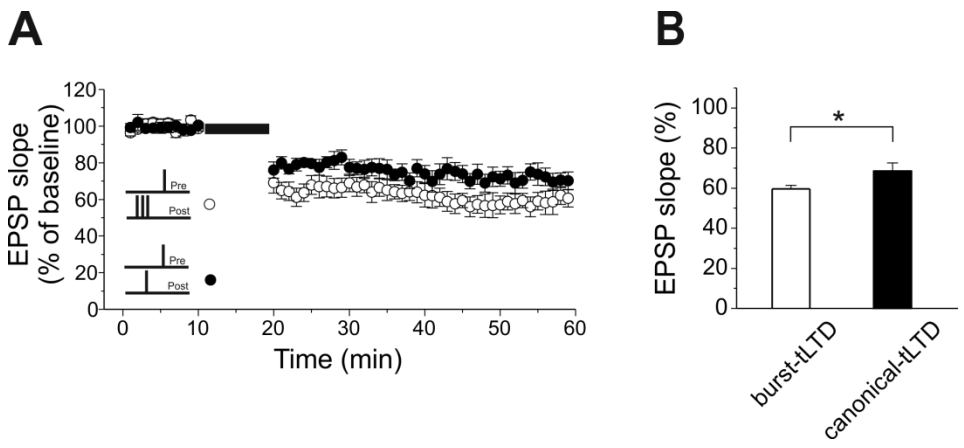
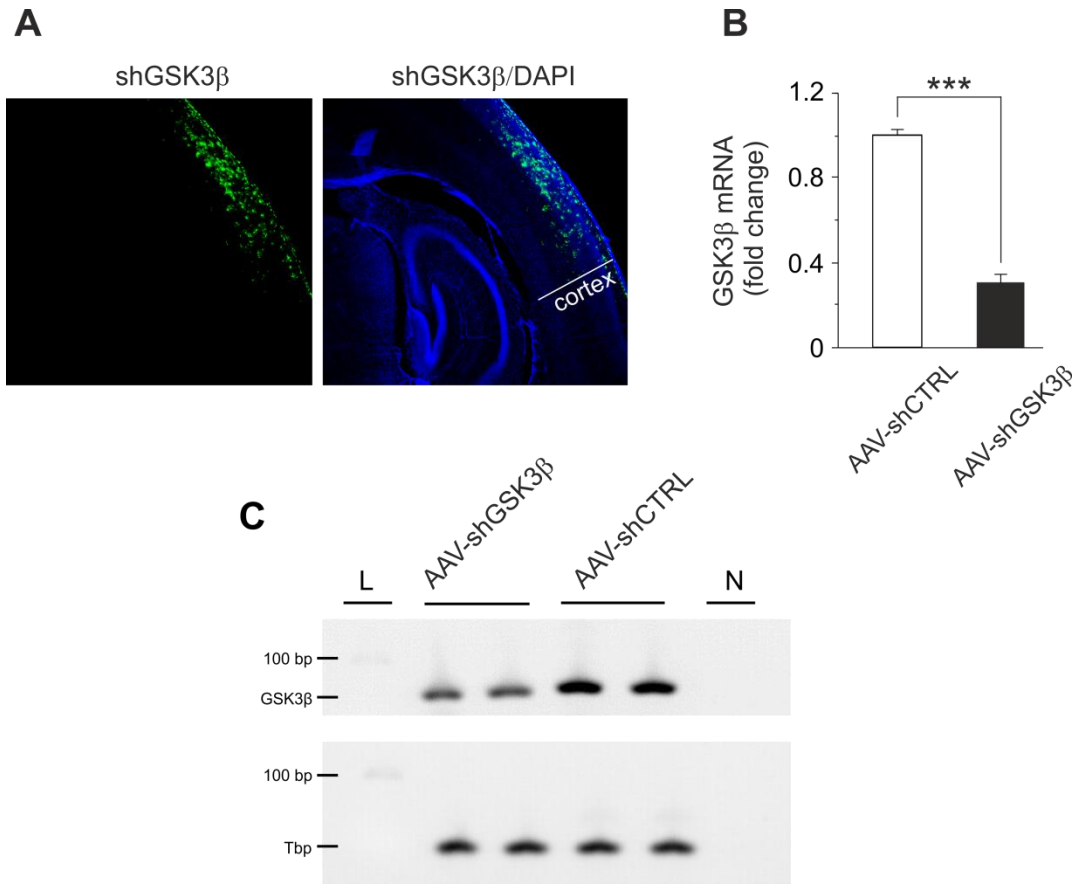
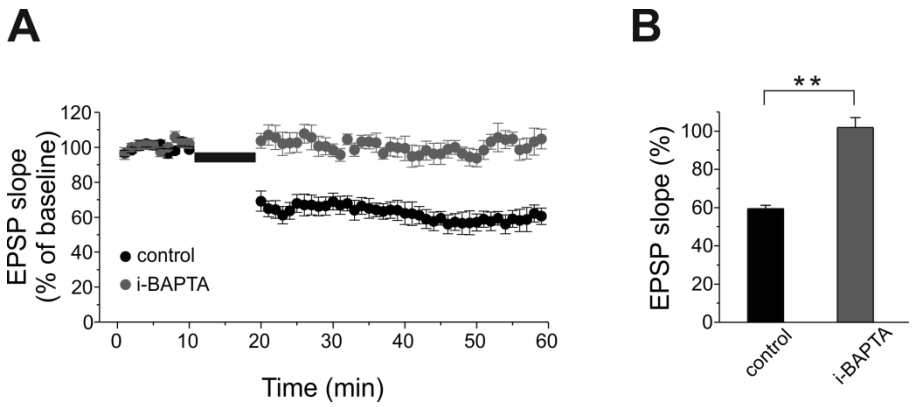


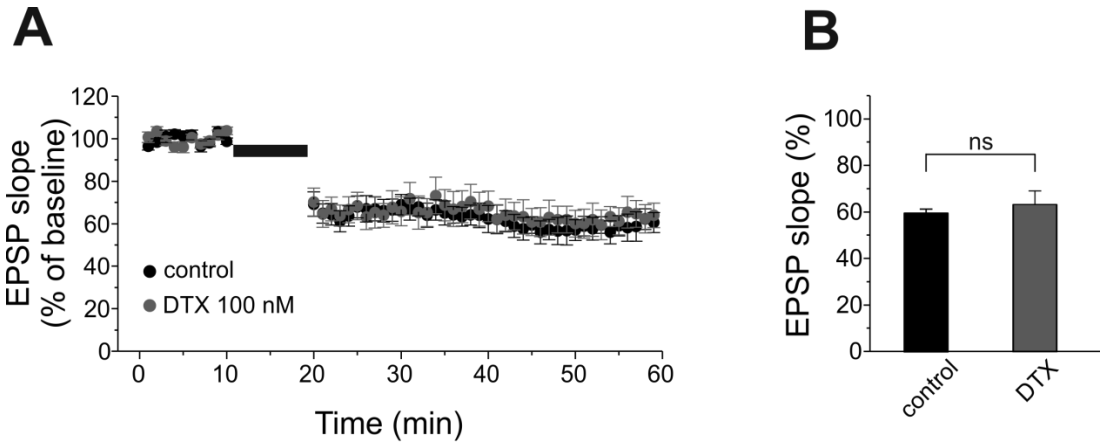
Supplementary Figure 1. **tLTD dependence on the number of APs in the induction protocol.** **(A)** Average time course of EPSP slope, normalized to baseline values, during tLTD experiments in which a single AP or a burst of three APs (at 100 Hz) was utilized in the induction protocol. Inset depict the pairing protocol. The last AP preceded the onset of EPSP by Δt = -10 ms. Note that tLTD magnitude was correlated only weakly with the number of APs preceding the EPSP. (**B**) Bar graph comparing the average EPSP amplitude measured during the last 5 min recording expressed as a percentage of the baseline slope (100%) under the experimental conditions showed in A (burst protocol: *n* = 10 from 5 mice; canonical protocol: *n* = 9 from 5 mice).



