MODIFICATION OF GOAL-DIRECTED ARM MOVEMENTS DURING SHORT-AND LONGTERM SPACEFLIGHT

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Introduction: Weightlessness causes modifications in the central interpretation of afferent signals from the otolith organ and from proprioception. Therefore arm pointing in microgravity during changed head-to-trunk position offers possibilities to study the mechanisms of adaptation of sensorimotor control in detail.
One spatial characteristic of these goal-directed arm movements (GDAMs) in G1 and G0, the slant of the moving plane of the arm during horizontal pointing, is presented here.

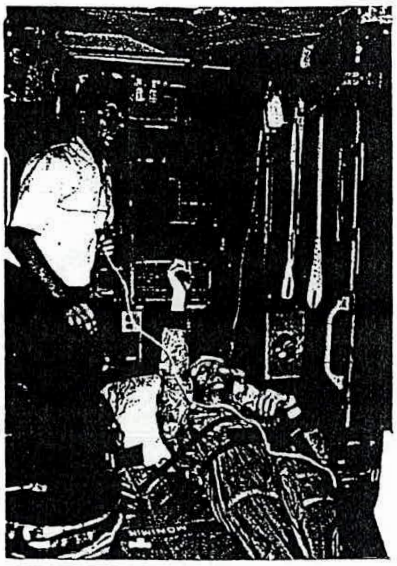

Fig. 1: Experiment MONIMIR in the MIR-Simulator: The cosmonaut is fixed on the floor and points with the arm lamp (laser beam) to flashing LED's on the LED-matrix fixed on the ceiling. Head and arm position/movement is recorded by infrared markers and infrared scanner cameras.

Methods: GDAMs were learned and reproduced by 10 cosmonauts in one short-term (7d, A), eight long-term (4 to 8 months) and one super-long-term flight (14 months, B). Measurements were taken preflight and on the 2nd and 5th day of flight (A), resp. approximately every month inflight (B). Postflight tests were on the 2nd and 5th day after landing. The cosmonauts learned to point to LED's in horizontal line, then turned or sidebended the head to the right and repeated the movement with eyes closed. The position of head and arm was measured by two IR scanning cameras (Fig.1). The arm pointer was placed on the right hand, the LEDs-matrix in front of the subject. In the space lab MIR the cosmonauts were fixed in supine position on the floor by belts.

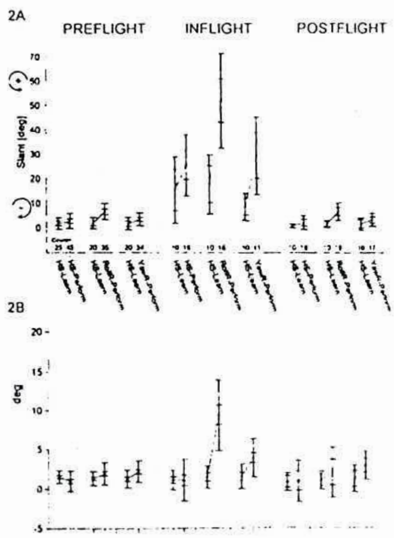

Fig. 2A+2B: Slant of the movement plane of the arm in different head-to-trunk positions in one short-term (A, 7 days) and one long-term flight (B, 14 months). (Learn = learning phase ; Perform = performing phase ; HS = head straight ; YawR = head rotated to the right ; RollR = head sidebended to the righ; slant in deg, scales in A and B different extent !)

Results: The analysis of the GDAMs during changed head-to-trunk positions revealed that, with eyes closed, sidebending of the head in microgravity and rotation of the head pre- and postflight is correlated with considerable counterclockwise slant of the movement plane of the arm (Fig.3). Fig.2A,B shows the amount of slant in short-term and long-term spaceflight. In the short-term flight (2A) large effects were seen (slant 70 deg in head roll position) with hardly any aftereffect on the 2nd day after landing. The longterm cosmonaut showed optimization of visually controlled arm movements but no improvement without visual guidance.

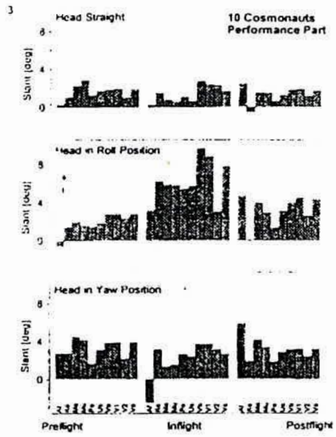

Fig. 3: Slant of the movement plane of the arm for each of ten cosmonauts (Pre-, in-, postflight) for three head-to-trunk position. Positive values correspond with counterclockwise slant of the movement plane during horizontal pointing with eyes closed

Conclusion: Head position with respect to the trunk plays an important role in encoding target position. It seems that without visual guidance the distorsion induced by rotation or side bending of the head disturbs the hypothezised „body scheme" by different reasons. As a consequence a significant contralateral tilt of the internal representation of the horizontal co-ordinate occurs. Loss of background information due to reduced proprioception inflight causes the development of a changed strategy for movement control even with eyes open: Minor mean velocities, longer durations and in most cases a reduced amplitude of the aimed arm movements.

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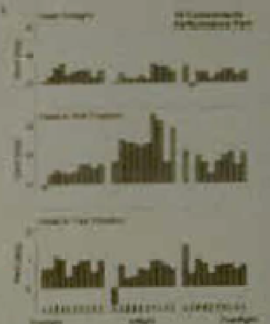

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This meeting contains abstracts of 383 papers, including slides, written in English, covering decompression sickness, space physiology, clinical issues in air transport, environmental factors: heat, cold, and altitude, medications, fatigue management, neurophysiology and night vision, and cardiology.