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NEUROSTRUCTURAL, COGNITIVE, AND PHYSIOLOGIC CHANGES DURING A 1-YEAR ANTARCTIC WINTER-OVER MISSION

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Exploration-type missions will require humans to live in isolated, confined, and extreme environments for prolonged periods of time. NASA's Mars Design Reference Mission 5.0 has a duration of 910 days, which is well beyond the duration astronauts and cosmonauts have remained confined in a spacecraft. NASA's recent evidence-based review of the behavioral health risks to crew and mission success during exploration spaceflight concluded they were among the most serious unmitigated risks to such missions. Due to their complex logistical operations, harsh threatening environmental conditions such as extreme cold, altered photoperiod, low humidity, isolation, and confinement, as well as the analogous population of researchers with multicultural backgrounds, but similar educational background compared to astronauts, Antarctic research stations are considered a high-fidelity analog for long-duration space missions. While NASA and NSBRI have begun collecting some neuroimaging data before and after missions, our knowledge on the effects of prolonged periods in space or space analog environments on neurostructural and neurobehavioral changes is still limited.

To address this knowledge gap, we are investigating neurostructural, cognitive, behavioral, physiologic, and psychosocial changes in a total of N=25 crewmembers during two 1-year Antarctic winter-over seasons (2015/2016) in the French/Italian Concordia station. We will assess subjects using quantitative structural and functional magnetic resonance imaging (MRI) before, immediately after (via collaborations with neuroimaging centers in Christchurch, NZ and Hobart, AUS), and 6-months after the winter-over. We will assess Concordia crew members during the mission using sensitive but unobtrusive methods to measure cognitive performance (*Cognition* test battery [1], monthly), sleep-wake behavior and sleep continuity (actigraphy, continuously [2]), heart rate and heart rate variability (24-h electrocardiography, monthly), relative proximity (actigraphy, continuously), psychomotor vigilance (PVT-B, weekly [3]) and subjective assessments of stress, mood, fatigue, health, workload, monotony, boredom, loneliness, and crewmember conflicts (questionnaires, weekly). A control group with individuals matched to each crewmember according to age and gender will be investigated with similar methodology at the German Aerospace Center (DLR, Cologne). Neuroimaging and Cognition data will also be compared to N=9 crewmembers over-wintering in the German Neumayer-III station in 2015. Furthermore, Cognition data will be compared to 13 crewmembers over-wintering in the British Halley station in 2015.

Baseline data collection for both winter-over seasons was finalized in October 2015. Human phantom scans at envihab Cologne, Christchurch, and Hobart were also completed in October 2015. Data acquisition in the first winter-over crew is ongoing with overall good compliance.

LITERATURE

[1] Basner M. et al (2015) *Aerosp Med Hum Perform* 86(11), 942-52. [2] Basner M. et al (2013) *PNAS* 110(7), 2635-40. [3] Basner M. et al (2011) *Acta Astronautica* 69, 949-59.

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