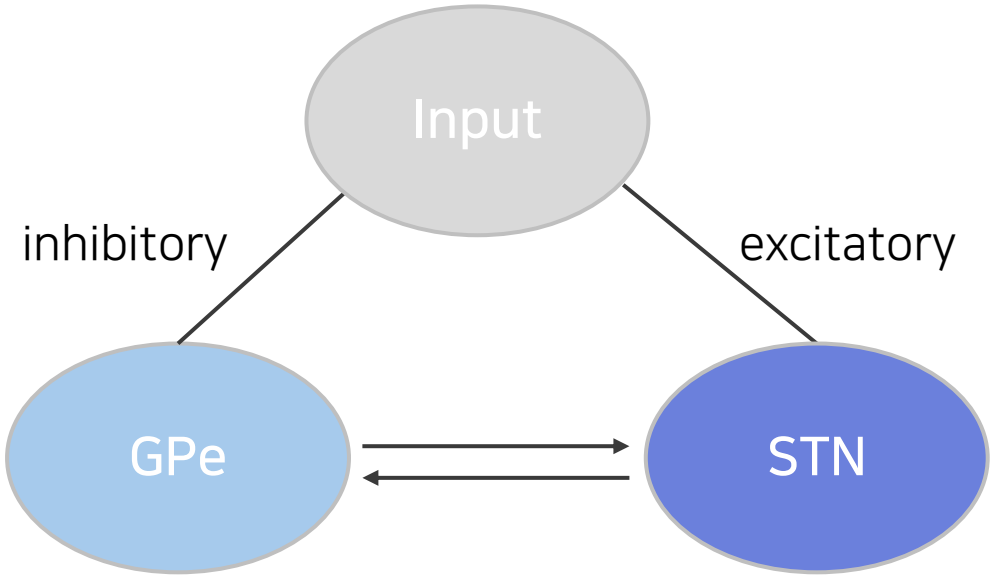
Untangling Basal Ganglia Network Dynamics and Function

