Supporting Information

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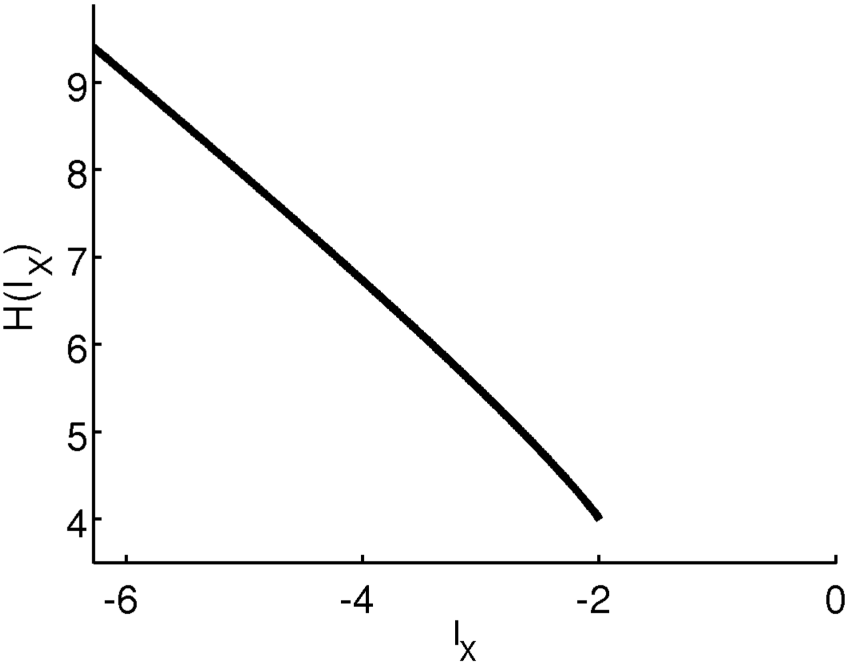

Fig. S1. Graphical representation of $H(I_X)$ in the equation for p_{cap} (Eq. **2**) with $f(I) = (1 + e^{-I})^{-1}$

