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The Effects of Peripheral Nerve Conditioning Stimuli on Responses of Lumbar Spinal Cord Neurons to Noxious Thermal Stimulation of the Skin in the Cat

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Consideration of the stimulus intensities and evoked sensations produced by pain relieving transcutaneous nerve stimulation (TENS) and acupuncture suggests that a wide range of primary afferents may be involved. High frequency (over 50 Hz), low intensity TENS probably only activates large mechanoreceptive primary afferents innervating skin, whereas low frequency, higher intensity TENS (Eriksson *et al.* 1979) and acupuncture will also activate other types of primary afferent from skin and deeper tissues. Studies in spinal cats have shown that conditioning stimuli applied to muscle nerve at intensities that would evoke group III (Sjölund *et al.* 1979) and C fibre (Chung *et al.* 1983) afferents, will inhibit reflex responses to cutaneous nerve stimulation at intensities which would evoke C fibre activity. These preliminary experiments have been carried out to examine the effects of various intensities and frequencies of peripheral nerve, particularly muscle nerve, stimulation, on responses of lumbar spinal cord neurons to noxious thermal stimulation of the skin.

In intact cats anaesthetized with α-chloralose (80 mg kg^{-1}), recordings were made with multi-barrelled micropipette electrodes of the activity of lumbar spinal cord neurons with receptive fields on the ipsilateral hind foot. Thirteen neurons that responded consistently with an increased firing rate to repeated application of a noxious thermal stimulus to their receptive field were tested during conditioning stimulation applied to the sural, tibial, medial gastrocnemius or lateral gastrocnemius nerves. The compound action potentials evoked by these conditioning stimuli were recorded proximally, from the sciatic nerve. These were used to calculate the stimulus intensities which are expressed in terms of multiples of the threshold current (T) for activation of the largest myelinated axons (Aα/β or group Ia afferents). The neurons studied were found on subsequent histological analysis to be widely distributed through the deeper laminae of the dorsal horn and into the ventral horn.

Reductions of the responses evoked by noxious heat were readily produced by low intensity ($< 10T$) stimulation of the sural and tibial nerves at all frequencies tested (1–100 Hz). High intensity (more than $10T$ up to $300T$), low frequency (1–5 Hz) stimulation applied to the medial or lateral gastocnemius nerves for durations ranging from 300 to 1040 s overall produced few clear inhibitions of the responses evoked by noxious heat (mean change in amplitude of the last conditioned response compared with controls was 6.4% reduction). However, wide variability in the effects of the conditioning stimulation were observed and two neurons showed a clear response reduction (58% and 37% reductions in peak amplitude). Lower intensities of higher frequencies of stimulation were not found to produce greater inhibitions, but, in a few cases longer periods of stimulation were more effective. No clear correlation between the location of the neuron tested and the effectiveness of conditioning stimulation was evident.

References

Chung, J. M., Fang, Z. R., Cargill, C. L. & Willis, W. D. 1983 *Pain* **15**, 35–54.
Eriksson, M. B. E., Sjölund, B. H. & Nielzén, S. 1979 *Pain* **6**, 335–347.
Sjölund, B. H. & Eriksson, M. B. E. 1979 *Neurosci. Lett. Suppl.* **3**, S264.