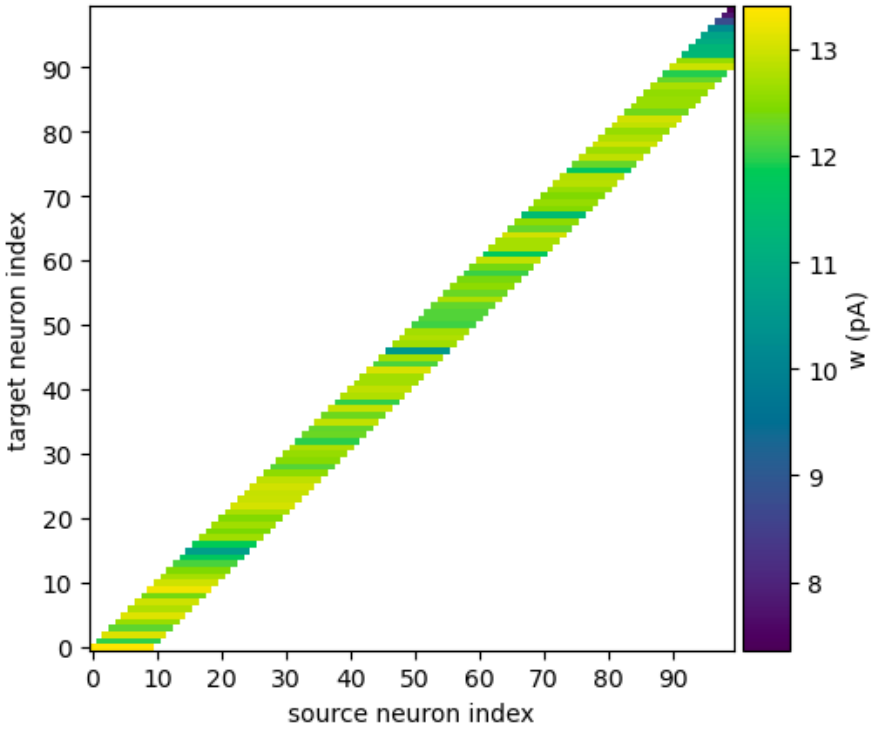
Experiments

Settings

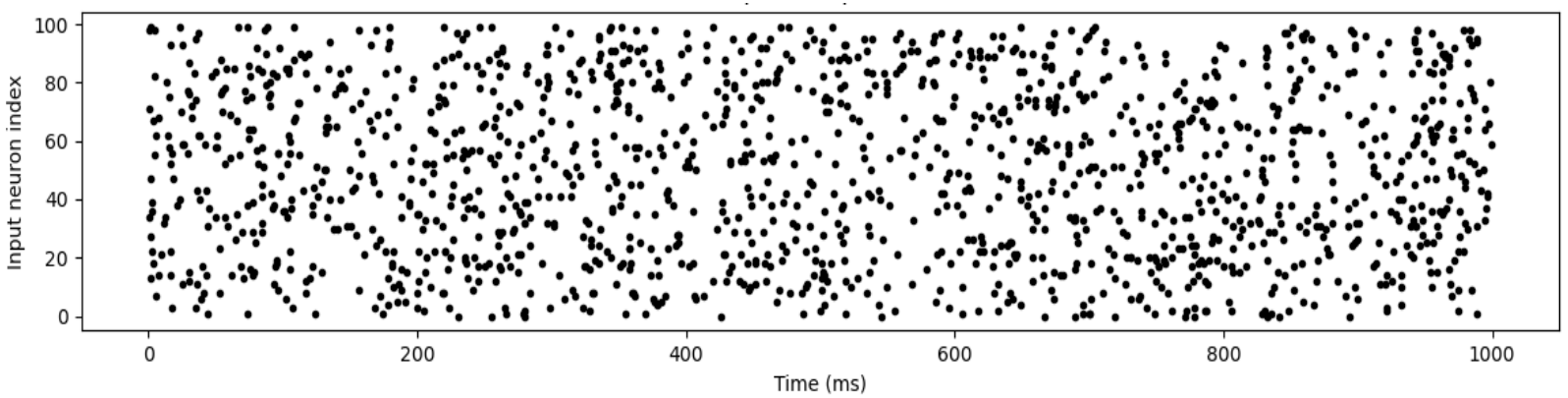
- Brian2 library packages 사용
- Input Dataset
  - Poisson distribution
  - 뉴런 인덱스 기준으로 순서대로 10개의 뉴런만 연결되도록 설정
  - 100 number of neurons



