Suborbital Spaceflight Training: Parabolic Flight Analog Environment

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Summary
Based on four decades of parabolic flight research experience with NASA's Reduced Gravity Research Program, we have developed an analog environment method for preparing commercial research astronauts for suborbital spaceflight. Guided by the research tasks, this protocol will optimize checklists, hardware and space utilization, equipment deployment/stowing, motion sickness and disorientation awareness and adaptation, and time pressure management, to result in consolidated and efficient mission task training.

Introduction
Prospective scientist-astronauts, flight crew, and human subjects of suborbital research would achieve maximum efficiency in flight if they have been properly trained on the ground, pre-flight. Such preparation should train in issues of motion sickness, disorientation and spatial illusion awareness and adaptation, onboard space utilization, communication efficiency, checklist fluency, workload and time management, and overall comfort and safety, to name just the most serious factors.

Whether mission goals allow or disallow the use of medication to counteract often debilitating effects of space motion sickness (MS) in flight [1], participants need to be aware of their individual susceptibilities, and trained to optimize their ability to operate in the presence of MS symptoms, under the side effects of medication, or both if symptoms develop despite medication. Additionally, disorientation, movement errors, and spatial illusions constitute another set of challenges in a non-earth gravitoinertial force environment [2, 3].

The extreme time pressure of suborbital parabolic flight, 3—5 minutes of 0g, will produce high levels of workload stress on all staff to achieve mission objectives. The obvious tasks such as positioning subjects in setups, conducting trials and data collection, and releasing subjects for descent readiness, would necessarily be guided by the safety regulations of flight such as deployment of equipment stowed for takeoff and re-stowing hardware for landing. The rapid activity to achieve setup readiness is likely to bring about symptoms of MS if not addressed in prior training.

Training Protocol Overview
Our studies in human factors, spatial orientation, and space motion sickness in spaceflight and parabolic flight, as well as in a variety of altered gravity environments such as rotating rooms and motion platforms, provide us with unique insights into the suborbital flight research environment. Based on this knowledge and experience, we designed an analog environment with the following key elements of research astronaut training:

A. General spaceflight human factors and awareness training: 1-3 days long, this protocol segment will help participants develop awareness of their individual MS and disorientation susceptibilities.
B. Streamlining experimental design: concurrent with A, this protocol segment includes creating annotated and optimized checklists, hardware overview and handling, and communication training for staff and subjects.
C. Consolidated research mission task preparation: 1-2 days long, this protocol segment will, within an analog space vehicle flight like environment and timeline, train participants to execute tasks specific to their mission.

Conclusion
Parabolic flight has long been used as a training platform for astronauts' spaceflight readiness as well as for decades of basic and applied research in human factors [4]. Its lessons can provide direct benefits to achieving efficiency in suborbital flight. There are advantages and limitations of the use of analog environments for space human factors research. Implementation of our protocol would complement other training paradigms to ensure that commercial research astronauts' flight preparation is comprehensive and maximizes the success of their research missions.

References
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