Opportunities for Life-Sciences Research in Commercial Suborbital Space Flight

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Life-sciences research areas

1. Medical operations and human factors
   - Flight testing and qualification, procedures and hardware
   - In-flight surgery, equipment training

2. Bioastronautics
   - Applied research, relevant to NASA exploration missions
   - Effects of g transitions on physiology & performance

3. Operational research for passengers/crew
   - Keeping passengers safe & comfortable (wide range of health & fitness levels)
   - Motion sickness, vertigo, latent balance problems
   - Possible cardiovascular, psychological effects

4. Basic research relevant to terrestrial health and function
   - Role of gravity in biasing vestibular sensors
   - Reference frames for sensorimotor function
Unique opportunities provided by suborbital flight

• Large, diverse passenger base (study effects of gender, age, fitness, etc.)
  • Researchers can fly as subjects and operators
  • Frequent flyers allow for repeated testing to assess adaptation

• Fewer constraints on payloads – rapid access, easier logistical burden
  • Access to g transition
  • Ability to launch in sync with circadian rhythms, other time points
  • Rapid access to subjects/samples before and after flight

• Study process with time constants between parabolic flight and orbital flight
  • Vestibular & sensorimotor, deposition of particulates in lungs
  • Acute cellular responses, fertilization and early development in 0g
Operational Research
How to improve the customer experience

- Precedent: parabolic flight [Vomit Comet]
  - About 50% of first-time flyers are sick
  - Adaptation is rapid (1-3 flights)
- Neurovestibular
  - Migraine: ~25% of population, ~20% dizziness component (motion sensitivity)
  - Benign positional vertigo: BPPV
  - Mal de debarquement: disembarkment syndrome
  - → Screening, detection of undiagnosed vestibular disorders, pre-adaptation
- Cardiovascular
  - Dramatic autonomic stimulus
  - → Screening, training
- Psychological
  - Identification of key sensory stimuli that might lead to anxiety/discomfort (noise, vibration)
  - → Screening, pre-flight habituation
- Problem equalizing pressure during rapid changes
- Glaucoma and other g/pressure effects on eye
- Intra-cranial pressure changes
- Possible radiation effects on repeat flyers
Basic Research
Use of altered g-level to investigate biomedical processes

- Basic-research issues
  - Neurovestibular – role of otolith organs (VEMPS, pitch VOR)
  - Role of gravity in orientation perception – external and internal
  - Motor control and the role of gravity
  - Gas mixing in lung
  - Baroreceptors – initial vasodilation in 0g – cortical and blood-pressure effects
  - Effects on immune system function – immediate leukocyte effects
  - Stress hormone secretion