Input – Gpe – STN Model



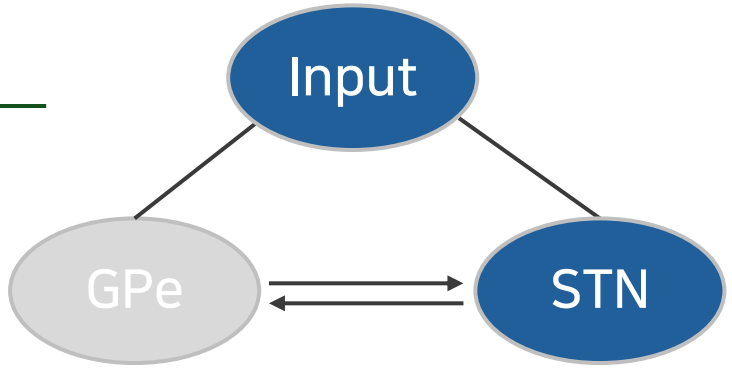
Connectivity Plot

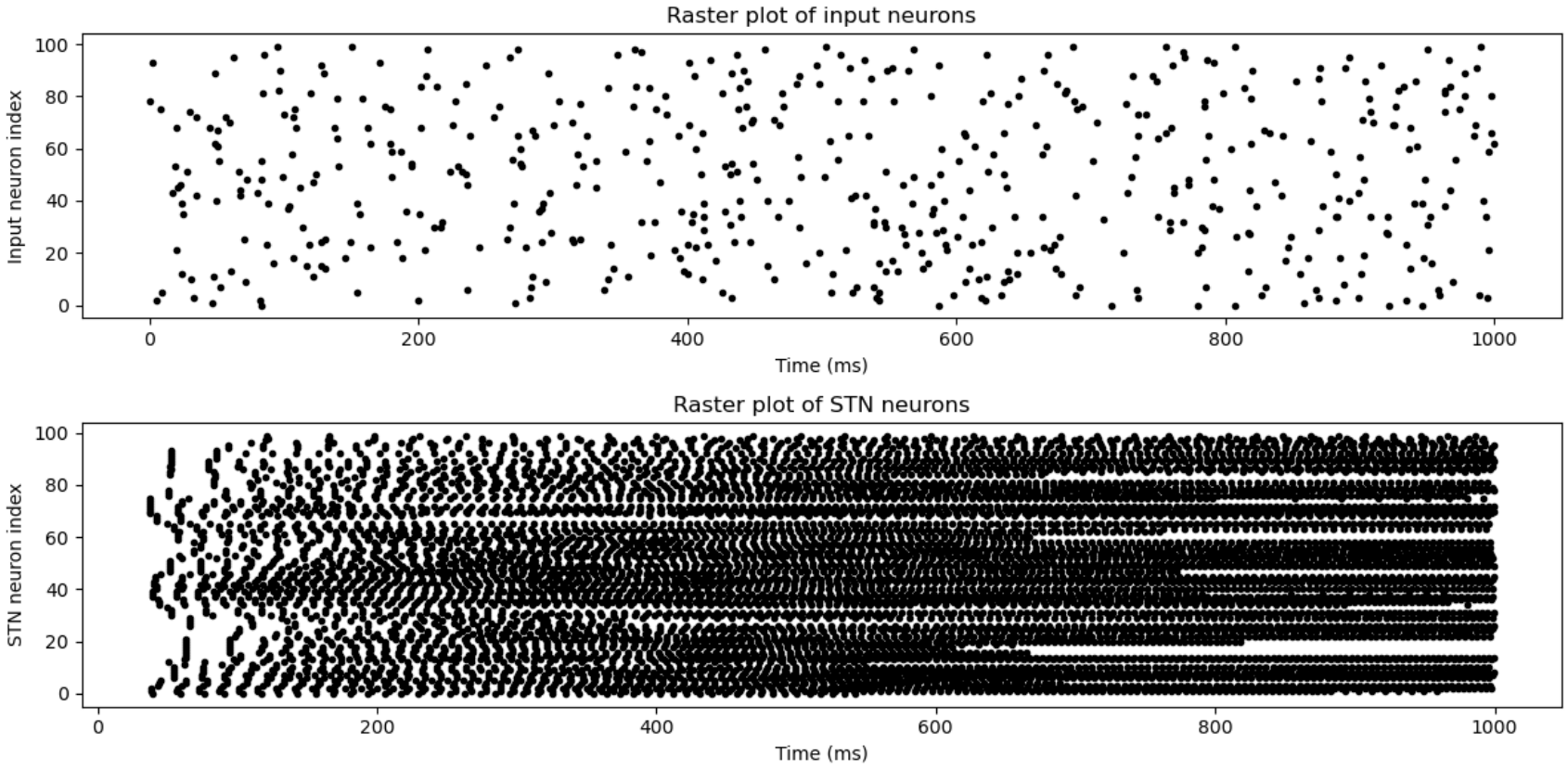


Raster Plot

Experiments Result

- 논문의 파라미터 값을 이용해 실험 진행
- Excitatory한 관계이기 때문에 $E_L < E_{rev}$
- 조건: STN neurons was modeled by resetting V after a spike to $V\_r + \max(w\text{-}15, 20)$ with $w < 0$





