Symptom-Free in Zero-G? A Portable Technology for Rapid, Multi-System Assessment and the Potential for Predicting Inflight Performance

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Introduction:
The unusual and physically demanding suborbital flight profiles will result in physiological disturbances (e.g., motion sickness, fatigue, dizziness and disorientation) for some passengers. Because of the large number of potential flyers, scientists have the unique opportunity to examine the effects of g-level changes in a diverse population. Results from these studies may assist operators in alleviating detrimental symptoms for their passengers. The ideal assessment device would incorporate simple, portable equipment and tests that can be quickly conducted by a novice tech or self-administered by the flyer. We are currently developing one such device to evaluate sensorimotor function before, during, and after spaceflight that is easily adaptable for the suborbital community. We call this system SARA: Sensorimotor Assessment and Rehabilitation Apparatus. It would be highly advantageous to be able to predict which passengers may have greater difficulty adapting to the novel g-levels of suborbital flight by measuring some aspect of baseline function with SARA preflight. Recent work in our laboratory has demonstrated the potential for predicting adaptation in both the saccadic and vestibulo-ocular reflex subsystems from baseline measures alone, and we are actively pursuing whether similar predictors exist in other processes that will be modified during suborbital and spaceflight experiences.

Protocol:
SARA incorporates a tablet computer, red-blue eyeglasses (one red and one blue lens), and small (watch-size) three-axis wireless motion sensors. Combining this simple hardware with clever analytical algorithms, we can evaluate multiple sensorimotor subsystems rapidly, on the order of several seconds to minutes. Specifically, SARA evaluates the vestibulo-ocular reflex, ocular skew and torsional disconjugacy, spatial orientation, posture, and locomotion. We have used SARA in several ground-based experiments to study multi-system adaptation, as well as in parabolic flight to track g-level dependent changes in sensorimotor function. In one such laboratory experiment, we found that the intertrial correlations of successive baseline vestibulo-ocular reflex gains (i.e., the temporal structure of baseline gain data) strongly correlated with the amount of adaptation achieved during a traditional VOR gain-down adaptation experiment. While we cannot yet fully explain some aspects of these results, the possibility of finding baseline performance parameters that can forecast adaptive characteristics has important implications for the scientific community.

Conclusions:
SARA's minimal hardware and open-access platform make it amenable for integration with other physiological monitoring devices, such as those used to measure autonomic and cardiovascular function. Integrating medical monitoring across multiple physiologic systems would save valuable time and resources for both the user and researcher, and has applications that extend beyond the suborbital community. Furthermore, extensions of our recent predictive findings in other physiological systems relevant to g-level exposure may provide practical strategies for improving suborbital passengers' experiences inflight. For example, it may enable the tailoring of individual preflight training measures to minimize passenger discomfort inflight.