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Average behavioural performance

P-value 0.78514

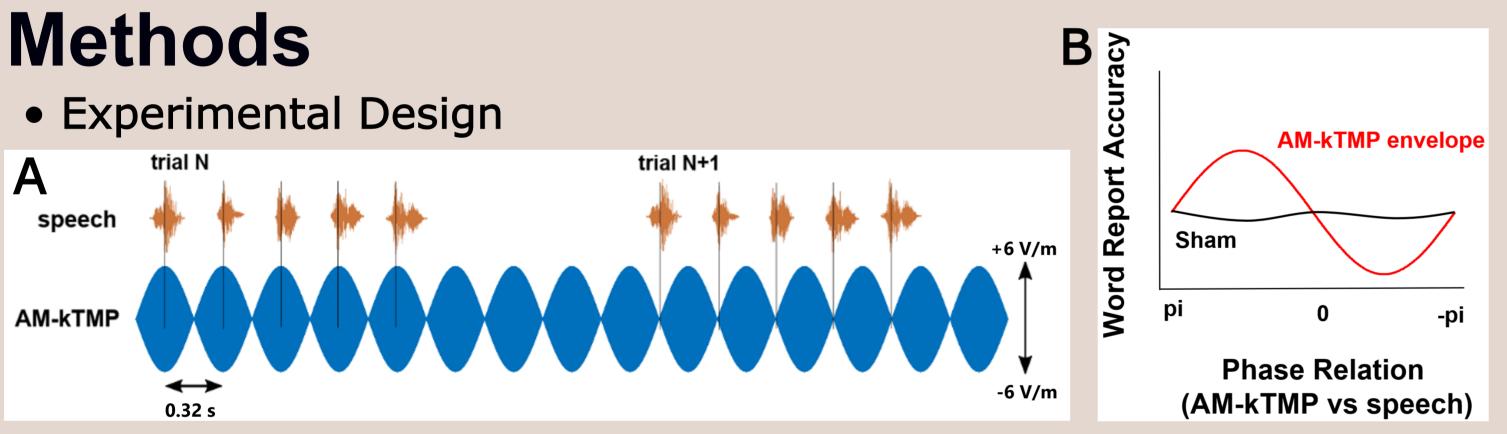
Entrainment of neural activity underlying speech perception with amplitude-modulated kilohertz magnetic perturbation (AM-kTMP)

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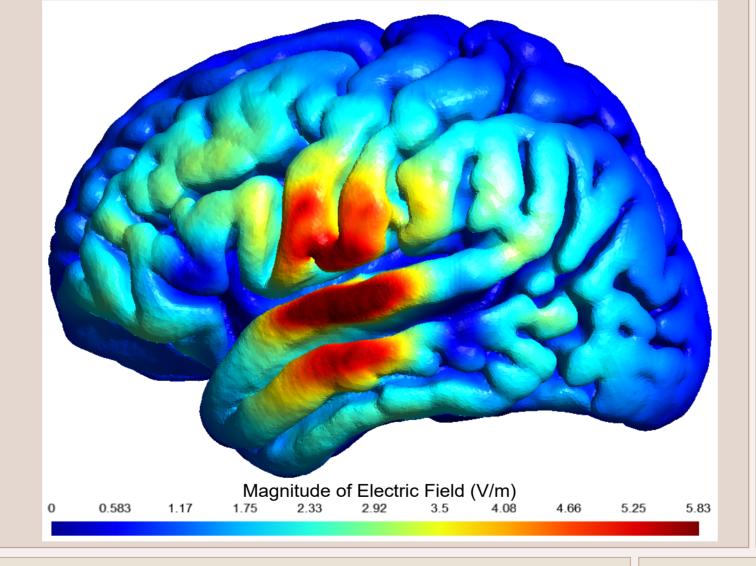
Background

- Previous studies have used transcranial alternating current stimulation (tACS) to modulate neural oscillations entrained to speech rhythms, demonstrating their causal role in speech perception. 1
- During tACS, most of the current is shunted by the skin, leading to weak neural stimulation. Transcranial magnetic stimulation (TMS) produces stronger effects, but is restricted to a pulse waveform and produces strong auditory and somatosensory co-stimulation. 2,3
- We used an amplitude-modulated (AM) version of kilohertz Transcranial Magnetic Perturbation (kTMP), a novel form of magnetic stimulation with flexible waveforms and reduced somatosensory co-stimulation.
- We tested whether AM-kTMP entrains neural activity by presenting sequences of rhythmic speech at different phase relations to AM-kTMP, applied simultaneously at 3.125 Hz.



