

EXPLORATORY HETEROGENEITY IN WORKLOAD-HRV RELATIONSHIPS ACROSS FLIGHT CREWS DURING HIGH-FIDELITY SIMULATION



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INTRODUCTION

- Subjective workload is widely used in aviation and human factors research.
- Psychophysiological markers such as heart rate variability (HRV) may capture complementary aspects of autonomic regulation beyond self-report measures.
- Most workload-HRV studies focus on population-level effects, potentially obscuring meaningful variability across crews.

Using the NASA SOTERIA high-fidelity flight simulation dataset, this study examined workload-HRV relationships and exploratory crew-specific heterogeneity.

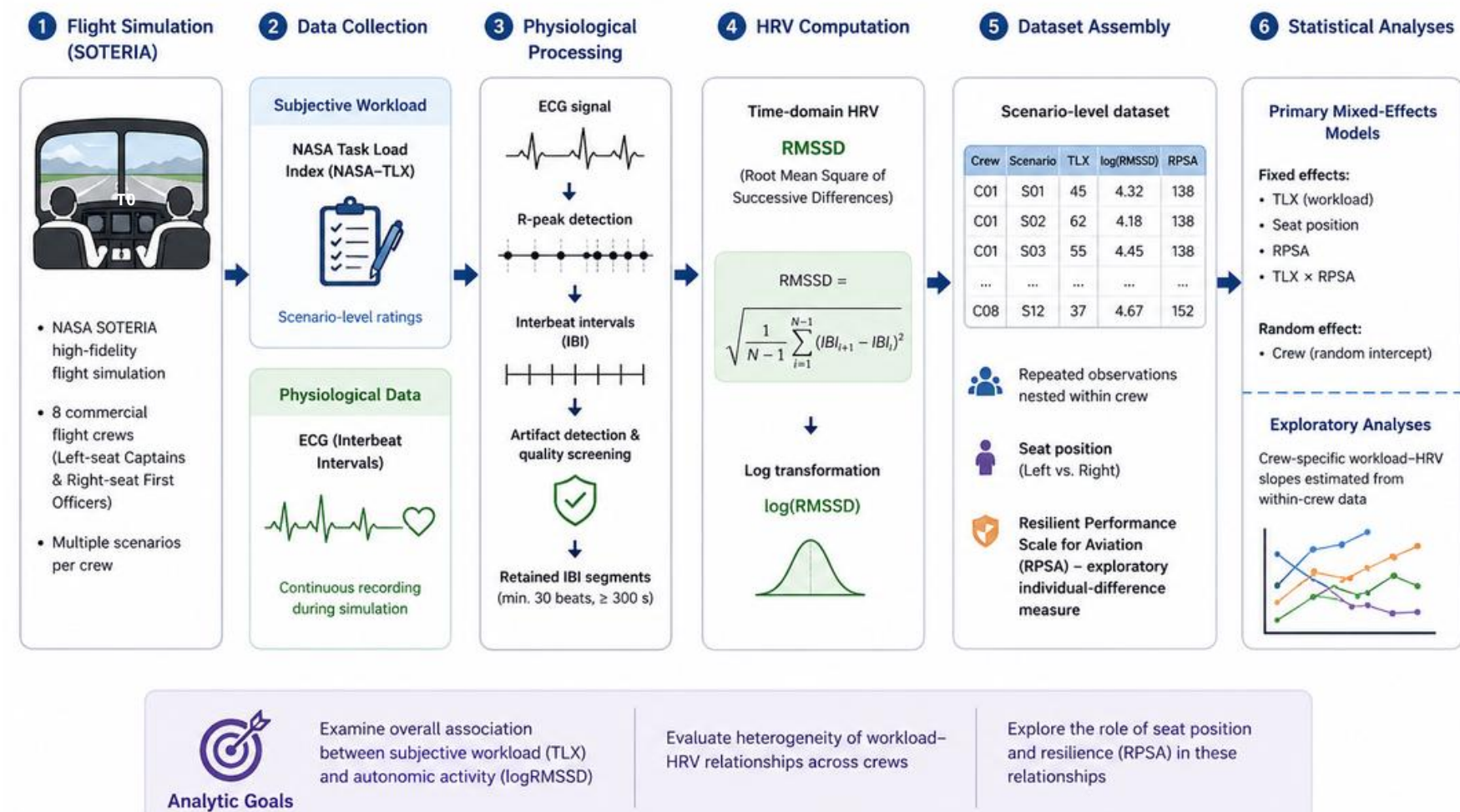
OBJECTIVES

- Examine whether subjective workload was associated with HRV during flight simulation.
- Evaluate whether workload-HRV relationships varied across flight crews.
- Explore whether crew-level heterogeneity emerged in workload-related autonomic patterns.

METHOD

- NASA Task Load Index (NASA-TLX) ratings were merged with ECG-derived interbeat interval data
