

The Effects of Transcranial Direct Current Stimulation on Beat Perception and Motor Performance



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Introduction

- Beat perception is thought to engage beat-based timing mechanisms.¹
- Different timing mechanisms may rely on different motor brain areas.^{2,3,4}
- Evidence points to an **SMA** role in timing of beat-based rhythms, while **premotor cortex** and **cerebellum** respond to both beat and non-beat rhythms, or more to non-beat.^{2,3,4}
- Evidence for **causal roles in timing** for these areas is limited.
- Using transcranial direct current stimulation (tDCS), previous work suggests causal roles for the SMA and cerebellum in beat-based timing during rhythm *discrimination*.⁵
- As a follow-up, we examined how *reproduction* of strong, weak, and non-beat sequences was affected by altering excitability of the SMA, cerebellum, and PMC using tDCS.
- We hypothesized that the SMA plays a primary role in beat perception, thus modulating SMA excitability should influence accuracy of beat-based rhythm reproduction.
- Premotor and cerebellar stimulation should influence accuracy of non-beat-based rhythm reproduction.

Methods

Participants

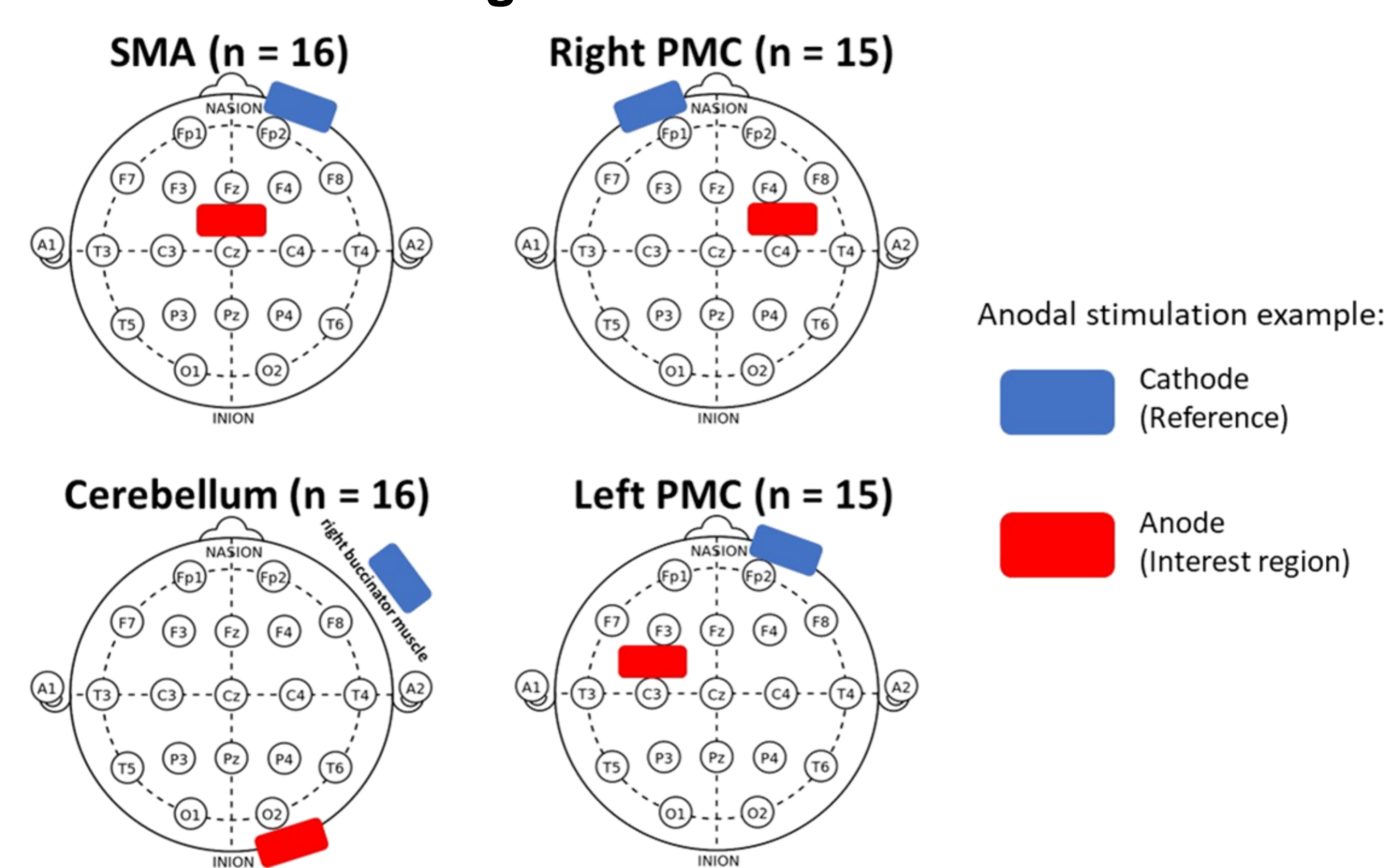
62 subjects (20 men; 42 women)

