

**Project title:** Multi-site neuromodulation: a network TMS approach in cognitive neuro-rehabilitation

**Project leader:** Dr. Teresa Schuhmann

**Function:** Assistant Professor

**Collaborators:** Prof. Dr. Alexander T. Sack, Dr. Tom de Graaf

**Proposal (250 words):**

**Introduction:** A wide range of neuropsychological and psychiatric disorders are caused by imbalances in brain activity. Brain stimulation is an innovative therapeutic approach to directly address these imbalances and disturbances. For instance transcranial magnetic stimulation (TMS) is used to treat conditions like depression, stroke-induced motor impairments, or attentional problems. So far, all TMS treatment protocols aim at stimulating only a single brain region. But many cognitive deficits associated with acquired brain injury are caused by disturbances in entire neural networks.

**Hypothesis/Objectives:** In this project, we will develop a new TMS treatment protocol, stimulating not a single brain region but two brain regions connected in a network. We call this new approach 'multi-site neuromodulation', and anticipate that effects on cognition / behaviour are stronger and more reliable compared to single-site stimulation.

**Setting/Methods:** We will focus on visuospatial neglect; spatial attention deficits caused mainly by right parietal stroke. Spatial attention actually involves both right parietal and right frontal regions. In healthy volunteers we use TMS to affect both frontal and parietal regions of the attention network, evaluating additive or superadditive effects. If multi-site neuromodulation indeed has superior effects on behaviour, we will pioneer this treatment in a stroke patient sample suffering from spatial neglect.

**Impact:** TMS treatment effects are promising, but remain variable and have potential to be strengthened. Network-TMS is now feasible and has a high potential for superior effects. It could become the new gold standard in global TMS treatment of cognitive deficits in a wide range of brain disorders.

**Requirements candidate:** Highly motivated student with good English communication skills and proactive and resolute attitude.

**Keywords:** network, brain stimulation, neuromodulation, life science, mental health, technological innovation

**Top 5 relevant selected publications (of proposed research team, citations as of Oct 2017):**

- 1) Duecker F, Schuhmann T, Bien N, Jacobs C, Sack AT. Moving Beyond Attentional Biases: Shifting the Interhemispheric Balance between Left and Right Posterior Parietal Cortex Modulates Attentional Control Processes. *J Cogn Neurosci*. 2017 Jul;29(7):1267-1278.
- 2) Sack AT, Schuhmann T. Hemispheric Differences within the Fronto-Parietal Network Dynamics Underlying Spatial Imagery. *Front Psychol*. 2012 Jun 28;3:214. doi: 10.3389/fpsyg.2012.00214. eCollection 2012. PubMed PMID: 22754546; PubMed Central PMCID: PMC3385155.
- 3) Ten Oever S, Sack AT. Oscillatory phase shapes syllable perception. *Proc Natl Acad Sci U S A*. 2015 Dec 29;112(52):15833-7.
- 4) Duecker F, Sack AT. The hybrid model of attentional control: New insights into hemispheric asymmetries inferred from TMS research. *Neuropsychologia*. 2015 Jul;74:21-9.
- 5) Dambacher F, Sack AT, Lobbestael J, Arntz A, Brugman S, Schuhmann T. A network approach to response inhibition: dissociating functional connectivity of neural components involved in action restraint and action cancellation. *Eur J Neurosci*. 2014 Mar;39(5):821-31.