



Modulating brain activity to improve dual task gait and balance in older adults

Brad Manor, PhD

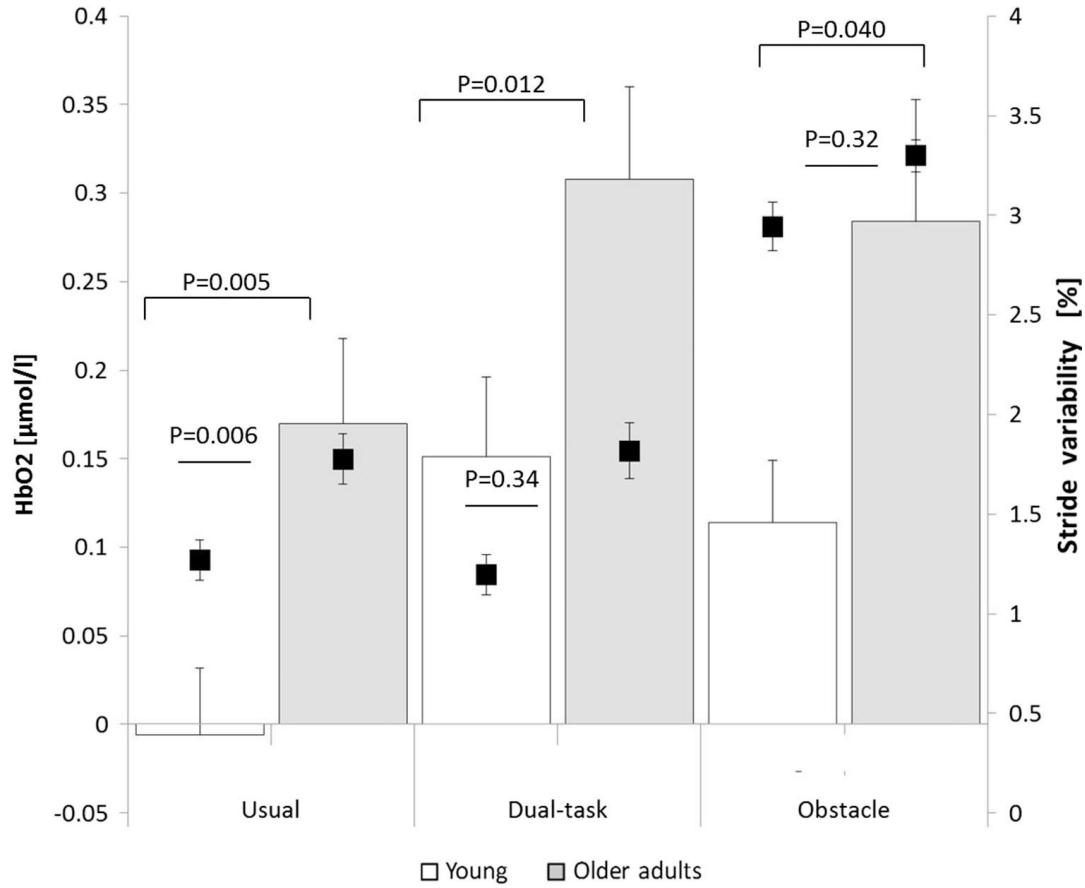
May 15, 2019

The control of standing and walking is dependent upon a host of interactive cortical networks.



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Dual tasking is the norm and requires timely and efficient activation of the prefrontal cortices.