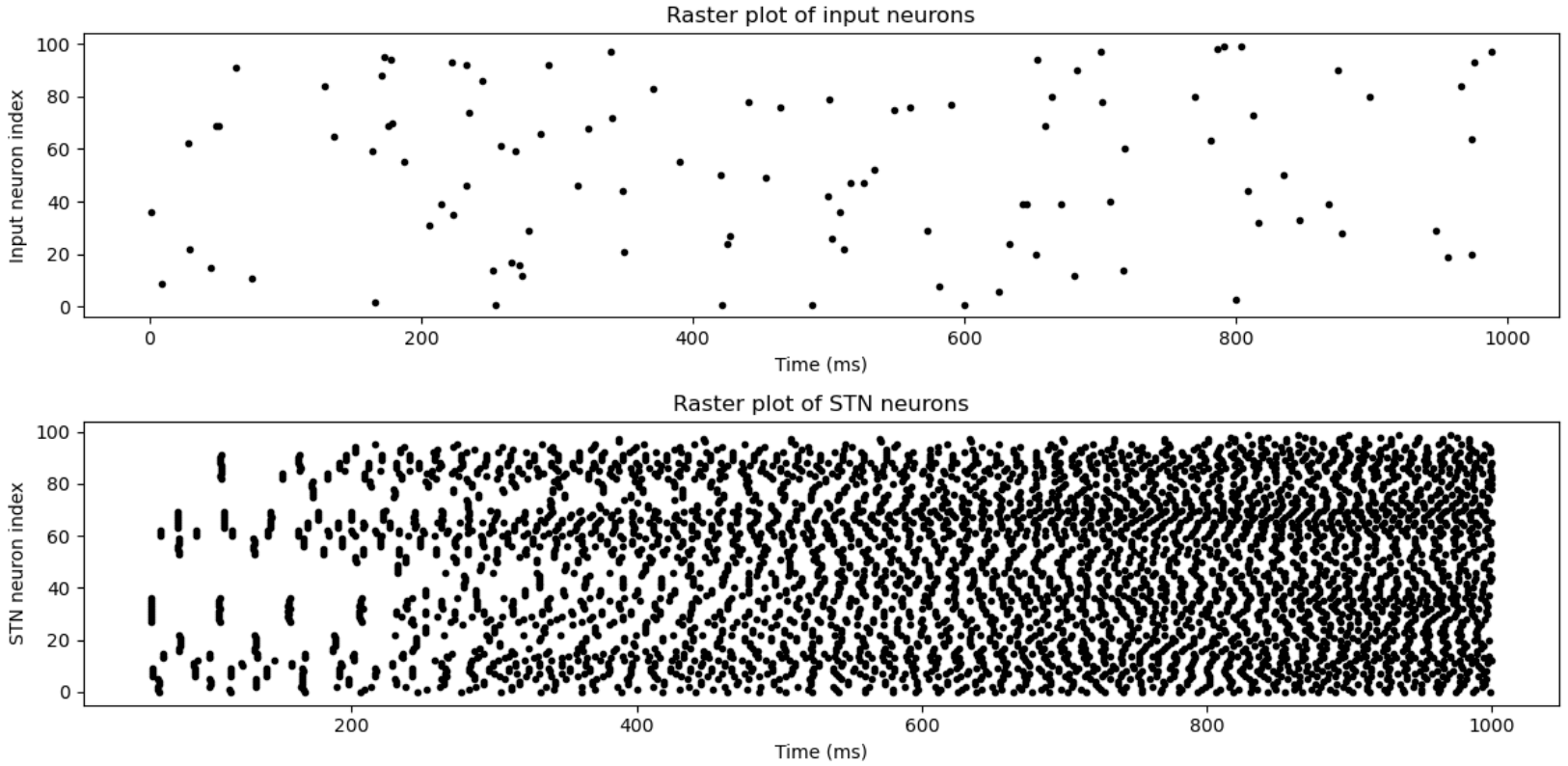
Input – STN Raster Plot

Name	Value	Name	Value
a	0.3	τ_w	333
b	0.05	t^f	15
C	60	V_r	-0
Δ_T	16.2	V_T	-64.0
E_L	-80.2	E_{rev}	0
g_L	10		
I_e	5		

STN Parameter

Experiments Result

- 파라미터 값을 일부 변경하여 실험 진행
  - Poisson rate 수정 (15 -> 1)



