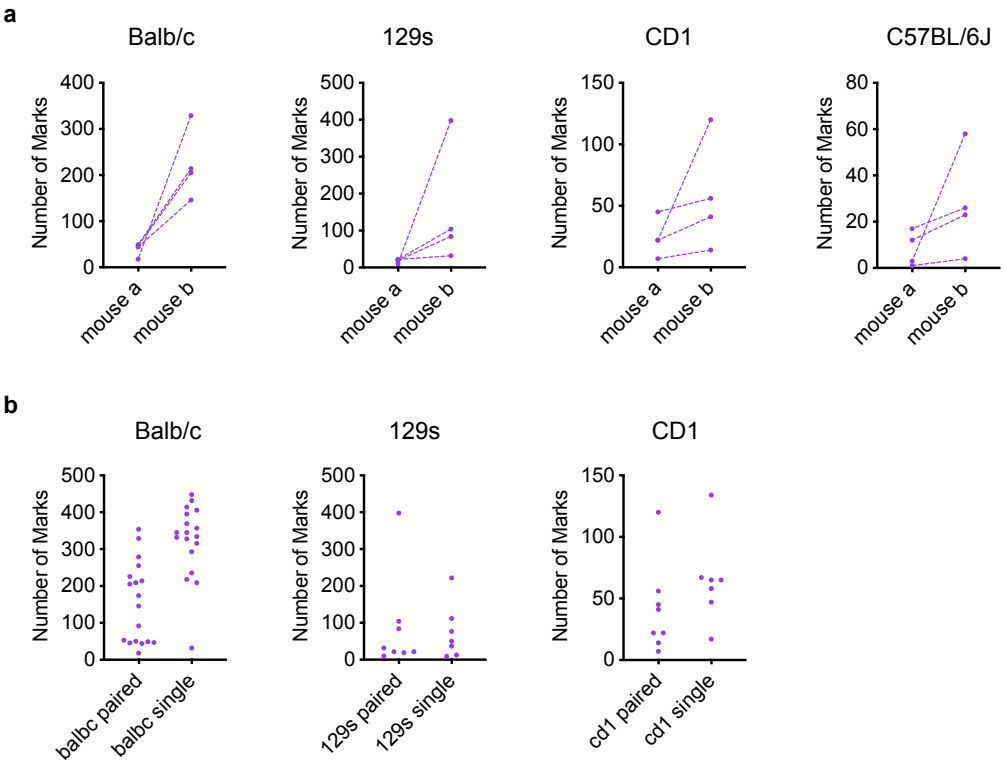

Fig. S1. TCM in inbred laboratory strains.

a) Comparison of micturition marks within pairs of male mice among 4 different laboratory strains. Mouse ‘a’ always denotes the partner with fewer micturition marks (n=8 mice per strain)

b) Comparison of micturition marks in paired and socially-isolated male mice among different strains after 1-hr TCM assay (n=8 pair-housed mice, n=7 socially-isolated mice).

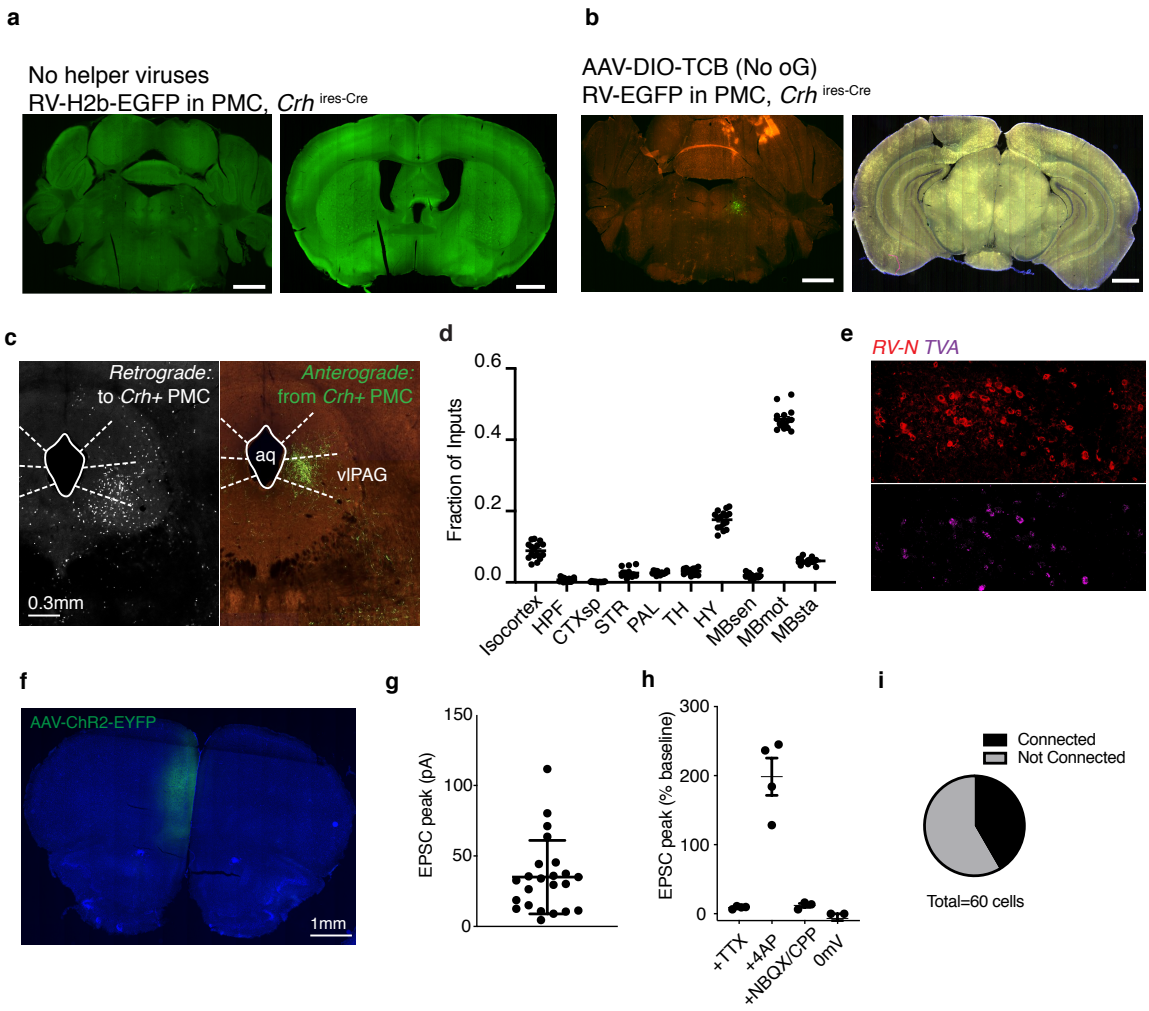

Fig. S2. Supplementary materials for brain-wide rabies tracing.

a) Helper virus injection was omitted, and RV-H2b-EGFP was injected into a *Crh*$^{ires\text{-}Cre}$ mouse. No EGFP+ cells were observed in or around the PMC (left). No long-range EGFP+ input cells were present in the forebrain (right).

b) AAV-DIO-RG was omitted from the helper AAV injection into a *Crh*$^{ires\text{-}Cre}$ mouse, and RbV-EGFP was subsequently injected. Starter cell infection was observed in PMC (right), but no long-range EGFP+ cells were observed in the forebrain (left). Scale bars: 1 mm.

c) PMC-PAG interconnectivity. Left: RV-h2b-EGFP labeled putative inputs to *Crh*+ PMC in ventrolateral periaqueductal grey (vlPAG). Right: Anterograde tracing from *Crh*+ PMC neurons (Allen Brain Institute) showing fibers from *Crh*+ PMC neurons in vlPAG.

d) Distributions of putative inputs to *Crh*+ PMC neurons throughout the whole brain.

e) *In situ* hybridization analysis of the PMC with *Rabies-N* mRNA (labels RV-infected cells) and *TVA* mRNA are visualized. *RV-N*+ but *TVA*- cells are putative local presynaptic neurons to *Crh*+ PMC starter neurons (*RV-N+/TVA+)*.

f) A coronal section of showing AAV-ChR2-EYFP infection in mPFC (DAPI in blue).

g) Quantification of peak amplitudes of optogenetically-evoked excitatory postsynaptic currents (EPSC) recorded from *Crh*+ PMC neurons.

h) Quantification of optogenetically-evoked EPSC currents normalized to baseline pre-drug EPSC amplitudes after serial addition application of TTX, 4AP, and NBQX/CNQX or after depolarization to 0 mV. This demonstrates that the evoked currents are glutamatergic and mediated by direct release from ChR2-expressing axons.

i) Percentage of analyzed *Crh*+ PMC neurons that were responsive to optogenetic activation of mPFC inputs.

