SUPPLEMENTARY INFORMATION

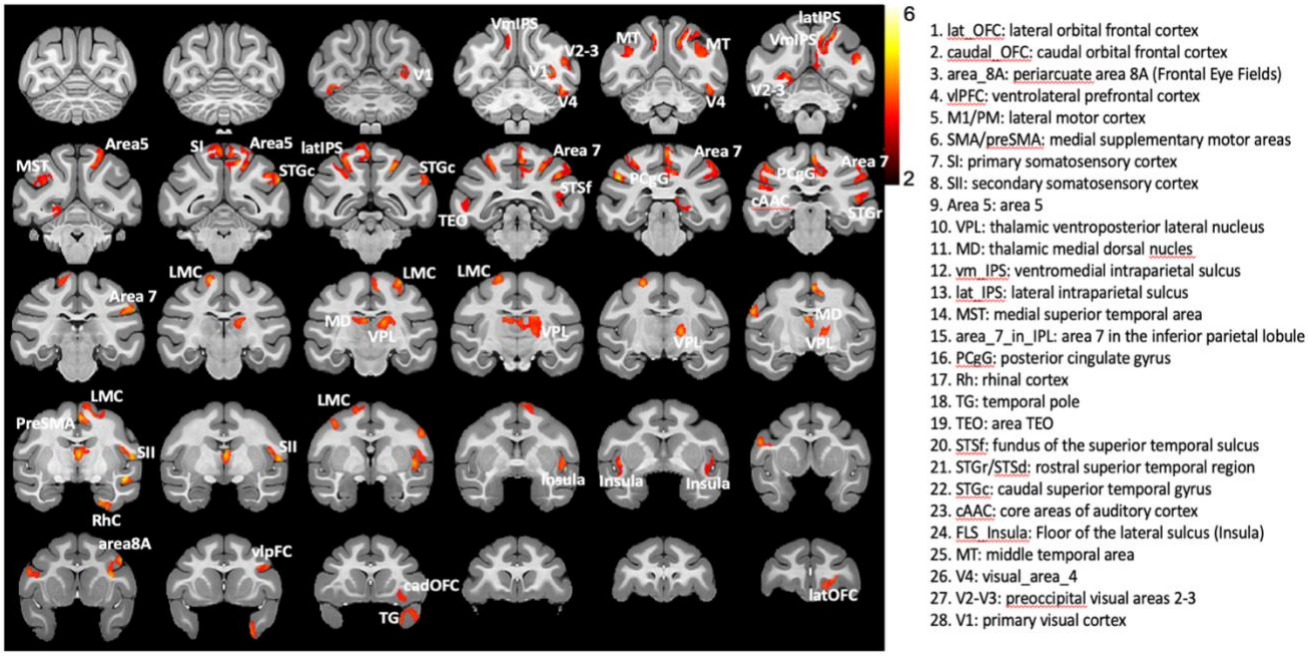


Figure S1. Whole brain fMRI activation map during FUS stimulation of the left thalamic VPL nucleus overlaid on macaque brain atlas, related to Figure 1. (Left) Coronal plane thresholded (at t>2) fMRI BOLD activation map overlaid on NMT v2 macaque brain atlas. (Right) The list of cortical areas showed robust activation. Data from 2 monkeys and 7 runs were quantified. The link to the macaque monkey NMT v2 atlas [1,2]: Download website: https://afni.nimh.nih.gov/pub/dist/doc/htmldoc/nonhuman/macaque_tempatl/template_nmtv2.html#download-symmetric-nmt-v2-datasets

