VAST | BriteMind AI

ARPA-H PROPOSAL

Autonomous Neurobehavioral Stability & Cardiovascular Coupling in Commercial Spaceflight

A flight-validated, agentic health monitoring system demonstrated aboard Vast Space orbital missions — translatable to rural cardiology, disaster response, and cardiology deserts on Earth.

SUBMITTED BY
Vast Space & BriteMind AI

SUBMITTED TO
ARPA-H

PLATFORM
Haven-1 & Successors

• Proposal

Executive Overview

This proposal establishes a flight-validated, agentic neurobehavioral monitoring and resilience system for deployment in isolated, confined, and extreme environments — beginning with commercial orbital missions conducted by Vast Space. Developed by BriteMind AI, the system is a psychotherapy-informed, closed-loop conversational agent that integrates structured behavioral dialogue with physiological telemetry to model the coupling between emotional regulation, cognitive load, and autonomic cardiovascular stability.

ARPA-H has identified agentic AI and cardiovascular health transformation as critical frontiers in autonomous care. The proposed **Psychotherapy Space Module** addresses these objectives by demonstrating that structured, safety-bounded conversational intelligence can detect early neurobehavioral destabilization and correlate it with measurable changes in heart rate variability, sleep integrity, and stress physiology during spaceflight.

THE CORE THESIS

Orbit is a controlled testbed for autonomous health technologies.

The commercial orbital environment provides a uniquely stressed, uniquely monitored context for validating agentic health systems — without reliance on continuous specialty care access. What works in orbit scales to rural America, disaster response, military deployment, and cardiology deserts on Earth.

Strategic Alignment with ARPA-H

The proposal aligns with ARPA-H's mandate for high-impact, high-risk biomedical innovation in three principal ways:

- ✓ Advances agentic AI beyond static decision support via structured conversational systems capable of adaptive probing, longitudinal state modeling, and physiologic correlation within defined safety constraints
- ✓ Addresses cardiovascular risk through neurobehavioral modulation — recognizing that autonomic instability frequently precedes adverse cardiac events
- ✓ Leverages a mission-critical environment to validate autonomous health technologies directly translatable to underserved and extreme-context populations

Scientific Rationale

Spaceflight induces predictable alterations in autonomic balance — reductions in heart rate variability, sleep fragmentation, and sympathetic activation under workload stress. Isolation and confinement concurrently influence mood variability, cognitive performance, and team dynamics. Emerging evidence points to a bidirectional relationship between emotional state regulation and cardiovascular autonomic function.

CENTRAL HYPOTHESIS

Structured conversational markers predict autonomic deviation.

Psychotherapy-informed conversational engagement can generate quantifiable behavioral markers that correlate with — and potentially predict — short-term deviations in cardiovascular autonomic stability during spaceflight. Daily micro-dialogue paired with wearable telemetry produces a dynamic Neurobehavioral–Autonomic Coupling Index.

Study Design

6–8 min
DAILY CREW ENGAGEMENT

Zero
NEW HARDWARE REQUIRED

Within-Subject
REPEATED-MEASURES DESIGN

Initial validation occurs during a short-duration commercial orbital mission conducted by Vast Space. Crew members voluntarily engage with the BriteMind agent on existing mission tablets. Each astronaut serves as their own baseline control, with pre-flight, in-flight, and post-flight measures compared across timepoints. Physiologic data includes daily heart rate variability summaries, resting heart rate, and sleep efficiency metrics via mission-approved wearables.

The conversational component does not resemble a questionnaire. The agent conducts brief, adaptive dialogue focused on cognitive load, emotional regulation, perceived team climate, and somatic stress awareness — designed to elicit reflective data that can be computationally modeled without requiring narrative disclosure of sensitive personal information.

PHASE 01
Pre-Flight Baseline

PHASE 02
In-Flight Daily Engagement

PHASE 03
Post-Flight Comparison

PHASE 04
Mixed-Effects Modeling

Safety & Governance

The Psychotherapy Space Module operates under deterministic safety constraints. It does not provide medication guidance, diagnostic labeling, or independent medical directives. Participation is voluntary; sessions may be skipped without consequence. All conversational data are tokenized into structured feature vectors — raw narrative content is not transmitted for research analysis unless explicitly consented. The proposal anticipates IRB review and adheres to HHS human-subjects protections, with data de-identified and segregated from any mission performance evaluation channels.

Mission Deliverables

1. **Validated Neurobehavioral–Autonomic Coupling Index** suitable for expansion in larger cohorts and terrestrial pilots.
2. **Compliance and operational feasibility dataset** for autonomous agentic health monitoring in extreme environments.
3. **Regulatory-aligned framework** demonstrating how conversational AI can be structured to produce physiologically meaningful data within defined safety constraints.

Translational Impact

While spaceflight provides the validation environment, the broader public health implications are terrestrial. If neurobehavioral conversational markers reliably correlate with autonomic instability, this technology extends directly to remote cardiology monitoring in rural communities, veteran care systems, disaster response zones, and isolated occupational environments. The long-term vision is an FDA-authorizable agentic system that augments cardiovascular monitoring by integrating behavioral state detection with physiologic telemetry.

A Proving Ground, Not a Destination

Through collaboration between Vast Space and BriteMind AI, the commercial orbital platform becomes a proving ground for next-generation autonomous health systems — protecting both astronauts in orbit and patients in remote communities on Earth.