Effects of vibration and G-loading on heart rate, breathing rate, and response time

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I. Introduction

Aerospace and applied environments commonly expose pilots and astronauts to G-loading and vibration, alone and in combination, with well-known sensorimotor (Cohen, 1970) and performance consequences (Adelstein et al., 2008). Physiological variables such as heart rate (HR) and breathing rate (BR) have been shown to increase with G-loading (Yajima et al., 1994) and vibration (e.g. Guignard, 1965, 1985) alone. To examine the effects of G-loading and vibration, alone and in combination, we measured heart rate and breathing rate under aerospace-relevant conditions (G-loads of 1 Gx and 3.8 Gx; vibration of 0.5 g at 8, 12, and 16 Hz).

II. Methods

\textbf{Task parameters:}

- G conditions: 1 Gx, 3.8 Gx
- Vibration conditions (0.5 g): no vibration, 8 Hz, 12 Hz, 16 Hz

\textbf{Participants:} 10

Heart rate and breathing rate data were collected using a Zephyr bio-harness

Facilities:

- Fixed-based vibration platform (1 Gx)
- 20 G centrifuge (3.8 Gx)

The laboratory is equipped with a mechanism with a mounting plate that allows free movement of the armrest in a cubic volume of 30 x 30 x 30 cm.

A vibration chair is placed within the 20 G centrifuge and can deliver Gx vibration during centrifugation.

III. Heart rate

We observed a significant main effect of G-loading (p < 0.0001), no effect of vibration frequency (p = 0.05), and no interaction (p = 0.05).

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IV. Breathing rate

We observed a significant main effect of G-loading (p < 0.0001), no effect of vibration frequency (p = 0.05), and no interaction (p = 0.05).

We observed a significant main effect of G-loading (p < 0.0001), a significant within-block effect (p = 0.05), and no interaction (p = 0.05).

V. Response time

We observed a significant main effect of G-loading (p < 0.0001), no effect of vibration frequency (p = 0.05), and no interaction (p = 0.05).

VI. Conclusions

G-loading had a strong effect on heart rate, breathing rate, and response time.

The effects of vibration frequency on heart rate, breathing rate, and response time are less robust.

For all measures, we observed strong within-block effects, which would obscure any potential effect of vibration frequency.

Further analysis is necessary to compensate for the strong within-block effects.

\textbf{References}


