Supporting Information

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SI Text 1

According to our measured range of peak magnetic field strength (0.2–0.5 T at a distance of $\sim\!\!15$ mm from the coil), the peak induced electric field would be $55\!-\!130~{\rm V}\!\cdot\!{\rm m}^{-1}$ in the human brain (1). Importantly, measurements in spherical models of different sizes demonstrated decreasing electric field strength with decreasing brain sizes (2). In this study (2), using a circular coil with similar properties to the one used here, the authors have shown that the electric field strength in a brain of the size of a cat was $\sim\!\!30\!-\!50~{\rm V}\!\cdot\!{\rm m}^{-1}$ lower compared with the human brain size (compare their figure 1). Thus, under the given constraints of a sphere, we induced an electric field of 25–80 ${\rm V}\!\cdot\!{\rm m}^{-1}$.

Electric fields at 60% Magstim Rapid² output, corresponding to 900 V capacitor voltage (3), were also found to induce motor evoked potentials when transcranial magnetic stimulation (TMS) was applied to cat motor cortex (4).

SI Text 2

To account for variation in signal-to-noise ratio across the image frames and to preserve units (in $\Delta F/F$) across spatial averages,

1. Hovey C, Jalinous R (2006) *The Guide to Magnetic Stimulation* (The Magstim Company, Whitland, UK).

 Weissman JD, Epstein CM, Davey KR (1992) Magnetic brain stimulation and brain size: Relevance to animal studies. Electroencephalogr Clin Neurophysiol 85(3):215–219. TMS-induced activity was calculated for each pixel of the region of interest (ROI) as

$$R_i^c = \frac{R_i}{m \cdot std(B_i)} \sum_{i=1}^m std(B_i),$$

where R_i is relative signal of fluorescence in the *i*th pixel of the TMS condition (mean across trials), m is the number of pixels within the ROI, and $std(B_i)$ is the SD of the relative signal in the *i*th pixel of the blank condition (first blank subtracted by the mean of the first two blanks) calculated across f = 100 frames:

$$std(B_i) = \sqrt{\frac{1}{99} \cdot \sum_{f=1}^{100} \left(B_f - \overline{B_i} \right)^2}.$$

Finally, a low-pass Gaussian filter with $\sigma = 250 \ \mu m$ was used for spatial smoothing of the activation distributions.

- The Magstim Company, Ltd. (2011) MAGSTIM RAPID² PIN MOP03-EN-01 Operating Manual (The Magstim Company, Whitland, UK).
- Fujiki M, Isono M, Hori S (1990) Spinal and muscle motor evoked potentials following magnetic stimulation in cats. Neurol Med Chir 30(4):234–241.

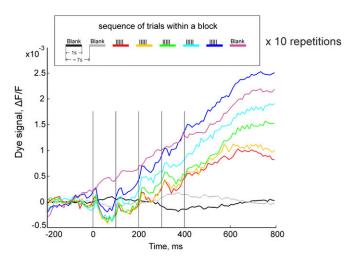


Fig. S1. Seconds to minutes buildup of TMS-induced excitatory cortical state upon 10 Hz repetitive TMS (rTMS). Data shown in Fig. 1D were averaged separately for each consecutive trial (different colors) and across 10 block repetitions (one experiment). Vertical lines depict time of TMS pulses. Data were normalized to the first two blanks. Note that induced cortical activity increased with every trial (interstimulus time ~7 s). The last blank (final trial without TMS pulses) showed monotonous increase of spontaneous activity reaching levels comparable to the preceding TMS-induced activity.

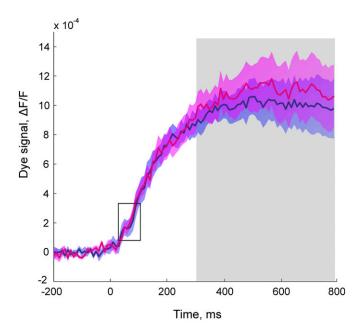


Fig. S2. Sham control. To rule out unspecific effects related to the relatively long experimental session, potential influences due to vibration, or auditory stimulation, we performed a sham control, in which we positioned the coil at a 45° angle, 10 cm away from the head of the animal, under otherwise identical experimental conditions. At this distance, the measured magnetic field was negligible (~12 mT) and, consequently, no TMS-evoked cortical activity could be detected. The traces show spatially averaged activity in response to moving gratings (compare Fig. 4). Blue curve depicts mean (color shadings show SEM) measured from 2 h to 30 min before sham, pink curve represents activity after 25 min of 10 Hz TMS sham (imaged 60–90 min postsham, thus during the time window where the strongest real 10-Hz TMS effects were observed; compare Fig. 3). For both conditions, 13 trials each comprising four grating orientations (with two motion directions) were averaged. Note the similarity in time courses during the rising phase of the responses. The deceleration—acceleration (DA) notch was still present after sham stimulation (rectangle). This result was in strong contrast to real 10 Hz TMS; compare blue and pink curves in Fig. 4. Also amplitudes during the late phase (gray area, 300–800 ms after visual stimulus onset) of the response remained unchanged (P > 0.67, two-tailed t test).

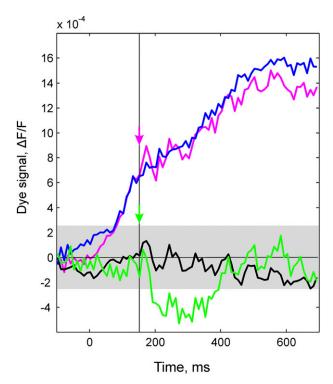
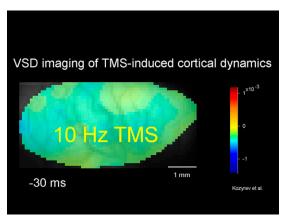


Fig. S3. Single TMS pulse combined with visual stimulation. In a control experiment, we used voltage-sensitive dye (VSD) imaging to measure visual cortical responses to moving gratings (blue) and a single TMS pulse (green curve, green arrow marks time of TMS pulse; compare Figs. 1D and 2A) alone and both simultaneously (purple). Traces depict spatial averages across image frames; seven trials were averaged, and the gratings were presented at two orientations (with two directions; *Materials and Methods*). Gray area spans average noise level, ±2 SD, derived from blank conditions. Note that the TMS pulse (vertical line and purple arrow) was given 152 ms after onset of the visual stimulus (0 ms), during the rising epoch of visual responses and after the DA notch. Under the assumption that suppression after a single TMS pulse reflects non-voltage-related signals, the combination of TMS and visual input should result in super-imposed signals. This was, however, not the case (black curve plots difference between blue and purple traces), making contamination of the VSD signal by intrinsic or other, perhaps unknown, biophysical sources unlikely. On the contrary, note that the TMS pulse in this case only marginally suppressed visual responses (compare slowly declining black trace). This implies that inhibitory mechanisms triggered by a single TMS pulse might be less effective during periods in which the cortex is driven by strong visual input, similar to that found in cat TMS experiments using electrophysiological recordings (1).

1. Moliadze V, Zhao Y, Eysel U, Funke K (2003) Effect of transcranial magnetic stimulation on single-unit activity in the cat primary visual cortex. J Physiol 553(Pt 2):665-679.



Movie S1. TMS-induced cortical dynamics as shown in Fig. 1 are displayed with sound. Each TMS pulse can be heard as a click, reflecting the coil's magnetic charge reversal.

Movie S1