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

Angelica Godinez¹ ², Ruthie Ayzenberg¹ ², Dorion B. Liston¹ ², and Leland S. Stone¹
1. Human Systems Integration Division, NASA Ames Research Center; 2. San Jose State University

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

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

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):
    - A vibration chair within the 20-G centrifuge can deliver Gx vibrations 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).

IV. Breathing rate

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).

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V. Response time

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

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.

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.

References

This material is based upon work supported by the National Space Biomedical Research Institute.