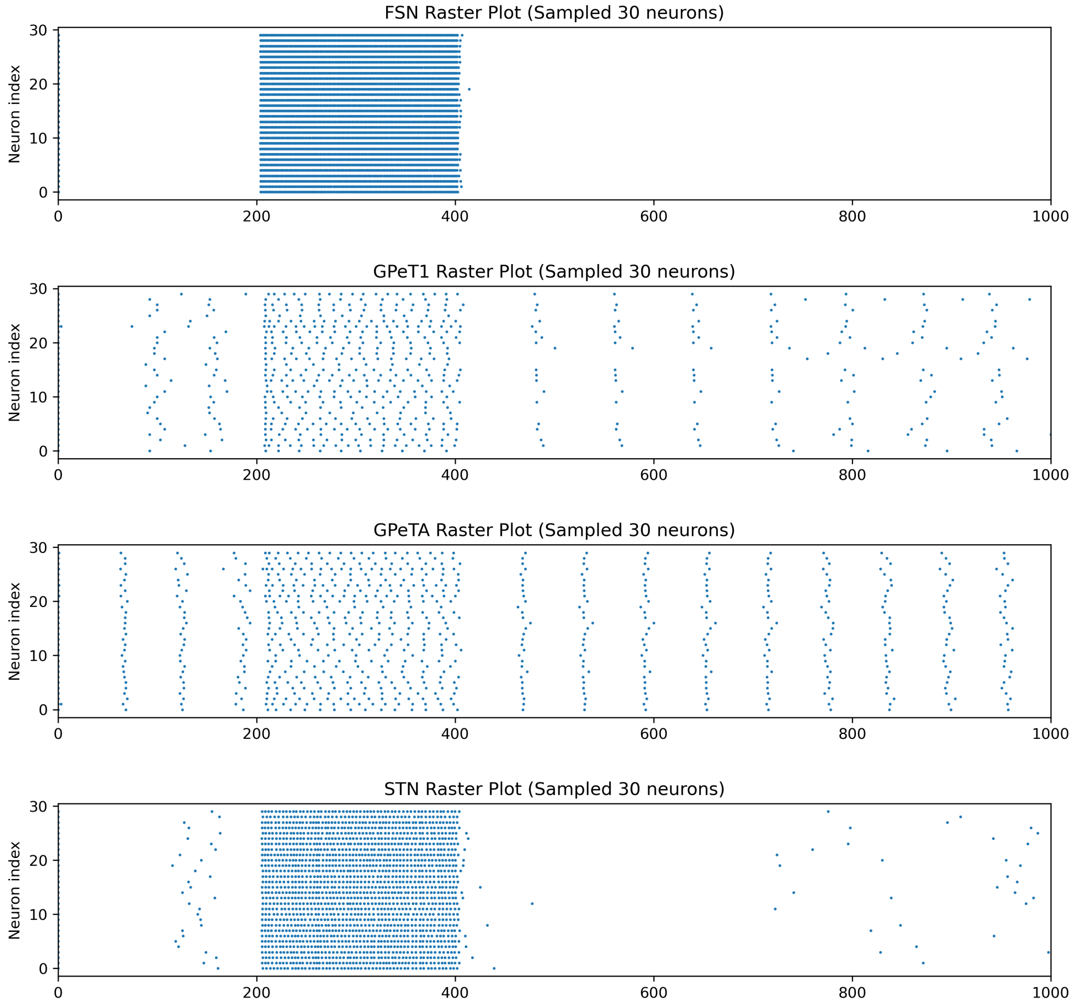
