MODELLING PROPRIOCEPTIVE SENSORY CONTROL OF THE MAMMALIAN LOCOMOTOR CPG

D.A. McCrea[1]*, N.A. Shevtsova[2], K. Stecina[1], I.A. Rybak[2]

1. Spinal Cord Research Centre, Univ Manitoba, Winnipeg, MB, Canada
2. Sch Biomed Eng, Drexel Univ, Philadelphia, PA, USA

We have developed a computational model of the lumbar locomotor central pattern generator (CPG) in adult cats that contains a half-centre rhythm generator (RG) and a pattern formation network (PF) with reciprocal inhibitory interactions between antagonistic groups of neurons at several levels. Each functional type of neurons is represented by a population of 10-20 neurons modelled in the Hodgkin-Huxley style. Sensory feedback has been incorporated in the model using known neuronal connections and those suggested from our studies of fictive locomotion in decerebrate cats. The model accurately reproduces a series of experimentally observed phase-dependent effects of stimulation of group I and II flexor and extensor afferents upon patterns of motoneuron activities, timing of phase switching, and locomotor cycle period. Specifically and similar to our experimental findings, activation of extensor group I afferents during extension may prolong the extensor phase with or without resetting the step cycle, whereas their activation during flexion produces a temporary resetting to extension without changing the ongoing cycle period. The model shows that these phenomena may result from different effects of sensory input to the RG and PF layers of the CPG. The model also suggests that the different effects of flexor afferent stimulation during flexion observed experimentally (phase prolongation vs. resetting) may result from opposing influences of group I and II flexor afferents on the flexor and extensor parts of PF and RG. We show that the two-layered CPG can readily accommodate the effects of sensory regulation of stepping that have been observed during real and fictive locomotion. Modelling the effect of afferent stimulation provides insight into organization of mammalian CPG and allows us to postulate specific neuronal interactions in the spinal cord during locomotion that can be tested experimentally.
Supported by CIHR and NIH.

Theme D: Motor Systems
Subtheme 7: Pattern generation and locomotion
Keywords: spinal cord, reflex, rhythmic activity, locomotion, model