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CORTICAL SOURCES OF RESTING STATE EEG DURING BED REST

Abstract

Various studies have demonstrated a positive correlation between physical exercise and brain plasticity and cognition. Hence, the reduction of physical activity could induce considerable neurobehavioral impairments. Immobilization during spaceflight is serious for cardiovascular deconditioning and bone and muscle loss. These effects have been well established under real and simulated weightlessness. However, studies specifically addressing the impact of reduced physical activity on the brain during spaceflight are clearly lacking. Head-down tilt bed rest (HDT) is an excellent terrestrial analog model to ascertain a cause and effect relationship between immobilization and brain plasticity. The aim of the present study was therefore to investigate the impact of long-duration HDT on brain electrocortical activity.

As part of the ESA sponsored 60-days head-down tilt bed rest study "Cocktail", we recorded resting state eyes-closed electroencephalographic (EEG) activity in N=20 healthy men. Data were collected before (BDC-8), after 60 days (HDT60) and one week after bed rest (R+7) using an active electrode 32-channel amplifier (actiCHamp, Brain Products, Germany). Power spectral analysis was performed to assess mean cortical activity in five different frequency bands, i.e. alpha-1 (7.5-10 Hz), alpha-2 (10-12.5 Hz), beta-1 (12.5-16 Hz), beta-2 (16-20 Hz) and beta-3 (20-35 Hz). EEG cortical sources were estimated for all frequency bands by exact low-resolution brain electromagnetic tomography (eLORETA).

Compared to BDC-8, alpha-1 EEG activity was significantly lower in the right insula as well as right superior, inferior and middle temporal gyrus after 60 days of HDT ($P<0.01$). Additionally, we found a significant bilateral reduction of beta-2 and beta-3 activity in the cuneus, precuneus, posterior cingulate gyrus and anterior cingulate gyrus ($P<0.01$). No significant differences were observed for alpha-2 and beta-1 activity. After one week of recovery, all data returned to baseline levels, indicating that these changes are reversible.

These findings are in line with data from our previous bed rest experiment and suggest that long-term immobilization has a considerable impact on electrocortical activity, potentially affecting brain function and neural adaptation processes. However, EEG provides an indirect measure of neuronal activity, and can therefore be confounded by various sources. For instance, at this point it is unclear whether the observed alterations are due to true neuroplastic changes or simply the consequence of fluid and/or brain shifts associated with HDT. For these reasons, brain structural and functional imaging studies using MRI and PET scans are critically needed to fully understand the effects of spaceflight and spaceflight analogs on brain plasticity.