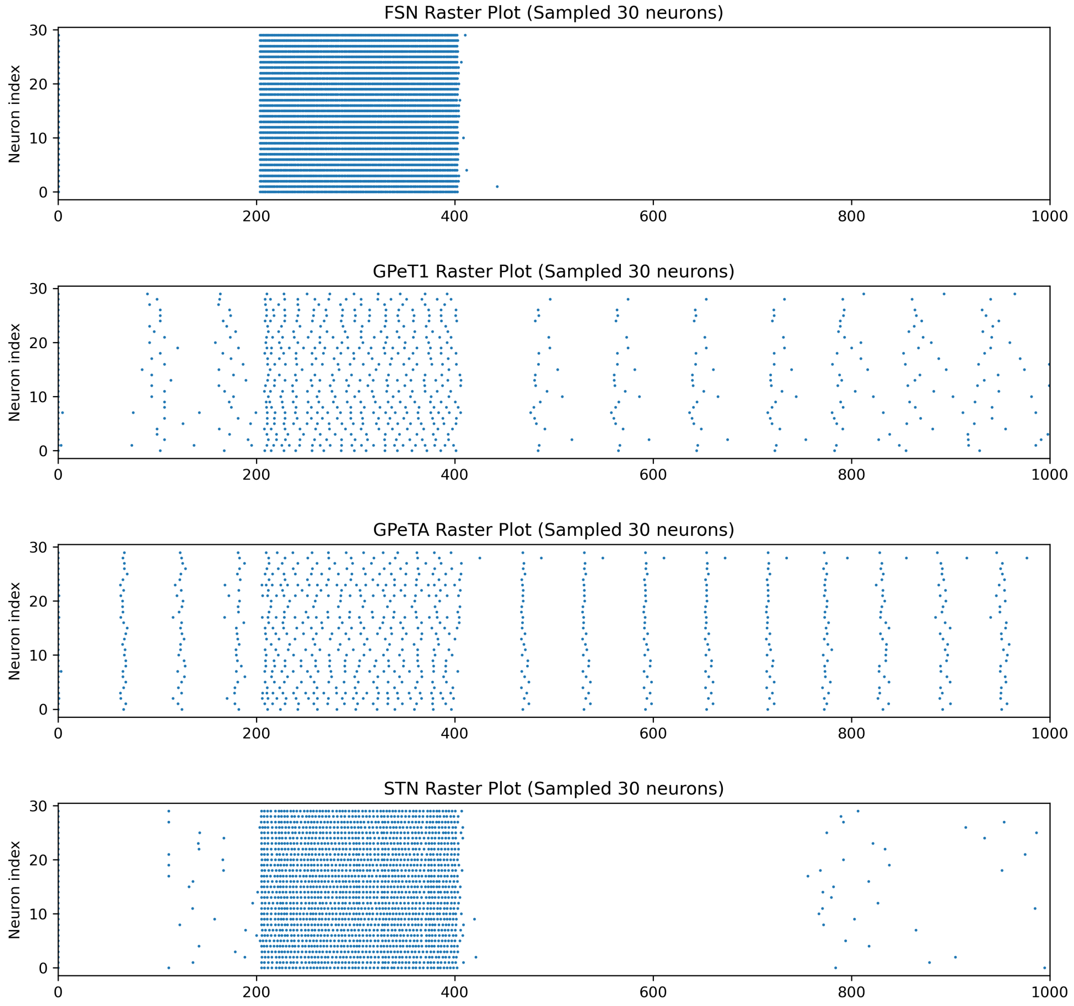
Experiment Result

