VALIDATION OF A MANUALLY OSCILLATING CHAIR FOR IN-THE-FIELD ASSESSMENT OF DYNAMIC VISUAL ACUITY ON CREWMEMBERS WITHIN HOURS OF RETURNING FROM LONG-DURATION SPACEFLIGHT

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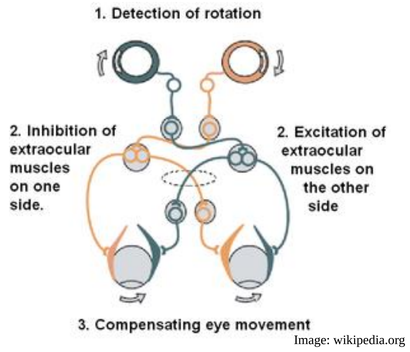
INTRODUCTION

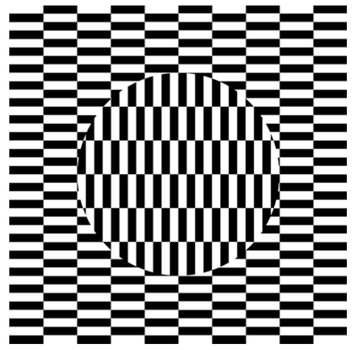
Adaptation to microgravity

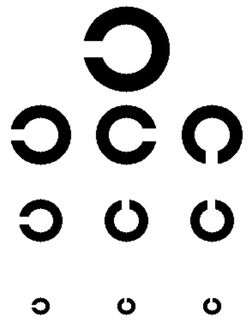
Return to 1g



Re-adaptation of vestibulo-ocular reflex (VOR)

Crew report oscillopsia and blurred vision





Estimate retinal slip with Dynamic Visual Acuity (DVA) test

Due to the deconditioned state of crewmembers in the initial hours after landing, it is safer and more practical to perform a vision test while seated in a chair versus walking on a treadmill.

The purpose of this study was to validate the ability of a manually operated oscillating chair to produce the oscillatory frequency and displacement equivalent of walking on a treadmill at a 4 mph pace.

METHODS

Healthy, non-astronaut subjects (n=14) performed three static (seated) and three dynamic (walking/oscillated) visual acuity tests. For all conditions the subject was asked to discern and verbally report the direction gap of Landolt-C optotypes of varying sizes. Subjects were outfitted with accelerometers (sampling rate = 128 Hz) on their head, trunk and lumbar spine. Dynamic Visual Acuity (DVA) was assessed as the difference in logMAR values between static and dynamic conditions.

Treadmill

Walk at 4 mph pace
Vertical oscillation
(approx. +/- 5 cm, 2 Hz)

Automated Chair

Motor driven
Vertical oscillation
(+/- 5 cm, 2 Hz)

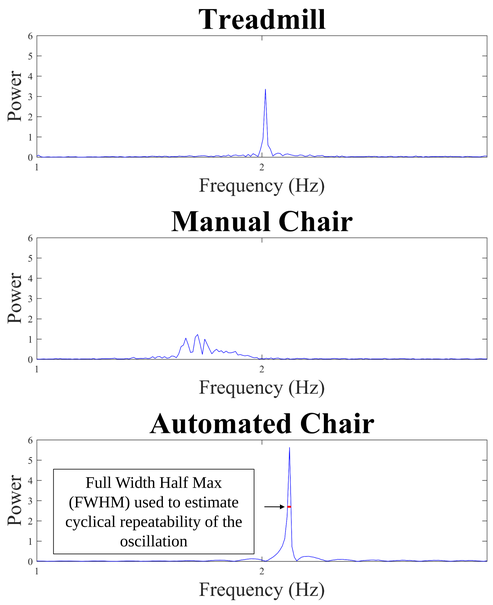
Manual Chair

Manually operated
Vertical oscillation
(approx. +/- 5 cm, 2 Hz)

