Non-invasive brain stimulation applications on Alzheimer’s disease

Carlo Miniussi

Cognitive Neuroscience Section, IRCCS Centro San Giovanni di Dio Fatebenefratelli, Brescia, Italy
Neuroscience Section, Dept of Clinical and Experimental Sciences, University of Brescia, Brescia, Italy

Recent studies have reported enhanced performance on specific cognitive tasks in patients with several types of neurological diseases (Alzheimer - AD, stroke) after receiving non-invasive brain stimulation (NiBS), i.e., repetitive transcranial magnetic stimulation (rTMS) or transcranial direct current stimulation (tDCS). Converging evidence has indicated that intermittent rTMS above 5 Hz (high frequency), which leads to increased neuronal firing, appears to have positive effects on behavior. Moreover it has also been shown that anodal tDCS can induce similar effects, increasing neuronal firing rates. Specifically, it has been showed by several experiments that rTMS reduces vocal reaction times for picture naming in normal young and old subjects and improves the number of correct responses in AD patients. Using tDCS, it has also been shown that anodal tDCS can ameliorate language performance in normal young and old subjects and deficits in AD e stroke patients. Studies have shown evidence of plastic changes in surviving neurons, even in severely affected areas. In AD patients, the NiBS-induced partial recovery of language abilities, may be due to a strengthening of the synaptic activity of the surviving neurons in the stimulated network. NiBS might induce a gradual readjustment of an area that remains intact but “functionally” suppressed due to a steady reduction in synaptic strength. Therefore, these data support the idea that brain stimulation-induced changes in synaptic strength are an essential step toward the recovery of function. Indeed, improving the performance of a specific system within the functional network leads to more effective processing. Compensatory networks may be recruited or rebalanced to accomplish the impaired function. Therefore, NiBS could be used to strengthen or modify a network that is specific to a diminished cognitive function. Studies have suggested that the best way to perpetrate this strengthening is to stimulate the area and activate the network supporting the specific function. This approach can be achieved by combining exogenously induced plasticity (i.e., NiBS) with a specific training-induced plasticity (i.e., cognitive training). In part, this approach resembles the one used to improve motor performance in patients with hemiplegia. If NiBS is applied when the system is in a given functional state, it will enhance and strengthen the specific distributed functional cortico-cortical (or subcortical) network that is active rather than inducing a non-specific arousal or activation of the system.

The potential for inducing a slowing down of the cognitive decline or even a behavioural improvement in AD patients, and the further possibility that these effects become long-lasting, are intriguing; and NiBS study's results could lead to the development of a new therapeutic approach.

Carlo Miniussi PhD
Professor of Human Physiology
Neuroscience Section
Dept of Clinical and Experimental Sciences
School of Medicine
University of Brescia
Viale Europa, 11 - 25123, Brescia, Italy
Phone off: (+39) 0303717-441; secretary -455 Fax: -443
&Cognitive Neuroscience Section
The Saint John of God Clinical Research Centre
IRCCS Centro San Giovanni di Dio Fatebenefratelli
Via Pilastroni, 4 - 25125, Brescia, Italy
Phone off: (+39) 0303501-597, laboratory -594 -595 Fax: (+39) 0303533513
E-mail: carlo.miniussi@cognitiveneuroscience.it
http://www.cognitiveneuroscience.it
Name: CARLO MINIUSSI

Work - Research Experience—present
2005 March–present. Professor of Human Physiology, Neurophysiology, Department of Biomedical Sciences and Biotechnology, School of Medicine, University of Brescia, Brescia Italy http://www.unibs.it/
2008 January–present. Member of the National Institute of Neuroscience (INN), a consortium formed by a number of neuroscience research university centres, http://www.ist-nazionale-neuroscienze.unito.it.
2008 January–present. Long term collaborator Faculty Member, Sector of Cognitive Neuroscience, International School for Advanced Studies (ISAS\SISSA), Trieste Italy http://www.sissa.it/cns/people.html.
2007 September–present. Member of the International School for Advanced Studies Ethical Committee, Trieste Italy.
2000 January–present. Associate Member of the Department of Neurological, Neuropsychological Morphological and Motor Sciences, Physiology Section, School of Medicine, University of Verona, Verona Italy.

past
2012 July–2012 November. Research Affiliate, School of Psychology, Sydney University, Sydney, Australia.
2011 October–2012 April. Visiting Professor, School of Psychology Trinity College Institute of Neuroscience, Lloyd Building Dublin Ireland (http://people.tcd.ie/miniusc).
2002 January – 2005 February. Coordinator of a full research line “Neuropsychophysiology” for the IRCCS St. John of God Fatebenefratelli, Brescia Italy.