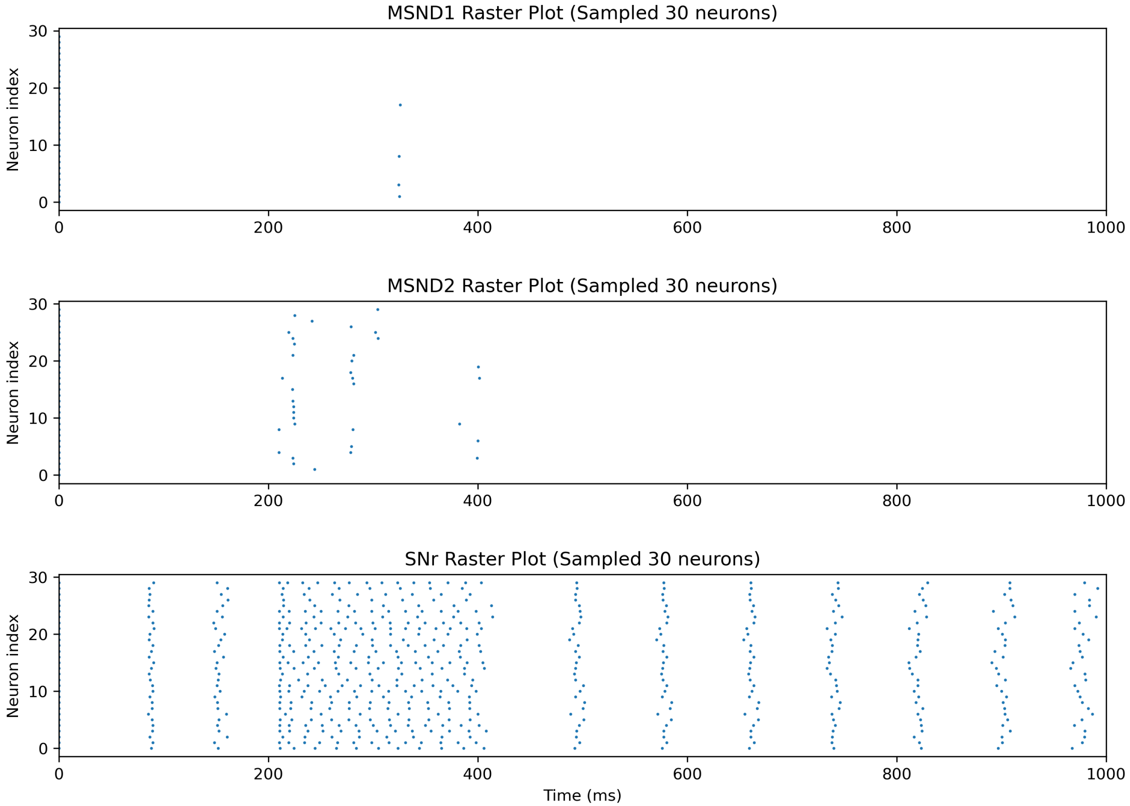
Normal

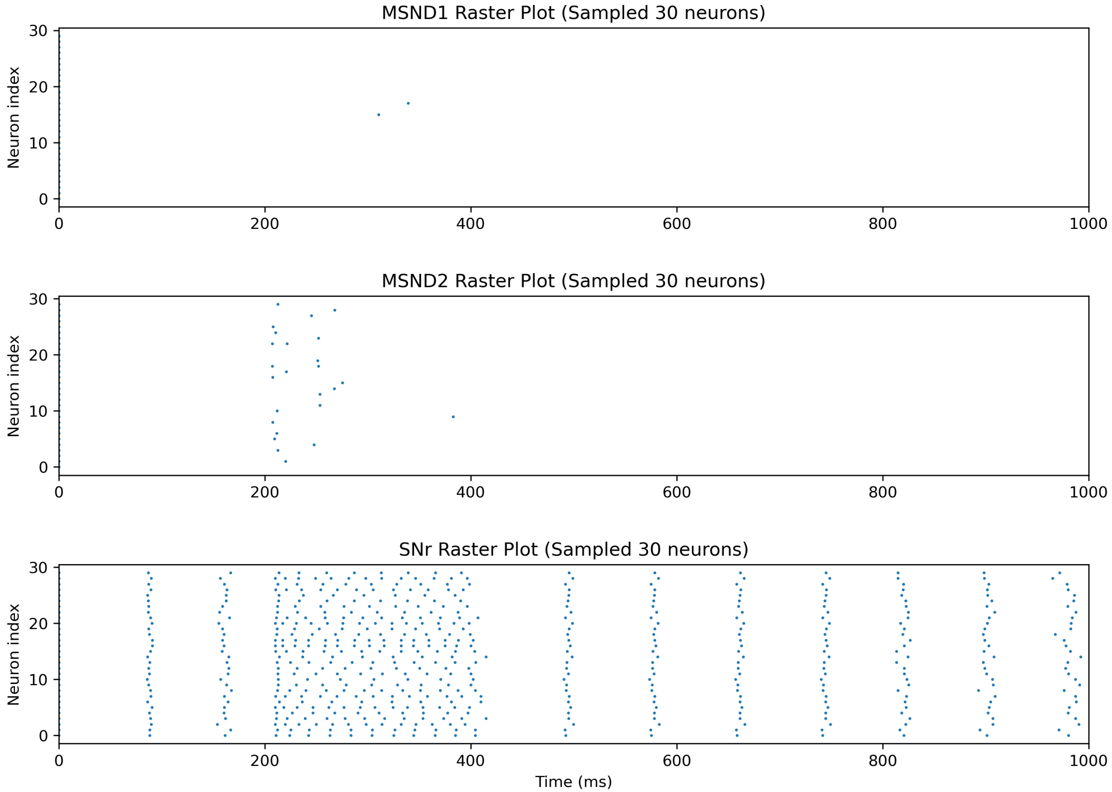




Experiment Result