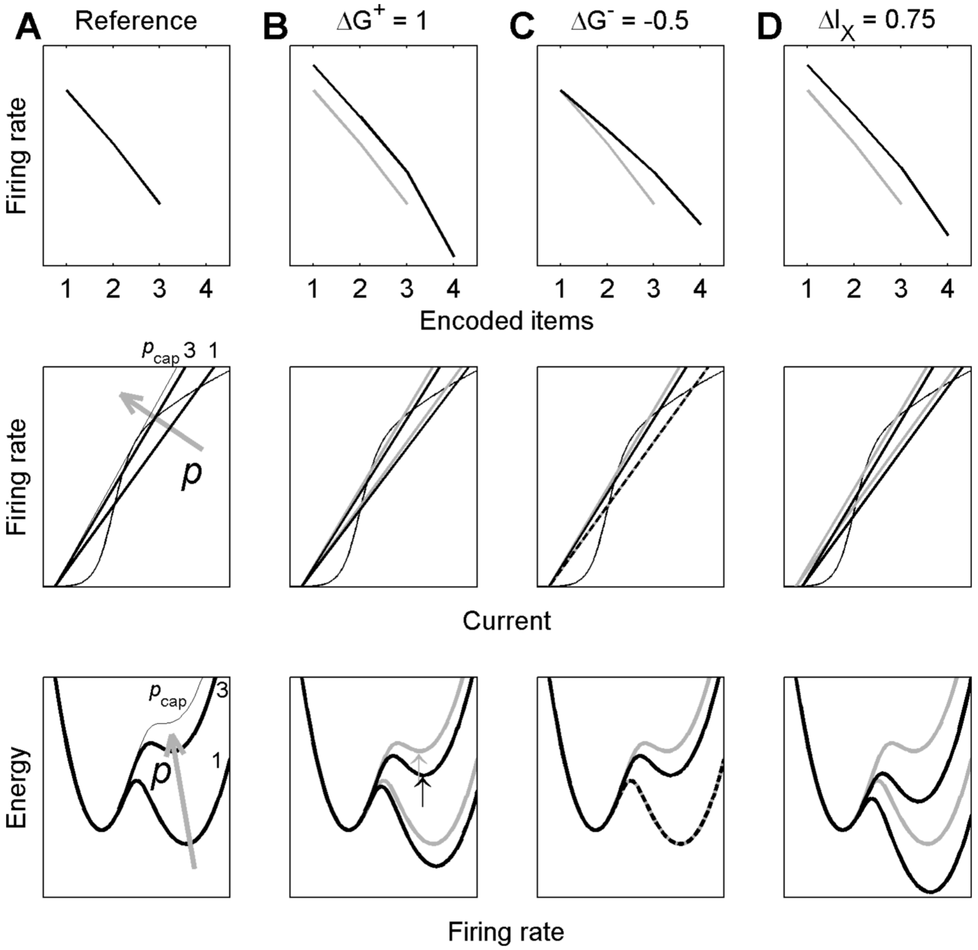

Fig. S2. Effect of changes in G^{+}, G^{-}, or I_X on memory capacity and persistent activity. Changes in parameters that lead to improved capacity generally increase network activity. (*Top*) Firing rate of memories at different loads. (*Middle*) Graphical solutions of the capacity equation for two different loads, $p = 1$ and 3. As p increases, the line representing the effective network synaptic strength shifts leftward. (*Bottom*) Potential energy landscape of the network at loads 1 and 3. Energy minima represent stable states. (*A*) Reference parameter set used in Fig. 2: $A = 0.1$, $G^{+} = 22$, $G^{-} = 2$, $I_X = -6.25$. When load equals capacity (thin line; here, $p_{cap} = 3.57$) the synaptic line is tangential to the neuronal-input output curve in the *Middle*. (*Bottom*) The energy minimum corresponding to the memory state disappears at capacity (thin line). (*B*) Increasing capacity from 3 to 4 by increasing G^{+} leads to increased persistent activity at the same load (arrows indicate memory activity at load $p = 3$). For comparison, the reference network is shown in gray. (*C*) Same for G^{-}. (*D*) Same for I_X. Generally, networks that have higher capacity caused by a change in a G^{+}, G^{-}, or I_X also have higher activity at the same load.

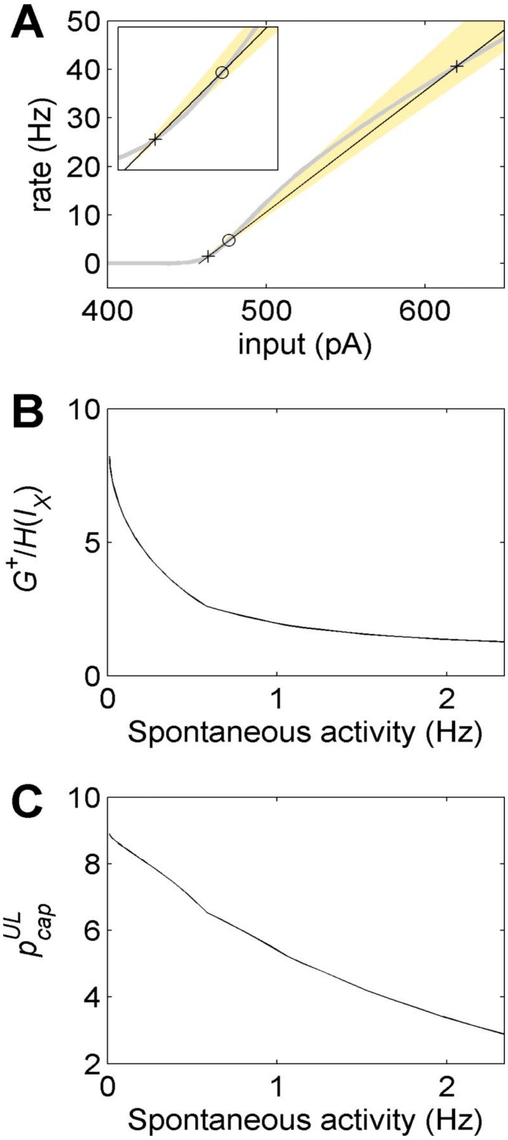

Fig. S3. Working memory capacity in a balanced network. (*A*) The network is stable when the line and the curve intersect in three places. For the value of I_X in the figure, the golden area represents the region of stable memory activity. The size of this area is determined by the ratio between G^+ and $H(I_X)$, which determines the right and left border of the area. (*B*) $G^+/H(I_X)$ is in turn determined by the spontaneous activity. For spontaneous rates above $\approx$1.5, $G^+/H(I_X) < 1.5$. (*C*) Having determined $G^+/H(I_X)$, Eqs. **3** and **S6** (see *SI Appendix*) can now be used to calculate $p_{\mathrm{cap}}^{\mathrm{UL}}$ for a given level of spontaneous activity. Note that although $p_{\mathrm{cap}}^{\mathrm{UL}}$ in Eqs. **3** and **s6** (see *SI Appendix*) is a continuous variable, only a discrete number of stimuli can be presented, making capacity an integer number. The following parameters were used. Standard deviation of input current, determining the linearity of the *f-I* curve: σ = 0.001. *w*: 0.1.