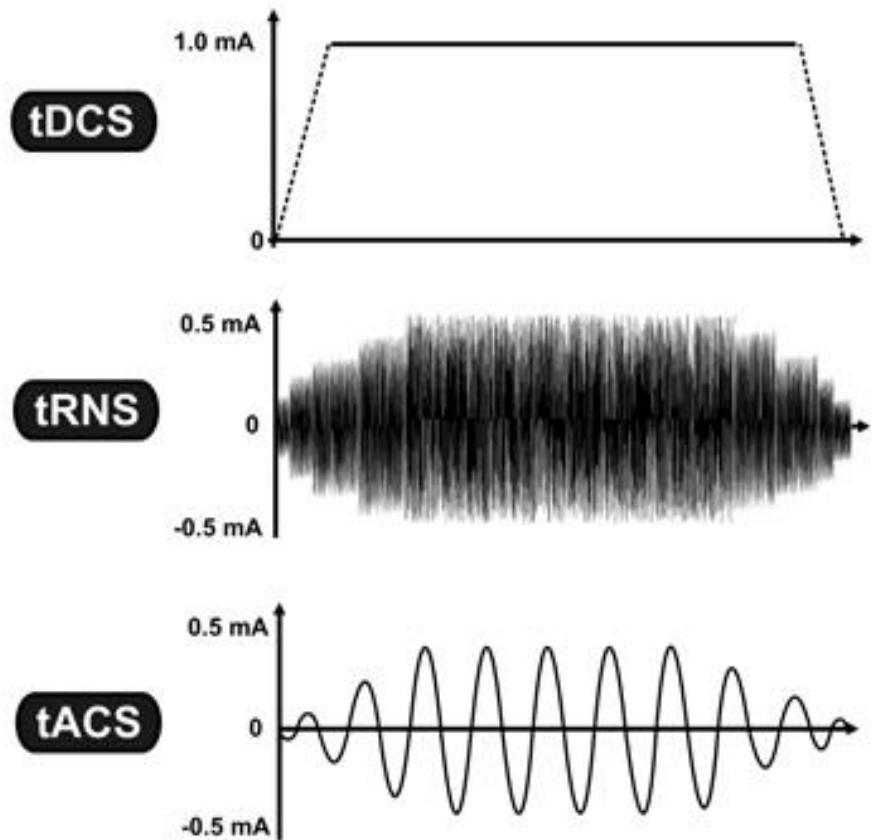
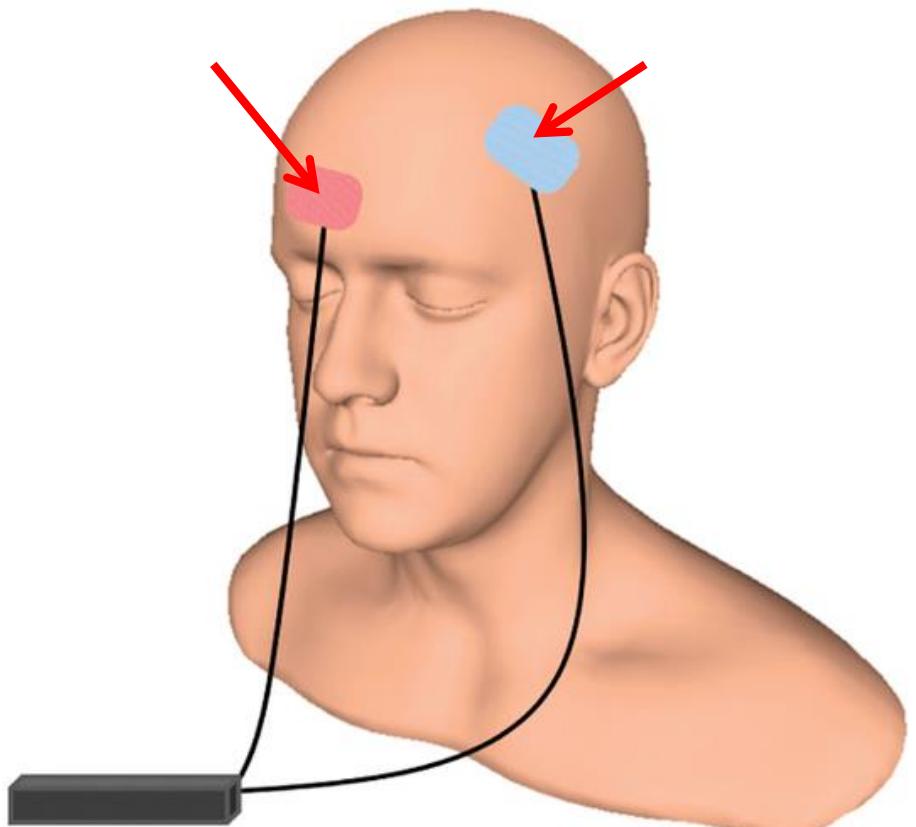


Strategies that modulate the ability to effectively activate the prefrontal cortices in response to task demands offer unique opportunities to understand, and enhance, the central control of balance in aging.

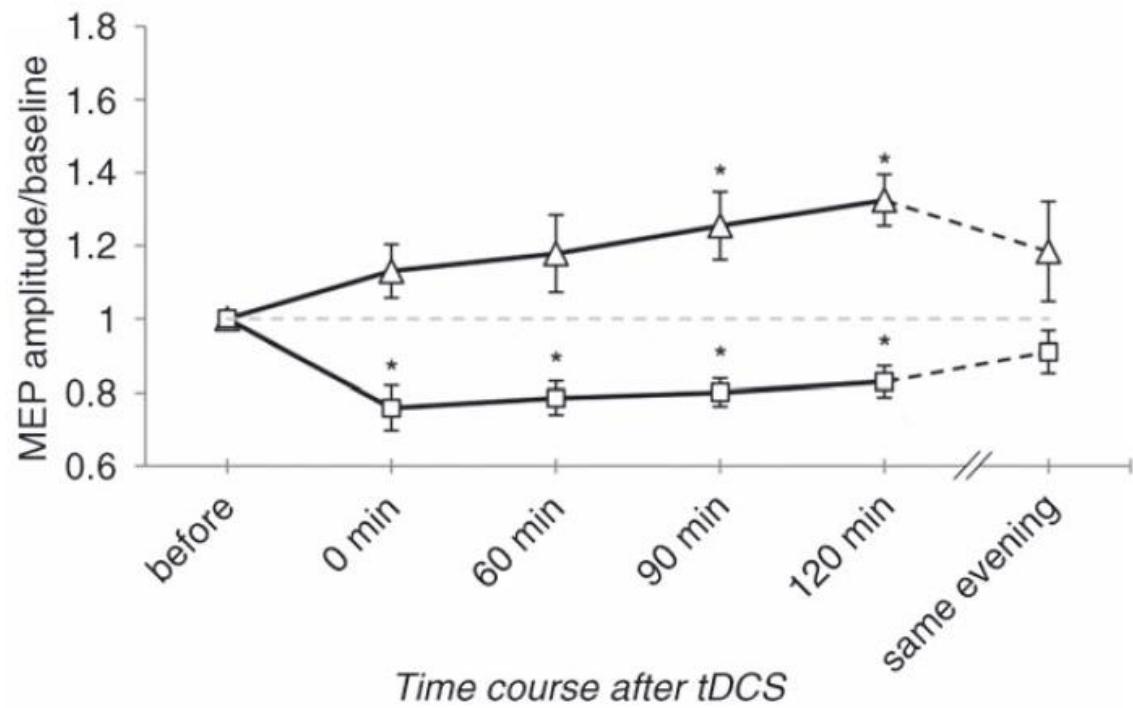
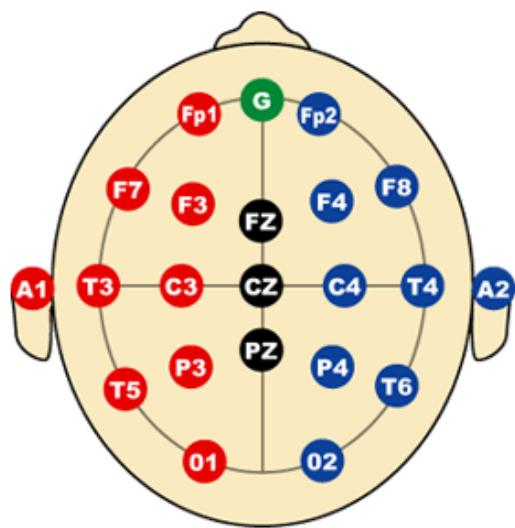


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We can use low-level electrical currents to safely and selectively modulate brain excitability.



tDCS polarizes populations of cortical neurons, and thus, alters their resting membrane potentials (i.e., likelihood of firing).