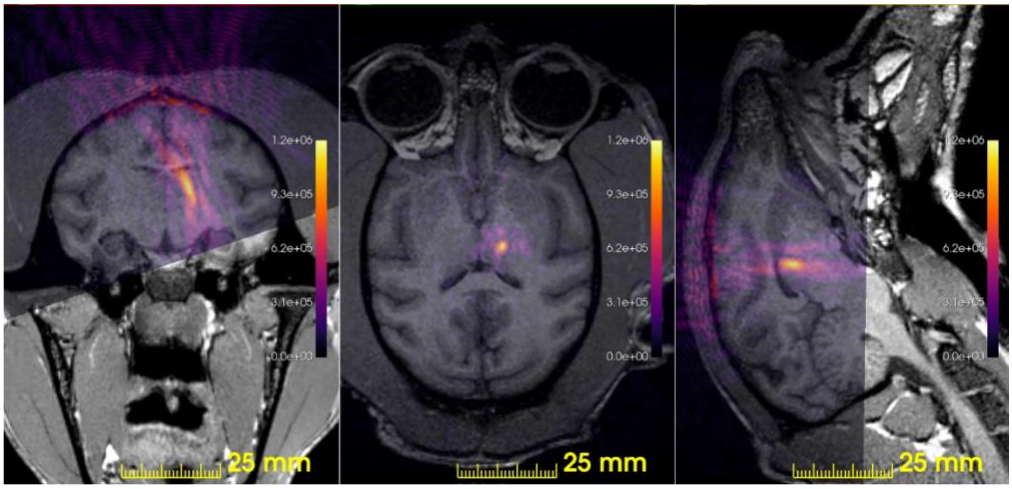
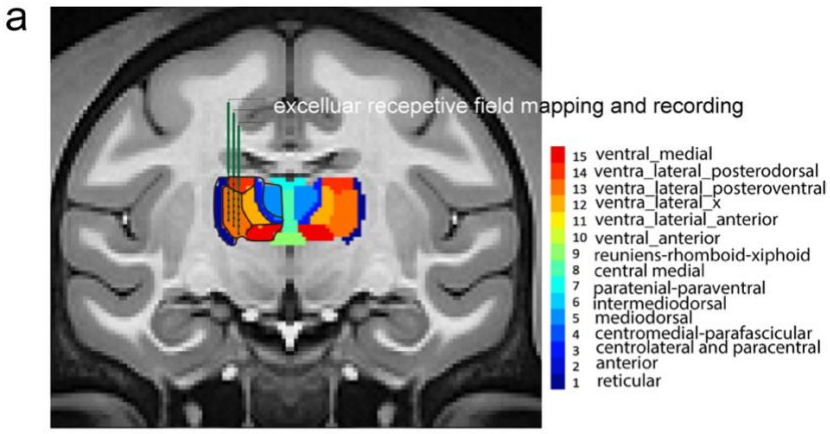


Figure S2. Full simulated acoustic pressure field overlay on anatomical MR for subject 1, related to Figure 1. Input amplitude was set associated with the free-field pressure of 2.69MPa. Simulation found that the in vivo peak pressure at the focus accounting for skull effects was 1.23MPa.



