Abstract— Chronic stroke patients without residual movements of the paretic side do not respond to any available rehabilitation strategy. Recently BCI technology has been proposed for as a neurorehabilitation tool after stroke. It has been shown that learning of brain control (MEG-sensorimotor rhythm, SMR) in chronic stroke is possible but no substantial improvements in motor control and no generalization to functional recovery were accomplished. Previous work of this group demonstrated how BCI could be used as a tool in chronic stroke motor rehabilitation when linking contingently and online brain activity (due to movement intention) and movement (the same intentioned movement assisted by robotic orthoses). In this work 32 chronic stroke patients without residual finger extension underwent BCI training coupled with behavioral physical therapy. The patients were divided in two groups. The experimental group received ≈ 18 sessions of contingent BCI-training: ipsilesional SMR-desynchronisation was linked to movements of robotic orthoses (arm/hand) fixed to the paralysed limb. The control group (sham) received the same training but movement of the orthotic device was randomized and independent of SMR-change. Both groups received identical behavioral physiotherapy related to the same movements trained after every BCI-session. The experimental group showed a significant continuous improvement in EMG activity and control in the paralyzed hand and arm during the intervention.

I. INTRODUCTION

Incidence of a first stroke in Europe is about 1 million and prevalence about 6 million per year. Currently, about 75% of people affected by a stroke survive one year or. From all the stroke survivors showing no active upper limb motion at hospital admission, 14% showed complete recovery, while 30% showed partial recovery and 56% showed no recovery [1]. Stroke survivors with chronic hand plegia and very low score in the Fugl-Meyer scale show limited residual muscle activity in the upper arm extensor muscles and normally no residual finger extension. Currently, there is no accepted and efficient rehabilitation strategy available that aims at reducing focal impairments in patients with chronic stroke and complete hand paralysis. It has been demonstrated that stroke patients with complete hand paralysis can learn to control a magnetoencephalography (MEG) based Brain-Computer Interface (BCI) to drive a hand robotic orthosis [2]. However the results could not be translated out of the lab. In a later single case study, we suggested that the combination of BCI and daily life-oriented physiotherapy can elicit functional recovery improving hand and arm movements as well as gait [3]. Furthermore, an online EEG-based proprioceptive BCI was tested in healthy participants controlling a robotic exoskeleton online (250msec delay) using brain signals (Ramos-Murguialday et al 2012) and posteriorly tested in stroke rehabilitation of severely affected chronic stroke patients (Ramos-Murguialday et al. 2013). In that double-blind pilot study employed two groups of 16 chronic stroke patients each without residual finger extension. Experimental group received ≈ 18 sessions of contingent BCI-training: ipsilesional SMR-desynchronisation was linked to movements of robotic orthoses (arm/hand) fixed to the paralysed limb. The control group (sham) received the same training but movement of the orthotic device was randomized and independent of SMR-change. Both groups received identical behavioral physiotherapy related to the same movements trained after every BCI-session. Several linear regressions demonstrated that the experimental group showed a significant continuous improvement in EMG activity and control in the paralyzed hand and arm during the intervention.

REFERENCES