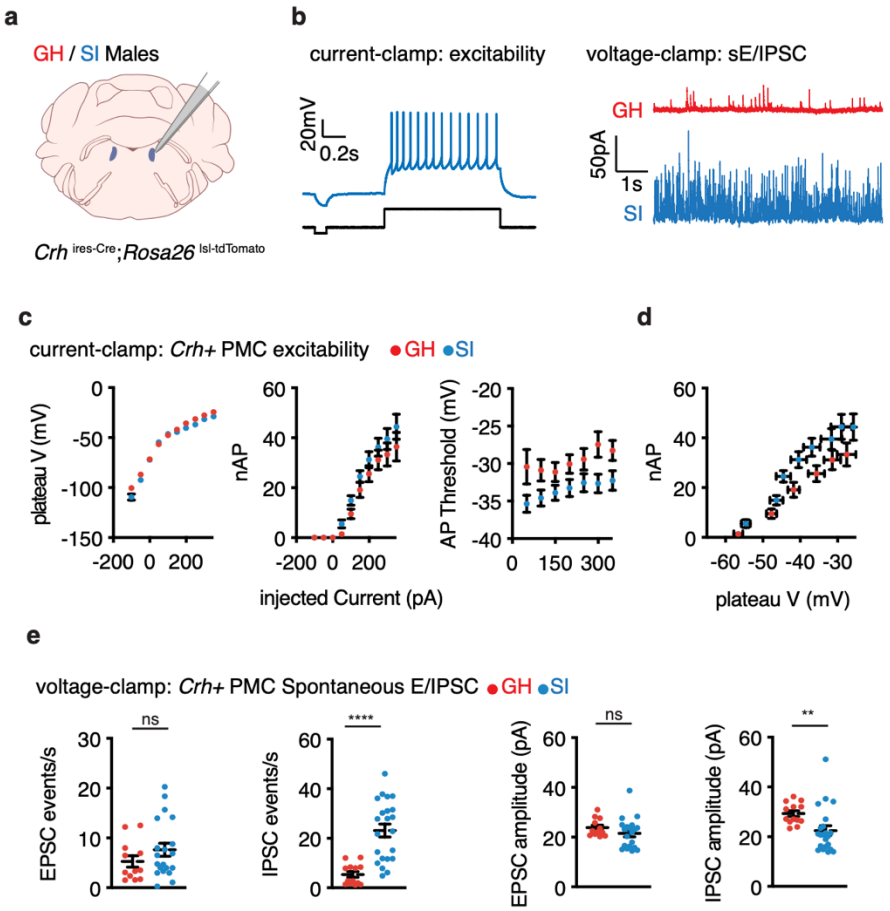

Fig. S3. Social isolation induces synaptic changes at *Crh*+ PMC neurons.

a) Schematic of whole-cell recordings configuration in acute brain slice containing PMC used to assess intrinsic excitability and synaptic changes in *Crh*+ PMC neurons.

b) Example traces of current-clamp and voltage-clamp recordings. (Left): Example trace of current-clamp recording (top) with the current injected (bottom). (Right): Example traces of spontaneous inhibitory post-synaptic currents (IPSC) in GH and SI males.

c) Plateau potential, number of action potentials, and first action potential threshold as a function of injected current (amplitude ranging from -200 to 400pA). Analysis method is described in Supplementary Fig. 4.

d) Comparisons of the numbers of action potentials and plateau potentials in *Crh*+ PMC neurons in GH (red) and SI (blue) mice (n=5 mice and 35 cells from GH males, 4 mice and 29 cells from SI males).

e) Frequencies and amplitudes of excitatory post-synaptic currents (EPSC) and IPSCs in *Crh*+ PMC neurons of GH and SI males (EPSC: n=4 animals 12 cells from GH males, n=5 animals 20 cells from SI males; IPSC: n=4 animals 13 cells from GH males, n=5 animals 22 cells from SI males; ns=not significant, ****P<0.0001, **P<0.01; two-tailed Mann-Whitney *U* test).

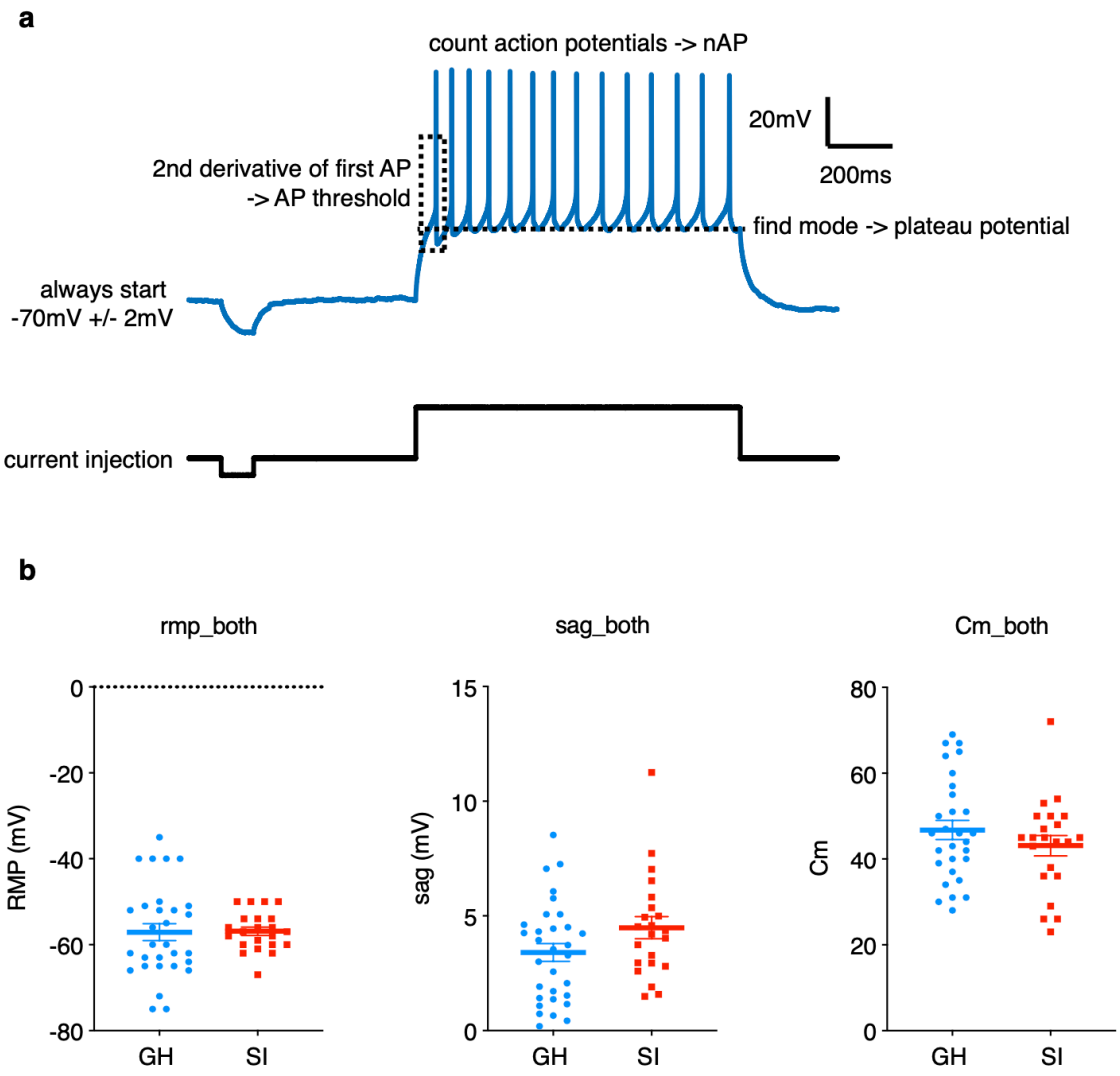

Fig. S4. Analysis of current-clamp recordings of *Crh*+ PMC neurons and supplementary data.

a) (top) Example current-clamp recording trace with brief description of analysis methods, and (bottom) corresponding current injection.

b) Resting membrane potential (RMP) (left), sag potential (middle), and membrane capacitance (right) in PMC *Crh*+ neurons from group-housed and socially-isolated males.

