Age-related differences in tDCS modulation of episodic memory: evidence from behavioral and neurophysiological measures

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Background & objectives

Episodic memory (EM) generally shows signs of an accelerated decline after the age of 60-65. Although transcranial direct current stimulation (tDCS) has gained attention as a potential tool to retain age-related memory decline, the effects are largely variable.

In order to delineate variability in the response to tDCS throughout the aging lifespan, the present study aimed to investigate:

1) Whether tDCS differently modulates EM at different stages of healthy aging (namely, before and after 65 years-old);
2) How tDCS modulation affects the neural mechanisms underlying EM.

Discussion

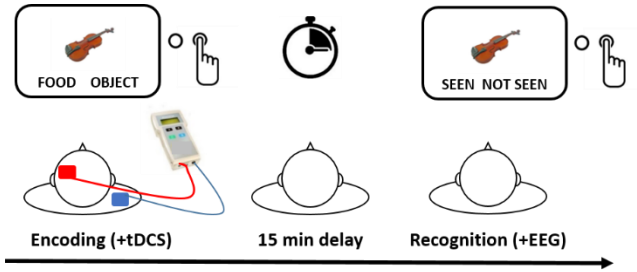
The present results showed age-related differential effects of anodal tDCS in EM modulation. Whereas tDCS enhanced memory performance in older adults, it induced a detrimental effect in middle-aged participants. The behavioral worsening observed in the middle-aged group was mirrored with an amplitude reduction of the neural EM correlates associated with familiarity-based recollection and monitoring of the retrieval attempt.

These findings highlight the need to consider the factors that determine responsiveness to tDCS and suggest to move toward an individualized use of tDCS, and possibly other brain stimulation techniques, in order to prevent null or even detrimental effects.

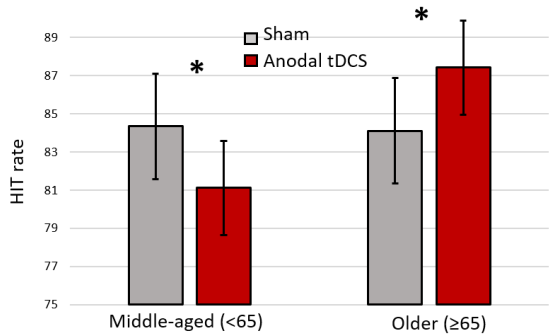
Methods & Results

Participants & Experimental procedure

19 middle-aged (<64 years-old; mean age 57.11; min-max 50-64) and 19 older (>65; mean age 71.63; min-max 65-81) healthy adults.
All subjects underwent two identical experimental sessions, except for the tDCS delivered (15 minutes of 1.5 mA anodal or sham) over the left dorsolateral prefrontal cortex during a picture-encoding task.
Behavioral and ERPs measures were collected during the delayed recognition phase.

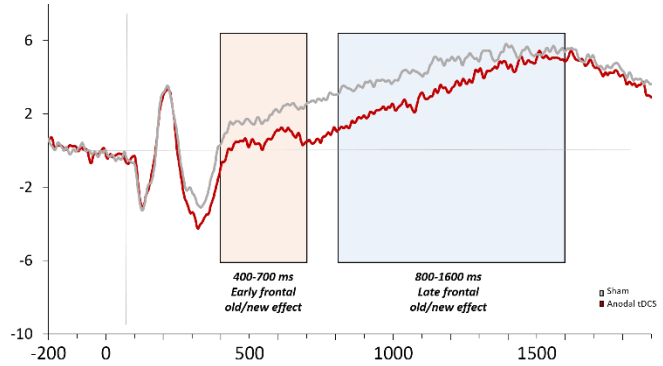


1) Behavioral results



Repeated measures ANCOVA with group (middle-aged, older), type of stimulation (anodal, sham) and education as covariate on ***hit rate*** showed a significant interaction between group and type of stimulation ($F(1,35)=7.514$; $p=0.010$), with middle-aged and older adults showing an opposite effect. Anodal tDCS induced a reduction in the number of correctly recognized pictures in middle-aged participants ($p=0.048$), but increased the recognition performance in the older ($p=0.043$).

2) ERPs results



Repeated measures ANCOVA with group (middle-aged, older), type of stimulation (anodal, sham), electrode (left, central, right) and education as covariate on ERPs (early frontal, parietal and late frontal old/new effects) mean amplitude showed a significant interaction between group and type of stimulation for ***early frontal*** ($F(2,70)=3.571$, $p=0.033$) and ***late frontal old/new effects*** ($F(2,70)=4.356$, $p=0.16$). Post-hoc analysis showed that in the middle-aged group anodal tDCS reduced the amplitude of both components ($p=0.020$ and $p=0.023$, respectively).

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