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NEUROADAPTIVE CREW COUNTERMEASURES FOR LONG DURATION SPACE EXPLORATION - A SYSTEMS ENGINEERING APPROACH – NEUROCOGNITIVE PREDICTIVE PERFORMANCE SCREENING & REMEDIATION TOOL (NPPSR): A PREDICTIVE NEUROBEHAVIORAL HEALTH PERFORMANCE MONITOR

Abstract

Long duration missions will produce new psychological challenges never before experienced, due, in part, to extended periods of microgravity and radiation exposure. Both are shown to alter Central Nervous System (CNS) performance, including the natural ability of the brain to process information, self regulate, maintain cognitive control and neurogenesis. The success of a manned space mission depends upon the crew's ability to perform as individuals as well as cohesive teams. Recent ISS (International Space Station) mission reports hint at the presence of psychosocial problems in crews that can result in detrimental effects on cognitive performance, moods, and work performance. These negative effects include not only lapses of attention, mood changes, but also a decline in cognitive and work performance. Two such examples include a recent retrospective brain scan study, showing brain structural changes with spaceflight and an ISS visual-perceptual experiment reporting visual-perceptual differences in space. In the first study the authors found extensive gray matter decreases within the temporal and frontal poles and the orbital areas, regions involved with cognitive control and memory. The effect was larger in ISS versus shuttle crew members. The second ISS visual perceptual study, showed indications of brain changes affecting visual 2-D vs 3-D processing activities. Here the authors found a greater demand on the executive function in space was required for the brain networks to process 3-D visual images. This excess demand directly impacts an individual's ability to exert cognitive control. This paper offers suggestions on how to approach the onboard astronaut's behavioral health monitoring and countermeasure problem from a Neuroengineering perspective. This perspective is derived from current clinical predictive insights and use of the NeuroCodex/Neurocoach system. The NeuroCoach remediation system integrates Cognitive Remediation Training methods with classical control theory using a real-time Brain Computer Interface to guide retraining of dysfunctional neuro-circuits. Applicable clinical examples, (rehabilitation work with TBI solders and other clinical populations) will be highlighted. A NFL player non-injury example of the application of the method and technology will be presented. Here the program, takes a snapshot of how a player's brain is performing before the beginningof their pro-ball play and use this brain performance image as a template to measure against subsequent re-evaluations during their NFL career. If major deviations occur, an instrumented Cognitive Remediation Training method to help professional athletes retrain any loss of neurofunctional performance until it again matches their brain performance before NFL play is used.