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Title Precision in muscular control: Gain modulation in spinal motoneurons by sub-threshold Vm-fluctuations.

Text The mechanisms underlying the large dynamic range in motor systems are poorly understood. We have previously shown that the intensity of synaptic inhibition and excitation co-vary in phase (rather than out of phase) during rhythmic limb movements (Berg et al. Science 2007). This could provide a mechanism for gain modulation in motoneurons. Fluctuations in membrane potential due to balanced synaptic input is a possible candidate for gain modulation in neurons, as suggested (Berg et al PLoS ONE 2008), but issues still remain: 1) is gain modulation by balanced synaptic fluctuations in fact used by the nervous system to adjust the dynamical range? 2) does this mechanism also adjust dynamical range and improve precision in motor systems? Scratch spinal network activity in the turtle is an ideal model for addressing both issues. Here we quantify the motor output during scratching and relate it to the intensity of the synaptic fluctuations and the gain recorded in individual motoneurons. We find that: 1) the FI-gain of individual motoneurons is modulated during motor behavior. 2) Motor output (quantified as the integrated electroneurogram (ENG) of hip flexor nerves) correlates with this gain. Interestingly, this relation represents a functionally meaningful gain modulation because it scales the force precision with the absolute force in analogy to Weber's law for sensory perception, i.e. $\Delta \text{Force} / \text{Force} = \text{constant}$. Gain is equivalent to ΔForce and the ENG is equivalent to Force. 3) Gain is reversely related to the magnitude of the fluctuations in membrane potential (i. e. σ of Vm, figure B), as previously predicted from theory (see e. g. Tuckwell 1988).

Theme 1 Excitability, synaptic transmission, network functions
Network interactions
Oscillations and synchrony

Theme 2 Sensory and motor systems
Motor neurons and muscle
None

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