Background

- Stimulation of the peripheral vestibular nerves with sinusoidal galvanic vestibular stimulation (GVS) has been shown to evoke sinusoidally varying postural sway. Previous studies have determined GVS thresholds by adjusting stimulus amplitude based on perceptual measures, observation of body sway, or both.

Methods

- Thirty participants (age M = 22.23, SD = 1.23; 12 male) completed three one-hour sessions.

Calculating Thresholds

- Sway thresholds: Sinusoidal curve fits were used to determine sway amplitudes during each stimulus amplitude.
- A nominal variable was created based on whether sway during a single stimulus amplitude was greater than the mean sway amplitude from that session; this was fit into a logistic function.
- An inverse prediction yield the GVS amplitude at which there was 50% confidence that greater-than-average sway would appear.
- Perceptual thresholds: Participants reported the onset of a sense of motion associated with the stimulus by giving a verbal cue during each trial.

Results

- Sway amplitude was positively correlated with stimulus amplitude with a Spearman Correlation Coefficient of 0.37 (p < .001), although the relationship was non-linear due to saturation of the sway response at higher amplitudes.
- Sway threshold estimates showed good test-retest reliability across sessions. An intraclass correlation coefficient (ICC) yielded an average measures coefficient of 0.73.
- Spearman Correlation Coefficients were used to examine the correlation between sway and perceptual thresholds. This test was significant for all sessions with a coefficient of 0.53 (p < .001) and for sessions 2 (p = 0.038) and 3 (p < 0.001) with coefficients of 0.43 and 0.68, respectively.
- Overall, mean perceptual thresholds (M = 0.16, SD = 0.11) were significantly lower than mean sway thresholds (M = 0.36, SD = 0.15).

Discussion

- Logistic Curve Fit

Conclusions

- Test-retest reliability for sway indicated that this stimulation protocol produces a reliable measure upon which to calculate a threshold.
- Perceptual measures can be reliable but may reflect both tactile (skin) and vestibular (motion) cues. Measures of postural sway are objective and may more closely reflect vestibular input.
- Sinusoidal fits at the stimulus frequency help filter out variations in performance related to random sway from a narrow stance width.
- Stepwise increasing stimuli at low levels help capture thresholds with less influence of compensatory mechanisms that suppress sway.
- This thresholding procedure has many potential applications, including future studies in which GVS is either presented at low levels to improve or high levels to disrupt balance function.

Future Directions

- Quantify the presence of sway relative to quiet stance and/or limits of stability to extend this approach in patient populations that exhibit greater sway without GVS.
- Extend this technique with seated measures that include eye movements and/or quantitative measures of perception.

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References


Customizing transcutaneous electro-cortical stimulation: An objective thresholding technique using sinusoidal galvanic vestibular stimulation and lateral body sway