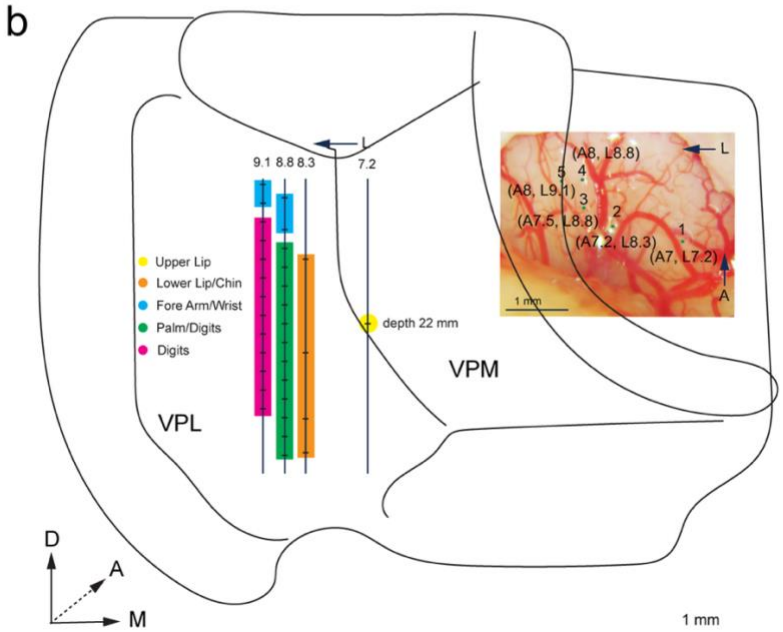


Figure S3. Electrophysiological map of the thalamic VPL region in one representative macaque monkey, related to Figure 2. (a) Schematic illustrations of the placements of multiple microelectrode penetrations into the VPL nucleus according to its stereotactic coordinates on the macaque brain MRI atlas. The thalamus nuclei map was derived from the NMT v2 atlas [1,2]. (b) Reconstructed somatotopic maps overlaid on the outline of the coronal plane of the MRI atlas image shown in a. The hand/digit regions are marked by magenta and green penetrations within the VPL nucleus outline. Electrode penetration tracts and the corresponding neuronal receptive field properties along the penetration depth are displayed within the VPL nucleus outline. The depth (22 mm) and lateral stereotaxic coordinates for each penetration are labeled as 7.2, 8.3, 8.8, and 9.1. The insert shows the penetration numbers (1-5) and their respective anterior (A) and lateral (L) coordinates on an image of the brain surface.

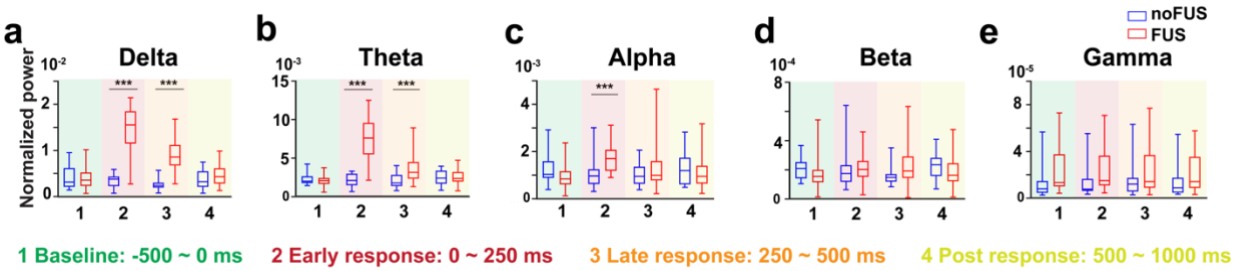


Figure S4. **The time-frequency features of FUS responses, related to Figure 3.** (a-e) Comparison of percentage power changes of LFP across five frequency bands between FUS (red boxes) and NoFUS control (blue boxes) conditions. In the FUS condition, 500-millisecond FUS stimulation was delivered to the right thalamus. The center line of box indicates the median, and the bounds of the box indicate the 25th and 75th percentiles, and the whiskers indicate the minimum and maximum values. Statistical comparisons were performed on run-level data using a two-tailed Mann-Whitney test. A total of 41 FUS and 15 NoFUS control runs are included in the quantification. ***, p<0.001.

