1996 Prize Papers

Francis McNaughton Memorial Prize for Clinical Research

Involvement of the Ipsilateral Motor Cortex in Finger Movements of Different Complexities

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Background: Functional imaging and behavioral studies suggested involvement of the ipsilateral hemisphere in hand movements, particularly the left side. If so, disturbance of the motor cortex (M1) may affect ipsilateral motor sequences.

Methods: Ten right-handed subjects played a simple and a complex piano sequence of eight seconds duration. Two seconds after the beginning of each sequence, rapid rate transcranial magnetic stimulation was delivered to the ipsilateral or contralateral M1, or directed away from the head (control). Ten trials were recorded for each condition for both hands. The key press and timing errors were measured.

Results: Ipsilateral M1 stimulation on either side induced timing errors in both sequences and with the complex sequence induced more timing errors in the left than the right hand. Errors of the right hand occurred in the stimulation period only but errors of the left hand with the complex sequence occurred in both the stimulation and post-stimulation periods.

Conclusions: Both M1 is involved in ipsilateral fine finger movements. The left side played a greater role in the timing of complex sequences and may be involved in processing of motor programs in addition to execution of movements. These results may explain greater deficits of ipsilateral limb sequences following left rather than right hemisphere stroke.

The Herbert Jasper Prize

The Cortical Representation of Somatosensory Evoked Potentials of the Phrenic Nerve

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Respiratory electrophysiological studies are of essential value in diagnosing and managing patients with respiratory failure, but assessment of the sensory phrenic nerve fibres has been neglected. We recorded phrenic nerve somatosensory evoked potentials (SSEPs) by combining neurophysiological and neuroimaging techniques in three healthy subjects. Evoked potentials of the phrenic nerve showed the highest amplitude at CP3, determined by the modified 10-20 EEG system, and occurred at a constant latency, P1 at 12.0 ± 0.6 ms and N1 at 17.3 ± 0.8 ms. Single photon emission computer tomography (SPECT) performed during phrenic nerve stimulation revealed focal neuronal activation in the somatosensory pathways. Intravenously administered Tc-99m Ethyl Cysteinnate Dimmer (ECD) was used as a blood flow tracer to obtain baseline and activated images. After image registration, baseline images were compared voxel-by-voxel with the activation images. The mean inter-subject summation image of the activated-state was compared with that of the baseline-state using ten normal subjects. The extent of the total voxel volume increase on the mean images of the 3 activated SPECT images was 0.7%, and a mean signal increase of 22%. For further anatomic localization of regional increases in signal, the magnetic resonance image (MRI) scan of each subject was registered and superimposed on the activated-stage SPECT image. This method may be used clinically to study the pathophysiology of impaired central respiratory drive.

The K. G. McKenzie Memorial Prize for Basic Neuroscience Research

The Ability of Cultured Human Schwann Cells Within PAN/PVC Guidance Channels to Support Regeneration in the Transected Nude Rat Spinal Cord

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Peripheral nerve grafting strategies to the CNS have demonstrated that axotomized CNS neurons can regenerate given a supportive environment. When peripheral nerve grafts are placed as bridges following thoracic level transection of the adult rat spinal cord several thousand regenerated fibers are seen within the graft (Richardson et al, 1980). Despite this abundant response no meaningful functional recovery occurs. There appears to be two major reasons for this lack of functional restoration: firstly functionally important neurons of the brainstem and motor cortex have not been found to enter grafts placed to span thoracic transections. Secondly, it appears that fibers which have successfully regenerated through the grafts are not able to reenter the host spinal cord. We have developed a model of bridge grafting which employs the combination of purified, expanded human Schwann cells and other materials within PAN/PVC guidance channels in the nude rat. Such grafts represent controlled regeneration environments which are amenable to alteration of several variables. We have determined that purified populations of human Schwann cells survive within these grafts, significantly promote regeneration and myelinate axons. Grafts consisting of the same constituent materials but not placed within PAN/PVC semipermeable guidance channels are ineffective. We employ a combination of anterograde and retrograde tracing together with immunohistochemistry to define the regenerative response both into the bridge grafts and beyond them for several key neuronal systems.

The K. G. McKenzie Memorial Prize for Clinical Neuroscience Research

Substrate for Plasticity in the Human Thalamus

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Both acute and chronic deafferentation can produce significant alterations in somatosensory organization in experimental animals at various levels of the CNS. Recent studies in humans have also suggested that cortical representation can change, however the extent of reorganization and the level of the CNS at which it may occur, is unknown. The aim of this study was to demonstrate that receptive field (RF) plasticity exists at the level

of the thalamus and determine if pre-existing subliminal inputs could be the source of such plasticity.

During stereotactic thalamic exploration in patients being treated for tremor or pain, microelectrode recording identified neurons responsive to tactile stimulation of one digit. Reversible denervation of 7 single cells, produced by lidocaine block, resulted in changes in responsiveness in 6 of these neurons: an improvement in or the new appearance of responsiveness to mechanical stimulation of adjacent digits/sites. Control injections of saline into the RF-digital nerves of 2 neurons did not change responsivity to adjacent fingers. To identify possible connections responsible for this phenomenon, the RFs and adjacent digits/sites outside the RF were subjected to electrical stimulation (ES) in 47 cells and repetitive mechanical stimulation (RMS) and more long latency responses (<30 ms) were obtained with ES within the RF and more latency responses (>30ms) were elicited with ES outside the RF. Latencies and proportions of responses to RMS were similar to that of ES.

These data imply that single neurons in hand representation of human thalamus have afferent inputs from multiple adjacent digits, and that these connnections can be improved by manipulation of afferent input. Such convergence of afferent input may be the substrate by which representational plasticity occurs in the human.

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