Supplementary Figure 1: HPC projections predominantly target IL neurons in the mPFC. Comparison of hippocampal inputs onto principal neurons in the IL and PL reveal significantly larger EPSCs in IL neurons compared to caudal or rostral PL responses (rostral PL: n = 12; caudal PL: n = 5; IL: n = 21 from 7 animals; one-way ANOVA with Dunnett's multiple comparison test, $F_{2,35}$ = 6.62, *P = 0.0037). Dots represent data from individual cells. Error bars indicate means ± s.e.m.

Supplementary Figure 2: Hippocampus-driven IL responses are monosynaptic, time-locked responses. a, Example of a HPC-driven response in a pyramidal neuron, containing the initial excitatory response, followed by an inhibitory component. The 5-fold enlarged inset shows the time-locked onset of individual responses (grey) to the light stimulation (blue) without any response-failures. Averaged response shown in black. Analysis of EPSCs show very low response jitter (**b**) (individual jitter of neurons shown as grey dots; n = 19) and response latency (**c**) (n = 14), both typical parameters for monosynaptic responses. Error bars indicate means ± s.e.m.

Supplementary Figure 3: Quantification of vHPC-evoked inhibitory conductances in IL principal cells. a, Schematic showing experimental setup. Optical terminal stimulation of ventral hippocampal inputs and whole-cell recording of pyramidal neurons in the IL. For the spiking suppression experiments (**d**), local electrical stimulation (battery symbol) was used. **b**, Current-clamp responses to hippocampal terminal release before (black trace) and after (red trace) the application of the $GABA_B$-receptor antagonist CGP55845 (n = 3), revealing the fast (yellow) and slow IPSCs (green). **c**, Bar graphs with response patterns of IL principal neurons to optical hippocampal stimulation containing fast (top, yellow) and slow (bottom, green) inhibitory conductances (percentage of the total). **d**, Investigation of spiking suppression of IL principal neurons by the hippocampus. Electrical suprathreshold stimulation was used to evoke spiking (left) while presenting optical hippocampal stimulation 150 ms before the spiking event (n = 8). Blue bars represent optical stimulation.

Supplementary Figure 4: Feed-forward inhibition onto pyramidal neurons is mediated by local IL interneurons. a, Schematic for electrical stimulation (battery symbol) of IL tissue *ex vivo* in the presence of AMPA- and NMDA-receptor antagonists NBQX and APV, respectively, to isolate GABAergic transmission. **b**, Voltage clamp (left) and current-clamp recordings (right) revealed inhibitory responses that contain both fast (yellow) and slow (green) inhibitory components. **c**, Application of the $GABA_B$-receptor antagonist CGP55845 (red trace) isolated the fast, inhibitory conductance, which was blocked by the $GABA_{A/C}$-receptor antagonist picrotoxin (green trace). Holding voltage: -60 mV.

Supplementary Figure 5: CNO- and virus-dependent silencing of IL neurons in freely moving rats. a, Schematic design of experimental approach alongside a representative image depicting DREADD-expressing neurons of animals implanted with multichannel recording arrays into the IL (40 μm coronal section; white bar inset = 250 μm). **b**, Vehicle (VEH) injections did not cause a significant change in the spontaneous activity (20 s bins) of IL neurons (n = 15 for hM4Di; n = 27 for mCherry control) (left). When the hM4D(G_i)-expressing animal was injected with 1 mg/kg (middle) or 3 mg/kg (right) of CNO, IL neurons (n = 18 for 1 mg/kg; n = 16 for 3 mg/kg) exhibited a significant reduction in spontaneous firing relative to neurons of control virus-infected animals (n = 25 for 1 mg/kg; n = 23 for 3 mg/kg; repeated measures

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Supplementary Figure 6: Pharmacological inactivation of the IL impedes retrieval of extinguished fear. Test data show mean baseline freezing (3 min), mean freezing during nine 5-ITI blocks (30-sec ITIs) and a during a post-trial period (150 sec) following infusions of muscimol or vehicle into the IL (MUSC, $n = 6$; VEH, $n = 10$; repeated measures ANOVA, main effect of drug: $F_{1,14} = 35.78$, $^{***}P < 0.0001$). Corresponding conditioning and extinction data are shown in Fig. 4. Error bars indicate means ± s.e.m.