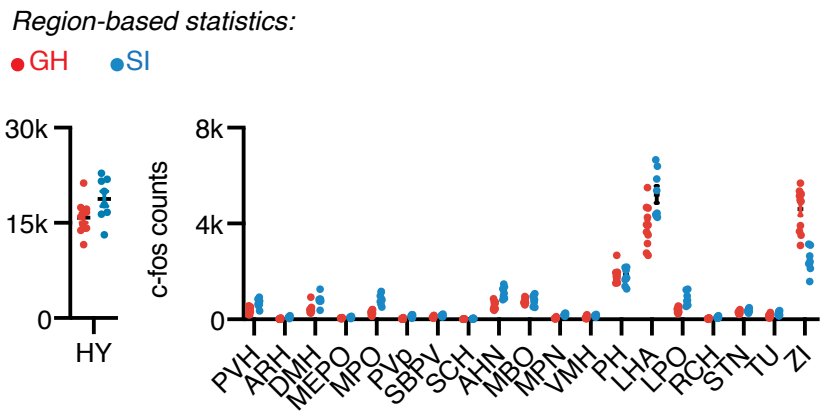

Fig. S5. Supplementary materials for brain-wide Fos comparison between SI animals and GH animals.

Fos immunolabeled cell counts in hypothalamus (HY) (left) and hypothalamic subregions (right).

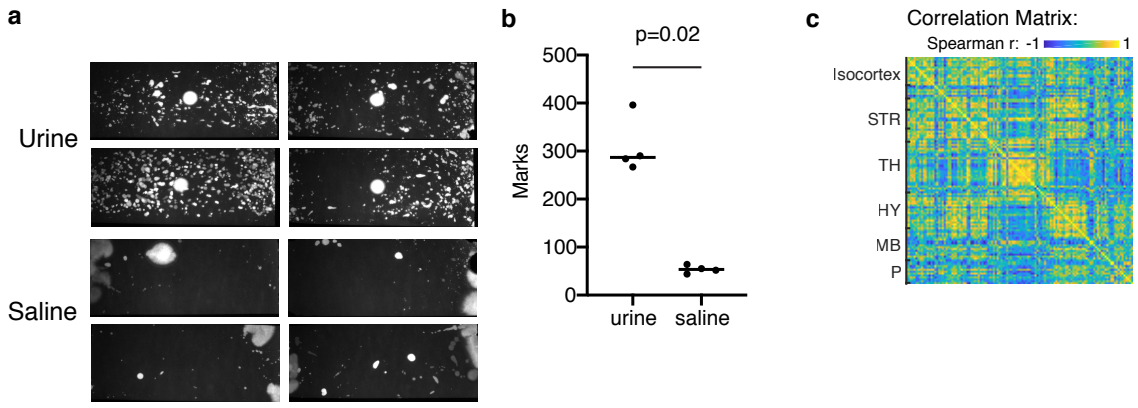

Fig. S6. Supplementary materials for brain-wide Fos comparison between SI animals exposed to urine and saline.

a) TCM patterns from 4 urine- and 4 saline-exposed mice analyzed for Fos expression

b) Quantification of urine spot numbers for the two groups (p=0.02, Mann-Whitney test).

c) Across brain areas of correlations of Fos immunolabeling.

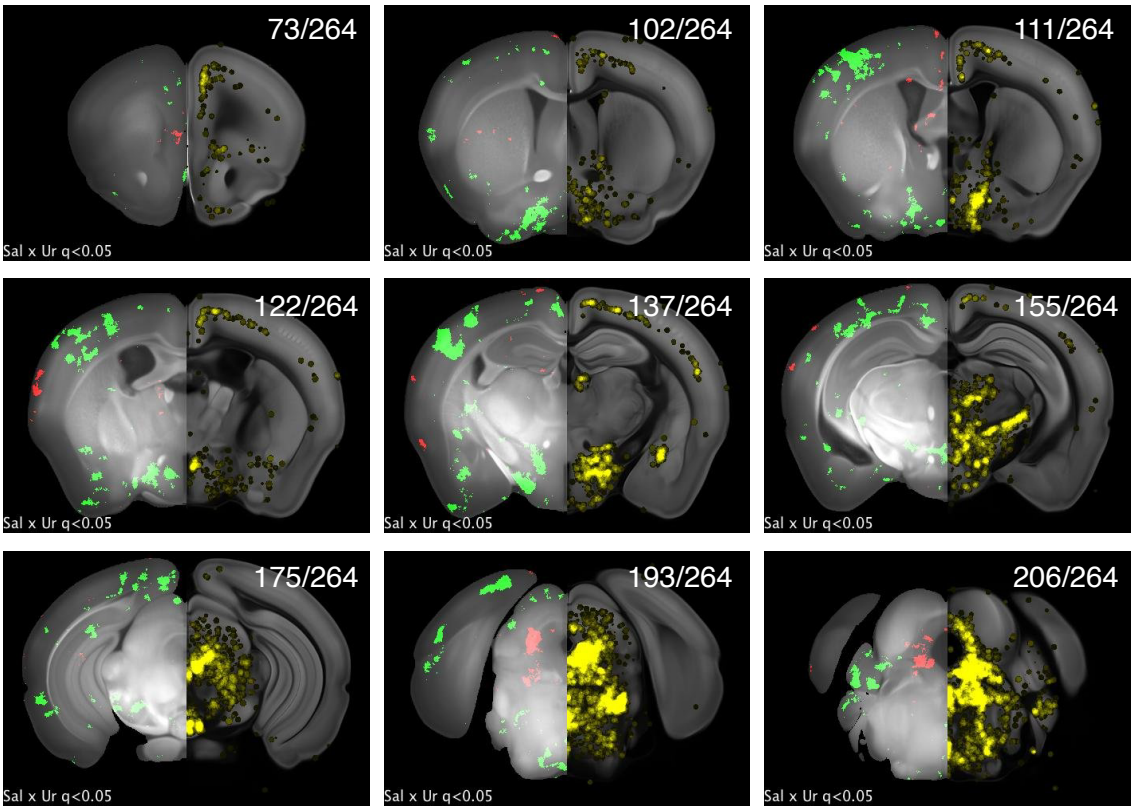

Fig. S7. Interesting examples of the relationship between Fos activation and rabies labeling

Statistical significance map of Fos iDisco+ data (left) and average voxelated maps of rabies inputs analyze by STPT (right) on the same coronal atlas based on ABA. Numbers at the top denote the coronal location within 264 coronal sections spanning the brain.

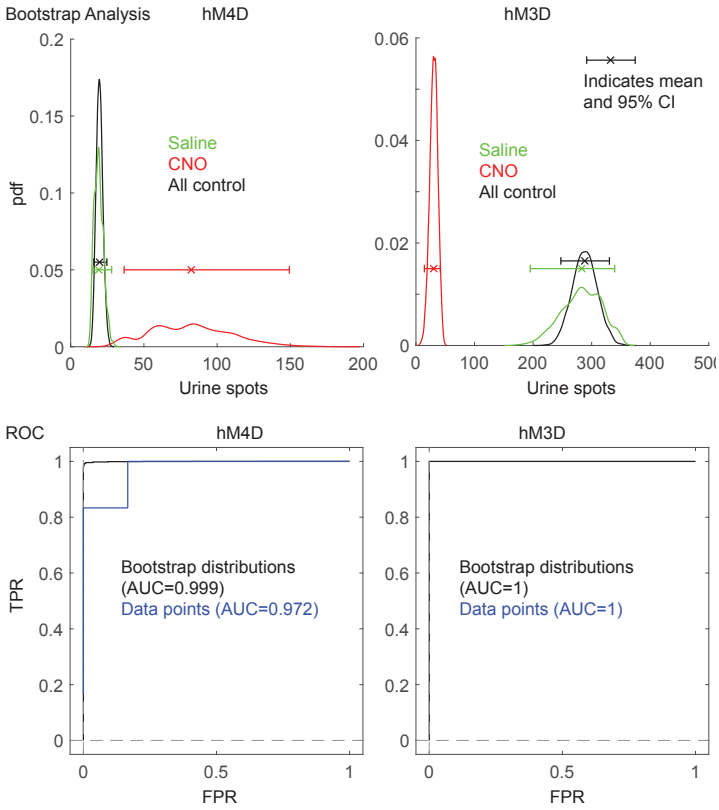

Fig. S8. Bootstrap and ROC analysis of the data in Figure 5.