Batsikadze et al, *J Physiol*, 2013

Multi-session interventions induce longer-lasting effects

The effects of tDCS depend upon numerous factors

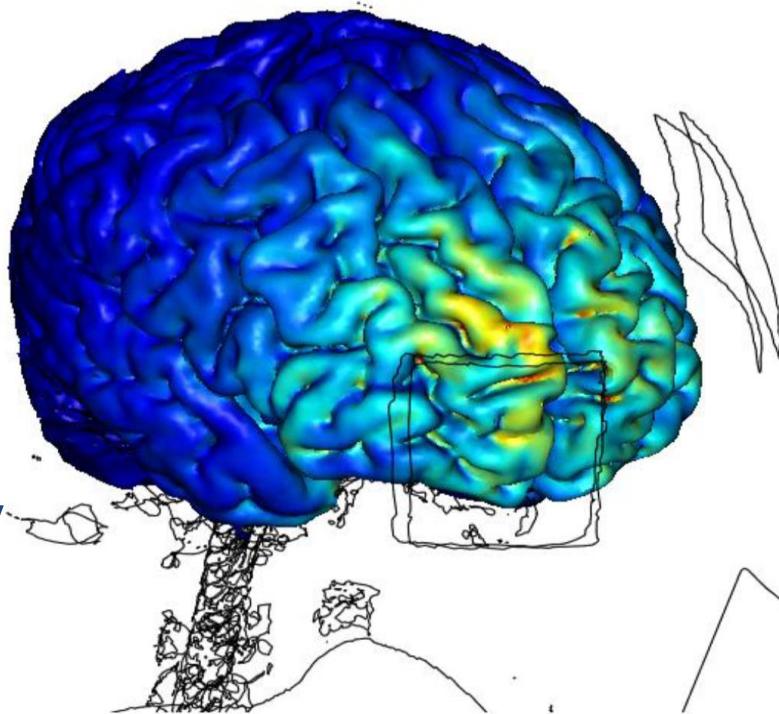
Electrode size

Polarity

Placement

Current intensity

Current duration



Anatomy:

- Skin
- Skull
- CSF
- gray mater
- White mater

Brain physiology

Brain state

The effects of aging on current flow, and its impact on the brain, are poorly understood.

In older adults, tDCS targeting the left dlPFC has been shown (in preliminary studies) to improve:

