



Motor Plasticity and Training: Cortical and Spinal Mechanisms

M. Schubert

Background: In man, the cortico-motoneuronal system is highly developed. This may explain why humans have comparatively poor functional recovery in case of complete spinal cord lesion. Accordingly, in incomplete spinal cord injury (SCI), a significant contribution to motor recovery may be due to supraspinal input inducing and shaping spinal plasticity.

Working Hypothesis: Given the tremendous capability of the neocortex to undergo plastic adaptive changes, supra-spinal plasticity might be as relevant for functional recovery in incomplete spinal cord injured patients as plasticity of the spinal central pattern generator. Following a lesion, the pathways conveying signals from the motor cortex as well as spinal circuitry will undergo large scale reorganization to accomplish compensation for functional loss. The main hypothesis for this study is that both, cortical and spinal motor circuits, contribute to plasticity and functional adaptation. Central motor plasticity will be tested using a standardized neurophysiological method, known as paired associative stimulation (PAS). PAS is thought to assess Hebbian associative long term potentiation non-invasively. In this study, we plan to transfer this specific collision protocol to the spinal level. It is assumed, that direct and indirect corticospinal transmission contribute differently to this plasticity.

Specific Aims: To test cortical and spinal motor plasticity, electrophysiological collision techniques will be applied twofold. First, it will be used as an intervention (as PAS) to modulate plasticity of the motor system in different central sites and second, it will be applied as a test to assess these changes after the intervention. For both, the intervention and assessment, the time interval between two stimuli determines the site of their collision (e.g. at the spinal cord). This allows selective focusing of the intervention and assessment on the site of expected plasticity. Longitudinal survey of effects will allow us to study the evolution of neuro-plasticity within the human spinal motor system following SCI.

Expected Value of the Proposed Project are (1) an instrument to assess spinal plasticity in the healthy and in SCI and other pathologies. By comparison with the pathological state (2) this will allow to study the evolution of neuro-plasticity of the human spinal cord following SCI and other pathologies. This may help to identify the most important contributors to compensatory plasticity following a lesion. An assessment of plasticity at the cortical and spinal levels during recovery in incomplete SCI (3) may help to design and focus therapeutic effort. (4) PAS may even bear therapeutic potential itself and could eventually be used early on after the lesion, before active physiotherapy is possible.