Top, Distributions obtained from 10,000-fold sampling with replacement from the data obtained for CNO (CNO; red) and drug vehicle (Saline, green) treated (i.e. IP injection) mice. Data were used from mice that expressed hM4D (*left*; n=6 mice) or hM3D (*right;* n=6 mice) in LHA neurons. In addition, in each panel, the distribution resulting from bootstrap analyses of all the control data (All control; black) pooled from vehicle and CNO treated mice that expressed mCherry in LHA neurons and from vehicle treated mice expressed hM4D (*left*) or hM3D (*right*), as appropriate. For each distribution, the mean (X) and the 95% confidence intervals (horizontal lines) are shown.

Bottom, Receiver operator characteristics (ROC) analysis plotting true positive rate (TPR) vs. false positive rate (FPR) as a hypothetical threshold of number of urine spots is set and tested for its ability to distinguish data from CNO-treated animals from the associated control dataset. The curves obtained for analysis of the bootstrap distributions (black) and for comparison of only the actual data points (blue) are shown. On the right, the curves overlap and the blue line is hidden behind the black. The area under the curve (AUC) values are near the maximal possible value of 1.0 for each ROC analysis, indicating excellent discriminability of the groups based on this simple threshold model.

Table S1. Abbreviations used to label brain regions

Acronym	Name
FRP	Frontal pole, cerebral cortex
MO	Somatomotor areas
SS	Somatosensory areas
ILA	Infralimbic area
GU	Gustatory areas
VISC	Visceral area
AUD	Auditory areas
VIS	Visual areas
ACA	Anterior cingulate area
PL	Prelimbic area
ORB	Orbital area
AI	Agranular insular area
RSP	Retrosplenial area
TEa	Temporal association areas
PERI	Perirhinal area
ECT	Ectorhinal area
CA	Ammon's horn
DG	Dentate gyrus
ENT	Entorhinal area
PAR	Parasubiculum
POST	Postsubiculum
PRE	Presubiculum
SUB	Subiculum
CLA	Claustrum
EP	Endopiriform nucleus
LA	Lateral amygdalar nucleus
BLA	Basolateral amygdalar nucleus
BMA	Basomedial amygdalar nucleus
PA	Posterior amygdalar nucleus
CP	Caudoputamen
ACB	Nucleus accumbens
FS	Fundus of striatum
OT	Olfactory tubercle
LS	Lateral septal nucleus
SF	Septofimbrial nucleus
AAA	Anterior amygdalar area

CEA	Central amygdalar nucleus
IA	Intercalated amygdalar nucleus
MEA	Medial amygdalar nucleus
GPe	Globus pallidus, external segment
GPi	Globus pallidus, internal segment
SI	Substantia innominata
MA	Magnocellular nucleus
MSC	Medial septal complex
TRS	Triangular nucleus of septum
BST	Bed nuclei of the stria terminalis
VAL	Ventral anterior-lateral complex of the thalamus
VM	Ventral medial nucleus of the thalamus
VP	Ventral posterior complex of the thalamus
SPF	Subparafascicular nucleus
MG	Medial geniculate complex
LGd	Dorsal part of the lateral geniculate complex
LP	Lateral posterior nucleus of the thalamus
PO	Posterior complex of the thalamus
POL	Posterior limiting nucleus of the thalamus
AV	Anteroventral nucleus of thalamus
AM	Anteromedial nucleus
AD	Anterodorsal nucleus
LD	Lateral dorsal nucleus of thalamus
IMD	Intermediodorsal nucleus of the thalamus
MD	Mediodorsal nucleus of thalamus
SMT	Submedial nucleus of the thalamus
PVT	Paraventricular nucleus of the thalamus
PT	Parataenial nucleus
RE	Nucleus of reunions
CM	Central medial nucleus of the thalamus
PCN	Paracentral nucleus
CL	Central lateral nucleus of the thalamus
PF	Parafascicular nucleus
RT	Reticular nucleus of the thalamus
LGv	Ventral part of the lateral geniculate complex
MH	Medial habenula
LH	Lateral habenula
PVH	Paraventricular hypothalamic nucleus
ARH	Arcuate hypothalamic nucleus
DMH	Dorsomedial nucleus of the hypothalamus
MEPO	Median preoptic nucleus

MPO	Medial preoptic area
PVp	Periventricular hypothalamic nucleus, posterior part
SBPV	Subparaventricular zone
SCH	Suprachiasmatic nucleus
AHN	Anterior hypothalamic nucleus
MBO	Mammillary body
MPN	Medial preoptic nucleus
VMH	Ventromedial hypothalamic nucleus
PH	Posterior hypothalamic nucleus
LHA	Lateral hypothalamic area
LPO	Lateral preoptic area
RCH	Retrochiasmatic area
STN	Subthalamic nucleus
TU	Tuberal nucleus
ZI	Zona incerta
SCs	Superior colliculus, sensory related
IC	Inferior colliculus
SNr	Substantia nigra, reticular part
VTA	Ventral tegmental area
RR	Midbrain reticular nucleus, retrorubral area
MRN	Midbrain reticular nucleus
SCm	Superior colliculus, motor related
PAG	Periaqueductal gray
CUN	Cuneiform nucleus
RN	Red nucleus
SNc	Substantia nigra, compact part
PPN	Pedunculopontine nucleus
RAmb	Midbrain raphé nuclei
NLL	Nucleus of the lateral lemniscus
PSV	Principal sensory nucleus of the trigeminal
PB	Parabrachial nucleus
SOC	Superior olivary complex
B	Barrington's nucleus
PCG	Pontine central gray
PG	Pontine gray
PRNc	Pontine reticular nucleus, caudal part
SUT	Supratrigeminal nucleus
TRN	Tegmental reticular nucleus
V	Motor nucleus of trigeminal
CS	Superior central nucleus raphé
LC	Locus ceruleus

LDT	Laterodorsal tegmental nucleus
NI	Nucleus incertus
PRNr	Pontine reticular nucleus

Table S2. Summary region-based statistics from brain-wide distribution of putative inputs to *Crh*+ PMC neurons, normalized by total number of forebrain RV+ input cells (n=6 mice for GH-male, n=4 mice for SI-male, n=6 mice for GH-Female. FDR=0.05 for q-value)