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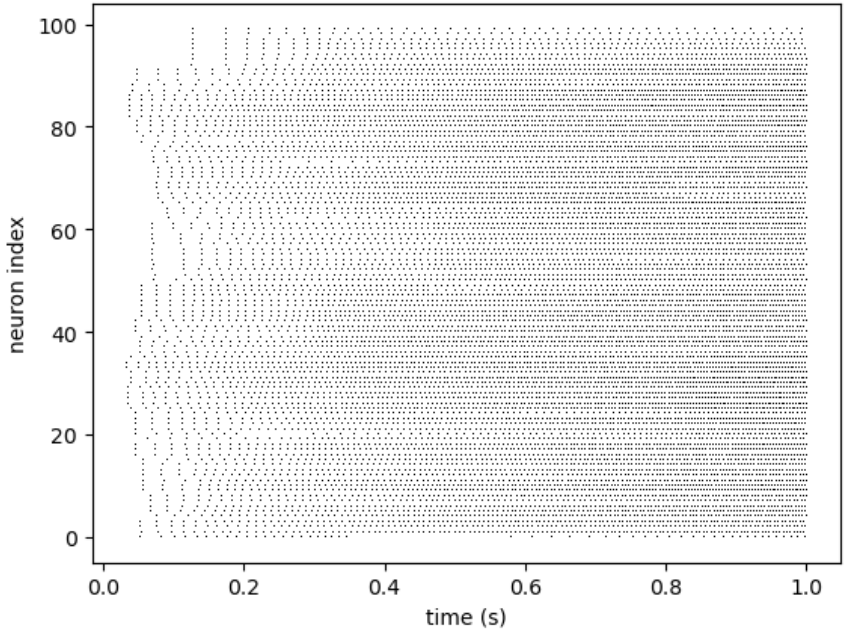
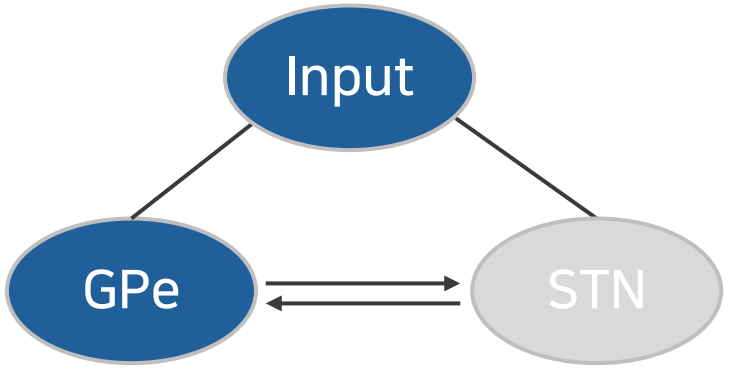
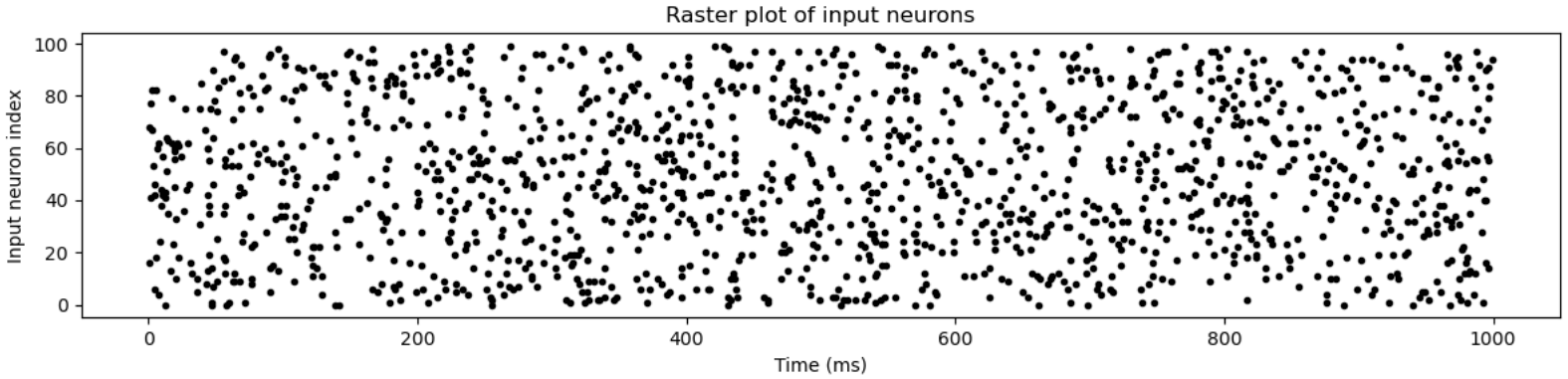
STN Parameter

