Anodal tDCS decreases total EEG power at rest and alters brain signaling during fatigue in high performance athletes

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Background

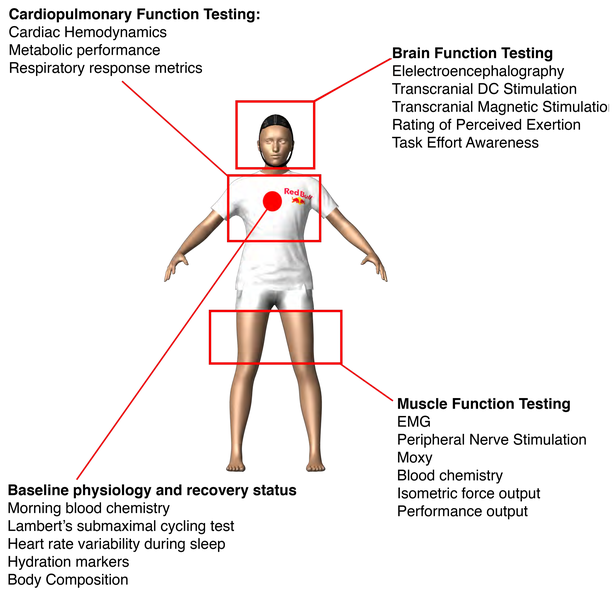
- It is known that anodal tDCS over motor cortex can alter motor output.
- Intense interest surrounding the role of tDCS n high performance sports.

Two preliminary questions:

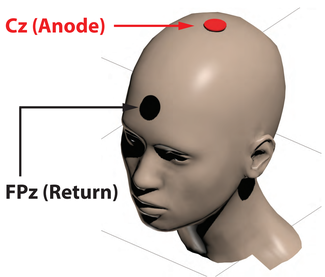
1. Will anodal tDCS affect observed EEG in athletes?
2. Can anodal tDCS improve athletic performance in endurance athletes?

Methods

- Four endurance athletes
- Specialized fatiguing protocol under comprehensive neurological and physiological monitoring



Neurological and physiological metrics tracked on each athlete.



Anodal tDCS was applied to 4 athletes over 3 days in a single-blind protocol. Subjects received 20 minutes of either real (1mA Cz Anodal, FPz return) or sham tDCS according to a randomly generated schedule.

Following tDCS, athletes warmed up and worked through a personalized fatiguing protocol on the stationary bike (~5watts/kg)

TDCS Session → Warm-up → Workload

Following completion of the fatiguing protocol, the athletes completed a series of maximum voluntary contractions (MVCs) while TMS and peripheral nerve stimulation were being performed

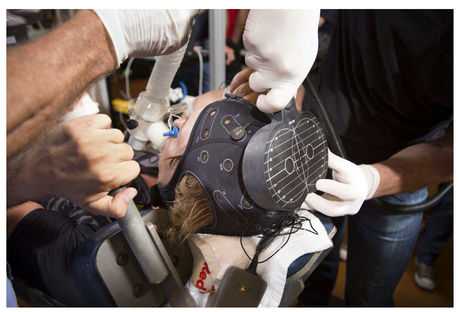
TDCS Session → Warm-up → Workload → MVC/TMS Protocol

TDCS Session → Warm-up → Workload 1 → MVC/TMS Protocol 1

Workload 2 → MVC/TMS Protocol 2 → Workload 3 → MVC/TMS Protocol 3

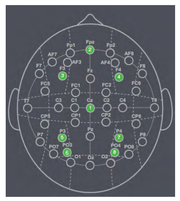
Workload 4 → MVC/TMS Protocol 4 → 10 KM Time Trial

The workload/MVC fatiguing protocol was completed four times, followed by a maximal, 10km time trial. This entire protocol was completed over 3 consecutive days

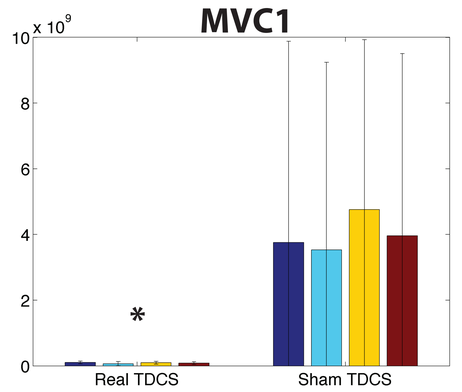


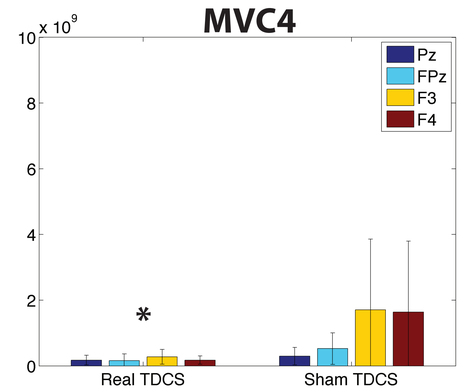
Scan the QR code to watch the video!

Results

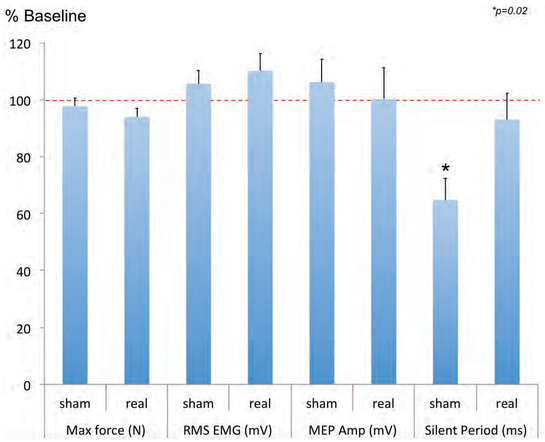


- We recorded EEG signal from eight channels across the scalp throughout the protocol
- Although movement artifact disrupted much of the signal during static cycling, during the MVC periods clean recordings were possible
- We performed moving window, multi-taper spectral analysis to monitor total spectral power across different conditions





Total signal energy was computed across all channels post MVC/TMS protocol. We noted significantly ($p<0.001$; rank-sum test) increased signal power during the "sham" condition in both fresh (left) and fatigued (right) conditions.



Group post time-trial data normalized to baseline. Force and EMG changes were negligible, subtle force decrement paralleled by subtle EMG increase. MEP amplitude also remained unchanged or marginally elevated. In contrast, silent period was substantially reduced. Results with prior real tDCS shows a similar pattern, however the silent period appears to be restored.

Conclusions

- **These findings suggest that tDCS to motor cortex significantly alters the resting state of the brain, and the way in which the brain responds to fatiguing exercises.**
- **We have also presented evidence that suggests that tDCS also influences peripheral function.**
- **We did not find evidence that a single dose of anodal tDCS to motor cortex could enhance motor performance in athletes.**
- **Further research is required isolate the potential benefits of this protocols in the high performance environment.**