Frequency-Specific Training of VOR Generalization in Mice

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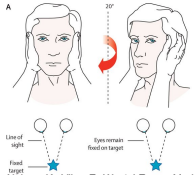
Background

The Vestibulo-Ocular Reflex (VOR) is a critical neural mechanism allowing the eye to stabilize vision during head movements by generating compensatory eye movements. The VOR can be adapted to make larger or smaller eye movements for the same amount of head movement by associating head movement with rotation of a visual field at a specific frequency The change in eye movement at one frequency of head rotation also induces smaller magnitude changes in eye movement at closely-related frequencies, a process termed generalization. It is not clear whether serial training at different rotation frequencies would produce the same generalization effects as combined training with multiple frequencies simultaneously.



Nelson JA, Viirre E.,*West J Emerg Med.* 2009

We hypothesize that generalization will be more effective for frequencies close to the training frequency most recently experienced, and less effective for training frequencies that were experienced more distantly, when presented in series. In contrast, we hypothesize that generalization will be equally effective across frequencies when training stimuli are presented simultaneously.

Methods

Two cohorts of 10 mice will undergo training and testing as outlined in the chart below with each cohort being equally divided with both sexes. Sum of sine procedures include both 0.2 and 1.5 Hz frequencies overlaid. VOR gain data recorded will be normalized to 1.0

Hirano, T., & Kawaguchi, S., *Frontiers in Cellular Neuroscience.* 2014

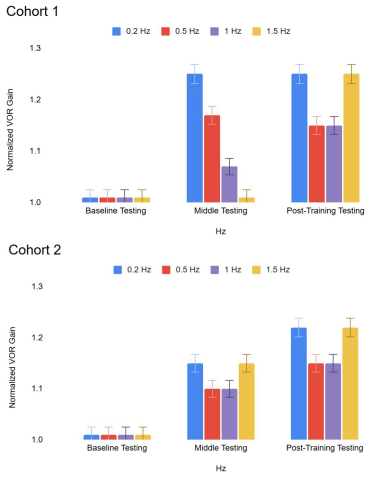
Cohort	Baseline Testing	Training 1	Middle Testing	Training 2	Post-Training Testing
Cohort 1	0.2, 0.5, 1, and 1.5 Hz	0.2	0.2, 0.5, 1, and 1.5 Hz	1.5	0.2, 0.5, 1, and 1.5 Hz
Cohort 2	0.2, 0.5, 1, and 1.5 Hz	Σ0.2 and 1.5 Hz	0.2, 0.5, 1, and 1.5 Hz	Σ0.2 and 1,5 Hz	0.2, 0.5, 1, and 1.5 Hz

Further Directions

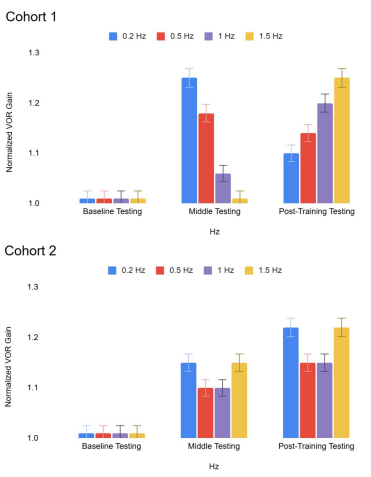
- Further investigate into the neural circuits involved in VOR generalization and frequency-specific adaptation utilizing electrophysiological recordings to help elucidate the underlying brainstem and cortical pathways.
- Explore effects of greater frequency ranges such as from 0.01-0.2Hz or between 2 and 5 Hz.
- Research whether or not there is a plateau where generalization equalizes regardless of serial vs simultaneous training through multiple training sessions.

Possible Results

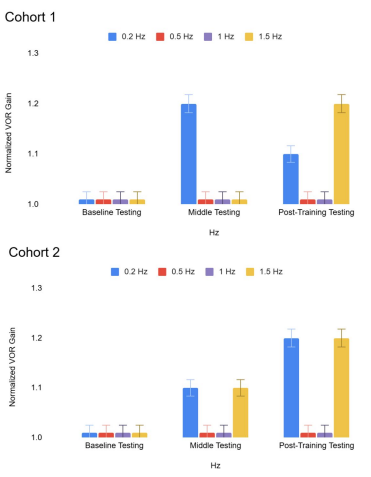
Serial = Sum of Sines



Serial ≠ Sum of Sines

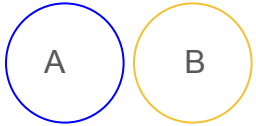


Training frequencies change but no generalization occurs

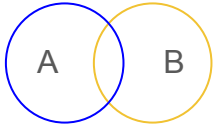


Possible Conclusions

Specific frequencies are preferentially modifiable, regardless of being presented simultaneously or sequentially. This suggests an inherent difference in those vestibular afferents reaching the vestibular nucleus.



Neural populations of the vestibulocochlear nerves responsible for VOR adaptation at particular frequencies are not unique to specific frequencies and thus can be repurposed upon training at a new frequency.



If generalization is not occurring, potentially the stimulus is not being presented for a long enough training period.

5 s → 30 s