Promoting neural plasticity in human sensorimotor cortex to alter activity in upper limb muscles

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My research aims to determine the mechanisms that mediate plasticity in the human sensorimotor cortex, as a novel means to alter the motor cortical output to skeletal muscles and influence the motor control of the upper limb. There are two forms of plasticity that are considered complimentary and fundamental to neural systems. Homosynaptic plasticity changes the efficiency of synapses that are themselves active during the induction of plasticity, a mechanism thought to underpin learning and memory formation. Heterosynaptic plasticity changes the efficiency of synapses because of input from another pathway to support learning through stabilizing synaptic weights. Transcranial magnetic stimulation (TMS) is a technique capable of inducing either hetero- or homosynaptic plasticity. Heterosynaptic plasticity is induced following repeat pairing of electrical stimulation of a peripheral nerve with single TMS pulses over the primary somatosensory (S1) nerve or primary motor (M1) cortex muscle representation. Heterosynaptic plasticity is induced using a protocol called rapid-rate Paired Associative Stimulation (rPAS) that delivers 600 nerve-TMS pairs at a rate of 5 Hz. RPAS induces long-term potentiation (i.e. neural plasticity) effects when the nerve-TMS interstimulus interval (ISI) is set to promote their coincident arrival in S1, based on the N20 latency of the somatosensory evoked potential (SEP). RPAS promotes long-term depression at ~ 10 ms ISI. Homosynaptic plasticity is achieved using 600 pulses continuous theta-burst stimulation (cTBS) and intermittent theta-burst stimulation (iTBS) to evoke long-term depression and potentiation effects, respectively. In this talk, I will describe evidence from recent publications and advances from my lab that use TMS protocols of RPAS and TBS to evoke neural plasticity in human sensorimotor cortex. The primary purpose of these approaches is to alter the neural output to muscles of the arm. This research indicates that different methods for inducing human neural plasticity in cortex yield varying results on the corticospinal excitability of arm muscles. This information provides information fundamental to creating new rehabilitation regimes that aim to improve arm movement following disease and neurological injury.

Speaker Biography

Aimee J Nelson is an Associate Professor in the Department of Kinesiology at McMaster University. She has completed her PhD at the Institute of Medical Sciences, the University of Toronto. She received her first Post-doctoral appointment at the McGovern Institute for Brain Research, MIT, and was subsequently a CIHR-funded Post-doctoral fellow at Toronto Western Hospital. Her academic appointment began in 2008 at the University of Waterloo and she subsequently joined McMaster University in 2012 as a Canada Research Chair, Tier 2. Her research is focused on promoting neural plasticity in brain and spinal cord for altering hand control. Her research is in basic neurophysiology and neuroimaging and her research has application in neurological injury and disease wherein hand/arm control is impaired. Her technical expertise includes transcranial magnetic stimulation, functional, anatomical and spectral imaging, and electroencephalography.

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