

Supplementary Motor Area Role in Beat Perception: a Transcranial Direct Current Stimulation Study



Marina Emerick¹, Joshua Hoddinott¹, Jessica Grahn^{1,2}

¹ The Brain and Mind Institute, Western University

² Department of Psychology, Western University

mdeoliv4@uwo.ca

Introduction

- **Beat** is the sense of a **regular pulse** in music
- Beat perception is thought to engage relative and not absolute timing mechanisms [1]
- Determining the specific role of motor areas in different timing processes remains an active area of investigation
- Functional neuroimaging studies have suggested that the supplementary motor area (SMA), the basal ganglia, the premotor cortex, and the cerebellum are involved in rhythm timing [2,3]
- Evidence for **causal roles** remains limited
- **We examined how beat-based timing and non-beat-based sequence timing were affected by changes in the excitability of the SMA using transcranial direct current stimulation (tDCS) in a rhythm reproduction task**
- Following the beat-based timing model, we predict that **stronger beat rhythms** will be **reproduced more accurately** than weak/non-beat rhythms
- We predict that **anodal stimulation will increase reproduction accuracy** while **cathodal stimulation will decrease reproduction accuracy**
- We predict that **musicians will perform better than non-musicians** on the rhythm reproduction task

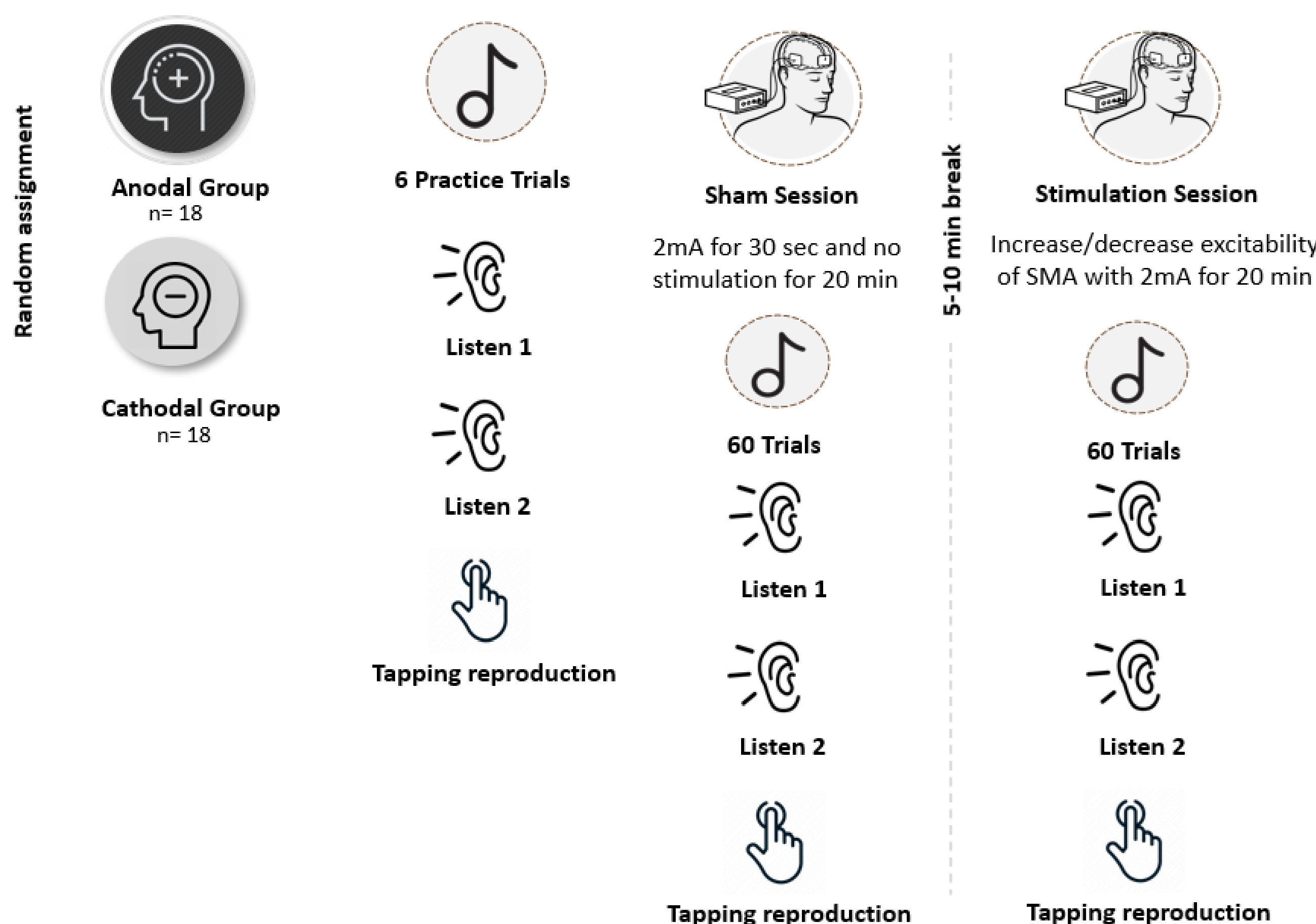
Methods

Participants

36 subjects:

