Critical Roles of the Direct GABAergic Pallido-cortical Pathway in Controlling Absence Seizures

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S1 APPENDIX

By applying several reasonable assumptions mentioned in the main text, the modified BGCT model implemented in the present study becomes computationally more tractable without significant deteriorating the precision of numerical results. Then, the final mathematical description of our current BGCT model can be rewritten in the first-order, given as follows:

$$\frac{\mathrm{d}\phi_e(t)}{\mathrm{d}t} = \dot{\phi}_e(t), \tag{A1}$$

$$\frac{\mathrm{d}\dot{\phi}_e(t)}{\mathrm{d}t} = \gamma_e^2 \left\{-\phi_e(t) + F[V_e(t)]\right\} - 2\gamma_e \dot{\phi}_e(t), \tag{A2}$$

$$\frac{\mathrm{d}V_e(t)}{\mathrm{d}t} = \dot{V}_e(t), \tag{A3}$$

$$\frac{\mathrm{d}\dot{V}_e(t)}{\mathrm{d}t} = \alpha\beta \left\{-V_e(t) + v_{ee}\phi_e(t) + v_{ei}F[V_e(t)] + v_{ep_2}F[V_{p_2}(t)] + v_{es}F[V_s(t)]\right\} - (\alpha+\beta)\dot{V}_e(t), \tag{A4}$$

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$$\frac{\mathrm{d}V_{d_1}(t)}{\mathrm{d}t} = \dot{V}_{d_1}(t), \tag{A5}$$

$$\frac{\mathrm{d}\dot{V}_{d_1}(t)}{\mathrm{d}t} = \alpha\beta\left\{-V_{d_1}(t) + v_{d_1e}\phi_e(t) + v_{d_1d_1}F[V_{d_1}(t)] + v_{d_1s}F[V_s(t)]\right\} - (\alpha+\beta)\dot{V}_{d_1}(t), \tag{A6}$$

$$\frac{\mathrm{d}V_{d_2}(t)}{\mathrm{d}t} = \dot{V}_{d_2}(t), \tag{A7}$$

$$\frac{\mathrm{d}\dot{V}_{d_2}(t)}{\mathrm{d}t} = \alpha\beta\left\{-V_{d_2}(t) + v_{d_2e}\phi_e(t) + v_{d_2d_2}F[V_{d_2}(t)] + v_{d_2s}F[V_s(t)]\right\} - (\alpha+\beta)\dot{V}_{d_2}(t), \tag{A8}$$

$$\frac{\mathrm{d}V_{p_1}(t)}{\mathrm{d}t} = \dot{V}_{p_1}(t), \tag{A9}$$

$$\frac{\mathrm{d}\dot{V}_{p_1}(t)}{\mathrm{d}t} = \alpha\beta\left\{-V_{p_1}(t) + v_{p_1d_1}F[V_{d_1}(t)] + v_{p_1p_2}F[V_{p_2}(t)] + v_{p_1\zeta}F[V_\zeta(t)]\right\} - (\alpha+\beta)\dot{V}_{p_1}(t), \tag{A10}$$

$$\frac{\mathrm{d}V_{p_2}(t)}{\mathrm{d}t} = \dot{V}_{p_2}(t), \tag{A11}$$

$$\frac{\mathrm{d}\dot{V}_{p_2}(t)}{\mathrm{d}t} = \alpha\beta\left\{-V_{p_2}(t) + v_{p_2d_2}F[V_{d_2}(t)] + v_{p_2p_2}F[V_{p_2}(t)] + v_{p_2\zeta}F[V_\zeta(t)]\right\} - (\alpha+\beta)\dot{V}_{p_2}(t), \tag{A12}$$

$$\frac{\mathrm{d}V_\zeta(t)}{\mathrm{d}t} = \dot{V}_\zeta(t), \tag{A13}$$

$$\frac{\mathrm{d}\dot{V}_\zeta(t)}{\mathrm{d}t} = \alpha\beta\left\{-V_\zeta(t) + v_{\zeta e}\phi_e(t) + v_{\zeta p_2}F[V_{p_2}(t)]\right\} - (\alpha+\beta)\dot{V}_\zeta(t), \tag{A14}$$

$$\frac{\mathrm{d}V_r(t)}{\mathrm{d}t} = \dot{V}_r(t), \tag{A15}$$

$$\frac{\mathrm{d}\dot{V}_r(t)}{\mathrm{d}t} = \alpha\beta\left\{-V_r(t) + v_{re}\phi_e(t) + v_{rp_1}F[V_{p_1}(t)] + v_{rs}F[V_s(t)]\right\} - (\alpha+\beta)\dot{V}_r(t), \tag{A16}$$

$$\frac{\mathrm{d}V_s(t)}{\mathrm{d}t} = \dot{V}_s(t), \tag{A17}$$

$$\begin{aligned}\frac{\mathrm{d}\dot{V}_s(t)}{\mathrm{d}t} =& \alpha\beta \left\{ -V_s(t) + v_{se}\phi_e(t) + v_{sp_1}F[V_{p_1}(t)] + v_{sr}^{A}F[V_r(t)] + v_{sr}^{B}F[V_r(t-\tau)] + \phi_n \right\} \\ & -(\alpha+\beta)\dot{V}_s(t).\end{aligned} \tag{A18}$$