

The effects of brain stimulation on cognitive inhibition

The term cognitive inhibition refers to the ability to control or suppress irrelevant responses, and to adopt instead relevant and flexible responses. A common situation that requires cognitive inhibition includes for example, the resistant to check messages on emails or Facebook while studying for an exam. Cognitive inhibition serves three aims: (1) restrict access to relevant information, (2) suppress information that is no longer relevant, and (3) restrain production of dominant but potentially incorrect retrieval of information from memory. Understanding the mechanism and the neural substrates underlying cognitive inhibition is important because it has been suggested that people with schizophrenia have deficient cognitive inhibition ability. Improving cognitive inhibition could help to adapt therapeutic strategies in people that demonstrate poor clinical and functional outcomes.

In order to adequately engage in daily life situations, the human brain has developed mechanisms aimed to coordinate internal goals and rules that guide appropriate behavioral responses. This adequate engagement activates multiple brain regions, including frontal, medial frontal and parietal areas. In particular, the dorsolateral prefrontal cortex (DLPFC), a relatively large region within the frontal lobe, has been implicated in various cognitive control processes including cognitive inhibition.

One task that requires cognitive inhibition is the Hayling task. In this task, participants are asked to either complete a sentence with a word that fits the sentence (initiation condition) or complete the sentence with a word that is completely unrelated to the sentence (suppression condition). For example, most of the people that hear the sentence stem *I went to the doctor because I was...* will complete the sentence with the word "sick". In the suppression condition, a word that is incompatible and completely unrelated in the context of the sentence *I brush my teeth every morning with...* is "wheel". The suppression condition requires cognitive inhibition as several missing words are activated, and need to be suppressed to select an unrelated word. Neuroimaging studies show increased activation in the DLPFC in the suppression condition, in comparison to the initiation condition. In our study (Metzuyanim–Gorlick & Mashal, 2015) we tested whether DLPFC stimulation improves cognitive inhibition using the Hayling task.

In the last decade several studies investigated the effects of transcranial direct current stimulation (tDCS) on cognitive control. tDCS is a noninvasive, painless cortical technique that affects neuronal excitability. Brain excitability can either be increased (using anodal electrode) or decreased (using a cathodal electrode). The beneficial effects of tDCS were documented in healthy as well as clinical patients in the motor as well as in the cognitive and language domains. For example, it has been shown that anodal tDCS over the left DLPFC cortex enhances working memory and improves language functioning.

In our study participants performed the Hayling task (baseline) followed by six stimulation sessions (in each stimulation session a 2 mA current was delivered for 20 minutes). Following these

stimulations, we assessed immediately Hayling performance and re-assessed this performance one month later. The results show improvement in irrelevant response inhibition (the suppression condition) immediately after the last stimulation and one month later as compared to baseline. The group that participated in a placebo- like stimulation (sham) did not improve their performance. Importantly, participants made approximately 30% less errors at the end of the six stimulation sessions as compared to baseline and approximately 40% less errors one month later in the suppression condition.

Our findings can be useful to improve life functioning for special populations who exhibit difficulties in cognitive inhibition which is a vital ability to every day functioning.

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