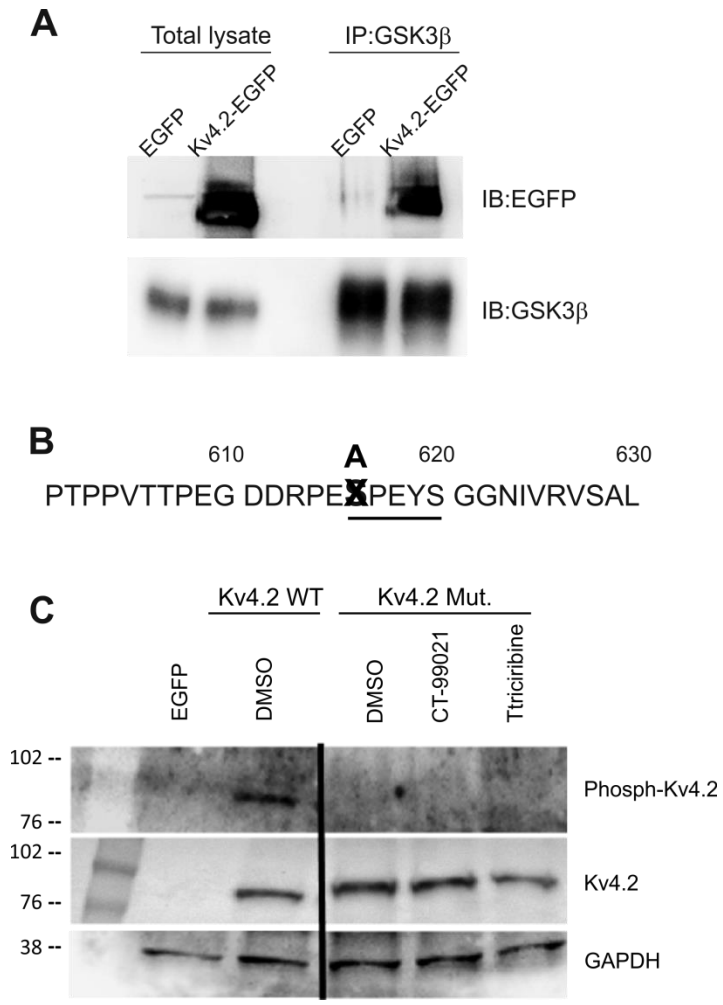
Supplementary Figure 2. GSK3β shRNA vector validation. (**A**) Representative images showing viral vector localization (EGFP immunofluorescence) in the somatosensory cortex (left). EGFP/DAPI staining merge is also shown (right). **(B)** *In vivo* validation of GSK3β mRNA knockdown in pyramidal neurons by single cell reverse transcription quantitative real-time PCR. Bar graph shows the fold change of GSK3β mRNA normalized to the housekeeping Hprt in control (AAV-shCTRL-GFP) and knocked down (AAV-shGSK3β-GFP) pyramidal somatosensory neurons. Values are expressed as means ± SEM. (*n* = 7 cells per group; total number of mice: 10). ***p<0.001. (C) Representative Sybr-safe precast agarose gel shows RT-qPCR products of the expected size for GSK3β (72 bp) and Tbp (65 bp) from siRNA GSK3β (Lanes 2 and 3) and Scramble (Lanes 4 and 5) single cell neurons. Two microliters of RT-PCR negative control, add to TaqMan Mix, was used for RT-qPCR negative control (N). Lane 1 represents DNA ladder (L).



