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ELECTROCORTICAL EVIDENCE FOR IMPAIRED AFFECTIVE PICTURE PROCESSING AFTER
LONG-TERM IMMOBILIZATION STRESS

Abstract

Previous studies on the neurobehavioral effects of spaceflight have largely focused on arousal and cognition. Future long-duration exploratory space missions (LDEM) will involve small crews of 4-6 persons, living and working in the environment of deep space for unprecedented durations. Given that social influences are considered one of the most powerful sources inducing neuroplastic changes, emotional regulation and its neural basis is gaining increasing attention in research.

As part of the ESA sponsored head-down tilt bed rest (HDT) study “Cocktail”, we investigated the effects of HDT on emotional processing using the International Affective Picture System (IAPS) and electrocortical recordings. A total of N=20 men participated in the study. For the present experiment these subjects were randomly allocated to one of two groups in a balanced fashion. One of the groups served as a control (CTRL) and was tested before HDT, and the other group was tested after 31 days of bed rest (HDT31). Stimuli consisted of 75 pictures from the IAPS, balanced between pleasant, neutral, and unpleasant trials. Each picture was projected for 2 seconds in a semi-random sequence on a monitor in -6 degrees head-down tilt position. Electrocortical activity was continuously recorded and synchronized with the stimuli using an active electrode 32-channel amplifier (actiCHamp, Brain Products, Germany). Emotional valence and arousal of each picture were evaluated using a 9-point Self-Assessment-Manikin scale. Differences in event-related potentials (ERP), i.e. P300 and Late Positive Potential (LPP) between groups were compared using a mixed model treating group and stimuli type as fixed effects and subjects as random factors.

Mean P300 and LPP amplitude to pleasant and unpleasant stimuli were significantly decreased after 31 days of bed rest compared to the CTRL group, especially in centro-parietal regions ($P < 0.05$). Moreover, positive and negative pictures induced significantly greater mean P300 and LPP amplitude than neutral stimuli in the CTRL group ($P < 0.05$). In contrast, no significant alterations among the emotional conditions were observed in the HDT31 group for both ERP components. Source localization using eLORETA revealed a bilateral lower activity in the posterior cingulate gyrus, insula and precuneus in the HDT31 group for both ERP timeframes in pleasant and unpleasant stimuli ($P < 0.05$). Behavioral evaluations of arousal and valence did not show any significant changes.

Our data indicate that HDT inhibits emotional processing. These changes raise important issue on the risk of astronauts and support the critical need of research on social support and appropriate countermeasures during LDEM.