Electrical Vestibular Stimulation to Evoke the Vestibulocollic Reflex

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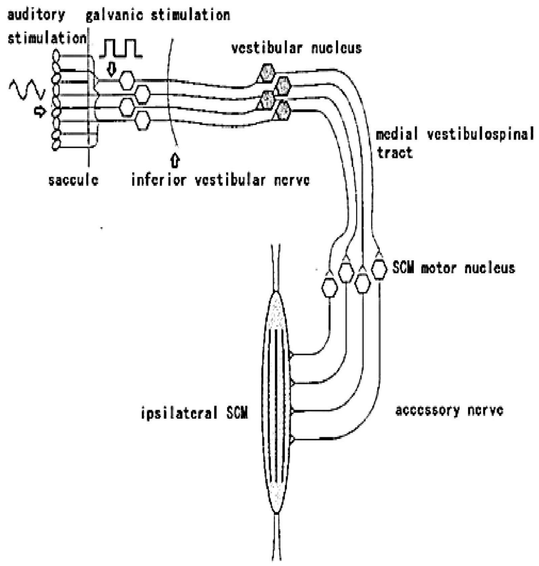
Introduction

- The vestibulocollic reflex (VCR) is a compensatory response that stabilizes head position in space, activated by vestibular organs of the inner ear
- Electrical vestibular stimulation (EVS) can be utilized to elicit the VCR. To evaluate vestibular nerve responses, galvanic vestibular evoked myogenic potentials (gVEMP) can be used by collecting resultant muscle activity from the sternocleidomastoid (SCM) muscle ipsilateral to the applied vestibular stimulation
- Based on the current literature and experimental methodology, we wish to determine which gVEMP parameters will best elicit the VCR to further establish this method of measuring vestibular function.

Figure 1. Pathway Schematic

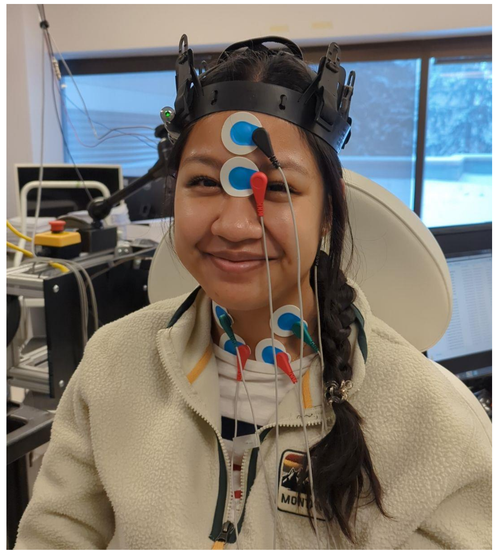


Adapted from Cheng et al. (2008)

Methods

- 14 participants aged 18-24 (9 females, 5 males) were recruited for this study.
- Exclusion criteria ensured participants had no diagnosed neurological or musculoskeletal disorder, pacemaker, or hearing aid implants.
- EVS electrodes were placed on the left mastoid and the nasion, with EMG electrodes recording bilateral SCM muscle activity. A ground electrode was placed on the forehead. Stimulation was initially delivered at 3mA at a frequency of 5 Hz for 12 20-second trials, repeated at 5mA for the second set of trials.
- Trials were performed with the head position in one of three conditions:
  - 1. Head Center (HC)
  - 2. Head Left (HL)
  - 3. Head Right (HR).
- Each set of trials were performed in one of two conditions:
  - 1. Eyes Open (EO)
  - 2. Eyes Closed (EC)

Figure 2. Experimental Setup



Results

Figure 3. Subject X gVEMP Response

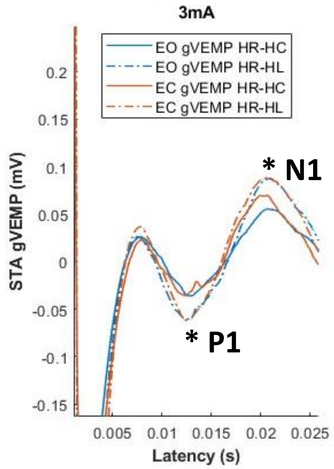


Figure 4. Subject Y gVEMP Response

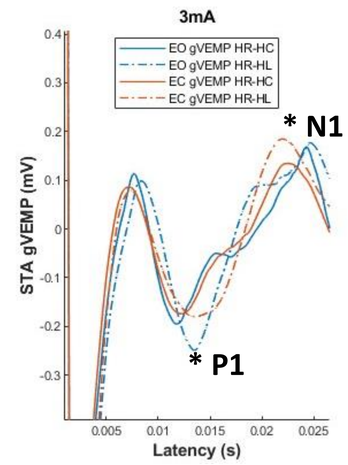


Figure 5. EC vs EO

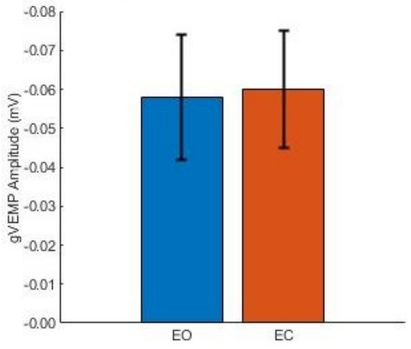


Figure 6. 3mA vs 5mA

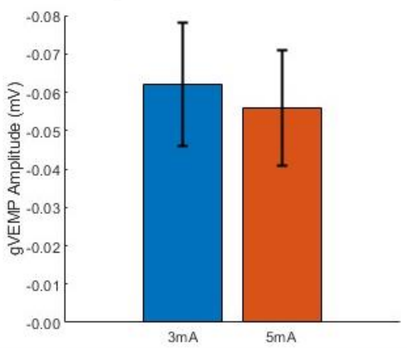
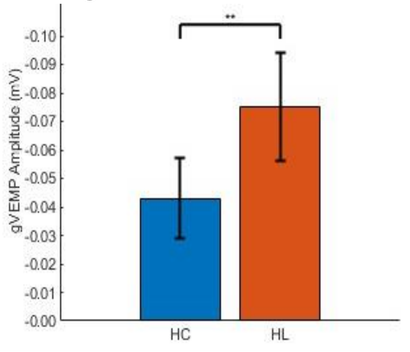


Figure 7. HR-HC vs HR- HL



Discussion

- ANOVA statistical analysis indicated that there were no significant effects of the EO/EC condition on reflex amplitude, with the EO condition requiring fewer corrections as participants had constant vision of each target their head was aimed at.
- The 3mA condition yielded stronger responses than 5mA while also being tolerated better by participants
- Using the HR-HL artifact subtraction method provided substantially stronger VCR responses than HR-HC (p=0.005)
- Reflex latency was independent of all factors, occurring at 12.38ms (sd=2.16ms) which aligns with previous literature

References

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3. Sun, X., Gao, D., Shen, J., Zhu, Q., Wang, L., Ma, X., Wang, W., Chen, X., Zhang, Q., Jin, Y., Chen, J., & Yang, J. (2022). Potential vestibular pathway impairment in children with recurrent vertigo: An investigation through air-conducted sound and galvanic vestibular stimulation-triggered vestibular evoked myogenic potentials. Frontiers in Neurology, 13, 997205–997205. https://doi.org/10.3389/fneur.2022.997205

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