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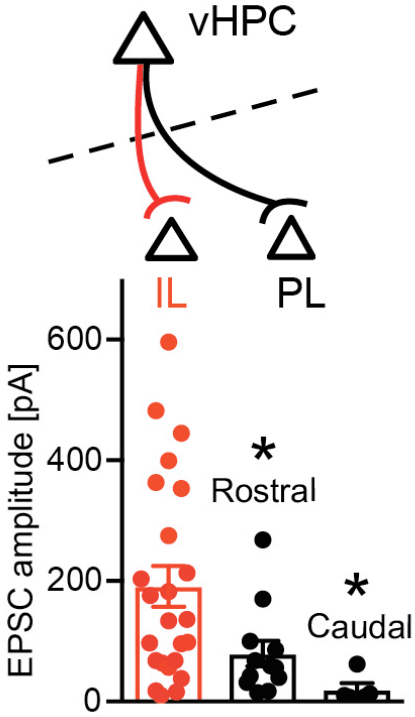

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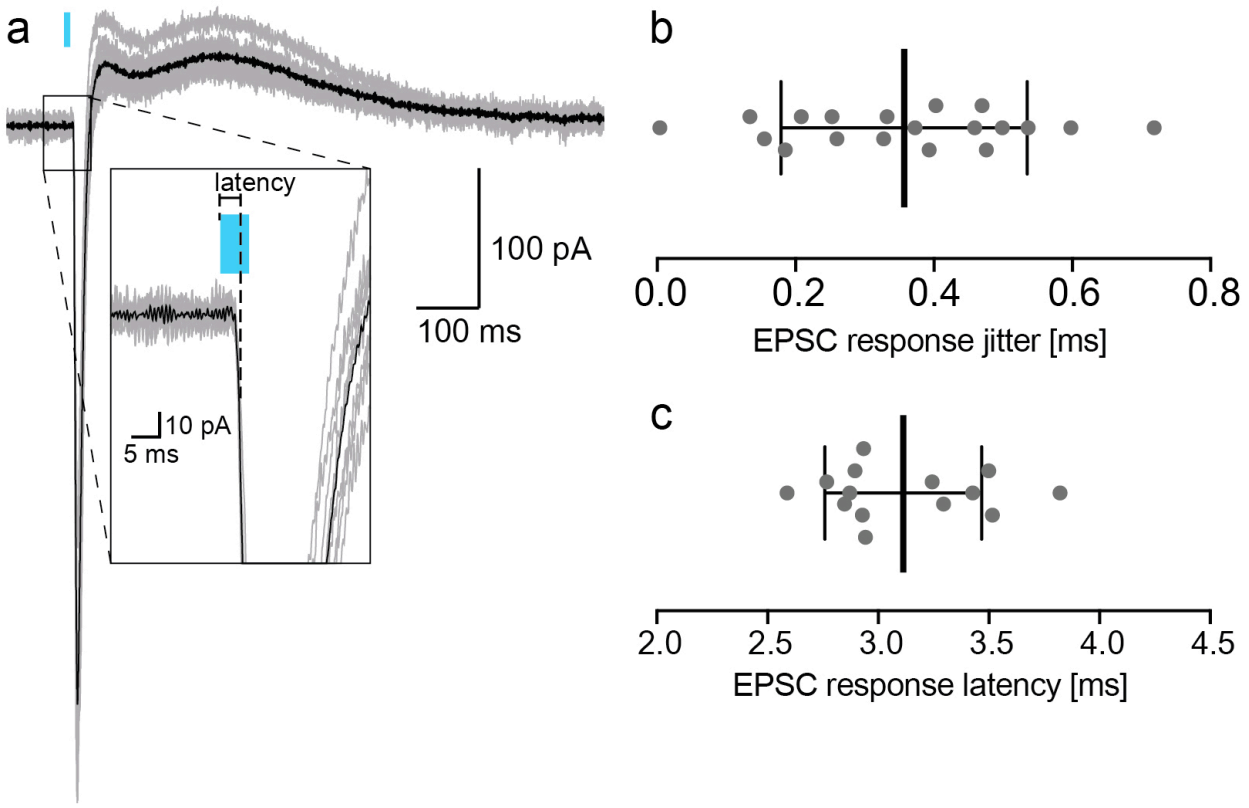