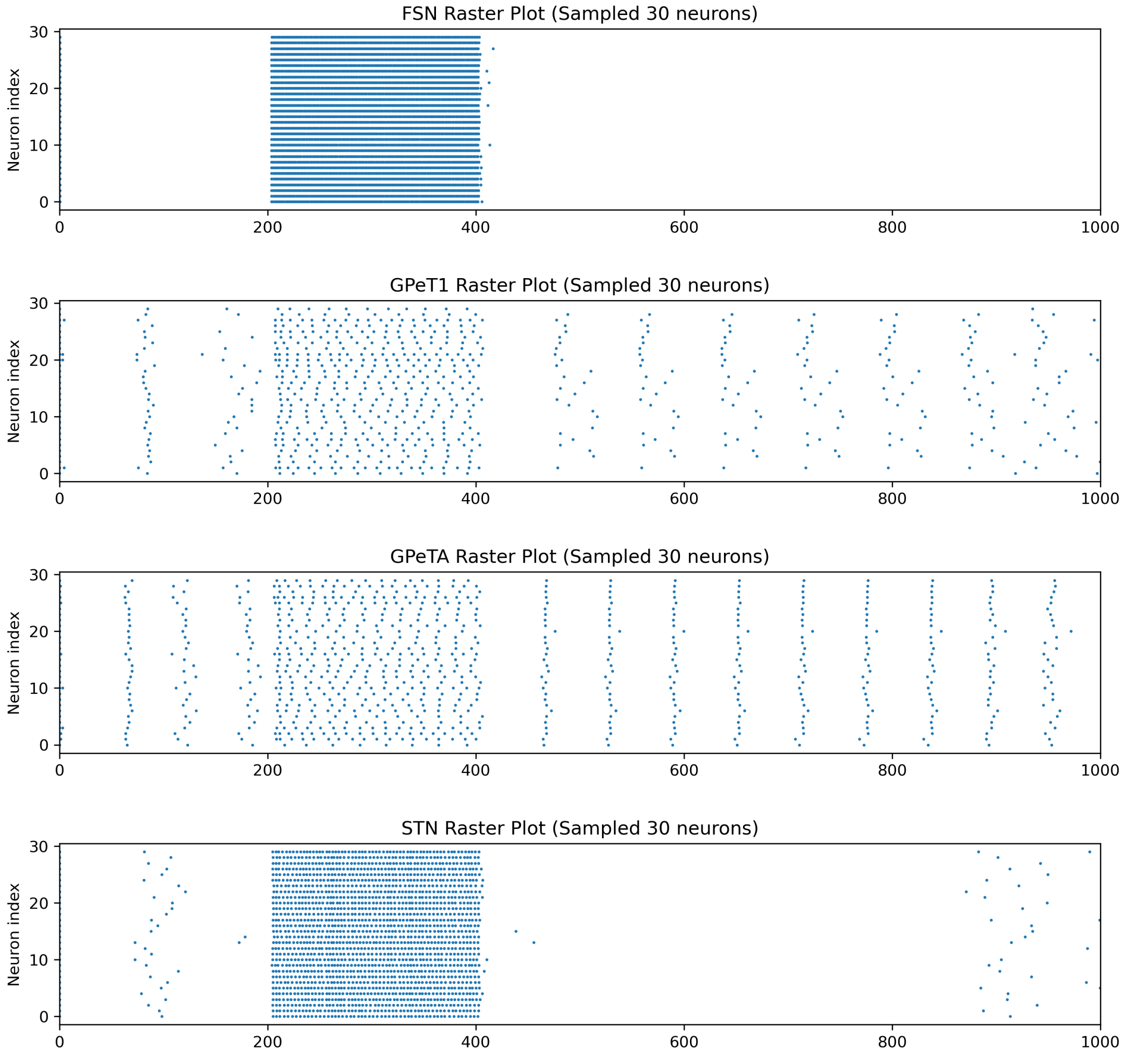
Normal

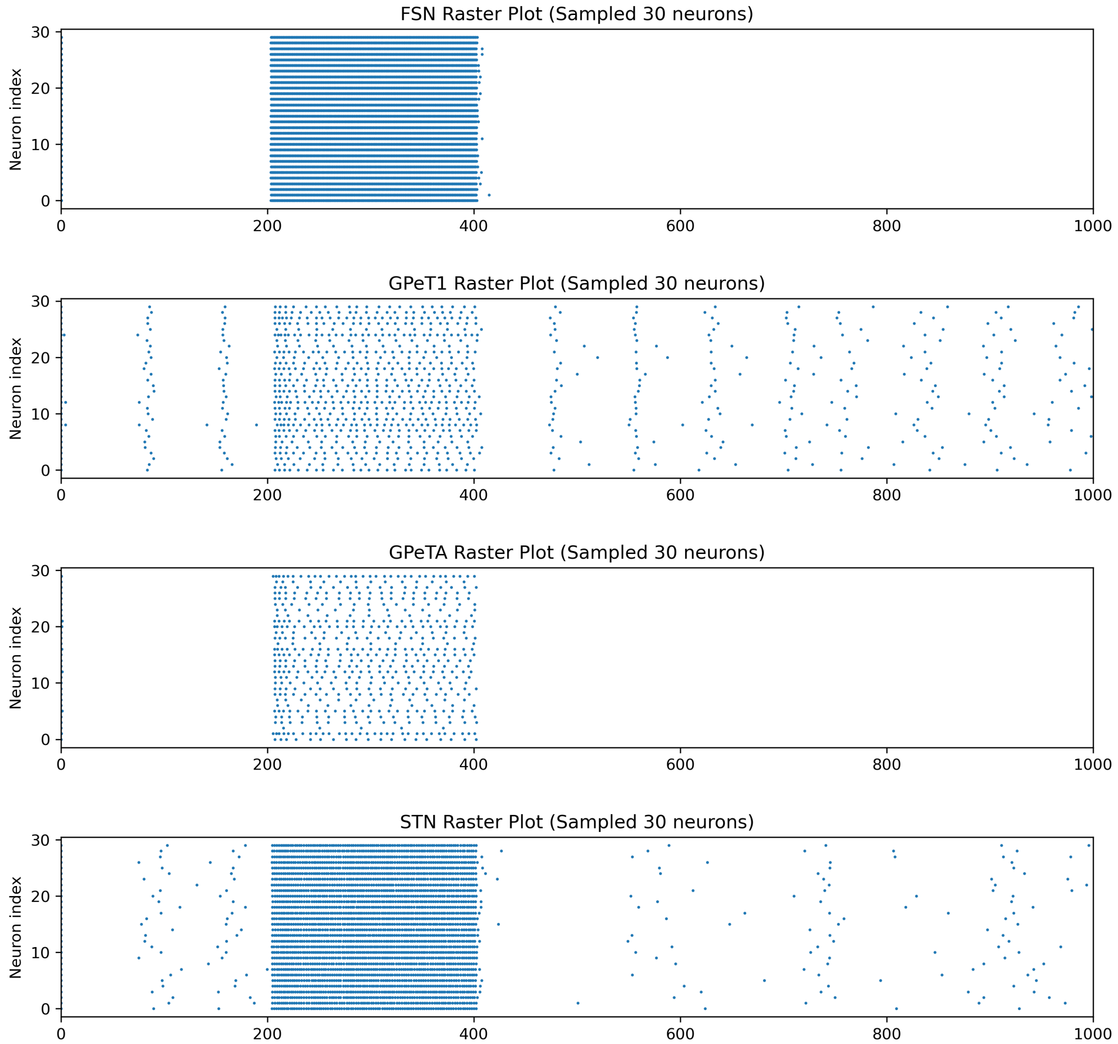




Experiment Result

