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Neural correlates of different attentional strategies

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Although it is well established that an external (EF) compared to an internal (IF) or neutral focus of attention enhances motor performance and learning, the underlying neural mechanisms remain scarcely investigated. Consequently, this thesis aimed to shed more light on the effect of specific motor-related attentional strategies (EF and IF) on neural activity. By using various non-invasive transcranial magnetic stimulation (TMS) protocols, the main objectives of this thesis were to investigate the immediate influence of different motor-related attentional strategies (EF and IF) on the activity of specific neural parameters, such as intracortical inhibition (Chapters II and III), surround inhibition (SI; Chapter IV) and on the modulation of cortico-motoneurons of distinct motor pathways (V). Additionally, in order to support potential neurophysiological differences found in cortical activity, we also aimed to test and confirm the beneficial effects of different attentional foci on a behavioural level (such as motor performance) and a physiological level (such as muscle activity of the agonist and/or adjacent muscle). Furthermore, as the constrained action hypothesis still remains, after almost twenty years, the principal explanation supporting the positive effects usually associated with an EF over an IF, we set out to fine-tune this theory, based on our own neurophysiological results. In all the studies being part of this thesis (Chapters II, III, IV and V), adopting different motor-related attentional strategies (EF and IF) was accompanied by changes in motor performance (as previously shown by numerous studies), and – most importantly – by direct and instant alterations of different, complementary neural parameters. By showing that adopting an EF induced an enhanced intracortical inhibition for the agonist, an improved spatial restriction by enhancing SI for adjacent muscles and an increased temporal restriction by inhibiting slower corticospinal pathways, we demonstrated, for the first time and from different perspectives, that adopting distinct attentional foci resulted in a differential cortico-motor organization and integration. In order to explain the behavioural benefits usually associated with an EF from a neurophysiological point of view, we refined the constrained action hypothesis and propose the more specific name ‘constrained inhibition hypothesis’. By using appropriate intracortical inhibitory levels and a beneficial down-regulation of slower cortico-motor pathways, we suggest that using an EF allows the performers’ motor system to more effectively self-organize and, as a consequence, to induce enhanced motor control and performances. Finally, the instant and immediate change in the inhibitory capacity that was observed within the scope of this thesis is absolutely new and inherits great potential, not only for healthy people and athletes, but also for populations that experience motor deficiencies due to an inadequate working inhibitory system.

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