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  Manipulation of afferent feedback from extraocular muscles: Effects on vergence, version and higher order perceptual judgements

  The central nervous system can use two extraretinal sources to stay informed about the position of the eyes in the orbit: outflow (efference copy) and inflow (afference). Palisade endings (PE), found at the myotendinous junction of the multiply innervated fibers of the global layer of extraocular muscles (EOM), are the putative receptors supplying the inflow eye position signal. Seminal neuroanatomical tracing studies identified a distinct set of non-twitch (NT) motoneurons whose activity does not add to the force used to move the eyes. It has been suggested that NT motoneurons could be involved in modulating the gain of sensory feedback from EOM analogous to the gamma-efferent fibres which control the sensitivity of muscle spindles in skeletal muscles. The goal of this thesis was to test the above hypothesis in humans using behavioural and psychophysical approaches. Jendrassik Maneuver (JM), which is a forceful muscle contraction that facilitates the amplitude of all spinal and brainstem reflexes, was used to manipulate afferent feedback. The facilitation is most likely due to a general up-regulation of the gamma system. It was hypothesized that if NT motoneurons are analogous to gamma motoneurons, the JM should also increase the activity of NT neurons and alter the afferent feedback from PE. As hypothesized, the JM perturbation altered registered vergence eye position when binocularly intact observers localized targets in depth but did not affect localization in the frontal plane associated with saccades. Patients with congenital strabismus who have had surgeries on their EOM were not affected by the JM perturbation. In contrast to the hypotheses, the JM did not affect higher order perceptual judgments (size and depth constancies). Overall, these studies provide insight into the putative mechanism involved in the control of sensory feedback from EOM. In particular, the NT motoneurons might be involved in parametric adjustment of the proprioceptive feedback loops to match the demands of different types of eye movements. Understanding the role of proprioceptive feedback loops could have important clinical implications for surgical treatment of strabismus.

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