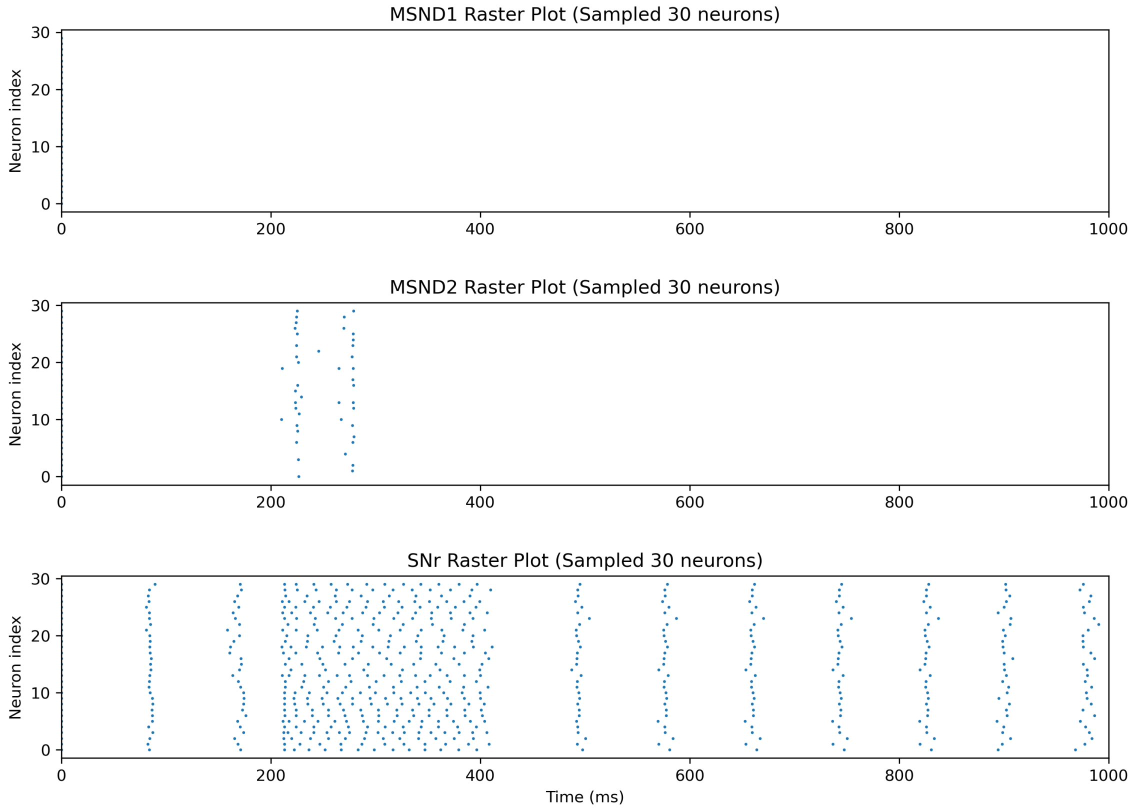
Parkinson’s disease

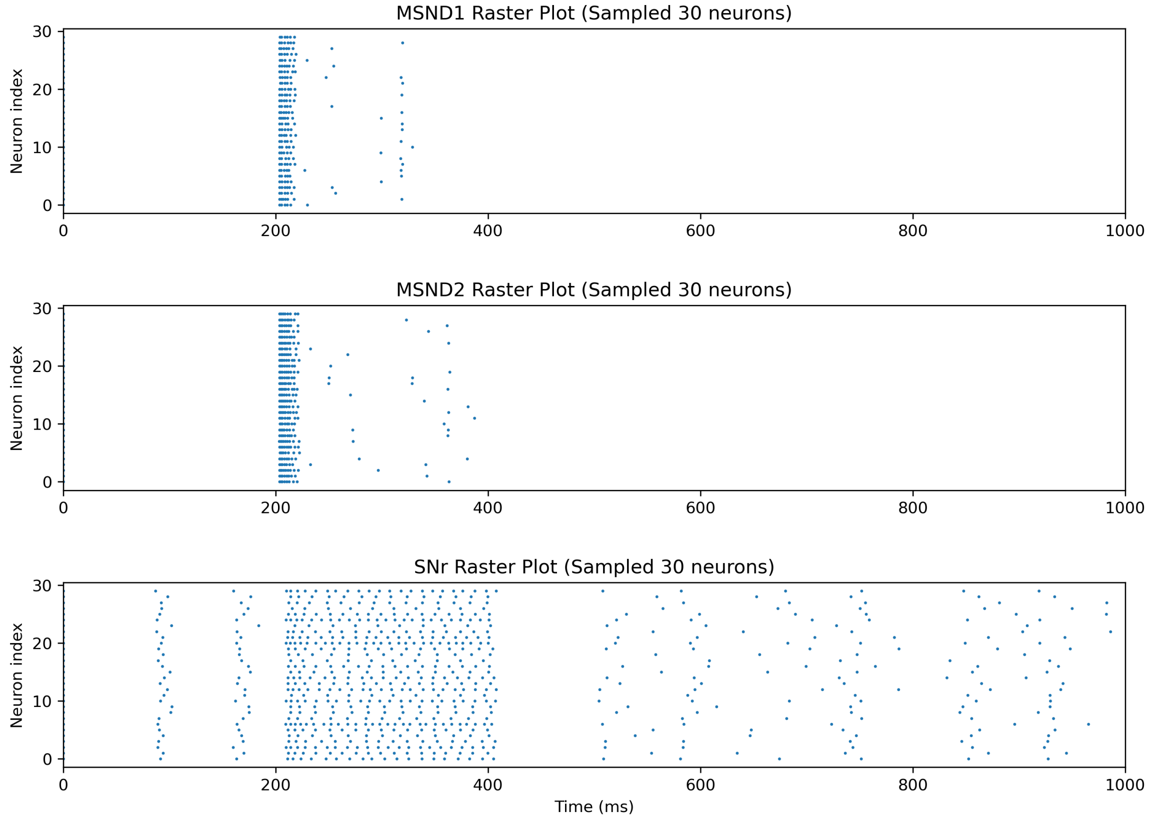