ROIs	GH-male mean	GH-female mean	SI-male mean	p (Male vs Female)	p (GH Male vs SI Male)	p (GH-Female vs SI-Male)	q (GH-Male vs GH-Female)	q (GH-Male vs SI-Male)	q (GH-Female vs SI-Male)
FRP	0.0005	0.0005	0.0002	0.8182	0.0095	0.3923	1.0000	0.6968	0.9505
MO	0.0314	0.0382	0.0346	0.5887	0.9143	0.7619	1.0000	1.0000	1.0000
SS	0.0203	0.0202	0.0136	0.9372	0.2571	0.1714	1.0000	0.8410	0.8803
ILA	0.0035	0.0035	0.0019	0.9372	0.1714	0.1714	1.0000	0.7643	0.8803
GU	0.0012	0.0013	0.0015	0.6991	1.0000	0.7619	1.0000	1.0000	1.0000
VISC	0.0006	0.0005	0.0011	0.4848	0.7619	0.9143	1.0000	0.9962	1.0000
AUD	0.0035	0.0033	0.0024	0.8182	0.3524	0.3524	1.0000	0.8602	0.8803
VIS	0.0048	0.0051	0.0034	0.8182	0.3524	0.2571	1.0000	0.8602	0.8803
ACA	0.0109	0.0110	0.0068	0.9372	0.3524	0.1714	1.0000	0.8602	0.8803
PL	0.0028	0.0025	0.0018	0.8182	0.0667	0.3524	1.0000	0.6968	0.8803
ORB	0.0082	0.0085	0.0068	0.8182	0.7619	0.3524	1.0000	0.9962	0.8803
AI	0.0024	0.0025	0.0029	0.9372	0.7619	0.7619	1.0000	0.9962	1.0000
RSP	0.0085	0.0096	0.0085	0.8182	0.3524	0.2571	1.0000	0.8602	0.8803
TEa	0.0012	0.0012	0.0013	0.6991	0.6095	0.9143	1.0000	0.9521	1.0000
PERI	0.0006	0.0005	0.0008	0.3939	0.6095	0.4762	1.0000	0.9521	1.0000
ECT	0.0010	0.0011	0.0016	0.8182	0.7619	1.0000	1.0000	0.9962	1.0000
CA	0.0015	0.0008	0.0004	0.3095	0.0667	0.3524	1.0000	0.6968	0.8803
DG	0.0025	0.0012	0.0006	0.1320	0.0190	0.1714	1.0000	0.6968	0.8803
ENT	0.0026	0.0022	0.0021	0.9372	0.3524	0.7619	1.0000	0.8602	1.0000
PAR	0.0003	0.0003	0.0000	0.6991	0.0114	0.0307	1.0000	0.6968	0.8803
POST	0.0003	0.0001	0.0001	0.0931	0.0666	0.2714	1.0000	0.6968	0.8803
PRE	0.0002	0.0002	0.0000	0.6868	0.0477	0.1393	1.0000	0.6968	0.8803
SUB	0.0010	0.0006	0.0002	0.4848	0.0381	0.0190	1.0000	0.6968	0.8803
CLA	0.0007	0.0009	0.0007	0.5887	1.0000	0.6095	1.0000	1.0000	1.0000
EP	0.0001	0.0003	0.0005	0.0649	0.2571	0.7619	1.0000	0.8410	1.0000
LA	0.0001	0.0001	0.0000	0.8089	0.1236	0.2110	1.0000	0.7487	0.8803
BLA	0.0001	0.0002	0.0001	0.9372	0.2352	0.2714	1.0000	0.8410	0.8803
BMA	0.0001	0.0002	0.0002	0.2539	1.0000	0.5895	1.0000	1.0000	1.0000
PA	0.0000	0.0000	0.0000	0.4460	0.1491	0.5403	1.0000	0.7643	1.0000
CP	0.0038	0.0050	0.0023	0.5887	0.2571	0.1714	1.0000	0.8410	0.8803
ACB	0.0015	0.0015	0.0012	0.9372	0.7619	0.2571	1.0000	0.9962	0.8803
FS	0.0003	0.0003	0.0006	0.9372	0.0381	0.0381	1.0000	0.6968	0.8803
OT	0.0014	0.0012	0.0005	0.5887	0.0190	0.3524	1.0000	0.6968	0.8803
LS	0.0011	0.0019	0.0003	0.8182	0.0422	0.0422	1.0000	0.6968	0.8803

SF	0.0001	0.0001	0.0000	0.6868	0.5824	0.3314	1.0000	0.9521	0.8803
AAA	0.0008	0.0008	0.0008	0.8182	0.7619	0.9143	1.0000	0.9962	1.0000
CEA	0.0145	0.0163	0.0190	0.5887	0.4762	0.7619	1.0000	0.9349	1.0000
IA	0.0000	0.0000	0.0000	0.4942	0.4712	0.8102	1.0000	0.9349	1.0000
MEA	0.0008	0.0007	0.0011	0.6991	1.0000	1.0000	1.0000	1.0000	1.0000
GPe	0.0005	0.0005	0.0005	0.6991	1.0000	0.9143	1.0000	1.0000	1.0000
GPi	0.0001	0.0002	0.0002	0.0904	0.2352	1.0000	1.0000	0.8410	1.0000
SI	0.0051	0.0051	0.0059	0.9372	0.1143	0.1714	1.0000	0.7411	0.8803
MA	0.0008	0.0010	0.0011	0.2403	0.1143	0.2571	1.0000	0.7411	0.8803
MSC	0.0020	0.0028	0.0018	0.3939	0.7619	0.2571	1.0000	0.9962	0.8803
TRS	0.0001	0.0001	0.0000	0.8182	0.0477	0.0131	1.0000	0.6968	0.8803
BST	0.0197	0.0191	0.0186	0.9372	0.9143	0.9143	1.0000	1.0000	1.0000
VAL	0.0001	0.0001	0.0002	0.8705	0.4500	0.3524	1.0000	0.9349	0.8803
VM	0.0033	0.0034	0.0029	0.9372	0.7619	0.3524	1.0000	0.9962	0.8803
VP	0.0003	0.0007	0.0004	0.1275	0.4542	0.2571	1.0000	0.9349	0.8803
SPF	0.0011	0.0010	0.0013	0.8182	0.7619	0.6095	1.0000	0.9962	1.0000
MG	0.0001	0.0001	0.0001	1.0000	1.0000	0.9143	1.0000	1.0000	1.0000
LGd	0.0000	0.0000	0.0000	0.4047	0.5403	1.0000	1.0000	0.9521	1.0000
LP	0.0001	0.0001	0.0000	0.7483	0.0307	0.0307	1.0000	0.6968	0.8803
PO	0.0003	0.0004	0.0002	0.8182	0.1714	0.1714	1.0000	0.7643	0.8803
POL	0.0002	0.0002	0.0002	0.9372	0.7619	0.6095	1.0000	0.9962	1.0000
AV	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
AM	0.0001	0.0000	0.0000	0.4620	0.6940	1.0000	1.0000	0.9962	1.0000
AD	0.0000	0.0000	0.0000	0.4047	0.5120	0.0942	1.0000	0.9521	0.8803
LD	0.0000	0.0000	0.0001	0.9289	0.5482	0.5696	1.0000	0.9521	1.0000
IMD	0.0003	0.0002	0.0002	0.8182	0.6689	0.6095	1.0000	0.9962	1.0000
MD	0.0002	0.0001	0.0004	0.1994	0.1143	0.1143	1.0000	0.7411	0.8803
SMT	0.0000	0.0000	0.0000	0.4047	1.0000	0.5403	1.0000	1.0000	1.0000
PVT	0.0009	0.0009	0.0008	0.9372	1.0000	1.0000	1.0000	1.0000	1.0000
PT	0.0000	0.0000	0.0000	1.0000	0.7609	0.7609	1.0000	0.9962	1.0000
RE	0.0003	0.0002	0.0003	0.3358	1.0000	0.9143	1.0000	1.0000	1.0000
CM	0.0000	0.0001	0.0001	0.7750	0.5482	1.0000	1.0000	0.9521	1.0000
PCN	0.0000	0.0000	0.0000	0.4047	1.0000	0.5403	1.0000	1.0000	1.0000
CL	0.0000	0.0000	0.0000	0.7526	0.7186	0.5120	1.0000	0.9962	1.0000
PF	0.0015	0.0015	0.0015	0.9372	0.9143	1.0000	1.0000	1.0000	1.0000
RT	0.0004	0.0003	0.0002	0.5887	0.9143	0.2571	1.0000	1.0000	0.8803
LGv	0.0006	0.0004	0.0005	0.5887	0.7619	0.9143	1.0000	0.9962	1.0000
MH	0.0021	0.0021	0.0013	1.0000	0.2571	0.3524	1.0000	0.8410	0.8803
LH	0.0082	0.0079	0.0081	0.8182	1.0000	1.0000	1.0000	1.0000	1.0000
PVH	0.0035	0.0024	0.0032	0.3939	0.9143	0.6095	1.0000	1.0000	1.0000
ARH	0.0025	0.0017	0.0013	0.1797	0.0667	0.6095	1.0000	0.6968	1.0000

