Project title: Entrain your Brain: optimizing neuromodulation of brain oscillations

Project leader: Dr. Tom A de Graaf

Function: Assistant Professor

Collaborators: Prof. Dr. Alexander T Sack, Dr. Sanne ten Oever

Proposal (250 words):

Introduction: Problems with oscillatory processes co-occur with a wide range of mental health/cognition deficits. It is therefore crucial to simultaneously understand, modulate, and potentially 'normalize' brain oscillations. Our group is internationally-renowned for the study of brain oscillations, as well as development of innovative brain stimulation protocols. 'Entrainment' combines the two; we use rhythmic sensory or direct brain stimulation to manipulate and control brain oscillations. This has both research and therapeutic potential.
Hypothesis/Objectives: In this project, we combine sensory and brain entrainment techniques to 1) study how they interact, 2) optimize entrainment efficacy, 3) study how oscillations determine perception and cognition. The ultimate goal is to optimize entrainment also for clinical use.
Setting/Methods: Rhythmic visual or auditory stimulation affects perception/cognition, but we are not sure how. For instance, 'binaural beats' reflect a new approach that may affect mood, through mechanisms largely unknown. Brain stimulation techniques include transcranial magnetic stimulation (TMS), transcranial alternating current stimulation (tACS), or related tools. An example project will study whether combining sensory and tACS brain entrainment would interact to accomplish superior amplification of frequency-specific brain oscillations. We measure the impact on perception, and on oscillatory brain activity using electroencephalography (EEG).
Impact: This project is about finding the optimal way to control and enhance brain oscillations, to simultaneously study how brain oscillations determine our day-to-day perception and develop protocols for treatment of brain-based disorders. Oscillatory disturbances may underlie various psychiatric conditions, making any approach that maximizes external control over oscillatory activity enormously valuable.

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

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

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

1. de Graaf, T. A., Hsieh, P.-J., & Sack, A. T. (2012). The "correlates" in neural correlates of consciousness. *Neuroscience and Biobehavioral Reviews*, *36*(1), 191–197. 101 citations
2. de Graaf, T. A., Gross, J., Paterson, G., Rusch, T., Sack, A. T., & Thut, G. (2013). Alpha-Band Rhythms in Visual Task Performance: Phase-Locking by Rhythmic Sensory Stimulation, *8*(3), e60035. 55 citations
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. Ten Oever S, Hausfeld L, Correia JM, Van Atteveldt N, Formisano E, Sack AT. A 7T fMRI study investigating the influence of oscillatory phase on syllable representations. Neuroimage. 2016 Nov 1;141:1-9
5. Ten Oever S, van Atteveldt N, Sack AT. Increased Stimulus Expectancy Triggers Low-frequency Phase Reset during Restricted Vigilance. J Cogn Neurosci. 2015 Sep;27(9):1811-22.