Speed of processing

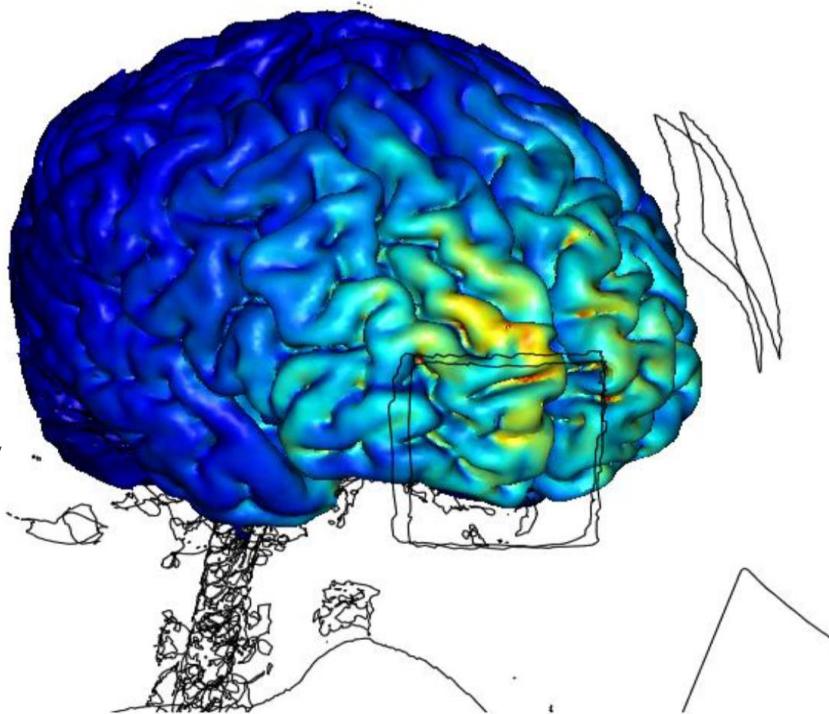
Working memory

Response inhibition

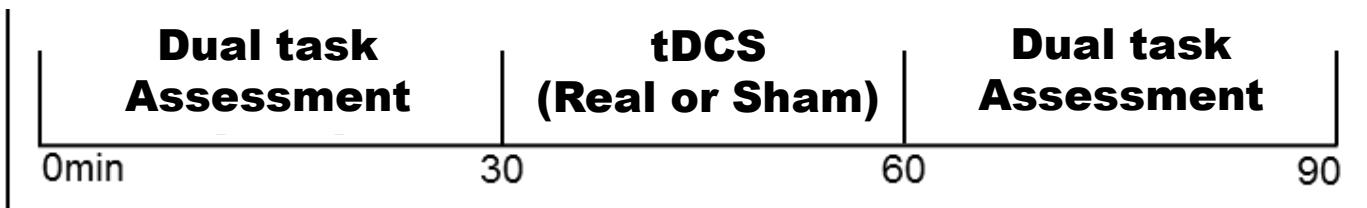
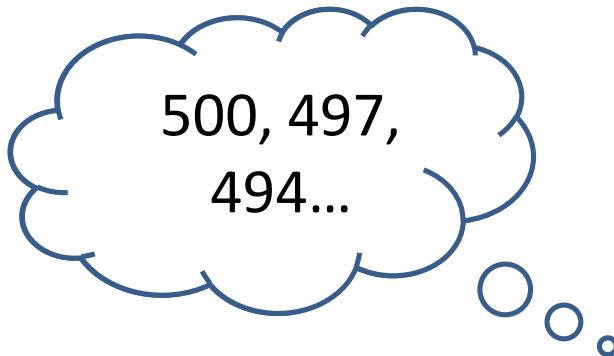
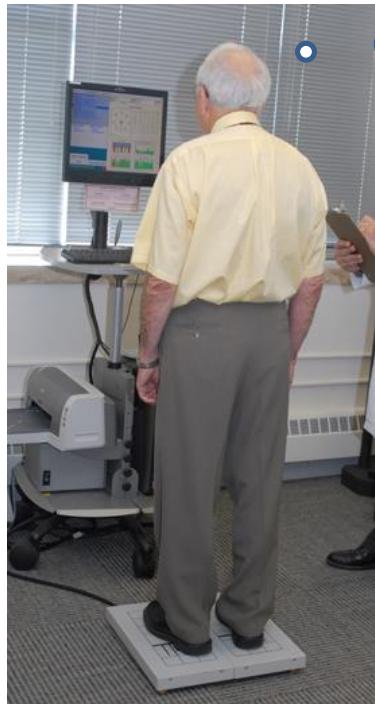
Task Switching