DMH	0.0122	0.0104	0.0088	0.3095	0.1143	0.4762	1.0000	0.7411	1.0000
MEPO	0.0013	0.0012	0.0008	0.8182	0.3524	0.1714	1.0000	0.8602	0.8803
MPO	0.0091	0.0093	0.0069	0.9372	0.2571	0.2571	1.0000	0.8410	0.8803
PVp	0.0009	0.0012	0.0005	0.4848	0.0667	0.0381	1.0000	0.6968	0.8803
SBPV	0.0013	0.0014	0.0013	0.8182	1.0000	0.9143	1.0000	1.0000	1.0000
SCH	0.0000	0.0002	0.0000	0.1581	0.6940	0.1236	1.0000	0.9962	0.8803
AHN	0.0021	0.0020	0.0021	0.6991	1.0000	0.9143	1.0000	1.0000	1.0000
MBO	0.0056	0.0056	0.0044	0.8182	0.1714	0.4762	1.0000	0.7643	1.0000
MPN	0.0016	0.0023	0.0021	0.3095	0.6095	0.9143	1.0000	0.9521	1.0000
VMH	0.0025	0.0014	0.0020	0.0931	0.9143	0.2571	1.0000	1.0000	0.8803
PH	0.0244	0.0207	0.0211	0.3939	0.6095	0.9143	1.0000	0.9521	1.0000
LHA	0.0608	0.0544	0.0533	0.3939	0.2571	0.7619	1.0000	0.8410	1.0000
LPO	0.0066	0.0060	0.0069	0.8182	0.9143	0.6095	1.0000	1.0000	1.0000
RCH	0.0005	0.0005	0.0002	1.0000	0.2850	0.2571	1.0000	0.8410	0.8803
STN	0.0018	0.0016	0.0023	0.8182	0.2571	0.1714	1.0000	0.8410	0.8803
TU	0.0030	0.0020	0.0017	0.3939	0.2571	0.7619	1.0000	0.8410	1.0000
ZI	0.0296	0.0320	0.0343	0.8182	0.4762	1.0000	1.0000	0.9349	1.0000
SCs	0.0009	0.0007	0.0009	0.8182	1.0000	0.9143	1.0000	1.0000	1.0000
IC	0.0075	0.0094	0.0124	0.6991	1.0000	0.9143	1.0000	1.0000	1.0000
SNr	0.0076	0.0080	0.0132	0.8182	0.1143	0.0667	1.0000	0.7411	0.8803
VTA	0.0092	0.0091	0.0106	1.0000	0.2571	0.1143	1.0000	0.8410	0.8803
RR	0.0123	0.0116	0.0177	0.9372	0.1143	0.0381	1.0000	0.7411	0.8803
MRN	0.0823	0.0936	0.1053	0.1797	0.0095	0.1714	1.0000	0.6968	0.8803
SCm	0.0519	0.0645	0.0650	0.3939	0.0381	0.7619	1.0000	0.6968	1.0000
PAG	0.2544	0.2350	0.2466	0.3095	0.9143	0.4762	1.0000	1.0000	1.0000
CUN	0.0041	0.0040	0.0040	0.8182	0.7619	1.0000	1.0000	0.9962	1.0000
RN	0.0013	0.0028	0.0015	0.8182	0.7619	0.6095	1.0000	0.9962	1.0000
SNc	0.0044	0.0045	0.0074	0.9372	0.1714	0.1143	1.0000	0.7643	0.8803
PPN	0.0167	0.0168	0.0184	0.5887	0.6095	0.3524	1.0000	0.9521	0.8803
RAmb	0.0334	0.0360	0.0310	0.5887	0.7619	0.7619	1.0000	0.9962	1.0000

Table S3. Summary region-based statistics from comparison of brain-wide Fos counts between socially-isolated and pair-housed males (n=8 for single-housed and n=11 for group-housed biologically independent samples. FDR=0.05 for q-value)

ROIs	mean.single	std.single	mean.pair	std.pair	p-value	q-value
FRP	8	7.78276484	3.63636364	2.69342634	0.05167725	0.09867253
MO	9474.5	2310.68734	2138.54545	606.273925	6.07E-34	2.80E-32
SS	37380.125	9731.39041	9930.27273	2511.03346	2.79E-31	1.08E-29
ILA	1508.125	374.516617	229.181818	228.420147	9.95E-10	3.99E-09
GU	796.25	273.602814	193.363636	65.6205345	1.91E-20	2.31E-19
VISC	1879.625	445.7568	449.454545	210.895881	3.06E-17	2.62E-16
AUD	25722.75	3659.13837	11576.3636	2015.48149	6.98E-30	2.09E-28
VIS	51038	6992.74097	19436.2727	6396.2222	1.11E-16	8.93E-16
ACA	3910.25	769.536363	1090.45455	346.650072	3.14E-28	8.35E-27
PL	840	134.437452	63.2727273	50.3251248	6.49E-19	6.59E-18
ORB	1019.875	335.884095	259.909091	122.861267	6.00E-13	3.16E-12
AI	3308.5	1070.91896	900.363636	283.193317	1.41E-18	1.41E-17
RSP	14287.25	2018.48527	5593.18182	1211.34304	2.37E-29	6.61E-28
TEa	13003.125	2030.78313	6484.45455	1275.57739	5.84E-19	6.03E-18
PERI	4940.125	671.090677	3336.09091	625.697284	3.90E-07	1.23E-06
ECT	13587.375	2101.77938	7439.81818	1423.85363	8.73E-15	5.63E-14
CA	12968.75	1300.50372	9122.72727	741.27459	6.25E-19	6.40E-18
DG	5504.875	565.877684	5507.27273	926.693271	0.99470159	1
ENT	35314.375	4604.23212	22176.8182	1896.29775	5.52E-23	8.39E-22
PAR	3847.875	732.782259	2509.72727	451.256488	1.64E-07	5.35E-07
POST	2674.75	305.771039	1732.63636	403.768566	3.19E-07	1.01E-06
PRE	4836.375	513.651894	3205	333.433652	9.41E-19	9.48E-18
SUB	13467.625	1167.36112	8723.18182	802.483373	9.68E-27	2.11E-25
CLA	1719.5	190.115003	631.727273	184.832406	3.36E-21	4.49E-20
EP	4412.125	766.91412	2492.90909	390.688995	1.72E-14	1.06E-13
LA	823	409.0358	529.636364	206.877874	0.01471798	0.02990993
BLA	2936.625	524.318861	1874.36364	624.916838	0.00011272	0.00027983
BMA	2534.625	501.47324	1289.27273	247.252539	1.76E-14	1.07E-13
PA	683.625	96.6376701	429.545455	112.034248	2.01E-06	5.89E-06
CP	9276.875	1485.62824	6820.27273	1293.6304	9.33E-05	0.00023359
ACB	1781.5	401.607129	705.818182	232.304033	3.55E-13	1.92E-12
FS	231.625	52.5627176	129	77.9102047	0.00113381	0.00261933
OT	979.125	231.175529	201.909091	95.0373132	3.44E-19	3.72E-18
LS	2439.625	987.57422	816.727273	268.756057	6.60E-11	2.93E-10
SF	582.25	364.854864	409	221.142036	0.38191238	0.627278

