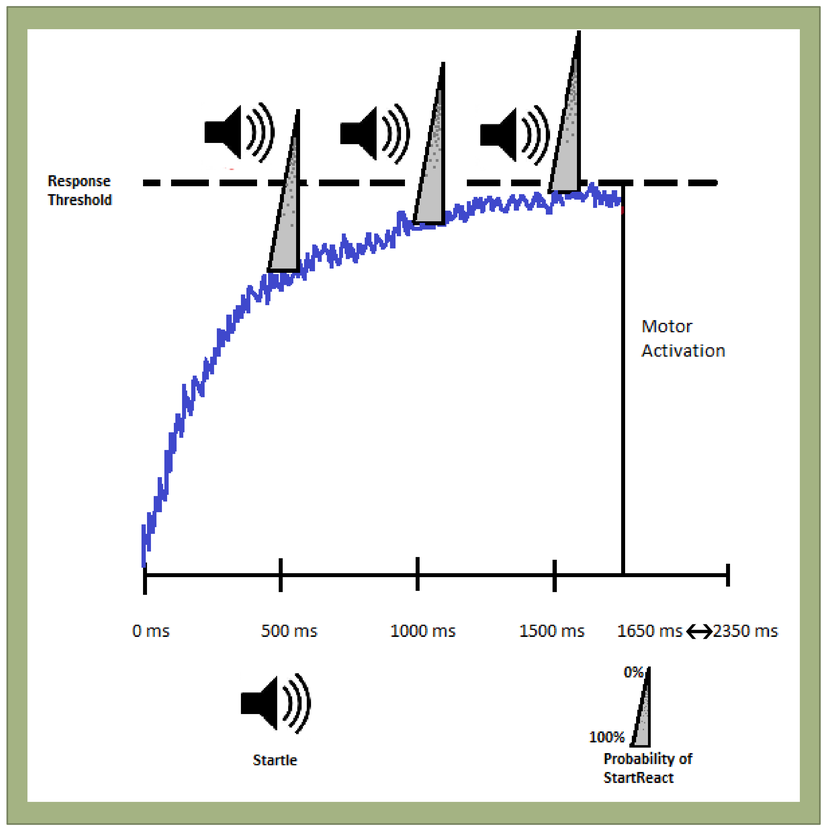

Figure 4. Rate of startle response at various SAS intervals.

- Preliminary evidence suggests that at 500 ms the startle rate is ~60%, at 100 ms it is ~80% and at 1500 ms it is ~100% (Figure 4).
- The startle response rates from this experiment were higher than those of the same direct movements in the context of the VMR task (Figure 3).
- This suggests that the task complexity of the VMR task also increases startle response rates of direct movements within the task

Methodology

Participants will perform 75 simple RT tests requiring wrist extension; a loud (124 dB) noise will be used as the SAS and will sound randomly on 25% of the trials at either 500, 100 or 1500 ms. Kinematic measurements of wrist movements will be collected as well as EMG from wrist prime movers and the sternocleidomastoid muscle to assess startle response

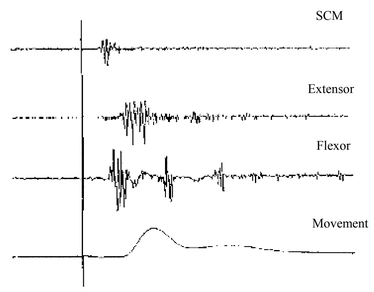

Figure 5. EMG showing startle response

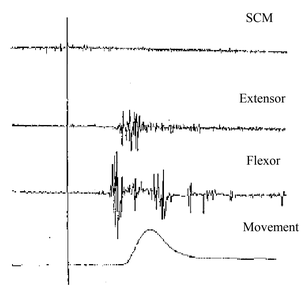

Figure 6. EMG showing no startle response.

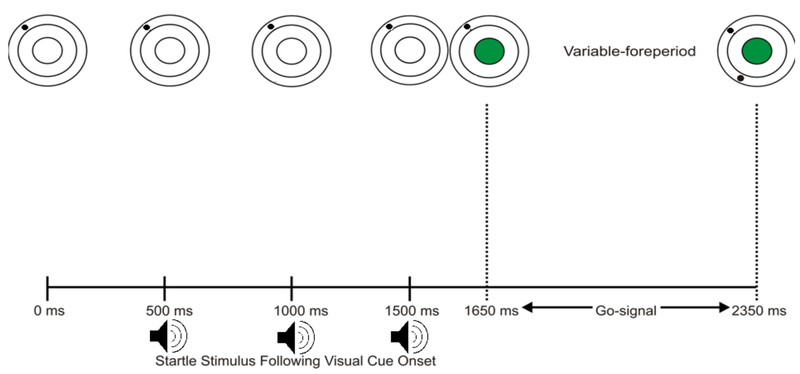

Figure 7. SAS occurrence at various time intervals prior to "go" signal.

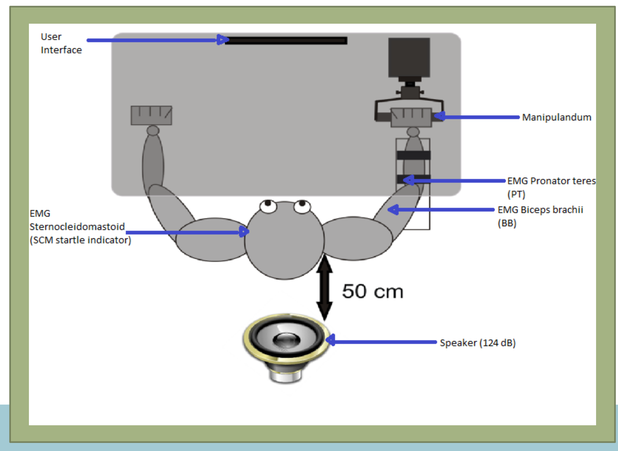

Figure 8. EMG placement and participant set-up.

Conclusion

- So far, the results appear to support the hypothesis; in the direct movement context a high rate of startle has been observed.
- Decreased preparatory state in the VMR task may be the result of increased task demands which causes an increase in neural noise
- Increased neural noise may lead to a lower mean level of motor activation to prevent early and/or errorful response initiation

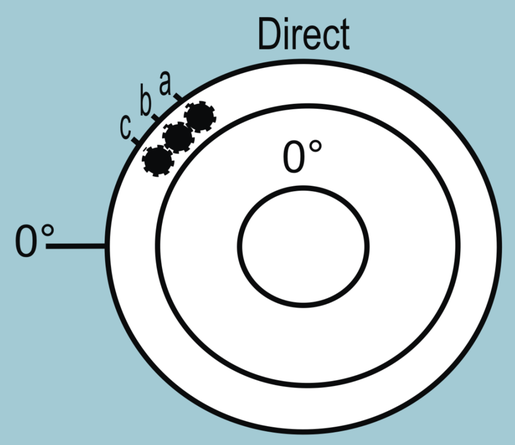

Figure 9. Three different movement goals.

References

Carlsen, A.N., MacKinnon, C.D. (2010). Motor preparation is modulated by the resolution of the response timing information. *Brain Research*, 1322:38-49.

Drummond, N.M., Carlsen, A.N., Cressman, E.K. (2013). Motor preparation is delayed for both directly and indirectly cued movements during an anticipation-timing task. *Brain Research,* 1506:44-54.

Acknowledgements

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