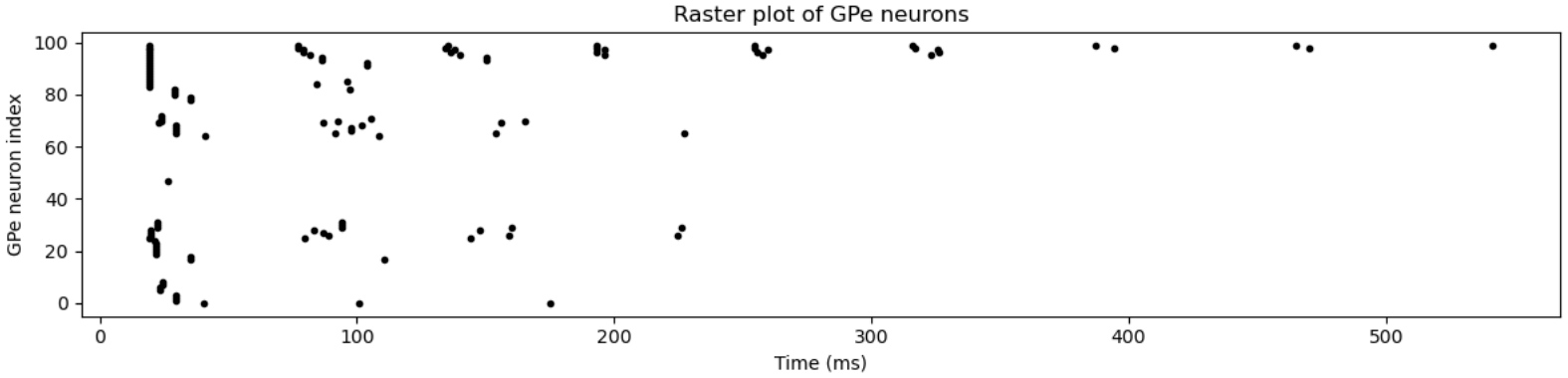


Experiments Result

- 논문의 파라미터 값을 이용해 실험 진행
- $E_L \rightarrow E_L(1 + \beta_{E_L}\emptyset)$
- Inhibitory한 관계이기 때문에 $E_L > E_{rev}$
  - 임의로 -70mV으로 설정하여 실험





