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# The effects of noise and other spaceflight environmental stressors on astronaut cognitive performance: dynamic ensemble prediction

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## ABSTRACT

During spaceflight, astronauts face a unique set of stressors, including microgravity, isolation, and confinement, as well as environmental (including noise) and operational hazards. These factors can negatively impact sleep, alertness, and neurobehavioral performance, all of which are critical to mission success. Here, we predict neurobehavioral performance over the course of a 6-month mission aboard the International Space Station (ISS), using ISS environmental data as well as self-reported and cognitive data collected longitudinally from 24 astronauts. Neurobehavioral performance was repeatedly assessed via a 3-min Psychomotor Vigilance Test (PVT-B) that is highly sensitive to the effects of sleep deprivation. To relate PVT-B performance to time-varying and discordantly-measured environmental, operational, and psychological covariates, we propose an ensemble prediction model comprising of linear mixed effects, random forest, and functional concurrent models. An extensive cross-validation procedure reveals that this ensemble outperforms any one of its components alone. We also identify the most important predictors of PVT-B performance, which include an individual's previous PVT-B performance, reported fatigue and stress, and temperature, noise levels and radiation dose. This method is broadly applicable to settings where the main goal is accurate, individualized prediction of human behavior involving a mixture of person-level traits and irregularly measured time series.

Keywords: sleep, spaceflight, astronaut, noise, performance, prediction

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