Supplementary information on methods

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Model of stochastic conductances

Background synaptic noise was simulated by stochastic conductances, as outlined in the Methods section of the manuscript. The total injected synaptic current I_{syn} was composed of two fluctuating conductances, excitatory $g_e(t)$, and inhibitory $g_i(t)$

$$I_{syn} = g_e(t)(V - E_e) + g_i(t)(V - E_i)$$

where E_e and E_i are the reversal potentials for excitatory and inhibitory conductances, respectively. Each synaptic conductance was described by a stochastic equation of the type

$$dg_x/dt = -1/\tau_x (g_x - g_{x0}) + \sqrt{(2\sigma_x^2/\tau_x)}\xi_x(t)$$

where g_x stands for either g_e or g_i, τ_x is the correlation time, σ_x^2 is the variance of the conductance and $\xi_x(t)$ is a Gaussian noise of zero mean and unit variance. These equations are identical to that derived in[27].

Note that this model describes excitatory and inhibitory conductance fluctuations as independent stochastic processes, which is equivalent to assume that the influence of the cortex on relay cells is a mixture of uncorrelated EPSPs and IPSPs. This seems to contrast with the fact that corticothalamic feedback activates in relay cells strong feedforward IPSPs[23], which would tend to correlate the direct cortical EPSPs and feedforward IPSPs. However, the latter are mediated by the bursts of thalamic reticular cells which are likely to be much reduced in activated states (see[49] and references therein). In addition, EPSPs and IPSPs result from different cortical presynaptic neurons through direct excitation and diffuse feedforward inhibition via the reticular nucleus and intrinsic interneurons, and these different populations are unlikely to be synchronized during activated states. Moreover, the reticular neurons also send inhibitory synapses to interneurons as well as within the reticular nucleus[23], which will also "blur" correlations. Thus, correlations are not likely to be large in activated states, and in the absence of experimental data, excitatory and inhibitory conductances were considered as uncorrelated.

The parameters τ_e = 2.7 ms and τ_i = 10.5 ms were adjusted to match the power spectrum of synaptic conductances resulting from thousands of randomly releasing synapses[27]. The mean and variance of conductances were adjusted to match the input resistance and membrane potential fluctuations observed *in vivo* (see text).

Data analysis

Programs for the acquisition and analysis of data were written using the in-house software ELPHY. Spike response curves were fitted using the following sigmoid function:

$$\text{spike probability} = b + (st - b)/(1 + \exp[-(x-h)/s]),$$

where *b* and *st* are, respectively, the minimal and maximal values of the sigmoid, *h* is the *x* value at half maximal *y* value and *s* is the slope factor. The slope of the sigmoid in *x* = *h* is given by

$$\text{slope (gain, total)} = (st - b)/(4 * s),$$

(expressed in nS^{-1}). For single-spike output curves, we calculated the slope at 0.5 probability (irrespectively of the value of *st*) which was then given by

$$\text{slope (gain, single)} = (1 - 2 * st) * (1 - 2 * b)/(4 * s) * (b - st)$$

During the stimulation, the membrane potential frequently hyperpolarized in the initial seconds of the protocol and remained stable for the rest of the recording. Except for the mean resting potential and input resistance values mentioned first in the results part, all analysis was performed on the stable stimulation period. To calculate the voltage mean and variability of a given trace, 10 - 50 ms periods preceding every stimulation were summed while omitting action potentials. The Gaussian function

$$y = amp * (\exp[-0.5 * ((x - mean)/SD)^2])$$

was then fitted to the resulting voltage distribution to extract the mean voltage (*mean*) and variance (*SD*). Bursts were defined and detected according to the following *interspike** interval (ISI) pattern: a large ISI (≥ 50 ms) followed by one or more small ISIs (≤ 6 ms)[35], except for Fig. 6 were only a high frequency criterion was used (ISI ≤ 5 ms). Note that this detection algorithm does not distinguish bursts due to intrinsic or extrinsic sources. The overlap (mixing) of multiple spike response curves, e.g. events with one (*A*) or two (or three, *B*) spikes, was calculated as

$$\%\ \text{overlap} = (\int(A) + \int(B)) - \int(A+B)/\int(A) + \int(B)$$

* Note that we have used the term "sISI" for "*interstimulus* interval", to disambiguate with "ISI", which usually stands for "*interspike* intervals".