- Participants reported the middle three out of a stream of five words. Presented words in each trial are at one out of eight different phases of AMkTMP (Fig 1 A)
- We expected a sinusoidal relationship between word report accuracy and the phase relation between AM-kTMP and speech, and no such relationship in a sham condition. (Fig 1B)
- We quantified this relationship in a regression model predicting word report accuracy from AM-kTMP phase (outcome shown in Fig. 6).

Figure 2. We targeted the left Superior **Temporal Gyrus (STG)** with AM-kTMP. This figure shows the magnitude of the electric field induced at the cortical surface.



Results

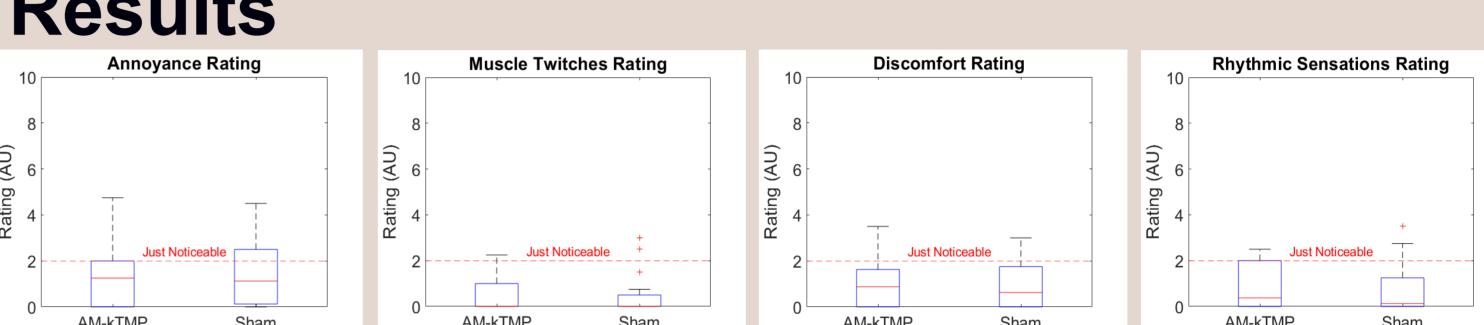
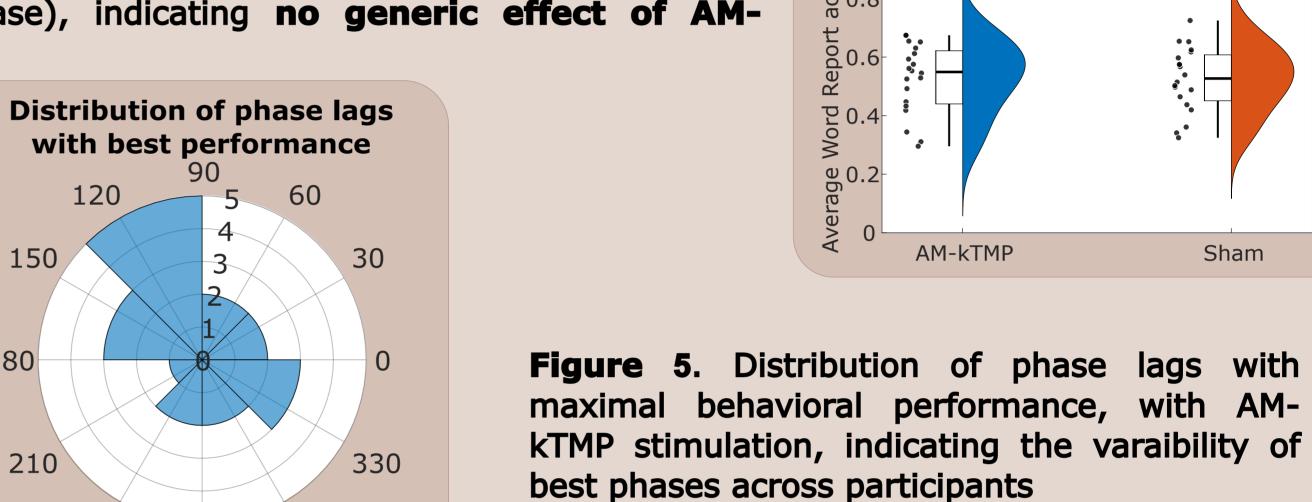
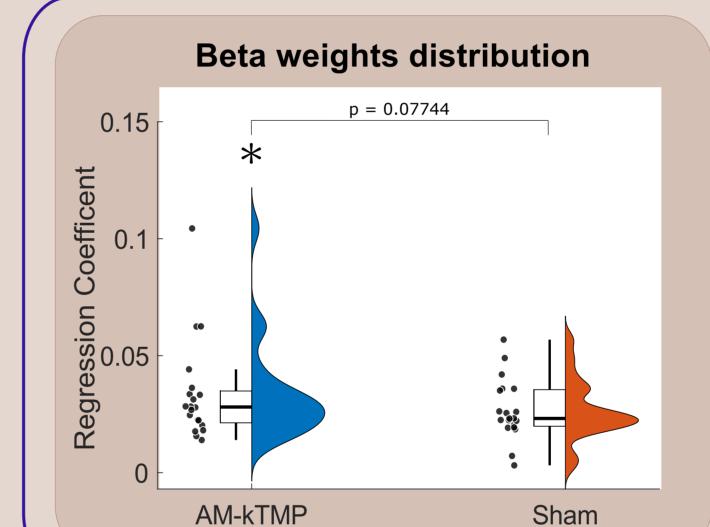