Publications:
in 16 years (1997-2013): 125 in international peer reviewed journals. Total impact factor 510; average IF 4, H-index: 43 (Google Scholar) 37 (Scopus); Sum of the time cited: ~4600. Editor of 2 international books. Author or co-author of 14 international book chapters and ~400 abstracts, presentations to Congresses/Symposia/Seminars/Workshops/Schools

Academic Qualifications:
2010 January Qualification for Full Professorship of Human Physiology, by a National committee at the School of Medicine, Università degli Studi di Catanzaro.
2004 January Qualification for Associate Professorship of Human Physiology, by a National committee at the School of Medicine, Università degli Studi di Sassari.
1999 February. Ph.D. in Neuroscience. University of Verona, School of Medicine, Verona, Italy.
1994 July. Master of Science in Experimental Psychology "Laurea", University of Padua, School of Psychology, Padua, Italy.
**Biosketch**

**Reviewing:**
Editorial Board of three journals, Ad hoc reviewer for more than 40 journals, 10 grant programs

**Track record**
Carlo Miniussi was educated in Padua, where he received his, M.Sc. in Experimental Psychology in 1994, and in Verona, where he was awarded a Ph.D. in Neuroscience in 1999. He has been a postdoctoral fellow at the Department of Experimental Psychology at Oxford University for two years. In 2000 he moved to the IRCCS Fatebenefratelli St. John of God in Brescia, Italy, where he became chief of the Neuropsychology Laboratory. Two years later he became the scientific coordinator of the “Neuropsychophysiology” research line. In 2004 he was appointed Associate Professor of Human Physiology and after a year he took up a chair in the School of Medicine, University of Brescia. At the same time he established the Cognitive Neuroscience Section (CNS) comprising the Neuropsychology, Neuropsychology and Sleep laboratories. In 2007 he became a member of the Ethical Committee of the International School for Advanced Studies, in Trieste, as well as long term collaborator Faculty Member, Sector of Cognitive Neuroscience for the same school. In 2010, eleven years after his PhD, he was qualified as full Professor of Human Physiology. In the 2011 he becomes President elect of Italian society of Psychophysiology. At present he coordinates the CNS at IRCCS St. John of God in Brescia and at the University of Brescia.

At present he teaches “Neurophysiology” to the following courses at the University of Brescia: School of Medicine 30 hours of lecturing per year (from 2005); Degree in Psychiatric Rehabilitation 36 hours of lecturing per year (from 2007); Degree in Physiotherapy 24 hours of lecturing per year (from 2006). Specialization in Psychiatry 10 hours of lecturing per year (from 2007). “Cognitive plasticity” and “Non invasive brain stimulation”, Master in Neuropsychology diagnostic and rehabilitation 8 hours at the University Cattolica del Sacro Cuore, Milan Brescia (from 2010). “Methods for signal recordings - Non invasive brain stimulation”, 4 hours Master in Neuropsychology at the University of Padua (from 2005). Panel member and tutor or co-tutor of many students in PhD Courses.

In the last years he has published seminal papers on a) mechanisms of transcranial magnetic stimulation, b) co-registration of transcranial stimulation and EEG, and c) brain stimulation in cognitive neurorehabilitation. He has successfully pursued translational research between plasticity studies in the laboratory and real world interventions. Two example of this work are his interventions with brain stimulation in dementia and in neuropsychiatry. In this respect he has recently been invited to be guest editor for a special issue of Neuropsychological Rehabilitation on “Non invasive brain stimulation: new prospects in cognitive neurorehabilitation” (2011). For Frontiers in Human Neuroscience as topic host editor “Manipulative Approaches to Human Brain Dynamics” (2013). Editor for a reference book for “Transcranial Brain Stimulation” for CRC Taylor press. He has been part of a group of experts who produced a consensus paper on the efficacy of brain stimulation in cognitive neurorehabilitation (2008) and on combining transcranial stimulation with neuroimaging (2009). He was also among a group of experts (Safety of TMS Consensus Group) preparing the Safety, Ethical Considerations, and Application Guidelines for the Use of Transcranial Magnetic Stimulation in Clinical Practice and Research. (2009).