Proprioceptive feedback can inhibit motoneuron activation via supra-spinal pathways

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Introduction
Sensory information from moving limbs is essential for voluntary movement and for correct involuntary responses to limb perturbation. How this information influences motor control is presently unclear. We have shown previously that moving a limb passively in a manner kinematically comparable to normal voluntary movement can inhibit the EMG response to magnetic brain stimulation over the motor cortex (Edwards et al. 2004, Edwards et al. 2002), and provided evidence that this inhibition is mediated by spindle afferents. The aims of the present study were to determine whether this inhibition occurs at the spinal or supra-spinal level.

Methods
The index finger of the dominant hand of 10 subjects (8 male, 20-45 years of age) was moved in a cyclic fashion at 1Hz through ab/adduction. F-wave numbers following 30 stimuli (first dorsal interosseous muscle) were recorded at mid range of adduction. In a second study, using the same movement parameters, MEP amplitude was measured in a male subject (61yrs) with a brainstem / thalamus lesion producing a sensory-only stroke (absent joint position sense / proprioception). The patient was studied 14 days after the stroke, then 2 months later when proprioception had improved.

Results
The number of F-waves almost halved during passive movement, (7.9±1.8 baseline, 4.5±1.2 movement, p<0.05) (Figure 1) and was comparable to the 50% reduction in MEP amplitude previously reported (Edwards et al. 2004). In the clinical case study, 14 days post-stroke, passive movement did not give rise to the reduction in MEP amplitude observed in healthy subjects. Median MEP amplitude during movement was significantly increased from baseline by 18% (baseline = 4.1 mV, movement = 4.9 mV, p<0.05). The subsequent study 64 days post-stroke showed the median MEP amplitude to be significantly reduced during movement, with the median value 13% lower than baseline (baseline = 6.7 mV, movement = 5.9 mV, p<0.05). Figure 2 presents a frequency histogram with normalised movement data for the two time periods.

Discussion/Conclusion
During passively applied limb movement the number of F-waves elicited in the moving muscle was significantly reduced when compared to rest, suggesting that that proprioceptive information can decrease the excitability of spinal motoneurons. However, the findings of the clinical case study demonstrate that afferent input to the brain is important for this inhibitory effect. Together these studies suggest that the inhibitory effect of passive movement may involve descending inhibition acting directly on the motoneuron. This inhibitory phenomenon may act to limit or fine-tune excitatory motor activity, in the control of moving limbs.

References