Figure 3. Perceived sensations for each condition. AM-kTMP and Sham stimulation did not reliably differ in any category of sensations that the participants were asked to rate.

Figure 4. Average Behavioural Performance across conditions. AM-kTMP and sham stimulation did not differ in their average report accuracy (independent of phase), indicating no generic effect of AMkTMP.

300



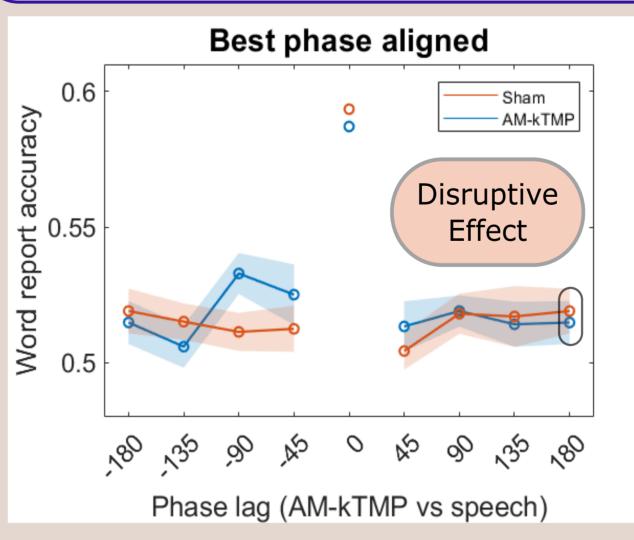


270

240

Main Results

Figure 6. Regression coefficients from the sinusoidal fit. The phase of presentation significantly predicted the word accuracy in the AM-kTMP condition but not in the Sham condition.



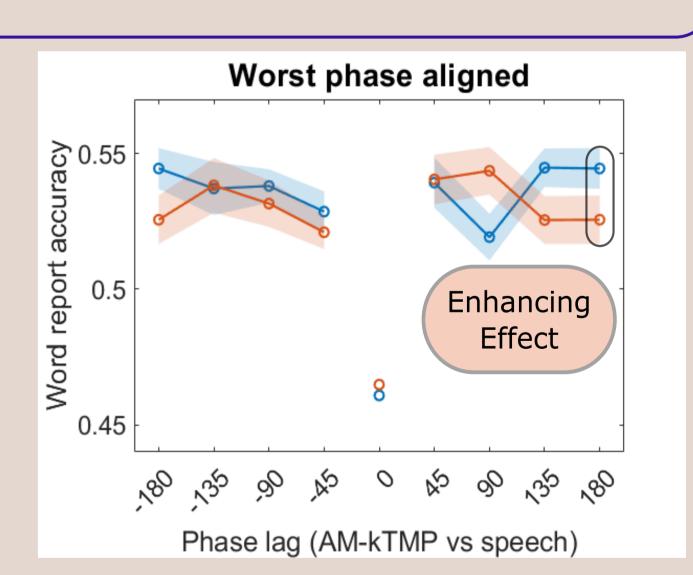


Figure 7. Relationship between Word Report Accuracy and Aligned Phase Lags. The phase lags are aligned based on the behavioural performance (best or worst). A decrease (increase) in accuracy, relative to sham, at the bin opposite to the aligned best (worst) phase is used as an indicator of disrupted (enhanced) speech perception. We found that disruptive and enhancing effects do not differ from each other in their magnitude.

Summary

- The phase relation between AM-kTMP and speech modulated indicating word report accuracy, entrainment of neural activity underlying speech perception.
- While the effect sizes observed are comparable to tACS, improvements to the experimental protocol (e.g. individualised, longer stimulation) will likely lead to stronger effects.

References

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Conflict of Interest

The authors declare the following competing interests: LL, CM, RBI and DS have stock ownership of Magnetic Tides, a non-publicly traded company created to develop new methods of non-invasive brain stimulation. UC Berkeley holds the patent rights related to the kTMP technology and has provided Magnetic Tides with an exclusive licensing agreement.

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