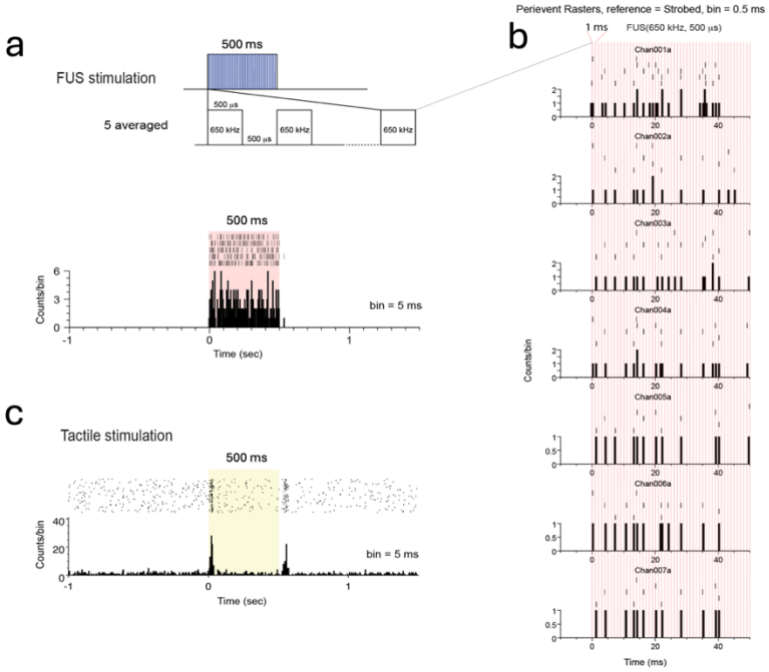


Figure S5. Temporal relationship between FUS pulses and spikes, related to Figure 5. (a) Display of the temporal features of the FUS pulse parameters (top) and one PSTH plot of spiking activity averaged over five stimulation trials (bottom). The pink background indicates the 500-ms FUS stimulation duration. **(b)** Zoomed-in views of 7 selected channels showing the temporal relationships between FUS pulses (red line) and isolated spikes as scatter plots (top: short black sticks) and PSTH (bottom: long black sticks). The FUS was delivered with a targeted *in vivo* pressure of 1.00 MPa. **(c)** Raster plot and PSTH of the tactile-responsive neurons (30 trials).

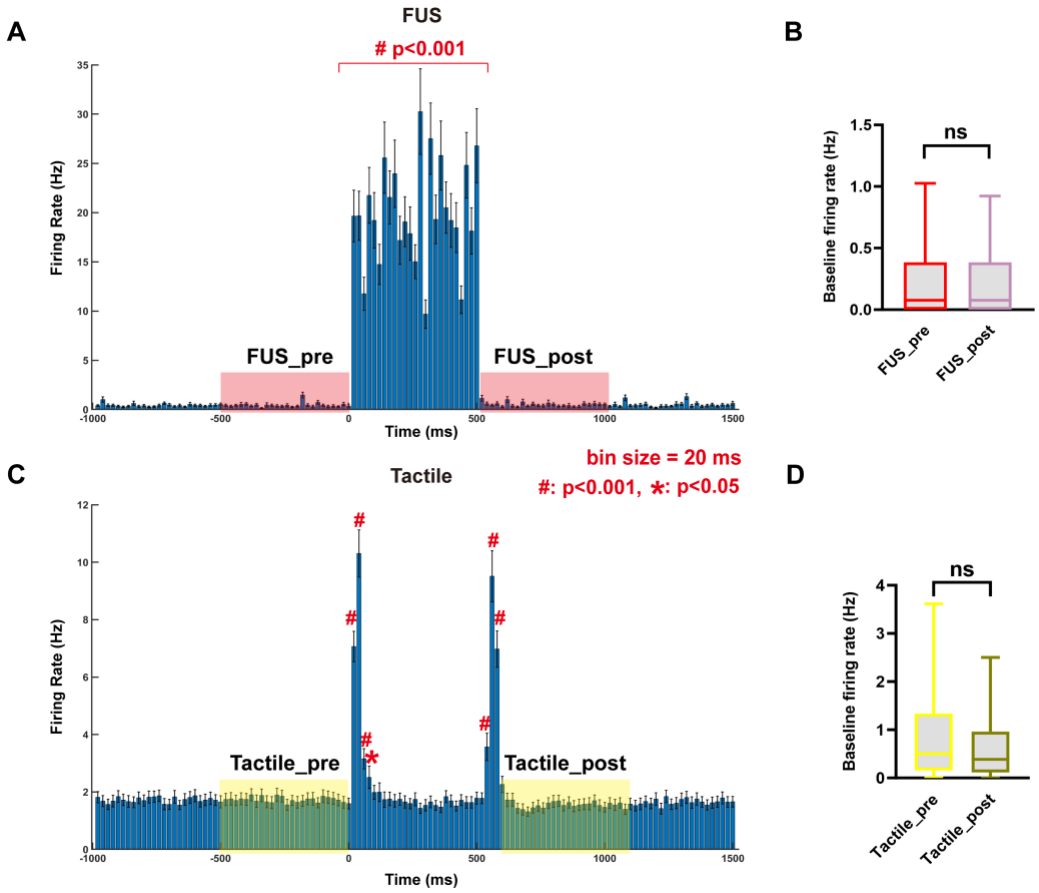


Figure S6. Lasting effects of FUS and tactile stimulation on baseline spiking activity, related to Figure 5. PSTH plots of spiking firing activity during stimulation (FUS and tactile) and baseline periods pre- and post-stimulation (A & C). Spiking activity significantly increased during stimulation. There is no statistical difference between pre- and post-stimulation (pick background periods in A and C) for both FUS (B) and tactile stimulation (D). The center line of box indicates the median, and the bounds of the box indicate the 25th and 75th percentiles, and the whiskers indicate the minimum and maximum values. Statistical comparisons were performed on run-level data using a two-tailed Mann-Whitney test. A total of 102 FUS-responsive and 227 tactile-responsive units were included in the quantification.