AAA	749	241.240248	368.636364	98.5629471	9.00E-08	3.01E-07
CEA	1434.5	276.400331	853.363636	454.129117	0.00078435	0.00183678
IA	472.125	88.2778689	219.272727	63.909453	4.62E-12	2.24E-11
MEA	2769.375	526.617763	1497.18182	399.15406	7.74E-09	2.85E-08
GPe	320.625	61.2394306	506	139.293934	2.31E-05	6.08E-05
GPi	97.5	23.4520788	262.363636	101.607355	3.94E-08	1.36E-07
SI	972.25	236.076713	607.363636	120.939053	1.35E-06	4.05E-06
MA	151.75	99.7836946	83	36.1718122	0.01405278	0.02860658
MSC	706.75	203.457788	330.909091	73.9911543	4.32E-12	2.11E-11
TRS	208.5	157.024111	165.545455	96.9859409	0.56032455	0.88166553
BST	1777.5	588.570908	643.272727	161.744299	1.45E-14	9.08E-14
VAL	153	142.652425	435.181818	209.302087	0.00121085	0.00278125
VM	272.5	94.1123948	406.454545	104.327718	0.00284802	0.00622967
VP	180.875	143.047882	2103	755.4727	1.49E-23	2.56E-22
SPF	516.625	102.611525	678.363636	92.1089276	8.99E-05	0.00022637
MG	787.125	266.58284	684.909091	167.700599	0.24454795	0.41947496
LGd	79.125	78.4409469	362.727273	133.032395	7.37E-10	2.97E-09
LP	338.875	306.076292	326.181818	77.4181092	0.86473098	1
PO	155.75	188.54916	404.818182	123.316518	0.00056425	0.0013344
POL	120.375	33.1961164	227.181818	39.7764206	1.11E-11	5.13E-11
AV	522.125	470.06639	277.272727	182.168653	0.07972087	0.14773619
AM	674.5	413.222873	278.636364	104.290242	0.00018877	0.00046381
AD	216.5	153.216933	123.818182	57.3982895	0.07140528	0.13273632
LD	148.625	83.4333566	297.818182	68.5285607	0.00023616	0.00057552
IMD	306	125.434103	260.181818	132.393971	0.45142635	0.7334149
MD	773	332.059805	663.545455	250.826778	0.4549281	0.73713482
SMT	31	25.3940375	29.8181818	10.1766221	0.87901879	1
PVT	2249.75	647.642924	1957.18182	667.246404	0.40805965	0.66748093
PT	521.625	205.16261	372.727273	121.59037	0.05233662	0.09960574
RE	1361.5	517.744283	1195.09091	220.106999	0.33289763	0.55359815
CM	447.375	115.881636	328.090909	55.9490028	0.00109979	0.00255057
PCN	55.625	35.7648571	37.4545455	10.6991928	0.06795918	0.12688431
CL	149.25	82.5915077	86.4545455	52.236699	0.04255162	0.0828237
PF	318.375	179.288226	270	167.512388	0.53914667	0.85281907
RT	466	175.730313	3061.63636	1065.49935	1.37E-27	3.35E-26
LGv	678.875	112.583223	864.090909	220.432055	0.01785526	0.03586006
MH	122	45.9409559	200.818182	121.505406	0.0317276	0.06267117
LH	267.75	103.673595	293	116.779279	0.63173157	0.9836963
PVH	694.75	188.081859	370.636364	129.540938	2.07E-05	5.48E-05

ARH	93.375	36.1027799	17.6363636	17.4371599	2.27E-06	6.63E-06
DMH	807.75	236.467908	427.272727	178.9425	1.83E-05	4.86E-05
MEPO	81.375	29.2522893	51.1818182	13.429953	0.00207436	0.00462297
MPO	849.75	232.656553	283.454545	94.7241929	1.16E-14	7.37E-14
PVp	130.125	54.9634619	28.9090909	21.9975205	1.77E-06	5.24E-06
SBPV	160	37.6221819	98.4545455	35.4185365	0.00039098	0.00093571
SCH	27.125	11.3821602	12.1818182	8.65815433	0.00574439	0.01212593
AHN	1094	245.908229	590.727273	159.854991	2.74E-08	9.61E-08
MBO	805.25	216.305175	757.545455	110.760429	0.51172074	0.81698157
MPN	198.5	45.033321	51.4545455	25.8703059	5.95E-16	4.46E-15
VMH	153.875	38.8529738	76.8181818	54.2158984	0.00247327	0.00546123
PH	1769.25	339.613962	1866.72727	311.243342	0.4837325	0.7743595
LHA	5209.625	1000.09841	3886.90909	857.446494	0.00140149	0.00318858
LPO	848.125	283.128662	404.545455	109.755513	2.10E-08	7.47E-08
RCH	86.25	35.2328986	32.4545455	16.0210089	3.64E-06	1.03E-05
STN	367.5	74.8484182	298.363636	56.6926322	0.01478468	0.02999463
TU	252.75	84.076071	147.909091	68.1049991	0.00417905	0.00897972
ZI	2455.625	511.563133	4609.18182	886.261115	4.51E-12	2.19E-11
SCs	4945.75	1160.32209	3745.09091	1042.10983	0.01394329	0.02843199
IC	7683.375	1588.1039	7350.45455	1501.29087	0.62202223	0.96983701
SNr	1111.375	592.97746	1656.18182	329.724375	0.00931997	0.01920042
VTA	1038.625	316.671952	1671.45455	246.471647	1.33E-06	3.99E-06
RR	949.75	331.713624	1543.18182	206.262851	2.83E-06	8.16E-06
MRN	5083.875	1520.67142	16277.7273	1487.87379	7.36E-42	5.52E-40
SCm	7913.375	1250.74617	9225.18182	1469.88318	0.0325595	0.06420863
PAG	4731	957.865782	4070.09091	1101.48095	0.13674879	0.24401484
CUN	209.25	59.4564667	298.727273	148.495179	0.02834945	0.05609075
RN	176.5	55.3224315	1420.18182	113.062654	1.12E-130	2.70E-128
SNc	466.375	167.249119	833.818182	183.825362	8.98E-07	2.73E-06
PPN	550.375	130.480363	1371.36364	215.255324	2.26E-25	4.44E-24
RAmb	929.375	173.095298	1344.45455	296.684467	2.42E-05	6.31E-05
NLL	827.5	185.683294	1539.90909	500.970948	1.50E-07	4.94E-07
PSV	555.375	73.7077966	1395.81818	630.354633	2.67E-10	1.11E-09
PB	719.625	218.480426	1301.36364	859.319297	0.00248172	0.00546982
SOC	380.625	92.0418189	400.545455	99.8442423	0.63872424	0.99329489
B	52.125	29.4833488	41.2727273	29.6347462	0.46034846	0.74387844
PCG	822	349.111935	1056.18182	485.823799	0.18381363	0.32080428
PG	3173.5	404.568906	2755.54545	405.212627	0.02226692	0.04442269
PRNc	1156.375	264.718685	4369.27273	2403.22779	4.39E-15	2.96E-14

SUT	92.625	72.2356016	208.636364	168.71175	0.00517259	0.01101587
TRN	2143.375	269.771828	2479.27273	643.581711	0.08842236	0.16260493
V	194.875	70.5031661	606	398.200954	6.61E-08	2.23E-07
CS	644.25	228.900946	1433	548.215104	7.22E-08	2.42E-07
LC	81.375	34.0836681	65.7272727	35.4347031	0.3146108	0.52831701
LDT	146.375	81.8394552	210.454545	163.707278	0.19968489	0.34698867
NI	179.125	84.0415501	365.818182	204.640572	0.00149195	0.00338157
PRNr	2227.75	479.209692	7805.63636	1843.80543	2.34E-39	1.47E-37

Table S4. Summary region-based statistics for comparison of brain-wide Fos counts for socially-isolated males exposed to urine vs. saline (n=4 biologically independent samples for each condition, FDR=0.05 for q-value)

ROIs	mean.saline	std.saline	mean.urine	std.urine	p-value	q-value
FRP	5.75	2.21735578	10.25	11.0867789	0.38635903	1
MO	10151	2698.73612	8798	1988.64979	0.33405048	0.99386234
SS	44241	7294.89995	30519.25	6498.20931	0.00252153	0.04651245
ILA	1400.75	205.344223	1615.5	504.349416	0.34562616	1
GU	859.75	312.097608	732.75	257.89969	0.49856546	1
VISC	1967.5	424.895673	1791.75	512.350385	0.5428334	1
AUD	27404.5	2749.26687	24041	4017.60235	0.11740854	0.61472856
VIS	54647	5387.75878	47429	7094.74223	0.0638999	0.45334898
ACA	3911.25	155.160938	3909.25	1165.19966	0.99708351	1
PL	870	161.517801	810	116.975781	0.47636564	1
ORB	995.75	270.905119	1044	433.936247	0.82932072	1
AI	3541.25	1088.7869	3075.75	1160.21848	0.51048768	1
RSP	15636.5	672.227392	12938	2049.4313	0.00834069	0.10092931
TEa	13874	2081.0901	12132.25	1808.16359	0.1449849	0.67771513
PERI	5259.75	476.1704	4620.5	742.752314	0.11651507	0.6141783
ECT	14308.25	1221.11762	12866.5	2725.90444	0.28428824	0.90345558
CA	13124.25	649.664721	12813.25	1860.06584	0.7178315	1
DG	5379	571.415202	5630.75	615.147882	0.49673518	1
ENT	36884.75	1427.92492	33744	6391.326	0.2736083	0.89145749
PAR	3847.75	288.674413	3848	1081.47893	0.9996073	1
POST	2881	124.362374	2468.5	298.753522	0.00568034	0.08108003
PRE	4709.75	516.269552	4963	553.472071	0.45081741	1
SUB	14090.75	258.3865	12844.5	1441.35989	0.06676397	0.46540698
CLA	1750.25	237.352586	1688.75	159.616989	0.62835086	1
EP	4785	770.920662	4039.25	638.189823	0.09876051	0.56070126
LA	1014.75	480.082198	631.25	248.72391	0.08923682	0.5270687
BLA	3330.5	189.015872	2542.75	438.212563	0.00089385	0.02232759
BMA	2842.25	270.991236	2227	510.866584	0.02881308	0.26018094
PA	700	87.2505969	667.25	116.029809	0.61919883	1
CP	10138.5	1121.0223	8415.25	1383.27929	0.02912966	0.26018094
ACB	1900.5	493.296733	1662.5	308.601685	0.36618832	1
FS	265.5	54.0709411	197.75	21.5154983	0.00374718	0.05933355
OT	1174.75	104.87572	783.5	107.927445	8.41E-09	1.12E-06
LS	2376.5	1211.51544	2502.75	892.922682	0.85183751	1
SF	366.5	384.349234	798	196.872209	0.21687968	0.80839929