Depression

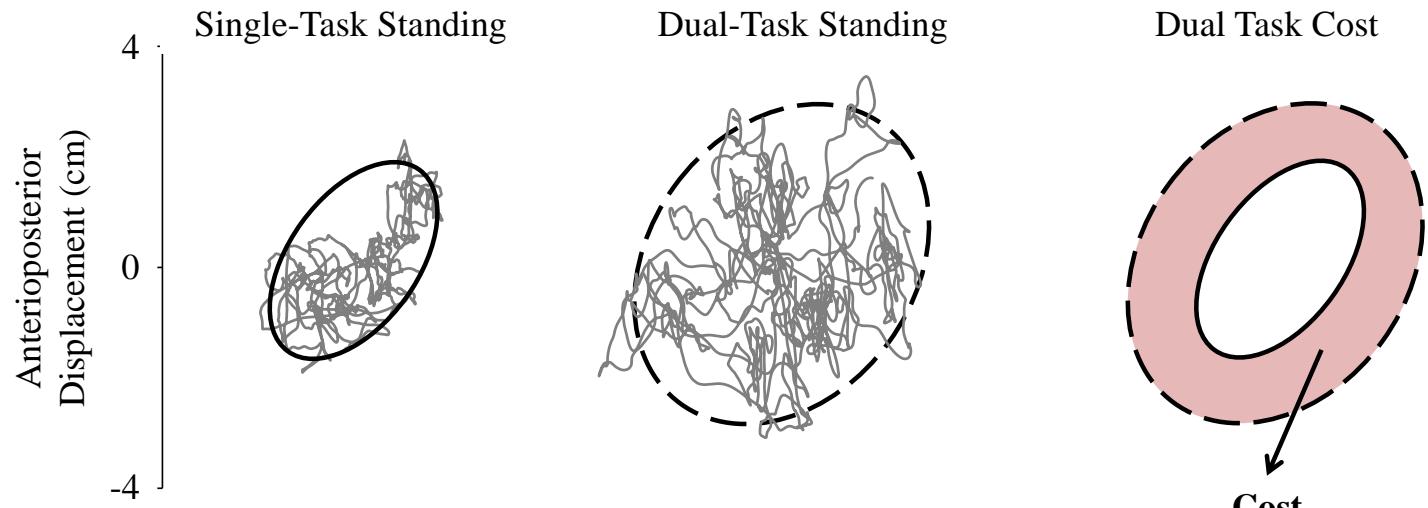
Chronic pain



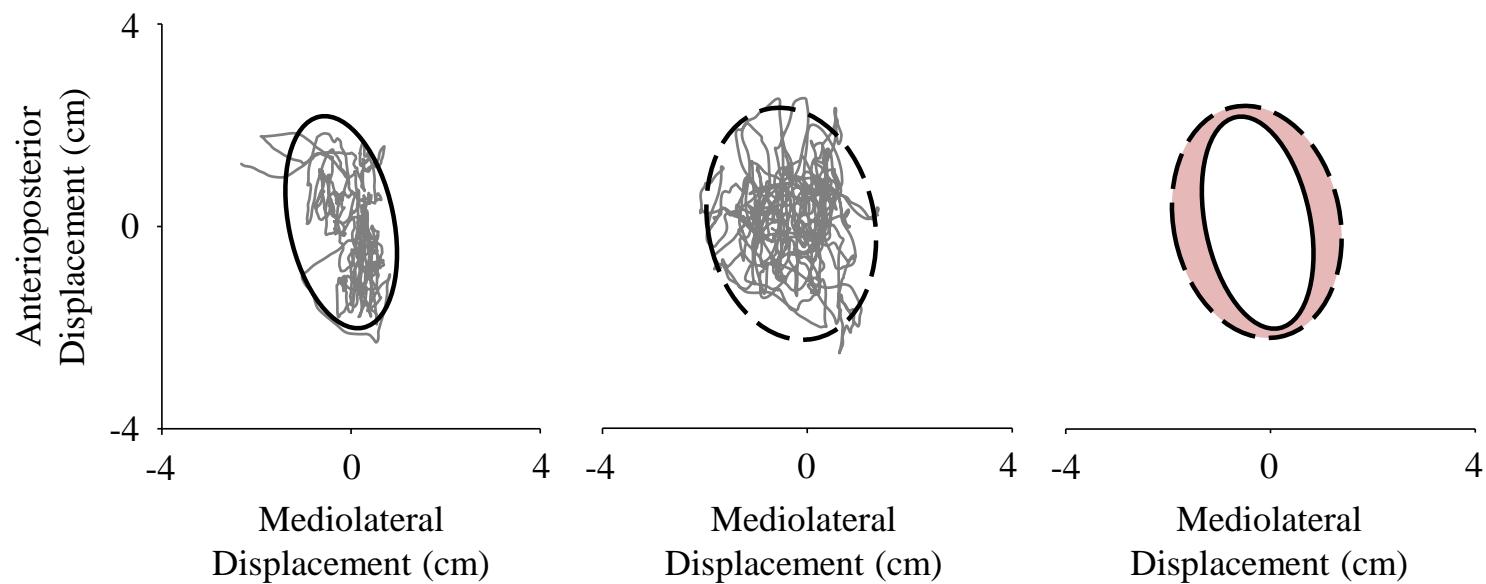
Single, 20-minute sessions of tDCS targeting the left dIPFC mitigate dual task costs.