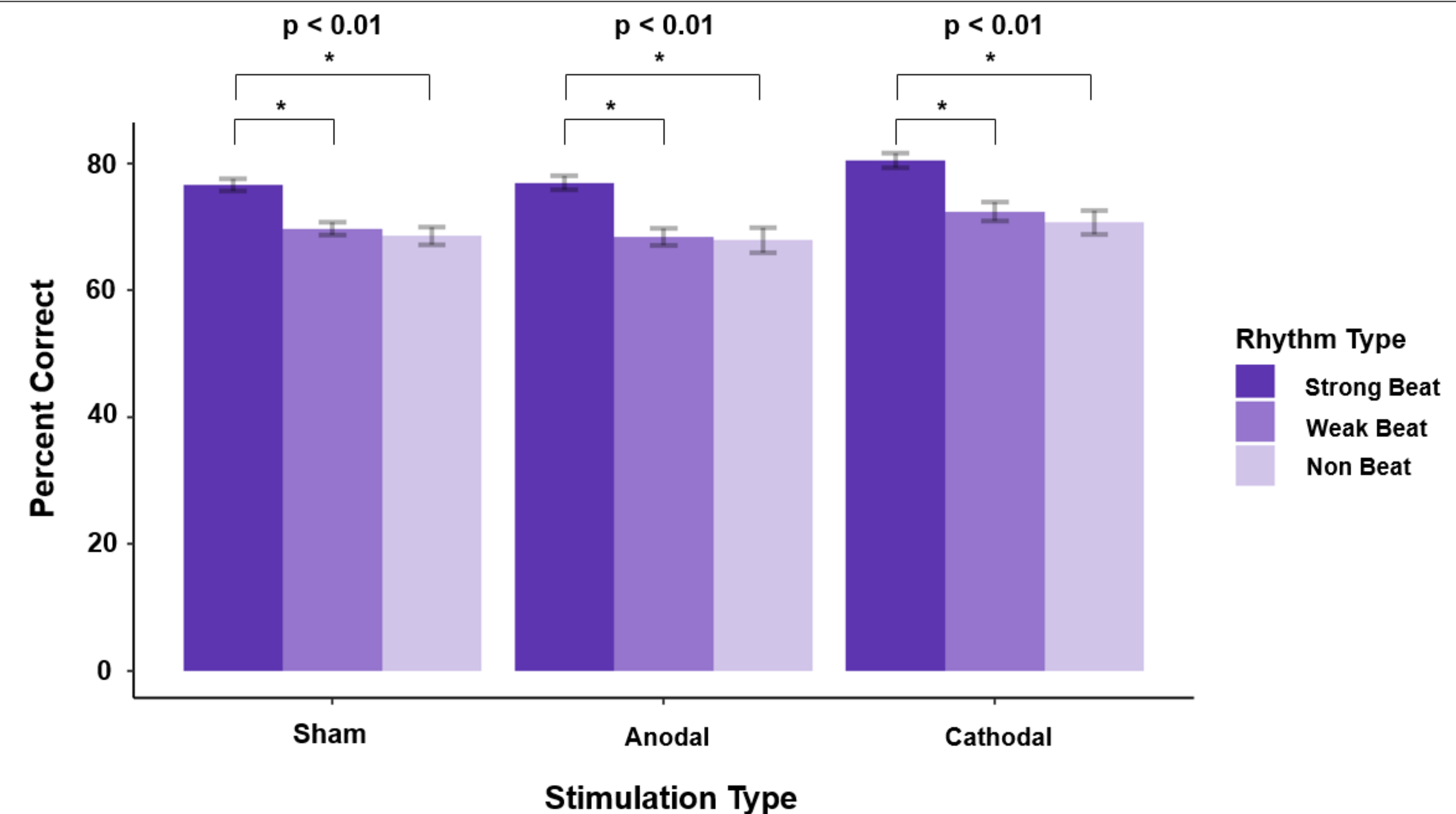
- 18 men; 18 women
- Mean age 21.58 ± 4.76 (17 to 42 years)
- Anodal group = 18
- Cathodal group = 18
- Musicians = 18 subjects (5+ years of music practice)
- Non-musicians = 18 (<5 years of music practice)