- Resilience-related individual differences were indexed using the Resilient Performance Scale for Aviation (RPSA) and examined as an exploratory moderator of workload-HRV relations.
- HRV indexed using log-transformed RMSSD from quality-screened interbeat interval segments

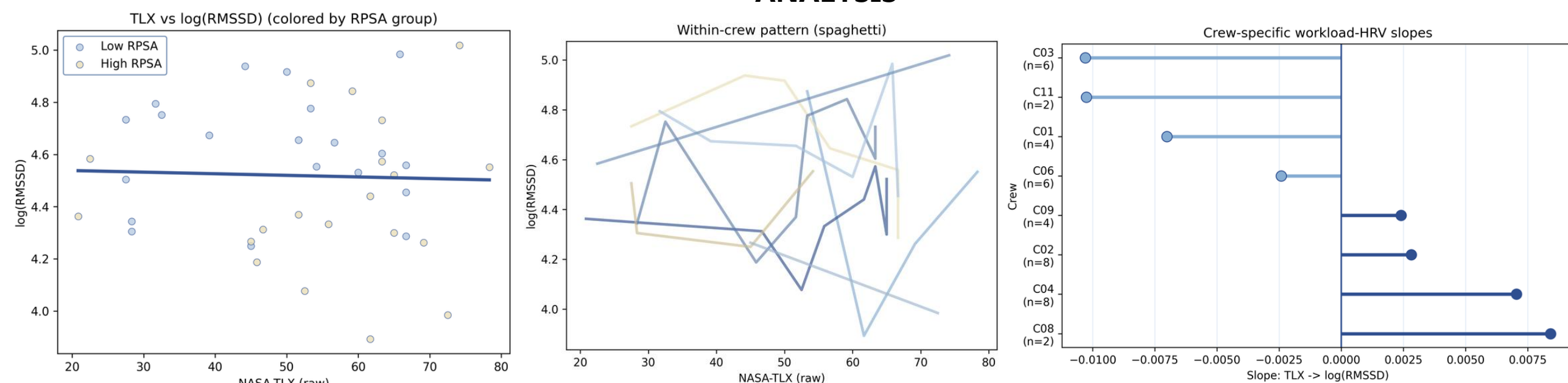
Data Pipeline: From Flight Simulation to Crew-Level Analyses



KEY FINDINGS

- Overall workload-HRV associations were weak at the population level
- No robust evidence emerged for workload × RPSA interaction effects
- Exploratory analyses suggested heterogeneous workload-HRV patterns across crews
- Several crews demonstrated opposing workload-related HRV slopes
- Aggregating across crews may obscure meaningful within-crew physiologic variability

ANALYSIS



CONCLUSION AND FUTURE DIRECTIONS

- Overall workload-HRV associations were modest at the population level
- Exploratory analyses suggested heterogeneous workload-related autonomic patterns across flight crews
- Future work should examine how operational context contributes to crew-specific physiologic variability

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REFERENCES