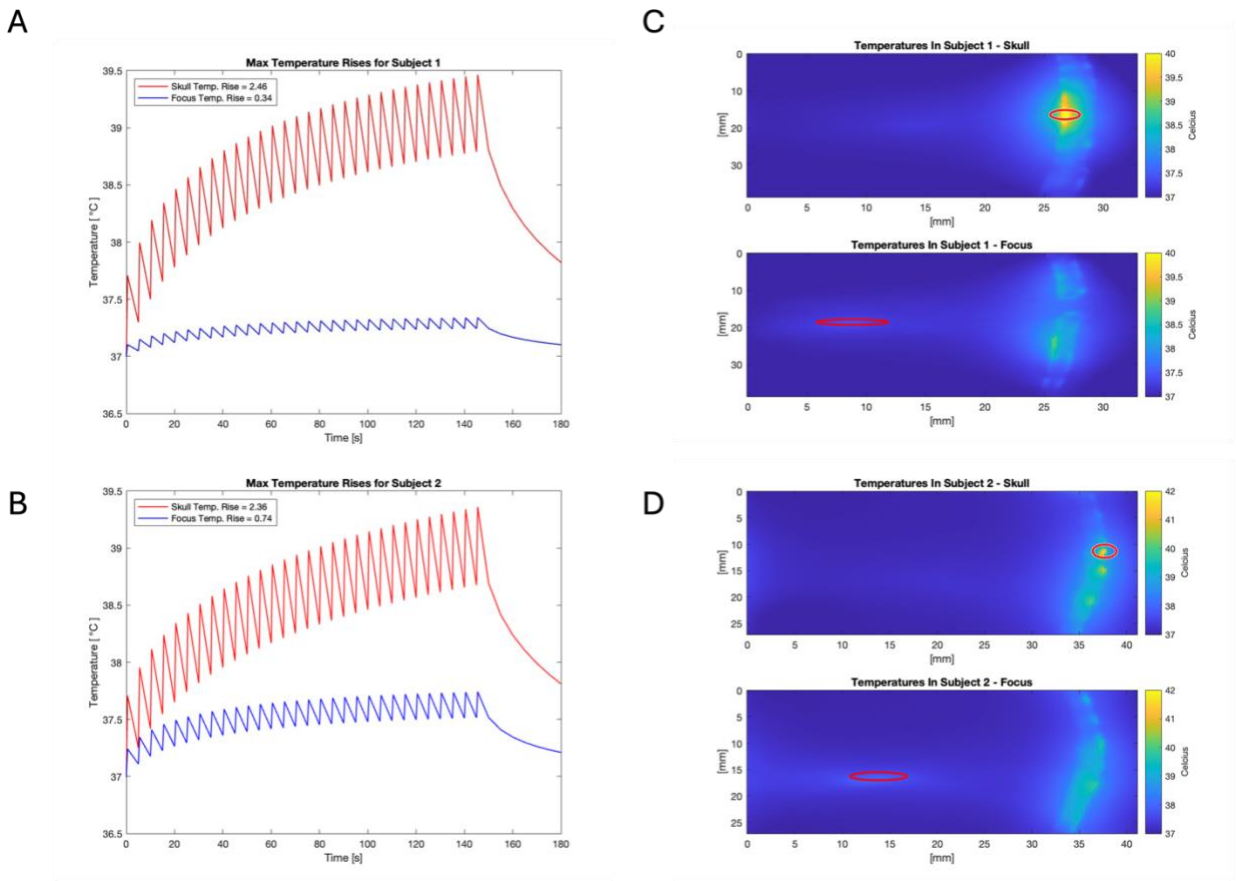


Figure S7. Temperature Simulations, related to Figure 1. Simulations for two different subjects (A&B) showed a maximum temperature rise of 2.5°C and 2.4°C, respectively, in the skull, while the brain temperature increased by 0.3-0.7 °C. Temperature maps show the 2D distribution of temperature for both subjects (C&D), with circles and ellipsoids outlining the locations of maximum and focal temperature.