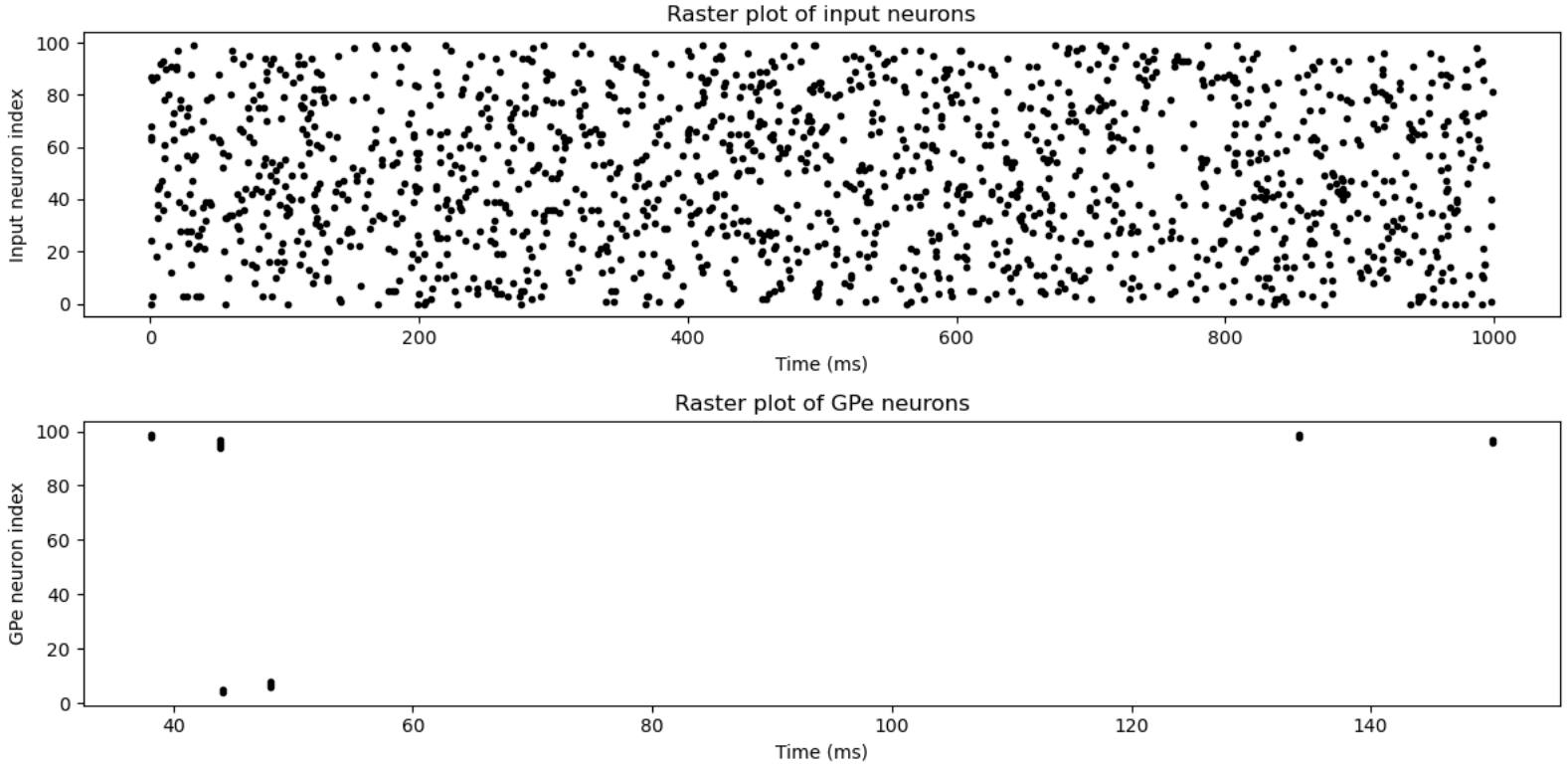


Name	Value	Name	Value
a	2.5	τ_w	20
b^{T1}	70	t^f	15
b^{TA}	105	V_r	-60
C^{T1}	40	V_T	-54.7
C^{TA}	60		
Δ_T^{T1}	1.7		
E_L	-55.1		
g_L	1		
I_{e-T1}	1		