- Mean age 18.5 ± 1.8;
- Randomly assigned to a stimulated brain area (4 distinct groups)

Stimuli

- Strong beat rhythms: Integer ratio intervals with regular accents.
- Weak beat rhythms: Integer ratio intervals with irregular accents.
- Non-beat rhythms: Non-integer ratio intervals with irregular accents.

tDCS Montages For Each Brain Area



Recruitment → Session 1 → Session 2 → Session 3

Random assignment

SMA

Right Cerebellum

Left PMC

Right PMC

Each participant had 3 counterbalanced sessions (sham, anodal, and cathodal). Each session included the self-paced tapping task and the reproduction of strong, weak, and non-beat rhythms

1. Stimulation/Sham

2. Self-Paced Tapping



3. Rhythm presentation 3 times

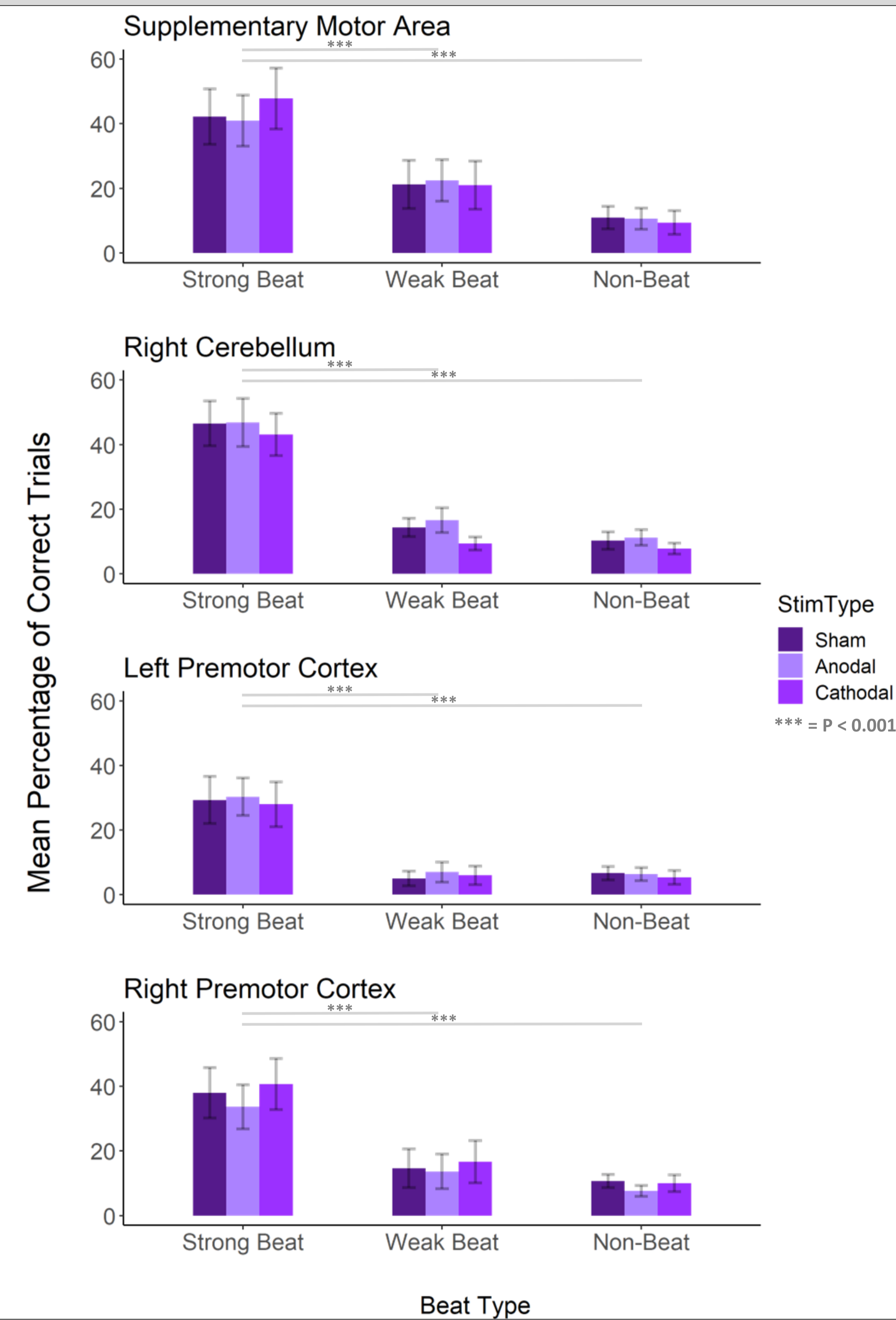


4. Rhythm reproduction

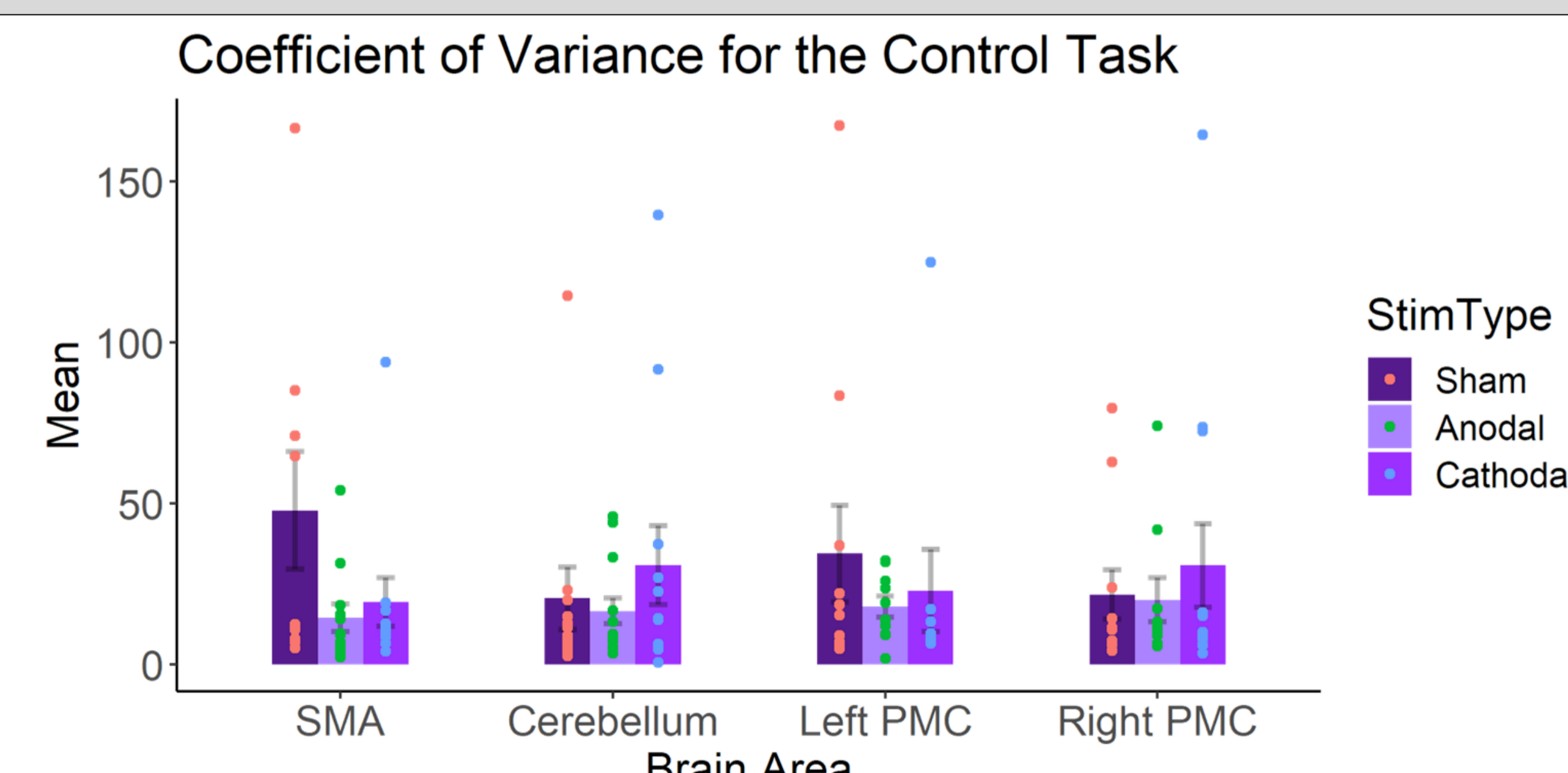
Analysis: A mixed-measures ANOVA was conducted on the proportion of correct trials of the reproduced rhythms and a repeated-measures ANOVA was conducted on the coefficient of variation of the self-paced tapping task.

