tACS- What goes on inside? The neural consequences of transcranial alternating current stimulation

Kohitij Kar[a*], *Jacob Duijnhouwer*[a], *and Bart Krekelberg*[a].

[a] Department of Neuroscience, Center for Molecular and Behavioral Neuroscience, Rutgers, The State University of New Jersey, Newark, New Jersey 07102, USA

*Email: kohitij@vision.rutgers.edu

There is considerable evidence for clinical and behavioral efficacy of transcranial alternating current stimulation (tACS). The effects range from suppressing Parkinsonian tremors to augmenting human learning and memory. Despite widespread use, the neurobiological mechanism of actions of tACS on the brain is unclear. We have taken a threefold approach to probe tACS mechanisms. First, we examined the behavioral effects of tACS on human motion perception. Second, we used known motion models to generate predictions about neural mechanisms that could produce the effects. Third, we tested these predictions by directly measuring tACS-induced neural activity changes in the macaque brain.

In human subjects, we found that tACS (10 Hz, 0.5 mA) applied over area hMT+, during coarse motion direction discrimination, increases observers' sensitivity. Based on reports suggesting that tACS interacts with mechanisms of plasticity, we hypothesized that a reduction in adaptation might cause this effect. We tested this hypothesis by applying tACS during visual motion adaptation. tACS over contralateral but not ipsilateral hMT+ mitigated the motion aftereffect and sensitivity changes induced by adaptation. These results suggest that tACS-induced membrane voltage modulations reduce adaptation in the motion-selective neurons. Tuning curve estimates of macaque MT neurons showed that tACS attenuated the effects of motion adaptation on tuning amplitude and width. In addition to single cell measures, tACS also mitigated adaptation-induced changes in evoked LFP responses.

Our results provide novel insight into how tACS interacts with neural activity and establishes the awake, behaving macaque as an in-vivo animal model to study tACS mechanisms.