

Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our [Editorial Policies](#) [Editorial Policy Checklist](#)

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a Confirmed

- | | | |
|-------------------------------------|-------------------------------------|--|
| ☐ | ☒ | The exact sample size (n |
| ☐ | ☒ | A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly |
| ☒ | ☐ | The statistical test(s) used AND whether they are one- or two-sided
Only common tests should be described solely by name; describe more complex techniques in the Methods section. |
| ☒ | ☐ | A description of all covariates tested |
| ☐ | ☒ | A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons |
| ☐ | ☒ | A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals) |
| ☒ | ☐ | For null hypothesis testing, the test statistic (e.g. F , t , r , P , χ^2 , ...) with <i>con</i> Give <i>P</i> values as exact values whenever suitable. |
| ☒ | ☐ | For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings |
| ☒ | ☐ | For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes |
| ☒ | ☐ | Estimates of effect sizes (e.g. Cohen's d , r) |

Our web collection on [statistics for biologists](#)

Software and code

Policy information about [availability of computer code](#)

Data collection

Characterization data of the metamaterial was processed in Matlab 2021a. An arduino was used to take an input trigger signal to control magnetic field drivers. All in vivo EMG data was taken through a dual amplifier AD Systems DAQ. The initial data processing was done through LabChart 8 and then processed in Matlab R2021a.

Data analysis

Data was analyzed with custom written scripts in Matlab 2021a.

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio [guidelines for submitting code & software](#)

Data

Policy information about [availability of data](#)

All manuscripts must include a [data availability statement](#)

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our [policy](#)

All relevant data supporting the results of this study are presented in the manuscript or the Supplementary Information. Raw data are available at <https://osf.io/yr78v/>

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☒ Life sciences ☐ Behavioural & social sciences ☐ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Life sciences study design

All studies must disclose on these points even when the disclosure is negative.

Sample size	For the in vivo experiments, four different rats were used and stimulation confirmed in all animals at the varying frequencies reported within the manuscript. Successful stimulation by the metamaterial was confirmed through visual observation of leg kicks as well as measured EMG signals. For both in vivo trials, no statistical methods were used to pre-determine sample sizes nor randomization methods used but our sample sizes are similar to those reported in previous publications (Prominski et al. Nature Materials 2022)
Data exclusions	No data was excluded from the analysis.
Replication	Experimental results of successful neuronal activation was replicated in all animals with successful stimulation trials at least three times. The experiment bridging a severed nerve was shown in one rat and was readily replicated within the same animal up to at least three times. All nerve stimulation trials in rats were done across 6 rats.
Randomization	Randomization was not relevant for this study where successful stimulation of neuronal activation was demonstrated with EMG recordings. Controls such as off resonant stimulation were used to show effect of the MNM thus randomization was not needed.
Blinding	Blinding was not used in this study because relevant controls were designed such as nonresonant stimulation to show effect of the MNM.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☐	☒ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☐	☒ Animals and other organisms
☒	☐ Human research participants
☒	☐ Clinical data
☒	☐ Dual use research of concern

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Eukaryotic cell lines

Policy information about [cell lines](#)

Cell line source(s)	HEK293T obtained from ATCC
Authentication	Certified by ATCC (CRL-3216)
Mycoplasma contamination	Cells were not tested for Mycoplasma
Commonly misidentified lines (See ICLAC)	n/a

Animals and other organisms

Policy information about [studies involving animals](#) [ARRIVE guidelines](#)

Laboratory animals	Adult (2-5 months) male Long Evans rats were used sourced from Charles Rivers. (300-400g)
Wild animals	No wild animals were used in this study.

Field-collected samples

No field-collected samples were used in this study.

Ethics oversight

All in vivo experiments were performed in accordance with the rules of the IACUC at Rice University. All procedures carried out in this research complied with the National Institutes of Health standards and were approved by the Animal Care and Use Committee of Rice University (Protocol #IACUC-20-181).

Note that full information on the approval of the study protocol must also be provided in the manuscript.