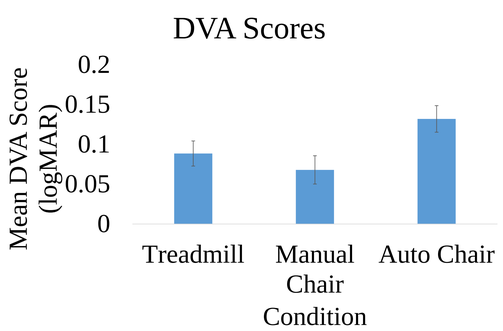
RESULTS

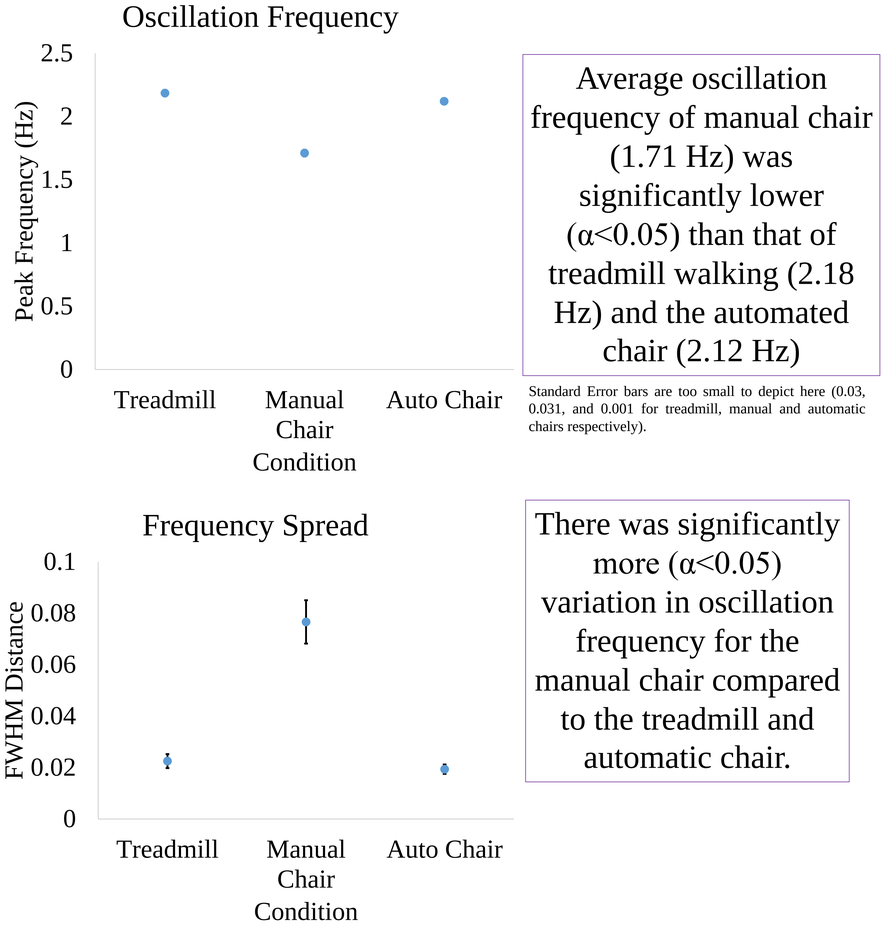
A fast Fourier transform (FFT) was performed on the vertical trunk acceleration to compare the peak and spread of the distribution of oscillation frequencies for each oscillating condition.

FFT plots for one subject in each condition. The automated chair has a narrow frequency range, whereas the manual chair and treadmill were slightly more variable.



DVA scores were not significantly different for the manual chair compared to treadmill walking.





Average oscillation frequency of manual chair (1.71 Hz) was significantly lower ($\alpha<0.05$) than that of treadmill walking (2.18 Hz) and the automated chair (2.12 Hz)

Standard Error bars are too small to depict here (0.03, 0.031, and 0.001 for treadmill, manual and automatic chairs respectively).

There was significantly more ($\alpha<0.05$) variation in oscillation frequency for the manual chair compared to the treadmill and automatic chair.

CONCLUSIONS

Peak oscillation frequencies achieved with the manual chair were lower and more variable than those of treadmill walking and the automatic chair. This can mostly be attributed to operator fatigue. However, DVA scores across conditions were not significantly different, indicating that the manual chair can provide adequate vertical oscillation frequency and displacement with the added advantage of being portable enough for testing outside a laboratory. Furthermore the automatic chair very closely matches the oscillation frequency of treadmill walking, making it an ideal method for testing DVA in a laboratory setting.

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