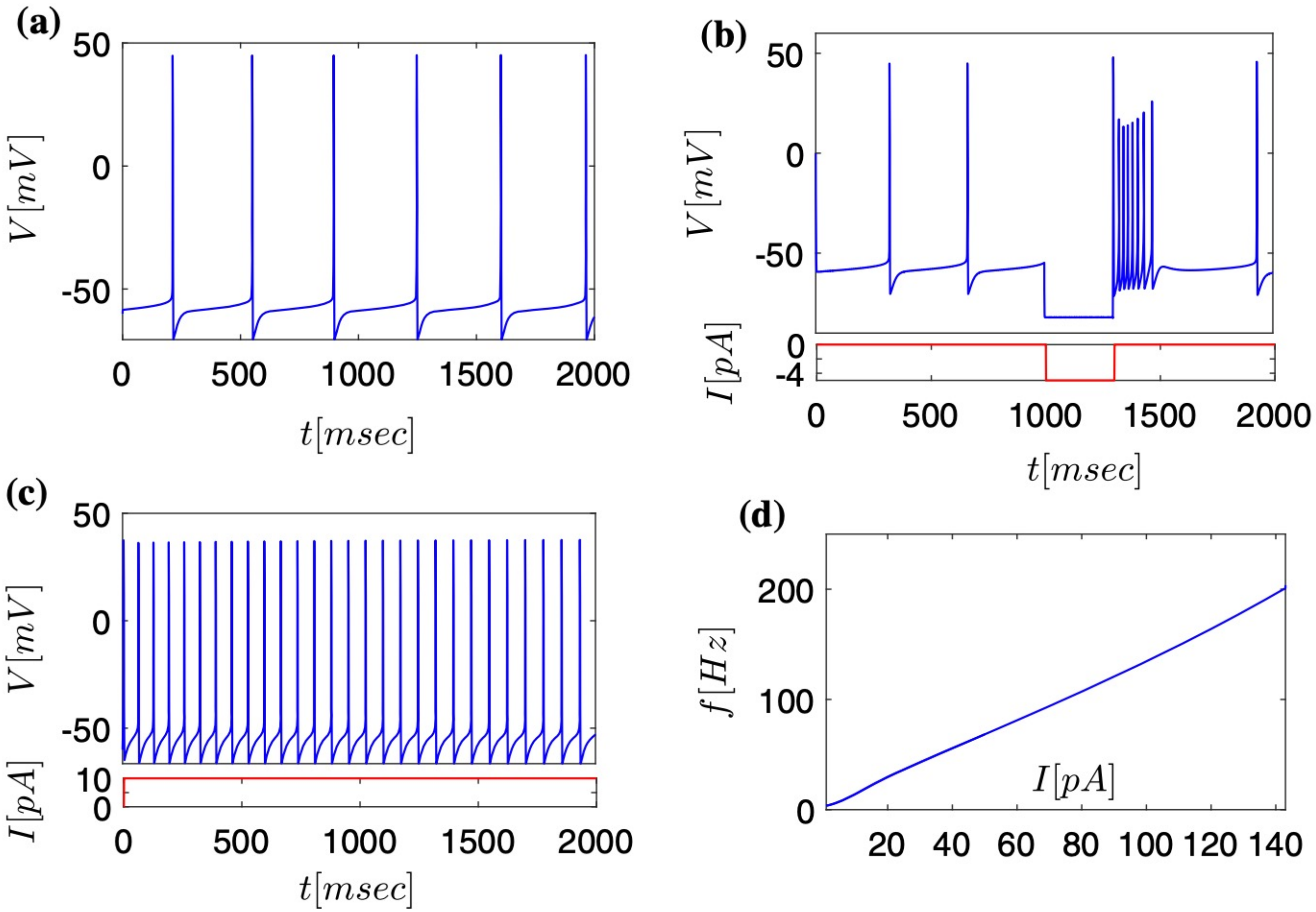
Experiment Result

Parkinson’s disease





Cortex Stimulus



Modelled activity of single STN neurons under different current injection input conditions described by eqs.