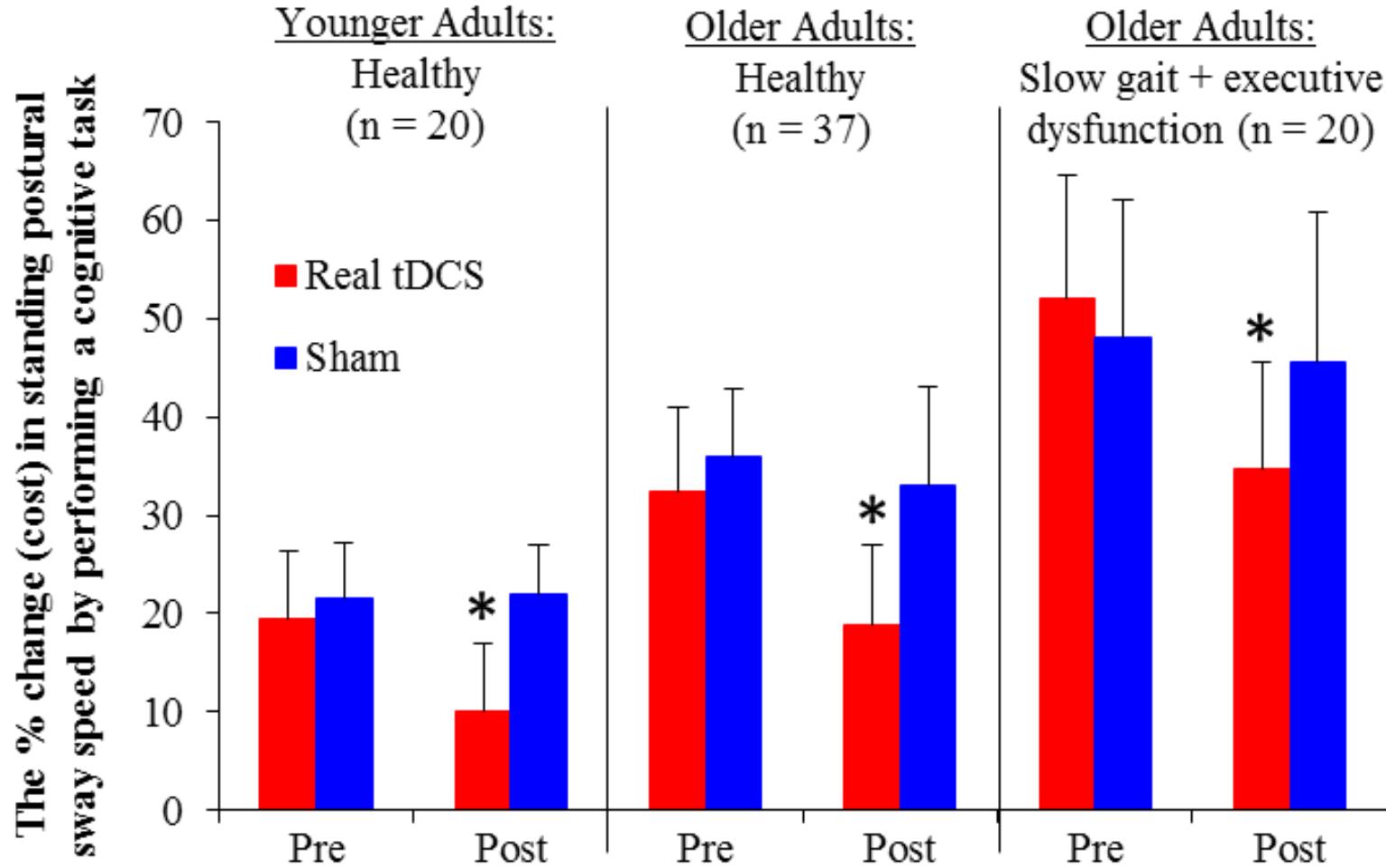
A: Post Sham tDCS



B: Post Real tDCS

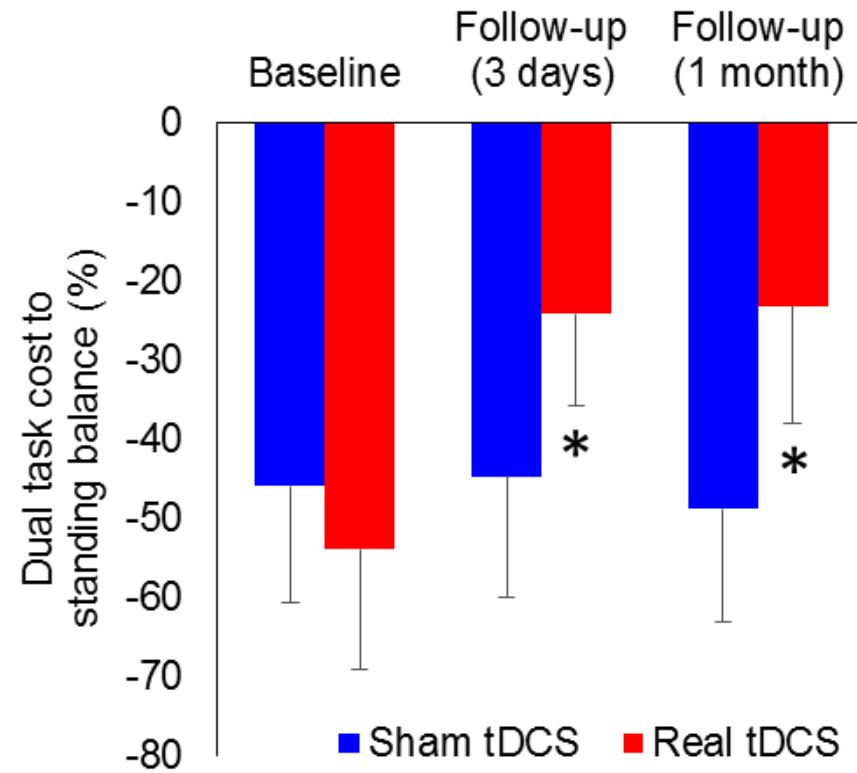


Single sessions of tDCS targeting the left dorsolateral prefrontal cortex (dlPFC) mitigate dual task costs.



Multiple sessions of tDCS induced lasting improvements in dual task performance.

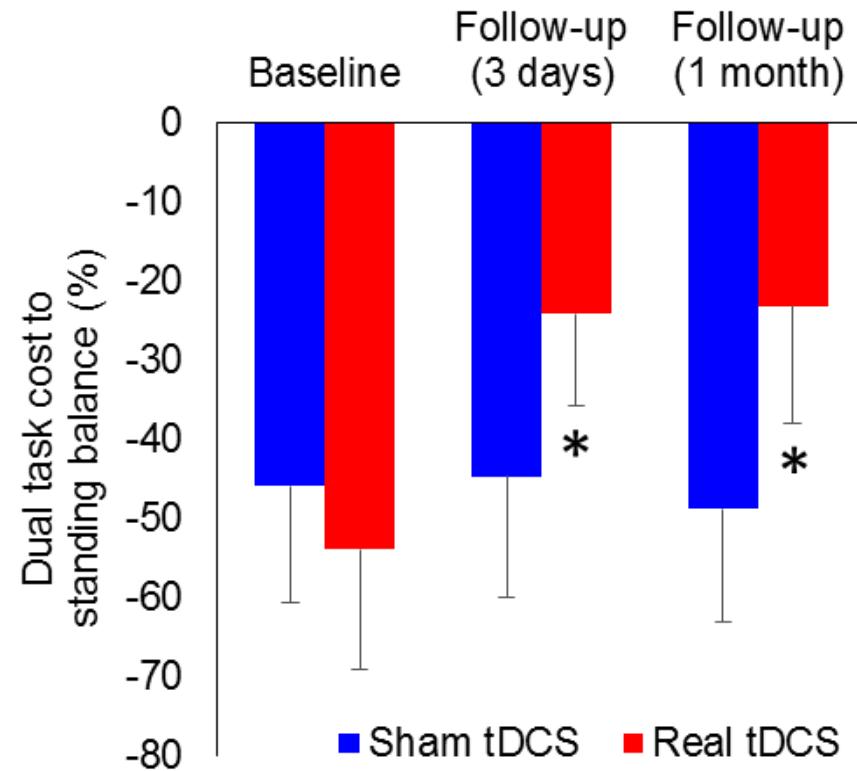
20 older adults without overt disease were randomized to a 2-week, 10-session intervention of tDCS targeting the left dlPFC, or sham stimulation



Increased performance was also observed in the MoCA and Timed Up-and-Go (TUG) test of mobility.

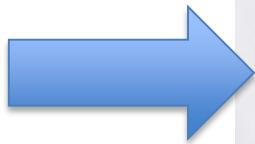
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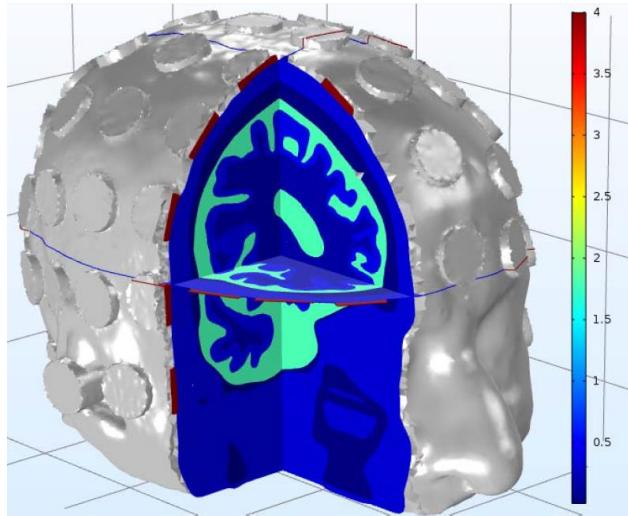


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But wait...are we targeting the optimal region? Does the current go where we want it to go?