Recruitment → Practice → Block 1 → Block 2

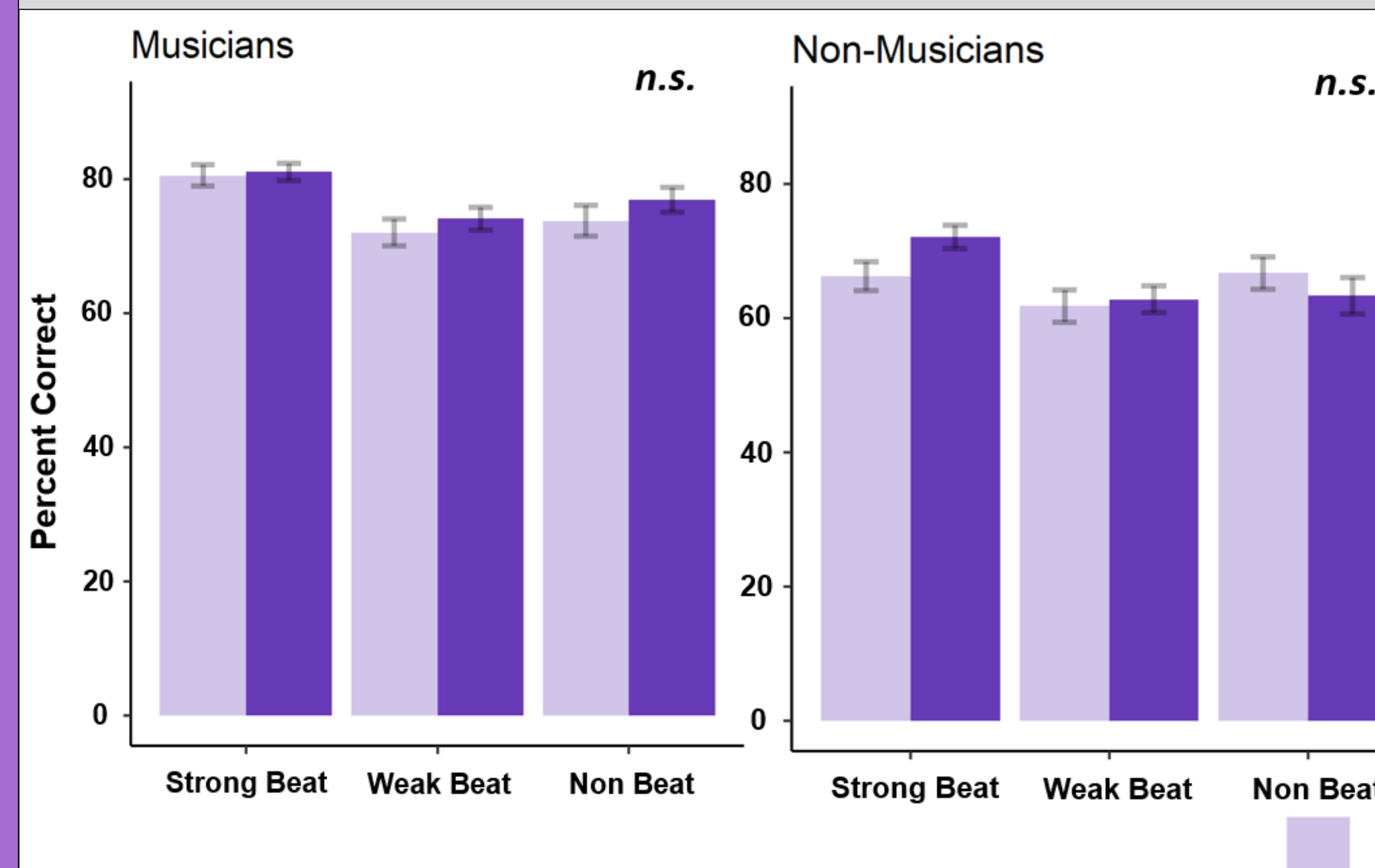


Results

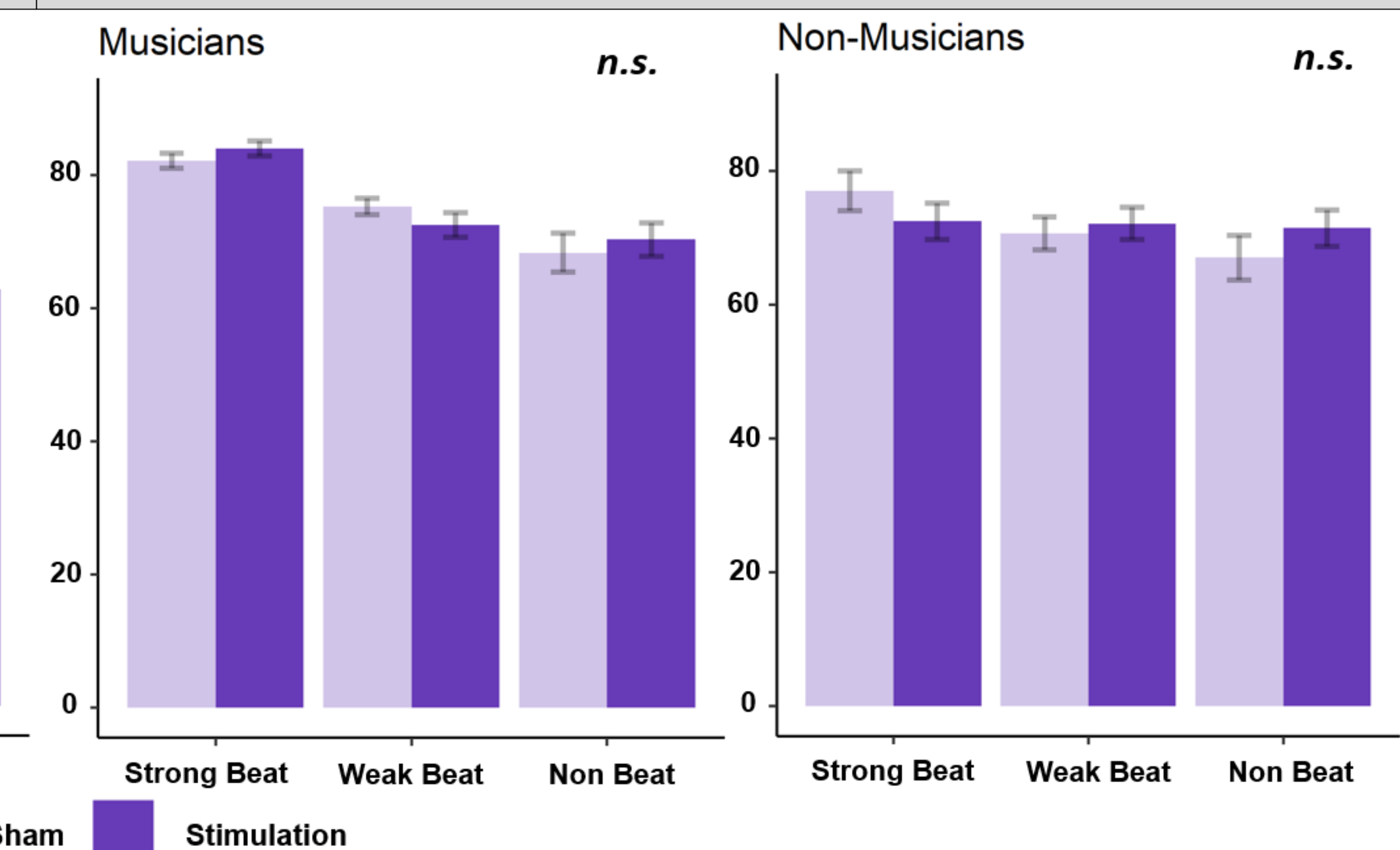
Beat Reproduction: Strong beat rhythms were reproduced more accurately



Anodal Stimulation: no significant difference



Cathodal Stimulation: no significant difference



Discussion

- As expected, stronger beat rhythms were better reproduced than weak/non-beat rhythms
- Although non-significant, musicians had a tendency of better performance than non-musicians
- Against our predictions, SMA stimulation showed no effect on the rhythm reproduction
- **Limitations:**
 - Small sample size
 - Lack of counterbalancing in sham and stimulation sessions
 - Lack of a motor control test
 - Lack of another motor area being stimulated for control
- **Future Directions:**
 - Recruit more participants
 - 2 days of experiment: counterbalancing sham and stimulation sessions
 - Have a motor control test
 - Test other brain areas, such as the premotor cortex or cerebellum

References

- [1] Essens, P.J. & Povel, D.J. (1985) Metrical and nonmetrical representations of temporal patterns. *Percept Psychophys*, 37, 1-7.
- [2] Grahn, J. A., & Brett, M. (2007). Rhythm and beat perception in motor areas of the brain. *Journal of Cognitive Neuroscience*, 19 (5), 893–906.
- [3] Chen, J. L., Penhune, V. B., & Zatorre, R. J. (2008). Listening to musical rhythms recruits motor regions of the brain. *Cerebral cortex*, 18(12), 2844-2854.

Acknowledgments