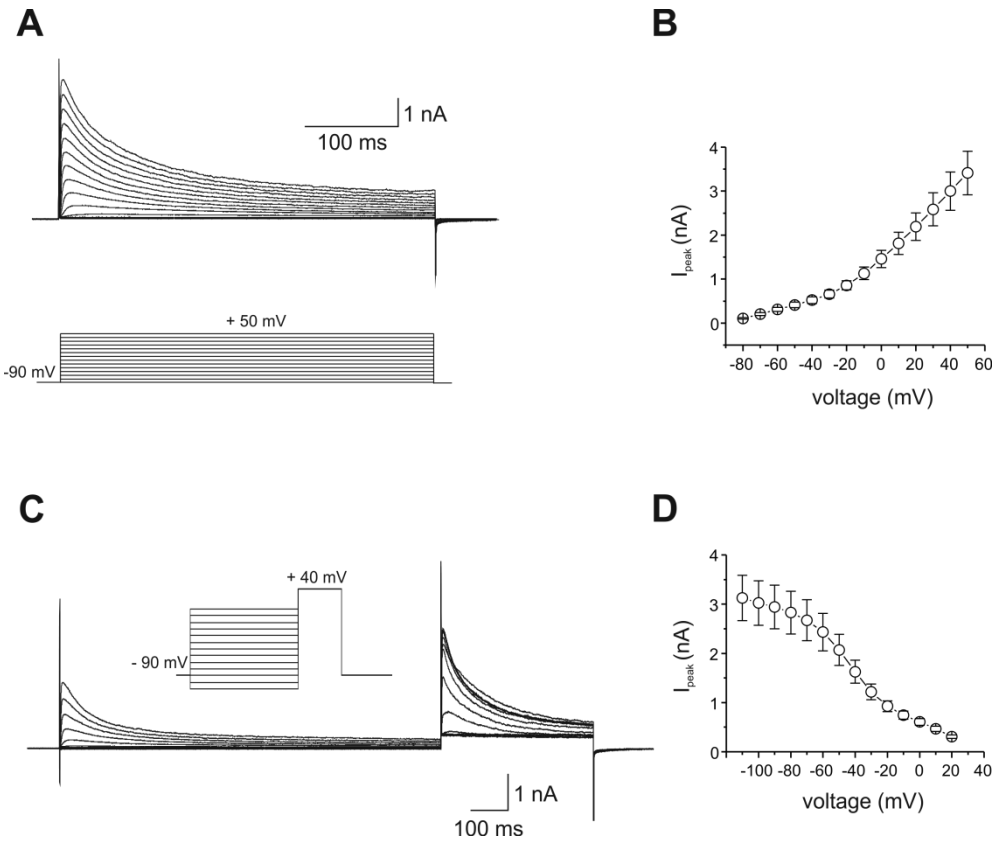
Supplementary Figure 3. **Postsynaptic Ca^{2+}-dependency of tLTD. (A)** Average time course of EPSP slope, normalized to baseline values, during tLTD experiments in which BAPTA (10 mM) was intracellularly perfused through the patch-pipette (10 mM; gray circle; *n* = 8 cells from 4 mice). For comparison, control tLTD is also shown (black circle). (**B**) Bar graph comparing the average EPSP slope under the experimental conditions showed in A.



Supplementary Figure 4. **Dendrotoxin, a selective Kv1 channel inhibitor, does not affect tLTD. (A)** Average time course of EPSP slope showing that slice treatment with 100 nM DTX does not affect tLTD (gray circle; *n* = 8 cells from 4 mice). For comparison, control tLTD is also shown (black circle, *n* =10 cells from 5 mice). (**B**) Bar graph comparing the average EPSP slope in the experimental conditions showed in A.



Supplementary Figure 5. Kv4.2 is bound and phosphorylated by GSK3β in HEK293. In HEK293 cells expressing the mutant Kv4.2^{S616A} the phosphorylation of Ser-616 was completely lost. (**A**) HEK293 cells expressing either the Kv4.2-EGFP or the EGFP empty vectors were immunoprecipitated (IP) with an antibody against GSK3β. Blots were probed (IB) with antibodies against GSK3β or EFGP. (**B**) Primary sequence of the C-terminal domain of Kv4.2 channels in which the aminoacid Ser-616 was substituted with the amino acid alanine. **(C)** Representative blots of total cell lysate from HEK293 cells transfected either with Kv4.2-WT or empty vector (EGFP) or mutated Kv4.2 plasmids probed with anti-phospho-Ser-616 (upper panel) or total Kv4.2 (lower panel) antibodies. Note the absence of phospho-Ser-616 immunoreactivity, in all the experimental conditions, in cells transfected with mutated Kv4.2.



Supplementary Figure 6. Voltage-dependence of activation and inactivation of transient Kv4.2-induced K^+ currents in HEK293 cells. (**A**) Current traces evoked in HEK293 cells expressing KV4.2 by depolarizing steps to potentials between -80 and +50 mV with 10 mV increment from an holding potential of -80 mV. (**B**) Averaged I-V relationship obtained from 22 recordings. (**C**) Current traces evoked by test depolarization to +40 mV after 1 s pre-pulse to potentials between -110 and +20 mV with 10 mV increment. (**D**) Voltage-dependence of steady-state inactivation.