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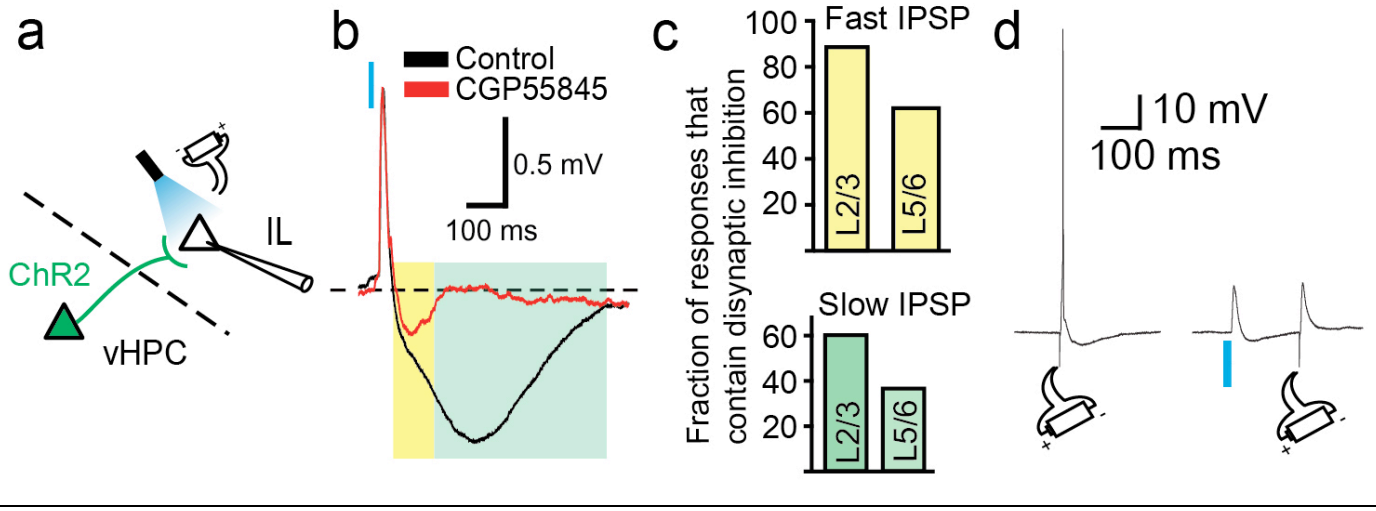

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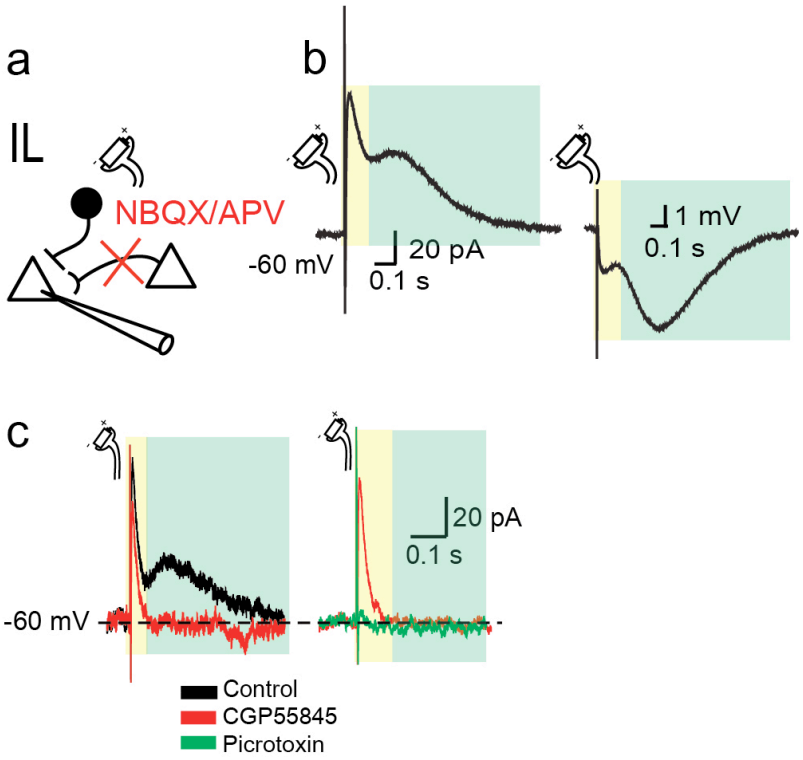