AAA	910.25	185.465855	587.75	179.046316	0.00360848	0.05846712
CEA	1589.25	264.521423	1279.75	210.780099	0.03846833	0.3258291
IA	512	54.4242593	432.25	104.79305	0.15304589	0.69656742
MEA	2974.75	481.770606	2564	550.013333	0.20177867	0.78295349
GPe	331.5	41.0731056	309.75	82.1477328	0.5755571	1
GPi	109.5	12.7148207	85.5	27.1600196	0.07224244	0.47507918
SI	1146.5	199.782382	798	95.7113717	0.0001815	0.00805979
MA	222.25	90.149413	81.25	43.0300283	0.00079467	0.02071317
MSC	836.25	201.769464	577.25	105.626307	0.00309025	0.05293153
TRS	154.25	182.540178	262.75	127.917617	0.38043442	1
BST	1766.25	305.473812	1788.75	845.370678	0.95588252	1
VAL	114	112.519628	192	175.402395	0.33793644	0.99799456
VM	279.75	18.1176709	265.25	142.120547	0.82228646	1
VP	184	185.854782	177.75	114.796559	0.93890976	1
SPF	515.25	72.4310016	518	138.984412	0.96610753	1
MG	785.75	150.648321	788.5	378.314243	0.98680155	1
LGd	103	112.679486	55.25	11.8427193	0.14238482	0.67212363
LP	400.25	453.129397	277.5	56.7597275	0.43269047	1
PO	205	271.682413	106.5	51.6946161	0.23342507	0.83651208
POL	114.25	17.0171482	126.5	46.7083147	0.53821854	1
AV	352	390.560281	692.25	534.66025	0.26369659	0.89092653
AM	592.25	419.338666	756.75	452.259789	0.57840833	1
AD	161	185.817114	272	109.69959	0.35633741	1
LD	126	91.6587875	171.25	80.4751514	0.4368459	1
IMD	304	179.244712	308	67.6214956	0.96288123	1
MD	660.75	418.517523	885.25	220.283719	0.35233694	1
SMT	21.75	13.4008706	40.25	33.1197323	0.20602717	0.7892223
PVT	2051.25	896.739046	2448.25	263.596124	0.38897174	1
PT	458	220.215046	585.25	197.292296	0.34093556	1
RE	1503.5	546.468968	1219.5	522.563234	0.43931411	1
CM	447.75	118.015183	447	131.929274	0.99240185	1
PCN	48	36.4508802	63.25	38.7416658	0.52625516	1
CL	138.25	114.59603	160.25	49.614346	0.73178738	1
PF	294.75	234.362077	342	136.342705	0.72124626	1
RT	539	202.808613	393	129.282636	0.14065112	0.66950901
LGv	671.75	81.6797609	686	150.890689	0.85185968	1
MH	99.25	35.0273703	144.75	48.1412851	0.10495892	0.58262641
LH	247.25	132.77142	288.25	79.5628682	0.56701022	1
PVH	744.75	175.262422	644.75	212.503137	0.44481552	1

ARH	89.75	12.3119183	97	53.4290807	0.77934917	1
DMH	922	227.190082	693.5	209.880125	0.11077879	0.60661487
MEPO	83.25	22.0056811	79.5	38.7685439	0.86500543	1
MPO	1017.5	176.299934	682	142.05398	0.00087888	0.02232759
PVp	157.5	53.2697538	102.75	47.0416482	0.111932	0.60665249
SBPV	187.5	22.4276615	132.5	27.9821372	0.00059798	0.01707085
SCH	32.5	12.2338329	21.75	8.69386757	0.10507286	0.58262641
AHN	1298.5	161.50645	889.5	59.1072472	1.47E-09	2.93E-07
MBO	919	121.81133	691.5	244.601036	0.07097627	0.47507918
MPN	224.75	38.6382798	172.25	37.4377261	0.02864844	0.26018094
VMH	161.5	33.1511689	146.25	47.6261483	0.57004251	1
PH	2010	240.570156	1528.5	238.087519	0.00155437	0.03328014
LHA	6075.5	572.94706	4343.75	78.8601082	2.02E-15	1.21E-12
LPO	1060	236.455775	636.25	106.881165	3.14E-05	0.0022162
RCH	103.25	37.9857429	69.25	26.1326743	0.0834592	0.50335405
STN	418.25	67.5394946	316.75	40.5246838	0.00237906	0.04527774
TU	307.25	68.4367104	198.25	62.3665241	0.00776885	0.09806855
ZI	2745.75	433.43925	2165.5	445.304765	0.03886035	0.3258291
SCs	5552.75	963.354685	4338.75	1109.45674	0.05834102	0.4317956
IC	8121	2181.89871	7245.75	783.229798	0.34457464	1
SNr	1506.5	614.419238	716.25	163.128528	0.00022185	0.00859915
VTA	1233	298.937006	844.25	209.463402	0.01140145	0.12896544
RR	977	482.340129	922.5	148.706646	0.79091902	1
MRN	4564.25	1032.19616	5603.5	1900.06342	0.23652276	0.839026
SCm	7331	952.152299	8495.75	1356.15815	0.09407589	0.54001546
PAG	4143.25	569.651575	5318.75	946.121689	0.00785651	0.09812458
CUN	197.5	57.2625532	221	67.8331286	0.53220721	1
RN	176	42.4735212	177	73.0524925	0.97773488	1
SNc	571.75	187.297224	361	24.0416306	0.00091366	0.02235674
PPN	536	171.388448	564.75	98.996212	0.7518104	1
RAmb	1009.25	209.281907	849.5	95.3886786	0.07982648	0.49083053
NLL	912.5	222.982062	742.5	107.059174	0.09198063	0.53797454
PSV	599.75	36.6731055	511	77.9786296	0.02236944	0.21986427
PB	722	260.435533	717.25	208.655018	0.97335098	1
SOC	369.5	91.7769034	391.75	104.948797	0.7152767	1
B	36.5	26.4007576	67.75	26.0816027	0.06562305	0.46012885
PCG	669.25	345.709295	974.75	320.389737	0.1167912	0.6141783
PG	3352.75	191.102721	2994.25	509.616441	0.16537059	0.71323501
PRNc	1195	329.24459	1117.75	226.11999	0.65902196	1

SUT	125.25	89.9865731	60	35.2041664	0.06835258	0.46565198
TRN	2259	320.609836	2027.75	177.118369	0.13814973	0.66317109
V	218.75	90.0902325	171	44.2944692	0.26576754	0.89092653
CS	698.75	326.305966	589.75	88.658051	0.40341985	1
LC	71.5	26.4133804	91.25	41.8678476	0.305915	0.94049253
LDT	129.75	113.793307	163	44.0681291	0.53475862	1
NI	169	87.5861481	189.25	92.3882207	0.7047483	1
PRNr	2518.5	461.991703	1937	311.394712	0.0171586	0.17735484