

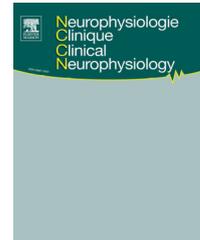


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EDITORIAL

Clinical neurophysiology: The quest to understand motor and postural control

**KEYWORDS**

Cortical plasticity;
EEG;
Movement disorders;
Neurofeedback;
TMS

For more than half a century, clinical neurophysiology has pursued better understanding of neural mechanisms of motor control. One of the main milestones in this domain was the discovery of neurophysiological activities of various cortical regions related to action preparation prior to movement. This includes the recording of anticipatory slow waves preceding movements, such as the Contingent Negative Variation (CNV), described by Walter et al. in 1964 [22] and the Bereitschafts potential (BP), described by Kornhuber and Deecke in 1964–1965 [11]. It also includes the development of power measurements of scalp electroencephalogram (EEG) with the characterization of event-related desynchronization preceding voluntary self-paced movement by Pfurtscheller and Aranibar in 1977–1979 [18,19]. In a different domain, brain mechanisms of sensorimotor integration were appraised by neurophysiological recordings of long latency reflexes to muscle stretch by Marsden et al. in 1973 [14,15], for example. Thus, techniques of clinical neurophysiology made tremendous progress in understanding various types of movement disorders, such as myoclonus with the help of jerk-locked back averaging EEG recordings [21], spasticity with conditioned H-reflex studies [20], or, in Parkinson's disease, EEG-EMG corticomuscular coherence [17]. However, a major step was the development of noninvasive methods of stimulating the motor cortex, first using high-voltage transcranial electrical stimulation by Merton and Morton in 1980 [16] and then using transcranial magnetic stimulation (TMS) by Barker et al. in 1985 [3].

All these aspects of clinical neurophysiology which aim at understanding motor control were addressed in the symposium "Neurophysiology of Movement: from Preparation to Action" held in Paris-Vincennes on June 26, 2017 during the 2nd "Journées de Neurophysiologie Clinique" (JNC). The main communications of this symposium are reported in this special issue of Neurophysiologie Clinique/Clinical Neurophysiology.

Here, Allart et al. [2] provide evidence of the major contribution of TMS techniques (virtual lesion, paired pulses) in assessing functional brain connectivity related to motor control, and particularly in demonstrating the crucial role of parietal connections to ventral premotor cortex in the modulation of M1. Other articles address the question of impact of physical exercise (Devanne and Allart [8]) or stroke (Birchenall et al. [4]) on motor cortex plasticity, also assessed by various TMS techniques. More therapeutic or rehabilitation aspects are the topic of the articles written by Calmels [5] on Jeannerod's motor simulation theory, Jeunet et al. [10] on EEG neurofeedback strategies based on the sensorimotor rhythms, and Lefaucheur [12], with the disturbing subject of misappropriation of transcranial direct current stimulation, an interventional neurophysiological technique, for doping purposes.

Methods of gait and posture measurements have become increasingly integrated within the scope of the sensorimotor neurophysiological field. New physiological biomarkers of postural control are now available to characterize gait and balance disorders in Parkinson's disease (Chastan and Decker [6]) or multiple sclerosis (Decavel and Sagawa Jr [7]). Relationships between posture and emotion (Lelard et al. [13]) and action and attention (Grandjean et al. [9]) were also addressed in this symposium. Thus, in the field of motor and postural control, clinical neurophysiology displays all its variety and strong potential for understanding mechanisms, just as or better than brain imaging methods [1], providing biomarkers, and even

contributing to the development of new therapeutic strategies. Our discipline has been at the forefront of research for more than half a century and this is certainly not the end of the road for this neurophysiological “motor quest”.

Disclosure of interest

The authors declare that they have no competing interest.

