FOREWORD

REHABILITATION MEDICINE AND THE NEW NEUROBIOLOGY

As has happened so often in medical history, traditional thinking and views have once again been proven wrong. Ever since the nineteenth century, scientists thought of the nervous system as 'wired' from early childhood, only gradually losing its structure and function over time. This was summed up in the saying, 'Any tissue may heal except the tissues of the central nervous system'.

At the same time, rehabilitation medicine was emerging as a medical speciality with increasing success in overcoming the results of neurological impairments. In our daily clinical work, we could observe that after injury, changes do indeed take place in nervous system function over time. In fact, it can be inferred from a number of empirically based treatment strategies that training to improve motor function should be based on such presumed progressive changes in motor ability. Other examples of functional change include spontaneous pain and other sensations, as well as epilepsy.

While Hebb, Marr and others had proposed on theoretical grounds that the occurrence of activity-related modifications in synaptic strength was necessary in explaining learning and memory processes, it was only after the neuroscientific progress of the last decade or so that the adult human brain was found to retain a capacity for plasticity and functional reorganisation throughout the life span. This is exemplified not only by demonstrations that cortical representation areas, so called 'cortical maps', can be modified by experience, learning and brain lesions, but also that a subcortical nucleus may actually grow in size upon a focussed demand of an ongoing spatial discrimination task. Even more spectacular are the recent findings that neuronal stem cells exist in the adult brain and that they may differentiate into mature functioning neurones upon local and external (environmental) cues. Such phenomena are also apparent in recent reports of the bridging in animals of a spinal cord transection with axons, establishing meaningful functioning distal connections and recovery of motor function.

Prior to this, a methodical integrative neurophysiological analysis of the mechanisms responsible for motor control was in progress during most of the twentieth century. Scientists like Sherrington, Eccles, Lundberg, Ito and Oscarsson laid the basis for this development, which forms a necessary step between cellular biology and human behaviour. A corresponding endeavour in sensory physiology was achieved by researchers like Head, Adrian, Hubel, Wiesel, Hagbarth and Tasker. For the exploration of higher cerebral functions, the names of Luria, Sperry and Gazzaniga come to mind. Without their dedicated work, the translation and integration of cellular processes into system function would not have been possible.

The current progress is mirrored in new therapeutic possibilities. The first major breakthroughs in the pharmacological field were probably those of the control of Parkinsonian akinesia and of spasticity. Through an ingenious use of knowledge of the basal ganglia monoaminergic pathways and their neuropharmacology, Arvid Carlsson and his group provided us with the standard symptomatic therapy for Parkinson's disease. The clinical use of the agonist to the inhibitory transmittor GABA, baclofen, as well as the skilful application of minute doses of the Botulinum neurotoxin to endplate regions in muscle, has provided relief to many disabled persons with pathologically increased muscle tone. Some regress of symptoms has been achieved by transplanting embryonic monoaminergic cells into the basal ganglia of patients with Parkinson's disease. Unfortunately, this therapy, which is still in the experimental stage, has been hampered by limited access to donors and there is a hope that cultured cell lines or stem cells can replace human foetuses as the cell source.

In the field of pain, the proposal of the much-debated gate control theory by Melzack and Wall in the sixties inspired new research in another important but neglected area of nervous system function, namely the mechanisms of transmission and inhibition of nociception. The pioneering studies of descending inhibitory control systems by Besson and Liebeskind (independently from each other), the discovery of endorphins independently by Hughes & Kosterlitz and by Terenius, and the first recordings from single human pain fibres in health and in pain states by Torebjörk and co-workers have all been instrumental to our understanding of the clinical presentation of pain. The most challenging puzzle, namely the mechanisms behind chronic pain, probably involves plasticity at both spinal, thalamic and cortical levels but still awaits a full explanation based on human studies.

What, then, does the most recent neurobiological knowledge provide us in terms of therapy? Without giving a direct answer to that question, we think it should be the responsibility of each rehabilitation medicine physician to thoroughly familiarise him- or herself with current neurobiological advances in the understanding of central nervous function and plasticity. Our speciality has sometimes been criticised for lacking a specific medical base other than 'the team approach'. It is now time to include *applied neurobiology* in that base. Who else supervises, supports

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and treats patients with long-standing neurological, motor (including muscle), sensory (including pain) and cognitive impairments like we do? At an early stage, Bach-y-Rita and Höök realised the importance of plasticity for brain injury rehabilitation. A further step was the first course in 'Applied Neurobiology for Rehabilitation Medicine Physicians' arranged in Lund, Sweden, in January 2000, which was an immediate success and generated many enthusiastic discussions. The Foundation for Rehabilitation Information and its journal, Journal of Rehabilitation Medicine decided to organise an international symposium, 'Neurobiological Background to Rehabilitation', in Göteborg in September 2002, in collaboration with the UEMS PRM Section & Board and the Departments of Rehabilitation Medicine at the Göteborg and Umeå universities. The themes were brain plasticity, motor control and spasticity, and pain modulation. There were some 250 participants, with clinical and experimental backgrounds from Scandinavia and other parts of Europe. The lectures, which are presented in modified form in this supplement, were followed by lively and constructive discussions.

As we see it, it is only by truly bridging the gap between experimental and clinical rehabilitation science that we can insure that new important therapeutic approaches will be developed that include appropriate functional assessment and combine specific training strategies in adequate environments, probably often in connection with pharmacological treatments and sometimes with surgical approaches. On the following pages, the reader will find fascinating examples of this application of new knowledge to clinical problems, and fortunately, this is only the beginning. We would like to thank all the contributors to the present supplement for sharing their vast knowledge with us and our readers. Let this supplement be a first concerted attempt to apply neurobiology in rehabilitation medicine!

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