- Friday, December 5, 1997
  Motor Learning in the Vestibulo-Occular Reflex

1.0 These are the minutes for YORKVIS 5 Dec 97 which was given by Dianne Broussard

1.1 I would like to take this opportunity to express my sadness at the sudden and unexpected death of my much-admired colleague Volker Henn (1942-1997). There is an in memoriam page on http://www.unizh.ch/neurol/vestlab.htm. I have also included a few photographs of him on: http://www.yorku.ca/research/vision/henn.htm

1.2 Next meetings are this Friday (Jim Clark) and Friday Jan 16, 1998

2.0 Dianne Broussard's talk was on mechanisms of learning the Vestibulo-ocular reflex

2.1 Dianne introduced the vestibulo-ocular reflex's (VOR) role as

being to stabilize gaze
being very plastic or modifiable in response to visual information
having open-loop (in the dark) and closed-loop (in the light) modes
being able to recover well from unilateral lesions
having a basic 3 neuron arc pathway controlling it
being dependent on the role of the reciprocal commissural connection
2.2 Fortunately the direct and commissural pathways seem each to be dominated by different neurotransmitter receptors. This allowed Dianne to interfere with different parts of the circuit separately and try and reveal the relative roles of the direct (glutamate, AMPA type of receptors) and commissural (glutamate, NMDA type receptors) pathways.

2.3 If the head of a cat is passively moved suddenly, the eyes move briskly in the opposite direction, often with a slight overshoot before returning to a plateau position.

2.4.1 Ketamine, which affects both types of glutamate receptors INCREASES the overshoot and REDUCES the plateau suggesting that the effect of taking out glutamate receptors is to make the system more "high pass" that is reducing its efficiency at processing slow, low frequency head movement.

2.4.2 MK801/APV selectively blocks NMDA type glutamate receptors (green, commissural pathway) and seems to reduce a low frequency VOR responses.

2.4.3 CNQX selectively blocks AMPA type glutamate receptors (yellow, direct pathway) and might even enhance low frequency VOR responses.

2.5 Conclusion: commissural pathway particularly involved in the response to low frequency head movements..

3.0 If a cat wears magnifying (minifying) lenses, then, for a given head movement, a greater (smaller) eye movement is required. This closed-loop visual feedback is able to alter the VOR quite quickly such that when measured subsequently in the dark (open-loop mode). This process is enhanced by 'forced rotation' in which the animal is rotated back and forth during the 'teaching' period.

3.1 The response to low frequency head movement is much more effected by this regime. Even though the appropriate visual feedback occurs at all frequencies (although, corrective high frequencies might be less effective at passing through the low-pass properties of the visual system).

3.2 Conclusion: The coincidence of the frequency ranges of the effects of NMDA blockers and the most modifiable head movements is compatible with a strong role of the commissure in VOR gain control.

4.0 If the semicircular canals on one side are plugged and rendered inoperative, neurones on that side (ipsilateral) can only get canal input via the commissure (see diagram above). The horizontal canals give an excitatory response for movement towards that side (ie. leftward rotation excites the left horizontal canal and inhibits the right canal and visa versa).

4.1 After unilateral plugging, the high frequency response remains symmetrical, although of reduced gain, suggesting that the response to head movement in both directions at high frequencies can be controlled unilaterally. The low frequency response, however, becomes quite asymmetric with the response to contralateral movement (away from the plug) being affected much more.

4.2 This suggests that the information coming across the commissure normally contributes to the control of the VOR evoked by low frequency, contralateral head movement.

5.0 General conclusion: Taken together these results suggest that the commissure is particularly involved in low frequency head movements and by association therefore in plasticity (which seems to be a low frequency phenomenon). It is probably no coincidence that NMDA receptors, used by this pathway, have been implicated in other forms of learning throughout the brain.

Dianne Broussard