Transcranial direct current stimulation (tDCS) is a noninvasive brain stimulation technique that has been investigated for the treatment of a variety of neurological or neuropsychiatric disorders such as chronic pain and depression. The main effect of tDCS is to modulate the excitability of cortical neurons depending on the polarity of the current applied. However, understanding the mechanisms by which these modulations are induced by tDCS and persist beyond the stimulation time is still an open question.

A possible marker indicating a change in cortical neuronal activity is the subsequent variation in the regional blood flow and metabolism. These variations can be effectively monitored using functional near-infrared spectroscopy (fNIRS), which offers a noninvasive and portable mean of measuring the regional oxygenation state of hemoglobin in the cortical tissue.

We studied healthy volunteers at rest and evaluated the changes in cortical oxygenation correlated to tDCS using fNIRS. Subjects were tested in two conditions: active stimulation (12 subjects) and sham stimulation (5 subjects). Electrodes were applied bilaterally at two prefrontal locations; the active
stimulation consisted of a 10-minutes anodal stimulation and, at the end of it, fNIRS data were collected for 20 minutes.

The anodal stimulation induced a significant increase in the oxyhemoglobin (HbO2) concentration compared to sham stimulation. Additionally, the effect of active tDCS was localized in time and lasted up to 6-8 minutes after the end of the stimulation. The cathodal stimulation manifested instead a negligible effect.

The changes induced by tDCS on HbO2, as captured by fNIRS, agreed with previous results obtained with positron emission tomography (Lang et al., 2005). Taken together, these results help clarify the mechanisms underlying the regional alteration in cortical activity following tDCS and validate the use of fNIRS as a possible non-invasive method to monitor the neuromodulation effect of tDCS.