Table S1. Maxima in the conjunction analysis of fMRI activation in either M3–C3 or M5–C5 contrasts; group analysis

Location		Area*	BA†	MNI coordinates	t statistic	Cluster size
Superior parietal lobule	R		7	16, −74, 52	6.69	12,494[I]
	L		7	−14, −70, 52	4.93	12,494[I]
Middle occipital gyrus	L		17/18	−34, −88, 14	5.08	12,494[I]
	R	e	17/18	36, −90, 14	5.12	12,494[I]
Superior frontal gyrus (SFG)/	R	b	6	30, −4, 56	4.02	1,852[II]
Middle frontal gyrus	L		6	−24, −2, 58	3.24	372
Medial frontal gyrus (mSFG)	R	d	8/32	8, 18, 50	2.16	1,852[II]
Inferior frontal gyrus (IFG)	R	c	47	34, 20, 6	3.41	443
	L		47	−30, 22, −4	2.92	199
Middle frontal gyrus (dlPFC)	R	a	9/46	52, 34, 32	2.94	791[III]
	R	a	46	42, 44, 22	3.56	791[III]
	R	a	10/46	38, 54, 26	2.12	791[III]
	L		46	−46, 48, 14	3.01	144[IV]
	L		10/46	−32, 62, 8	1.94	144[IV]

Clusters identified testing the global null hypothesis of no activation in either M5–C5 or M3–C3 contrasts, with a threshold at $P = 0.05$ after correcting for multiple comparisons using the false-discovery rate procedure. Only clusters larger than 100 voxels are shown.

*Identification of areas tagged with lower-case letters in the brain illustration of Fig. 4*B*.

†Brodmann area (BA) estimation from Talairach Daemon Client v2.0 (http://ric.uthscsa.edu/resources) and xjView (http://people.hnl.bcm.tmc.edu/cuixu/xjView/). I, II, III, and IV indicate same activation cluster.

Table S2. Cell parameters

Parameter	E cells	I cells
N	1,024	256
C_m	0.5 nF	0.2 nF
g_L	25 nS	20 nS
E_L	−70 mV	−70 mV
V_{res}	−60 mV	−60 mV
V_{th}	−50 mV	−50 mV
τ_{ref}	2 ms	1 ms
r_X	1,800 Hz	1,800 Hz

N, number of cells; C_m, membrane capacitance; g_L, leak conductance; E_L, leak reversal potential; V_{res}, reset potential; V_{th}, spike threshold potential; τ_{ref}, refractory period time constant; r_X, rate of external afferents. For an explanation of these parameters and the equations they govern, see Compte A, Brunel N, Goldman-Rakic PS, Wang XJ (2000) Synaptic mechanisms and network dynamics underlying spatial working memory in a cortical network model. *Cereb Cortex* 10:910–923.

Table S3. Synaptic parameters

Parameter	AMPA	NMDA	GABA
τ_s	2 ms	100 ms	10 ms
α_s		0.5 ms^{-1}	
τ_x		2 ms	
V_{rev}	0 mV	0 mV	−70 mV

τ_s, decay time constant for *s*, the fraction of open channels; α_s, saturation constant; τ_x, rise time constant; V_{rev}, reversal potential. For an explanation of these parameters and the equations they govern, see Compte A, Brunel N, Goldman-Rakic PS, Wang XJ (2000) Synaptic mechanisms and network dynamics underlying spatial working memory in a cortical network model. *Cereb Cortex* 10:910–923.

Table S4. Connectivity

Parameter	IPS	dlPFC
	Connection strength *G*, nS	
E→E, AMPA	0.0	0.0
E→E, NMDA	0.684	0.968
E→I, AMPA	0.0	0.0
E→I, NMDA	0.479	0.723
I→E*	3.643	3.660
I→I	2.896	2.832
X→E†	→Table S5	3.000
X→I	5.800	2.3803
	Connection curve width σ, degrees	
E→E	9.4	
E→I	32.4	
I→E	32.4	
	Connection curve height J^{+}, unitless	
E→E	5.7	
E→I	1.4	
I→E	1.4	

For an explanation of the parameters and the equations they govern, see Compte A, Brunel N, Goldman-Rakic PS, Wang XJ (2000) Synaptic mechanisms and network dynamics underlying spatial working memory in a cortical network model. *Cereb Cortex* 10:910–923.

*Connections from I cells are always $GABA_A$R-mediated.

†X, external afferents.

Table S5. Parameters varied in simulations

Figure	$G_{X\rightarrow E}$, *nS*	dlPFC→IPS, nS	dlPFC rate, Hz
1*B*	6.6		
1 *C* and *D*	6.4, 6.45, 6.5		
1*E*	6.55–6.725		
3 *B* and *C*	6.525	9	
3*D*	6.525	0–15	
3*E*	6.525	6.525	0–95
3*F*	6.625–6.775		

For an explanation of these parameters and the equations they govern, see Compte A, Brunel N, Goldman-Rakic PS, Wang XJ (2000) Synaptic mechanisms and network dynamics underlying spatial working memory in a cortical network model. *Cereb Cortex* 10:910–923.

Other Supporting Information Files

SI Appendix