Sensorimotor Rhythms During Preparation for Robot-Assisted Movement

S.L. Norman[1*], D.J. McFarland[2], W.A. Sarnacki[2], J.R. Wolpaw[2], E.T. Wolbrecht[3], D.J. Reinkensmeyer[1]

[1]*University of California Irvine, Irvine, CA,USA;* [2]*Wadsworth Center, Albany, NY, USA,*
[3]*University of Idaho, Moscow, ID, USA*

*3151 Engineering Gateway, UCI, Irvine, CA 92697. E-mail: slnorman@uci.edu

Introduction: Brain-computer interface (BCI) technology can restore communication and control to people who are severely paralyzed. There has been speculation that this technology might also be useful for rehabilitation of motor function [1]. Toward this end, we are exploring the possibility that sensorimotor rhythm (SMR) training could enhance the therapeutic efficacy of robot-assisted training of individuated finger movements for people with stroke. As an initial step, we are characterizing SMR activity in stroke patients preparing for robot-assisted movement.

Materials, methods and initial results: Individuals with paresis of the hand resulting from chronic stroke (n=3 to date, upper limb Fugl-Meyer: 35, 50, 58) and several unimpaired control subjects operated a simple go-nogo task using the FINGER robot-assisted movement system [2]. Visual stimuli cued movement conditions for index, middle, or both fingers. Participants with stroke used their impaired hand; unimpaired participants used their non-dominant hand. In both groups, robust SMR event-related desynchronization (ERD) occurred bilaterally during the preparatory period.

Discussion: Our previous work [3] in normal subjects suggests that operant conditioning of SMR ERD during movement preparation can improve performance. The present results provide a potential basis for conditioning such activity in stroke patients in order to beneficially modify neural circuits important in movement. It would also be possible to determine whether this conditioning should target SMR activity from the perilesional area or contralesional cortex [4].

Significance: By focusing on the movement preparation period, this work is exploring a new way in which BCI technology might contribute to rehabilitation after stroke or in other chronic movement disorders. BCI-based shaping of pre-movement SMR activity together with robot-assisted movement could potentially enhance rehabilitation and augment recovery of useful function.

References:

[1] Daly, JJ, Wolpaw JR. Brain-computer interfaces in neurological rehabilitation. *Lancet Neurology*, 7, 1032-1043, 2008.
[2] Taheri H, Rowe JB, Gardner D, Chan V, Graty K, Bower C, Reinkensmeyer D, Wolbrecht ET. Design and preliminary evaluation of the FINGER rehabilitation robot: controlling challenge and quantifying finger individuation during musical computer game play. *Journal of NeuroEngineering and Rehabilitation*, 4;11(10);0003-11, 2014.
[3] McFarland DJ, Sarnacki WA, Wolpaw JR. Effect of training pre-movement sensorimotor rhythms on behavioral performance. *Journal of Neural Engineering*, 12:066021, 2015.
[4] Caleo M. Rehabilitation and plasticity following stroke: insights from rodent models. *Neuroscience*, 311, 180-194, 2015.