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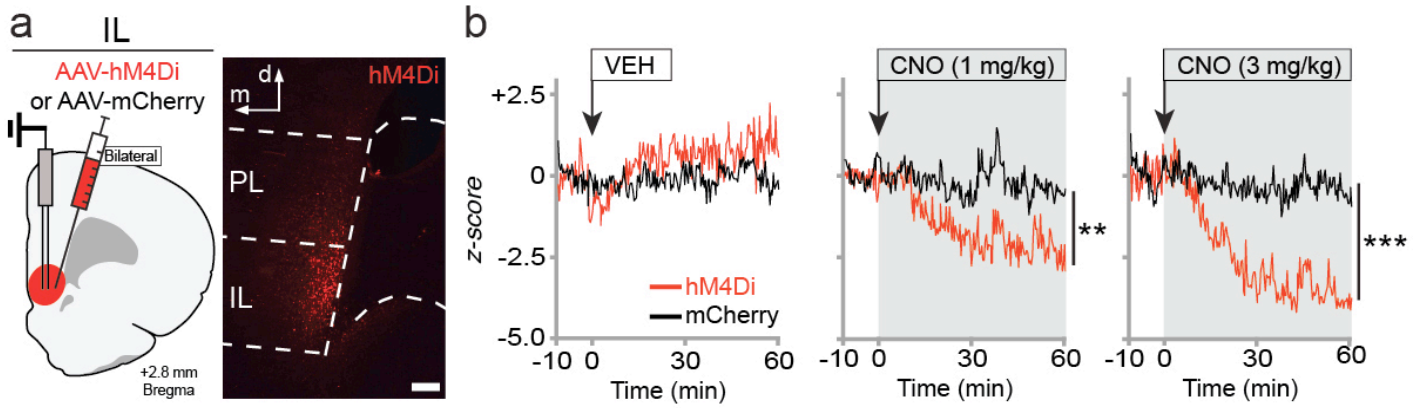

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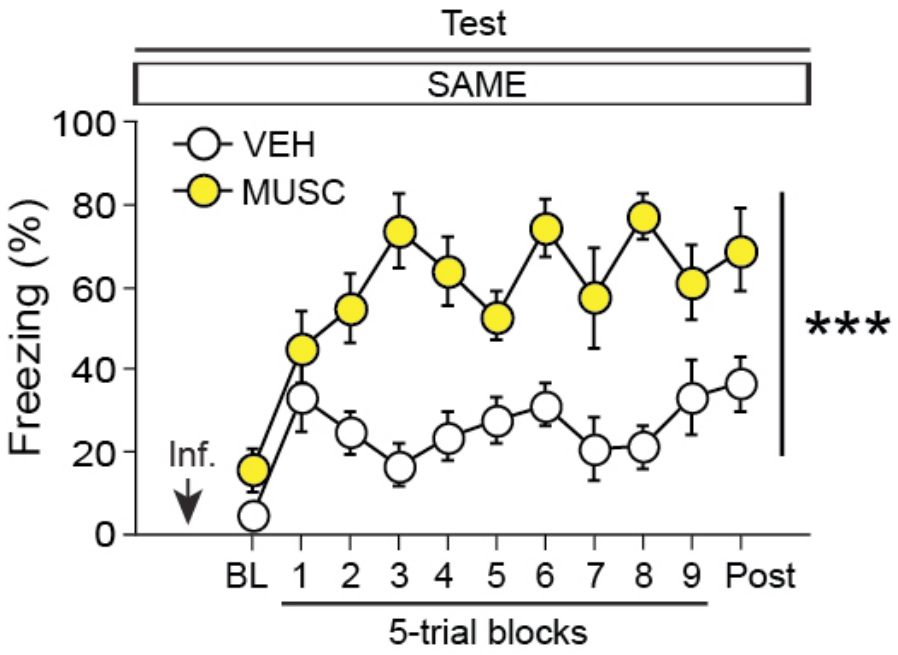

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