HUMAN MOTOR CORTEX PLASTICITY INDUCTION IS INFLUENCED BY MULTIPLE FACTORS

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Abstract

The primary motor cortex (M1) has the essential role of controlling voluntary movement, but is also a crucial site for learning new motor skills and recovery of motor function after injury. The development of non-invasive brain stimulation techniques, particularly transcranial magnetic stimulation, has significantly contributed to our understanding of human M1 and its ability to alter in structure and function (cortical plasticity). However, large within- and between-subject differences in the capacity for cortical plasticity exist in humans. This thesis examined factors capable of influencing human M1 plasticity and motor learning, focussing on the effects of exercise, ageing, hand preference and genetics.

Study 1 examined whether regular exercise influenced plasticity in human M1. Individuals with increased physical activity levels had increased M1 excitability and enhanced neuroplasticity. This was the first study to demonstrate that participation in regular physical activity offers a generalised neuroplastic enhancement within M1. Therefore, these results suggest that participation in regular physical activity may offer global benefits to human M1 function.

Study 2 addressed the influence of age (young and old adults) and hand preference (dominant and non-dominant) on human M1 plasticity and motor learning for a simple motor task. In contrast to previous studies, the extent of plasticity was not diminished in old compared with young adults for either hand following simple ballistic training. However, neuroplasticity was enhanced in the right hemisphere (left non-dominant hand) compared with the left hemisphere (right dominant hand) with training. This finding suggests that there is greater strengthening of corticomotor circuits for control of the left compared with the right hand during simple ballistic training. Subsequently, Study 3 examined the effect of advancing age on a complex task, which more likely engages M1 and increases attentional demand. Following training of complex visuomotor tracking, the extent of plasticity remained similar between young and old

adults, suggesting that a reduction in plasticity is not an obligatory consequence of the ageing process. The findings from Studies 2 and 3 demonstrate that older adults may have a similar neuroplastic capacity under some circumstances, and identifying factors for this maintenance may guide healthy ageing interventions aimed at promoting brain health across the life-span

In Study 4, it was found that the modulation of M1 excitability was strongly influenced by a common polymorphism in the *BDNF* gene, but the effect was dependent on the intervention used. The most pronounced differences in plasticity between *BDNF* genotypes were observed following the complex motor task, but this did not influence motor learning. Although there was no effect on motor performance and short-term motor learning in healthy young subjects, the differences in brain plasticity between *BDNF* genotypes may be more important for the recovery of motor function after neurological injury.

These findings suggest that sustained regular exercise, hand preference, and *BDNF* genotype contribute to the variability of M1 plasticity in healthy adults. Therefore, to further understand factors that influence M1 plasticity, future studies should assess these subject characteristics as potential confounding factors in the response. Furthermore, there may be potential to capitalise on these factors to optimise M1 plasticity and recovery of motor function following neurological injury.

Declaration

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