EMBEDDED COGNITIVE TRAINING: ASSESSING COGNITIVE AND OPERATIONAL PERFORMANCE IN A SIMULATION OF MANUAL SPACECRAFT DOCKING

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Operational tasks such as the manual control of space vehicles or robotic arms place high demands on the cognitive and sensorimotor performance of astronauts. The success of a mission and the safety of the crew depend on whether critical skills can be maintained with consistently high reliability over long periods of time. However, exposure to stressors such as microgravity, sleep deprivation, isolation, and high workload pose risks to optimal performance. Future long-duration missions to the Moon and Mars in particular require new methods to allow for autonomous monitoring and training of cognitive and operational capabilities.

The *6df* simulation developed by the German Aerospace Center (DLR) facilitates to acquire and maintain the skills required for the manual control of a space vehicle with six degrees of freedom of motion. Aim of the newly developed Embedded Cognitive Training is to train and monitor operational docking performance against a background of simultaneous high cognitive demand in various domains. The supplementary cognitive tasks were developed in such a way that they fit plausibly into the docking scenario and cover a variety of potentially sensitive cognitive domains, i.e. working memory, visual attention, logical and numerical reasoning.

We present the embedded training concept and first performance results from a spaceflight analog environment. In the SANS-CM bed rest studies at the DLR Institute of Aerospace Medicine in Cologne, 47 participants took part in the *6df* Embedded Cognitive Training. Participants spent 30 days in 6° head-down tilt bed rest to simulate the physiological effects of microgravity. Lower body negative pressure (N = 12) and lying ergometer cycling with veno-occlusive thigh cuffs (N = 12) were tested as countermeasures against spaceflight-associated neuro-ocular syndrome and compared with daily upright sitting (N = 11) and a strict bed rest control group (N = 12). After achieving sufficient skills in controlling six degrees of freedom with the learning program of the *6df* simulation, participants completed docking sessions that included embedded cognitive tasks twice a week during the bed rest phase and the two-week regeneration period.

Embedded Cognitive Training is intended to provide operators with more comprehensive feedback on their own operational as well as cognitive performance and individualized training to maintain performance, especially for long-duration missions. In contrast to conventional test procedures, operational tasks are less affected by motivation effects due to their direct relation to the working environment. Further developments are planned to enable training adaptations contingent on the operator's status and thereby support a growing crew autonomy.