Results

No effect of stimulation Strong beat rhythms reproduced more accurately



No effect of stimulation on self-paced tapping



Conclusion

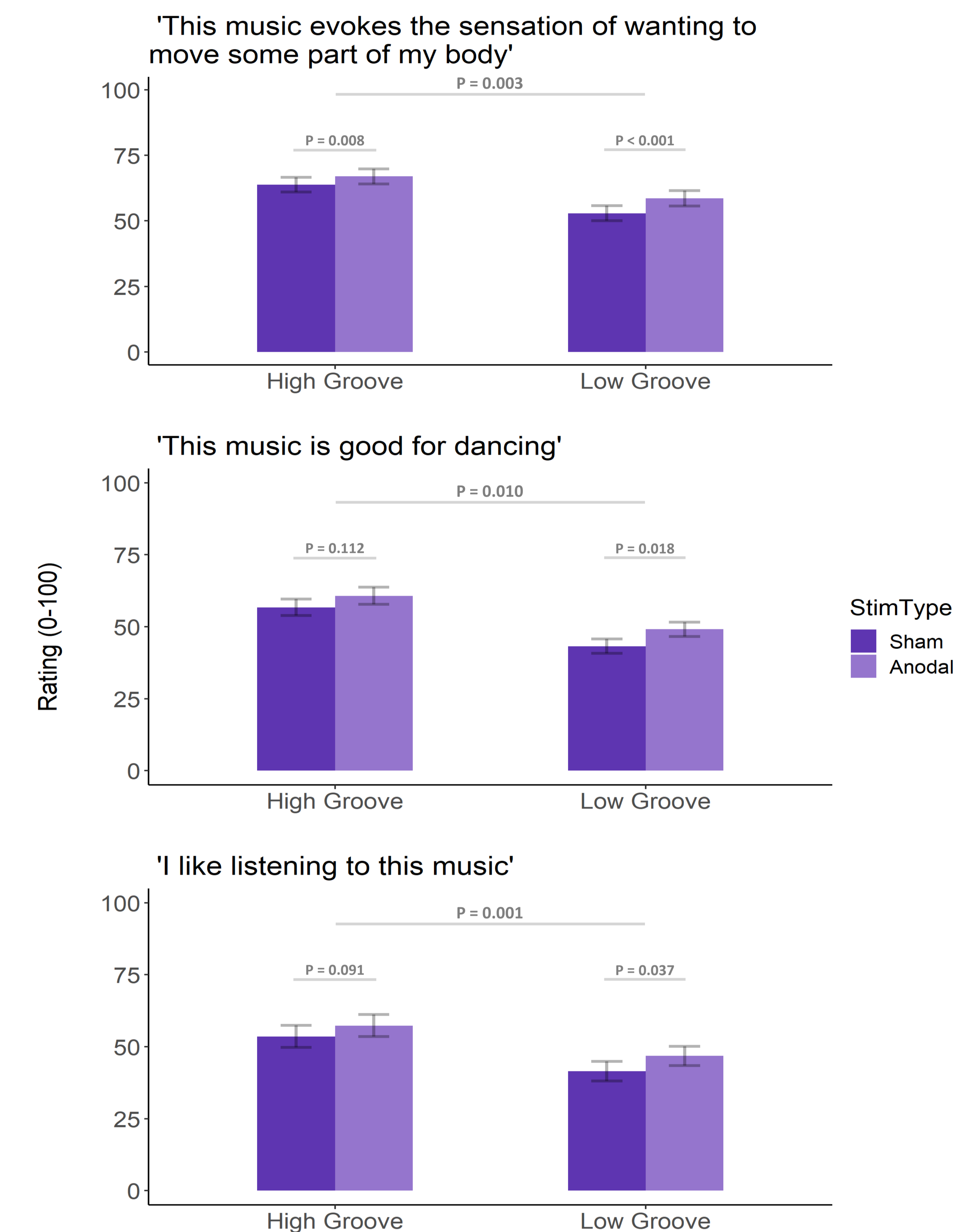
- No effect of stimulation for any brain area on rhythm reproduction or self-paced tapping;
- A null result cannot lead us to conclude that the SMA is not necessary for beat perception nor that premotor cortex and cerebellum are not important for non-beat-based sequences;
- Given the effects of tDCS on the SMA during rhythm discrimination⁵, stimulation effects of stimulation may be too weak to be observed during a rhythm reproduction task.

Future Directions

Groove and the SMA

Does anodal stimulation of SMA increase groove sensation?

- 31 participants.
- Anodal and sham SMA stimulation on 2 different days while rating drum musical clips from the Lucerne Groove Research Library.⁶



Findings: Anodal SMA stimulation increased groove and pleasure ratings.

References

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