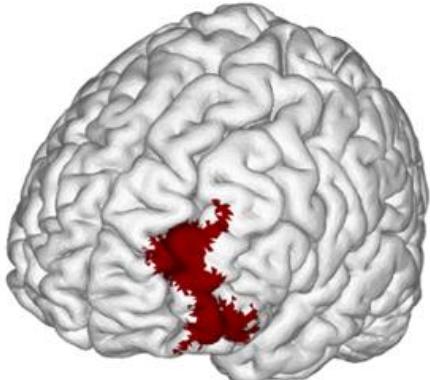
tDCS can now be personalized to individual brain anatomy, and even function.



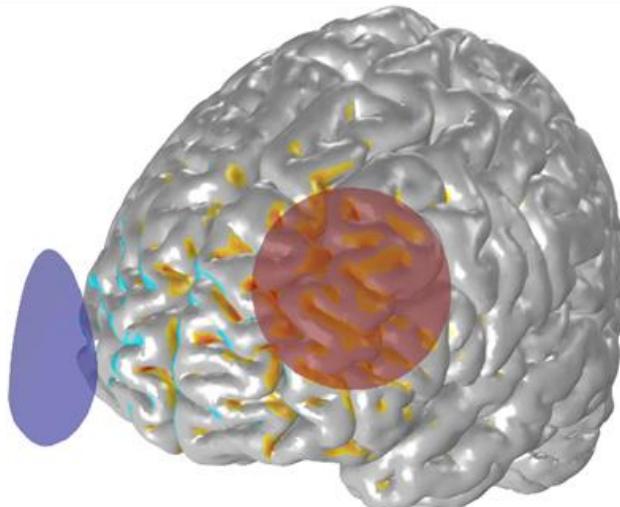
Structural and functional fMRI can be used to identify individual target(s) of interest.

Algorithms can identify tDCS montage to optimize flow of electrical current

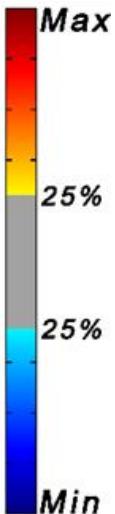
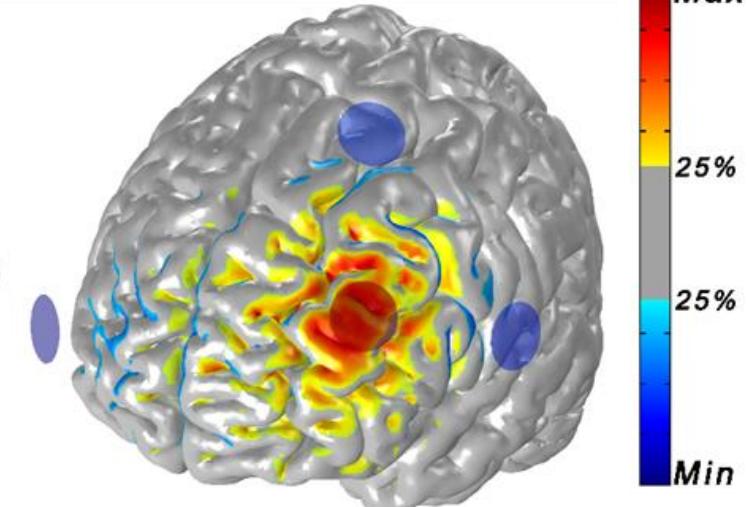
Left dIPFC target



Traditional bipolar tDCS



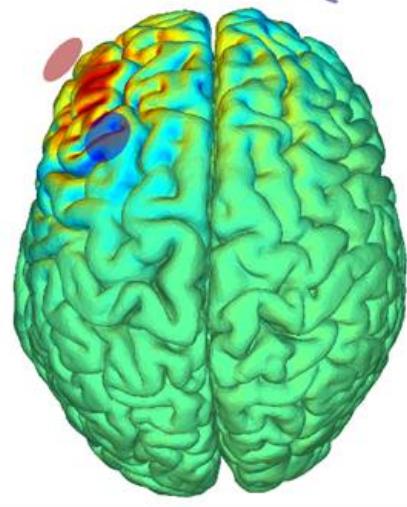
Personalized tDCS



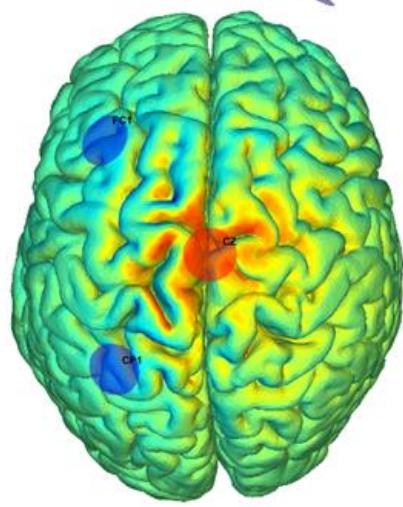
PESC Pilot Study: Do single sessions of high-resolution, multi-target tDCS improve dual tasking?