References

- [1] Allali G, Blumen HM, Devanne H, Pirondini E, Delval A, Van De Ville D. Brain imaging of locomotion in neurological conditions. *Neurophysiol Clin* 2018;48:337–59.
- [2] Allart E, Devanne H, Delval A. Contribution of transcranial magnetic stimulation in assessing parietofrontal connectivity during gesture production in healthy individuals and brain-injured patients. *Neurophysiol Clin* 2019;49:115–23.
- [3] Barker AT, Jalinous R, Freeston IL. Non-invasive magnetic stimulation of human motor cortex. *Lancet* 1985;1:1106–7.
- [4] Birchenall J, Térémetz M, Roca P, Lamy JC, Oppenheim C, Maier MA, et al. Individual recovery profiles of manual dexterity, and relation to corticospinal lesion load and excitability after stroke -a longitudinal pilot study. *Neurophysiol Clin* 2019;49:149–64.
- [5] Calmels C. Beyond Jeannerod’s motor simulation theory: an approach for improving post-traumatic motor rehabilitation. *Neurophysiol Clin* 2019;49:99–107.
- [6] Chastan N, Decker LM. Posturo-locomotor markers of preclinical Parkinson’s disease. *Neurophysiol Clin* 2019;49:173–80.
- [7] Decavel P, Sagawa Jr Y. Gait quantification in multiple sclerosis: a single-centre experience of systematic evaluation. *Neurophysiol Clin* 2019;49:165–71.
- [8] Devanne H, Allart E. Boosting brain motor plasticity with physical exercise. *Neurophysiol Clin* 2019;49:91–3.
- [9] Grandjean J, Quoilin C, Duque J. Investigating the effect of anticipating a startling acoustic stimulus on preparatory inhibition. *Neurophysiol Clin* 2019;49:137–47.
- [10] Jeunet C, Glize B, McGonigal A, Batail JM, Micoulaud-Franchi JA. Using EEG-based brain computer interface and neurofeedback targeting sensorimotor rhythms to improve motor skills: Theoretical background, applications and prospects. *Neurophysiol Clin* 2019;49:125–36.
- [11] Kornhuber HH, Deecke L. [Changes In The Brain Potential In Voluntary Movements And Passive Movements In Man: Readiness Potential And Reafferent Potentials]. *Pflugers Arch Gesamte Physiol Menschen Tiere* 1965;284:1–17.
- [12] Lefaucheur JP. Boosting physical exercise with cortical stimulation or brain doping using tDCS: fact or myth? *Neurophysiol Clin* 2019;49:95–8.
- [13] Lelard T, Stins J, Mouras H. Postural responses to emotional visual stimuli. *Neurophysiol Clin* 2019;49:109–14.
- [14] Marsden CD, Merton PA, Morton HB. Is the human stretch reflex cortical rather than spinal? *Lancet* 1973;1:759–61.
- [15] Marsden CD, Merton PA, Morton HB. Latency measurements compatible with a cortical pathway for the stretch reflex in man. *J Physiol* 1973;230 [58–9P].
- [16] Merton PA, Morton HB. Stimulation of the cerebral cortex in the intact human subject. *Nature* 1980;285:227.
- [17] Mima T, Hallett M. Corticomuscular coherence: a review. *J Clin Neurophysiol* 1999;16:501–11.
- [18] Pfurtscheller G, Aranibar A. Event-related cortical desynchronization detected by power measurements of scalp EEG. *Electroencephalogr Clin Neurophysiol* 1977;42:817–26.
- [19] Pfurtscheller G, Aranibar A. Evaluation of event-related desynchronization (ERD) preceding and following voluntary self-paced movement. *Electroencephalogr Clin Neurophysiol* 1979;46:138–46.
- [20] Pierrot-Deseilligny E. Electrophysiological assessment of the spinal mechanisms underlying spasticity. *Electroencephalogr Clin Neurophysiol Suppl* 1990;41:264–73.
- [21] Shibasaki H, Yamashita Y, Kuroiwa Y. Electroencephalographic studies myoclonus. *Brain* 1978;101:447–60.
- [22] Walter WG, Cooper R, Aldridge VJ, McCallum WC, Winter AL. Contingent negative variation: an electric sign of sensorimotor association and expectancy in the human brain. *Nature* 1964;203:380–4.

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