Transcranial alternating current stimulation affects motion adaptation in V1 and MT neurons in awake, behaving macaques

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Transcranial electrical stimulation (tES) has been widely used in the clinic and in behavioral neuroscience research. The effects of transcranial alternating current stimulation (tACS) range from treating depression to augmenting human cognition. Optimization of tACS protocols will require an understanding of the mechanisms of actions of externally applied electric fields on the brain. We have started to probe the influence of tACS on the well-explored macaque visual system, specifically area V1 and MT. We have observed that tACS reduces motion aftereffect in human subjects (Kar et al. 2012, VSS abstract). This leads to the hypothesis that subthreshold rhythmic membrane voltage modulations produced by tACS reduces adaptation in the motion selective neurons.

To explicitly test this hypothesis, we recorded from adapted and unadapted cells from area MT and V1 with and without tACS. The tACS electrodes were placed extra-cranially on either side of the recording chamber (over area MT). In the adaptation condition, we presented the adapter stimulus (dots moving coherently in the cell's preferred direction) for 3 s. This was followed by a 300ms blank period and a 300 ms test phase during which we presented a random dot stimulus moving in one of the eight directions. In the stimulation condition the visual adapter stimulus was accompanied by tACS (10 Hz, 1 mA). In non-adapted control trials, the adapter stimulus was replaced by a noise stimulus consisting of dots moving in randomly chosen directions.

We measured changes in the tuning amplitude, tuning width, and preferred direction of all recorded cells. We also measured changes in the evoked amplitude and the power spectrum of the local field potentials. We found that tACS induced statistically significant changes in adaptation in many cells, but these effects were quite heterogeneous across the population. We also found significant increases in high frequency LFP power; well outside the frequency band of the applied stimulation. These results provide novel insight into how tACS interacts with neural activity and

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