**48 older adults free of overt illness or disease
(mean \pm SD age=75 \pm 6 years, 35 women)**

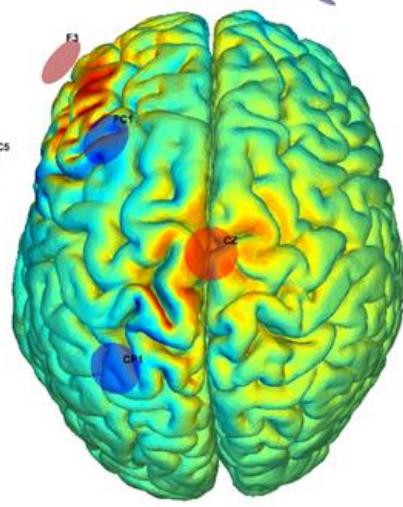
Left dorsolateral prefrontal cortex (dlPFC)



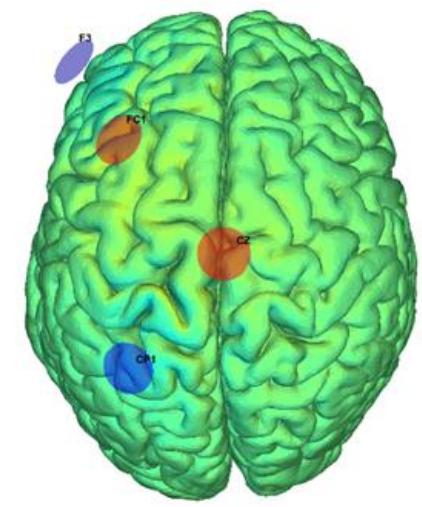
Bilateral Motor Cortex (M1)



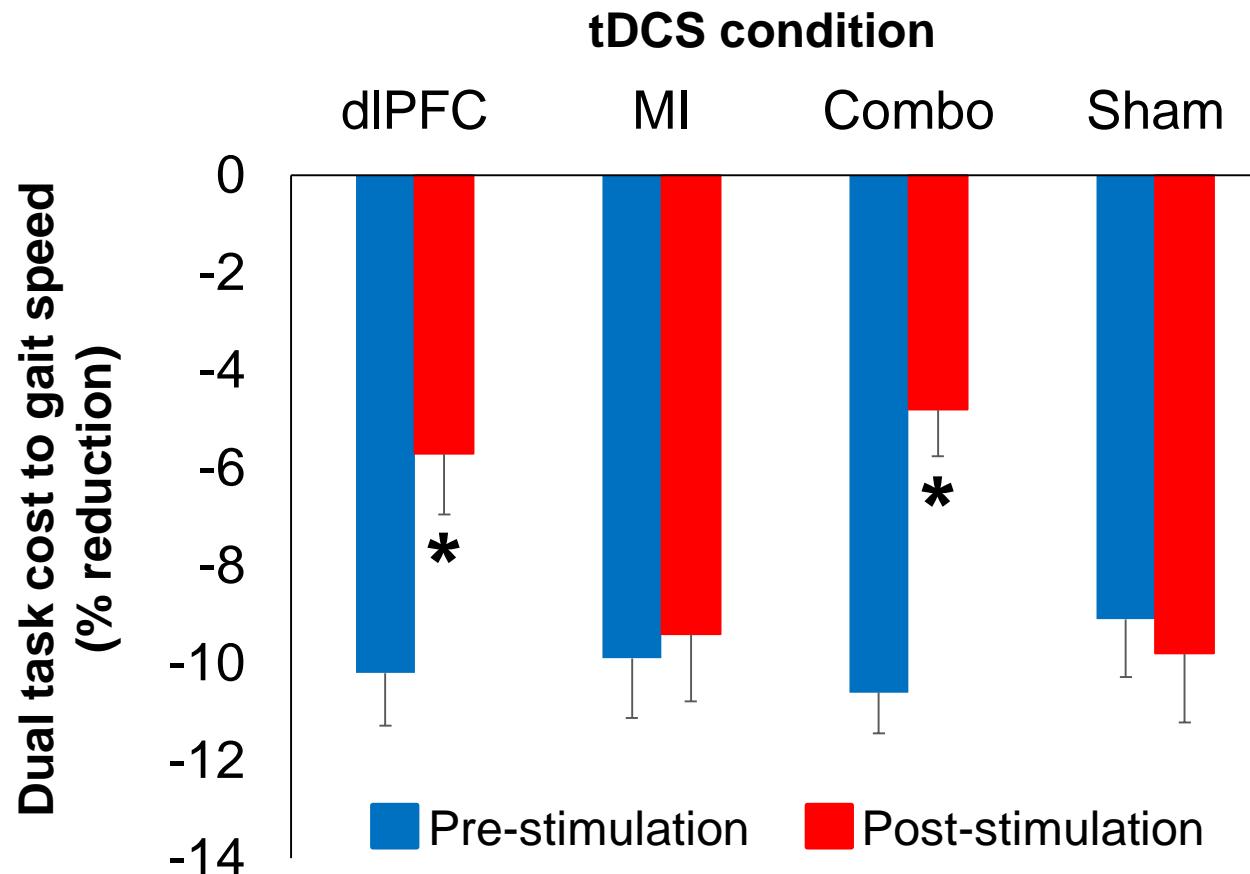
Left dlPFC + M1



Sham



PESC Pilot Study: Do single sessions of high-resolution, multi-target tDCS improve dual tasking?



- Similar effects were observed for standing balance.
- Effects sizes were similar to traditional (sponge) tDCS.

What's next? We have used our PESC data in three separate grant applications:

Does a multi-session tDCS intervention induce meaningful, lasting changes in dual task performance?

- **R01 (Active): tDCS in recurrent fallers.**

Does tDCS personalized to brain anatomy optimize effectiveness and reduce intra-subject variability?

- **R21 (Pending, 5th percentile): MRI acquired to optimize tDCS to each older adult's left dIPFC.**

Is tDCS a feasible and effective balance intervention for older adults with cognitive impairment?

- **AD Supplement (Approved!): tDCS in mild AD.**