(a) neurons without current injection fire with a frequency around 3 Hz
(b) A negative current injection applied between t=1.0 and t=1.2 sec
(c) Injection of 10 pA positive current

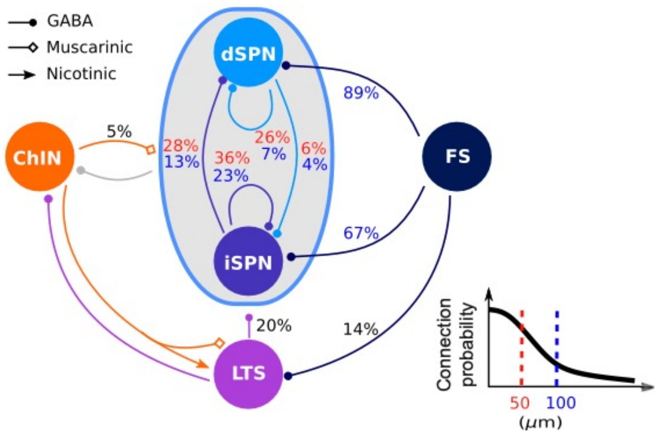
Spiliotis, Konstantinos, et al. "Deep brain stimulation for movement disorder treatment: exploring frequency-dependent efficacy in a computational network model." *Biological Cybernetics* 116.1 (2022): 93-116.

Cholinergic Interneurons

- 아세틸콜린(ACh)을 분비하여 Striatum에 주요한 기능을 수행함
  - M1, M2 수용체를 통해 SPN의 excitatory, inhibitory에 관여함
  - D2 수용체를 활성화해 도파민에 의해 억제됨

- Corlinergic Interneurons을 표현하기 위해 3가지 firing 패턴을 나타낼 수 있게 함
  - Tonic (4-15 Hz), bursting, irregular firing pattern

- Hodgkin-Huxley 방식으로 conductance based 모델을 구현함



connection

$$
\begin{aligned}
C_T \frac{d}{dt} v_T = &- I_{Na} - I_K - I_L - I_h - I_{IR} \\
&- I_{Ca} - I_{sAHP} - I_{mAHP} \\
&- I_T - I_{NaP} - I_{MT} \\
&+ I_{app} + \zeta_T W_T(t),
\end{aligned}
$$

$$m_\infty(v) = -0.1(v+28)/\tau_m(v)$$

$$\tau_m(v) = -0.1(v+28) + 4\{\exp[-0.1(v+28)] - \exp[-(v+53)/18]$$

$$\frac{d}{dt}X = (X_\infty(v) - X)/\tau_X.$$

$$
\begin{aligned}
I_{Na} &= g_{Na} m_\infty^3(v) h (v - E_{Na}) \\
I_K &= g_K n^4 (v - E_K) \\
I_L &= g_L (v - E_L) \\
I_h &= g_h p (v - E_h) \\
I_{IR} &= g_{IR}\left(1/\exp\left(\frac{v-\theta_{IR}}{\sigma_{IR}}\right)\right)(v - E_K) \\
I_{Ca} &= g_{Ca} s^2 (v - E_{Ca}) \\
I_{sAHP} &= g_{sAHP} \xi (v - E_K) \\
I_{mAHP} &= g_{mAHP}([Ca]/([Ca] + k_m))(v - E_K) \\
I_T &= g_T a^3 (v - E_{Ca}) \\
I_{NaP} &= g_{NaP} r (v - E_{Na}) \\
I_{MT} &= g_{M2/4} m_T (v_T - E_K).
\end{aligned}
$$

Model

Hjorth, JJ Johannes, et al. "The microcircuits of striatum in silico." Proceedings of the National Academy of Sciences 117.17 (2020): 9554-9565.
Codianni, Marcello G., and Jonathan E. Rubin. "A spiking computational model for striatal cholinergic interneurons." Brain Structure and Function 228.2 (2023): 589-611.
Grillner, Sten, Brita Robertson, and Jeanette Hellgren Kotaleski. "Basal ganglia-A motion perspective." Compr. Physiol 10.4 (2020): 1241-1275.