Figure S3, related to figures 3,4

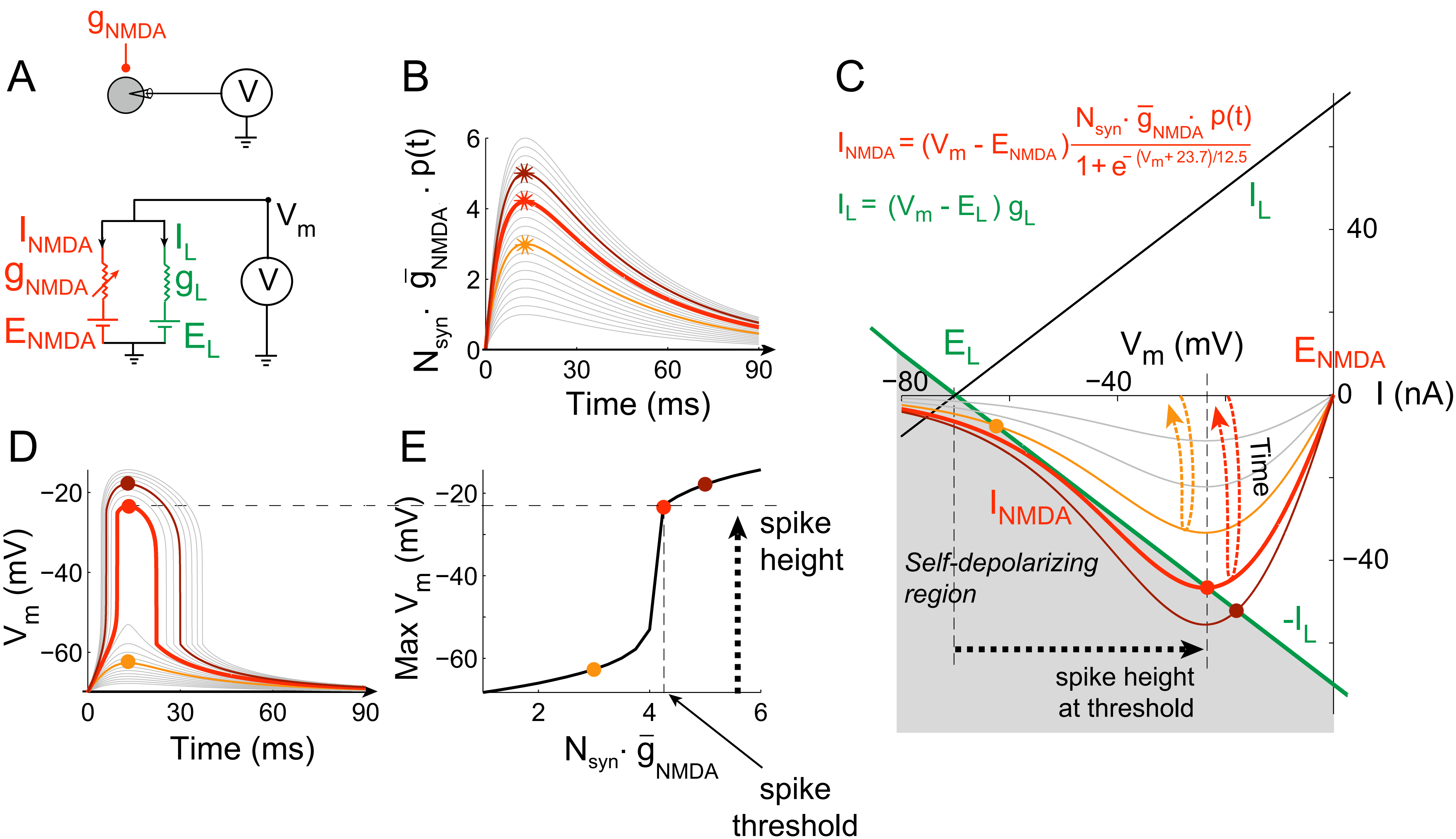

Figure S3 Model of NMDA channel and definitions of NMDA spike threshold and height. (A) A single compartment model of neural membrane with an NMDA and leak conductance. (B) Example time courses of peak NMDA conductance for different values of N_{syn}. Asterisk indicates time at which p(t) = 1. (C) I-V curves for leak (I_L) and steady-state (i.e. p(t) = 1) NMDA conductance (I_{NMDA}) in the single compartment. Mathematical formulation of NMDA conductance shows a dependence on both membrane voltage and time-dynamics [54]. Also shown are the equations for steady-state value of V_m. The I-V plots show the resulting V_m (colored dots) for the different values of N_{syn} shown in B: it is the voltage for which net inward current (I_{NMDA}) is balanced by the outward current (I_L). These I-V plots can also give us an idea of how the membrane voltage will change as p(t) changes in time, as shown in B. They can be thought of as instantaneous I-V curves giving an estimate for V_m (as described above) for different values of $N_{syn}\times p(t)$. The "Time" arrow follows the I-V curves for I_{NMDA} as $N_{syn}\times p(t)$ changes in time. The intersection of each of these time-changing I-V curves with the leak I-V curve (I_L, reflected in green) gives an estimate for V_m as a function of time. Notice that as $N_{syn}\times p(t)$ changes follow the yellow curve in B, the intersection of resulting I-V curves with the leak I-V curve is a linear progression similar to the linear rise and fall of V_m in D (yellow curve). When $N_{syn}\times p(t)$ changes follow the red curve in B, the sintersection of resulting I-V curves with the leak I-V curve involves a non-linear jump (yellow dot and red dot) leading to the non-linear rise and fall of V_m in D (red curve). Any value of N_{syn} larger than this will ensure a non-linear jump in the I-V domain (all curves below red) and consequently the time domain (D, all curves above red). Thus, spikes in the time domain correspond to all the NMDA I-V curves in C whose negative slope region lies completely below the $-I_L$ (green) I-V curve, as shown. Specifically, the smallest N_{syn} (red curve) for which this is the case is a representative of the minimum conductance required, given the membrane leak, to generate a spike in time-domain. The exact N_{syn} would depend on the exact time-course of the conductance and the membrane capacitance.

(D) V_m at the single compartment in the presence of time-varying NMDA conductance, as described in C. Sufficient value of N_{syn} (red) leads to a non-linear jump in peak V_m - the NMDA spike. (E). I/O curve for peak values of voltage traces shown in D. Notice the NMDA-based super-linear jump in the function.