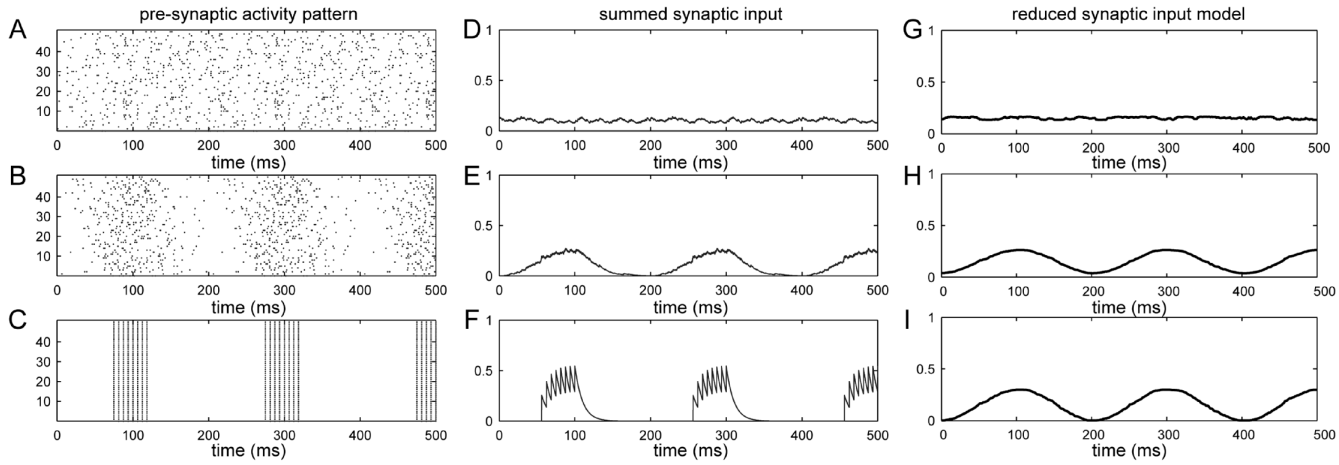

Fig. S1. Derivation of the reduced synaptic input: As the firing patterns of the pre-synaptic GPi neurons vary due to PD from uncorrelated firing to correlated bursting (*A-C*) (Chen *et al.*, 2006, 2007; Fogelson *et al.*, 2005; Hutchison *et al.*, 2004; Levy *et al.*, 2000, 2002; Terman *et al.*, 2002; Trottenberg *et al.*, 2007; Raz *et al.*, 2000), the temporal characteristics of the synaptic input observed by the post-synaptic TC relay neuron alter (*D-F*) (Rubin and Terman, 2004; Guo *et al.*, 2008). We studied the summed synaptic conductance change applied to the multi-compartment neuron model for different synaptic input correlation levels (*C*) and firing patterns (i.e. regular firing, bursting, frequency-modulated tonic firing) of individual GPi neurons, in order to reduce the synaptic input to perform quantitative analysis on the single compartment model. *D:* For uncorrelated pre-synaptic GPi input ($C = 0$), the summed synaptic conductance induced in the TC relay neuron resembled a fixed conductance with superimposed noise; *E:* As the correlation level increased; the summed synaptic conductance converged to an oscillatory signal. Enhancing the correlation level in the GPi input increased the ratio between the summed synaptic conductance amplitude and mean conductance in a nonlinear fashion ($C = 0.8$); *F:* For very high correlation levels, the synaptic conductance resembled the scaled postsynaptic conductance change induced by a single GPi neuron ($C = 1$). *G*: The reduced synaptic input for the single compartment model approximates the multi-compartment synaptic input model using a constant synaptic conductance with noise when the group of pre-synaptic GPi neurons are in the intrinsic uncorrelated state (i.e. $\alpha = 0$). *H*: The reduced synaptic input approximates the multi-compartment synaptic input model by using a noisy sinusoidal signal when the group of pre-synaptic GPi neurons are in the correlated state due to PD (i.e. $0 < \alpha \leq 1$). The nonlinear increase in the ratio between the summed synaptic conductance amplitude and mean level due to changes in the correlation level (multi-compartment model) is approximated by varying the modulation depth (α) of the sinusoidal signal ($\alpha = 0.75$). *I*: The reduced synaptic input model no longer captures all the temporal characteristics of the summed synaptic input when pre-synaptic correlation level is greater than 0.95 ($\alpha = 1$). Correlation levels greater than 0.95 correspond to pre-synaptic neurons being synchronized at biologically implausible levels (e.g. Fig. S1C).