Table S1. Transducer and Drive System Parameters

Column1	Manufacturer	Model Number	Center Frequency	Radius of Curvature	Diameter	Number of Elements	Element Distribution
Transducer	Imasonic	Custom Design	650kHz	72mm	103mm	128	randomized array of 6.6mm elements on a spherical surface
Matching	Custom Design with Image Guided Therapy						
Integrated Driver System	Image Guided Therapy						

Table S2. Pulse Timing Parameters During Experiments

	Duration	Ramp Duration	Ramp Shape	Repitition Interval
Pulse	500µs	50 µs	Linear	1ms
Pulse train	500ms	/	/	5s
Pulse train Repeat	100s to 250s	/	/	Minimum of 30s resting time

Table S3. Free Field Pressure Parameters

Subject number	PsP (Mpa)	MI	Steering Coordinates [X, Y, Z] (mm)	Axial Position of Psp [X, Y, Z] (mm)	Centroid of -3dB pressure region [X, Y, Z] (mm)	Axial Focus Size -3dB (mm)	Lateral Focus Size -3dB (mm)	Axial Focus Size -6dB (mm)	Lateral Focus Size -6dB (mm)
1	2.69	3.34	[0, 0, 0]	[0, 0, 0.25]	[-0.01, 0.01, 0.05]	6.17	1.59	8.70	2.16
2	3.72	4.61	[0, 0, 0]	[0, 0, 0.25]	[-0.01, 0.01, 0.05]	6.17	1.59	8.70	2.16

Table S4 Estimated Transcranial Pressure Parameters Based on Simulations

Subject number	PsP (Mpa)	MI	Steering Coordinates [X, Y, Z] (mm)	Axial Position of Psp [X, Y, Z] (mm)	Centroid of -3dB pressure region [X, Y, Z] (mm)	Axial Focus Size -3dB (mm)	Lateral Focus Size -3dB (mm)	Axial Focus Size -6dB (mm)	Lateral Focus Size -6dB (mm)
1	1.23	1.53	[0, 0, 0]	[-0.5, 0.25, -2]	[-0.61, 0.26, -1.52]	7.12	1.98	12.63	2.85
2	2.00	2.48	[0, 0, 0]	[0, 0, -1]	[-0.10, 0.00, -0.88]	6.35	1.67	10.76	2.61

Table S5. Parameters Used for Thermal Simulations

Parameter	Medium	Value	Units
Thermal			
Specific Heat	Skull	1700	[J/(kg*K)]
Specific Heat	Water	3600	[J/(kg*K)]
Thermal Conductivity	Skull	0.3	[W/(m*k)]
Thermal Conductivity	Water	0.5	[W/(m*k)]
Perfusion			
Density	Tissue	1030	[kg/m^3]
Specific Heat	Tissue	3617	[J/(kg*K)]
Perfusion Rate	Tissue	0.008	[1/s]
Ambient Temperature	Tissue	37	[°C]

References

[1] Jung B, Taylor PA, Seidlitz PA, Sponheim C, Glen DR, Messinger A (2021). “A Comprehensive Macaque FMRI Pipeline and Hierarchical Atlas.” NeuroImage, July 15:235:117997. https://pubmed.ncbi.nlm.nih.gov/33789138/. doi: 10.1016/j.neuroimage.2021.117997.

[2] Seidlitz J, Sponheim C, Glen DR, Ye FQ, Saleem KS, Leopold DA, Ungerleider L, Messinger A (2018). A Population MRI Brain Template and Analysis Tools for the Macaque.” NeuroImage 170: 121–131. https://doi.org/10.1016/j.neuroimage.2017.04.063. PMID: 28461058