CASE STUDY

Music-Supported Therapy induces plasticity in the sensorimotor cortex in chronic stroke: A single-case study using multimodal imaging (fMRI-TMS)

NURIA ROJO1,7, JULIAN AMENGUAL1,7, MONTSSERRAT JUNCADELLA3,7, FRANCISCO RUBIO3,7, ESTELA CAMARA1, JOSEP MARCO-PALLARES1,7, SABINE SCHNEIDER4, MISERICORDIA VECIANA3,7, JORDI MONTERO3,7, BAHRAM MOHAMMADI3, ECKART ALTMÜLLER3, CARLES GRAU2, THOMAS F. MÜLTE5, & ANTONI RODRIGUEZ-FORNELLS1,6,7

1Department of Psicologia Bàsica, Faculty of Psychology, 2Department Psiquiatria i Psicobiologia Clínica, University of Barcelona, Barcelona, Spain, 3Hospital Universitari de Bellvitge (HUB), Neurology Section, University of Barcelona, L’Hospitalet (Barcelona), Spain, 4Institute of Music Physiology and Musicians’ Medicine, University of Music and Drama Hannover, Hannover, Germany, 5Department of Neuropsychology, Otto von Guericke University, Magdeburg, Germany, 6Institució Catalana de Recerca i Estudis Avancats (ICREA), Barcelona, Spain, and 7Bellvitge Biomedical Research Institute (IDIBELL)

(Received 10 August 2010; revised 22 February 2011; accepted 25 March 2011)

Abstract
Primary objective: Music-Supported Therapy (MST) has been developed recently in order to improve the use of the affected upper extremity after stroke. This study investigated the neuroplastic mechanisms underlying effectiveness in a patient with chronic stroke.
Methods: MST uses musical instruments, a midi piano and an electronic drum set emitting piano sounds, to retrain fine and gross movements of the paretic upper extremity. Data are presented from a patient with a chronic stroke (20 months post-stroke) with residual right-sided hemiparesis who took part in 20 MST sessions over the course of 4 weeks.
Results: Post-therapy, a marked improvement of movement quality, assessed by 3D movement analysis, was observed. Moreover, functional magnetic resonance imaging (fMRI) of a sequential hand movement revealed distinct therapy-related changes in the form of a reduction of excess contralateral and ipsilateral activations. This was accompanied by changes in cortical excitability evidenced by transcranial magnetic stimulation (TMS). Functional MRI in a music listening task suggests that one of the effects of MST is the task-dependent coupling of auditory and motor cortical areas.
Conclusions: The MST appears to be a useful neurorehabilitation tool in patients with chronic stroke and leads to neural reorganization in the sensorimotor cortex.

Keywords: Neuroimaging, rehabilitation, stroke, TMS, fMRI

Introduction
Motor disabilities after stroke have been the target of several recently-developed therapies that have been shown to be more effective than standard physiotherapeutic approaches [1]. For example, inducing the use of the paretic limb over extended periods of time leads to marked clinical improvements which are accompanied by neuroplastic changes [2, 3]. Several basic neuroscience studies have shown that music training produces rapid changes in motor-related brain areas [4, 5]. Against this background, a new motor rehabilitation therapy...
cortex during unimanual motor tasks [22], which appears compromised after stroke. The reduced ipsilateral activation after therapy accordingly suggests restored transcallosal inhibition.

Finally, the present fMRI findings in the music task argue in favour of the idea that the mechanism that contributes to the efficacy of MST (besides massed practice of the paretic arm as in the CIT) is audiomotor coupling [6, 7]. Audiomotor coupling has been evidenced in healthy volunteers who were exposed to prolonged piano practice and showed co-activation of motor areas when listening to practiced music in a post-training fMRI-scan [4, 5, 18].

Acknowledgements

We are particularly grateful to the patient for participating in this study. This project has been supported by la Fundació La Marató TV3 (Spain) and the DZNE (German Center for Neurodegenerative Diseases).

Declaration of Interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

References