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V. INTEGRATIVE FUNCTIONS

EVIDENCE FROM SPACE ON THE INDEPENDENT CONTROL OF OTOLITH-GENERATED EYE MOVEMENTS

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Binocular studies of torsional eye movements were performed on two astronauts during a six-month mission on the Russian Space Station Mir. Preceding the flight, numerous baseline studies provided a reliable indication of the torsional position of the two eyes in the normal 1G of Earth, and these positions were used as the baselines against which the studies in space were compared. In both g conditions, the subjects sat quietly upright.

In both space and on Earth, the head was held by an apparatus consisting of a pre-molded bitebar rigidly attached to a mask in a solidly fixed position. The mask had two video cameras and a clear field of view. On Earth, a line throngh the center of both pupils was verified to be Earthhorizontal. Video-taping both eyes provided 25 synchronized images per second using the videooculography system on SensoMotoric Instruments.

Eight or nine studies were interspersed during the 180-day mission. In both subjects, the torsional positions of the eyes differed from the positions on Earth and each eye differed from the position of its mate. In one astronaut, torsional position was 3° to 4° counterclockwise from baseline. In the other astronaut, the left eye was torted counterclockwise and the right eye clockwise. The offset of eye torsion during the entire mission persisted for several days postflight, as did the difference between the two eyes. The next tests, performed several months later, found the eyes had reverted to their preflight baseline positions.

In contrast to the torsional conjugacy observed on Earth-based testing, the independent behaviour of the two eyes in space suggests that a partial decoupling between the otoliths and eye muscles may occur in novel gravitational states. A sudden change in otolith signal may act to decouple the multisynaptic connections from each labyrinth to the separate neuronal pathways going to each eye.

A third astronaut was examined monocularly during a 30-day mission. Torsional eye position in this subject was similarly offset from baseline, persisting for many days postflight. Althongh only one eye was examined, his findings are consistent with the observations in the binocular studies.