GPe Parameter

Experiments Result

- 파라미터 값을 일부 변경하여 실험 진행
- $E_L \rightarrow E_L(1 + \beta_{E_L}\emptyset)$



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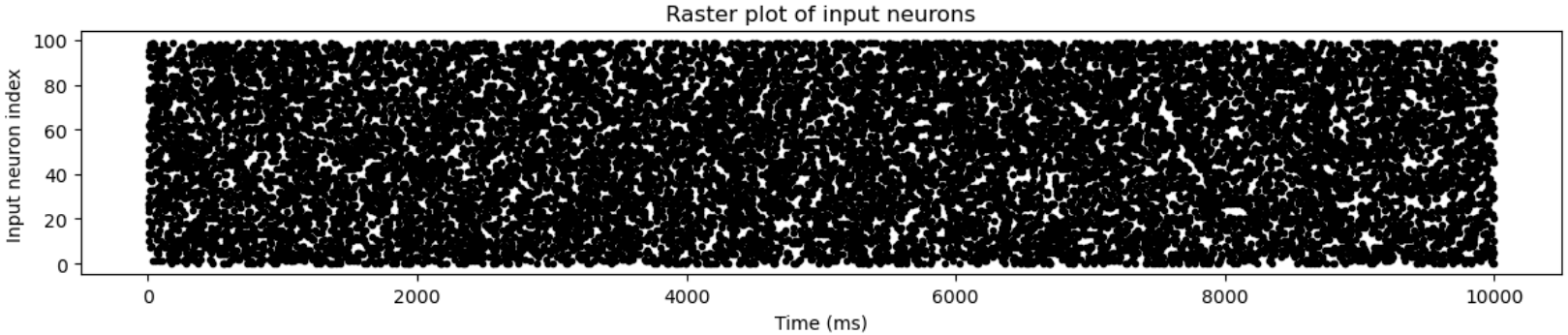
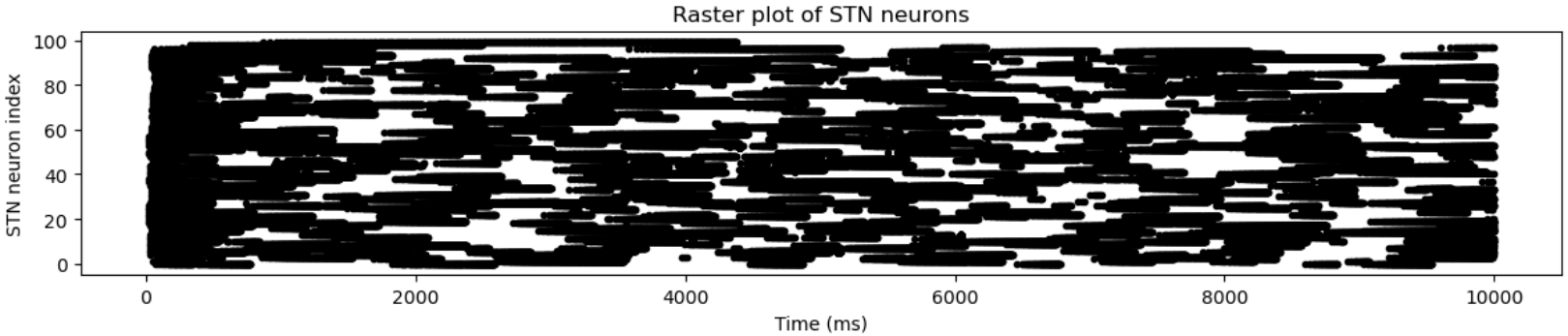
b^{T1}	70	t^f	15
b^{TA}	105	V_r	-60
C^{T1}	40	V_T	-54.7
C^{TA}	60	I_{e-TA}	**12**
Δ_T^{TA}	**2.55**		
E_L	-55.1		
g_L	1		

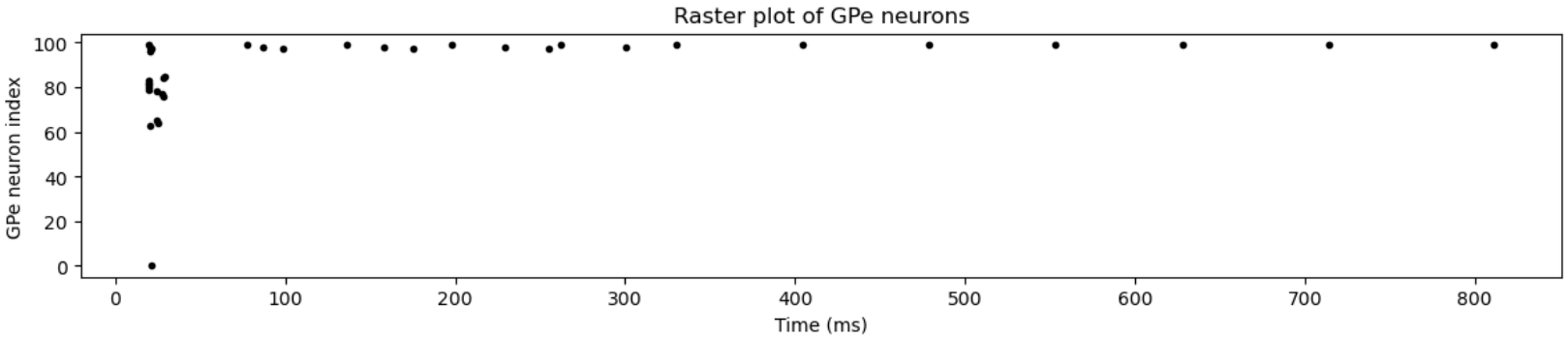
- 기존 결과에는 500ms 까지 action potential이 발생하지만 파라미터를 변경할 경우 발생량이 감소
- 또한, 전체적인 뉴런에 action potential가 발생하는 기존 결과와 달리 처음과 끝 뉴런에 대해서만 발생

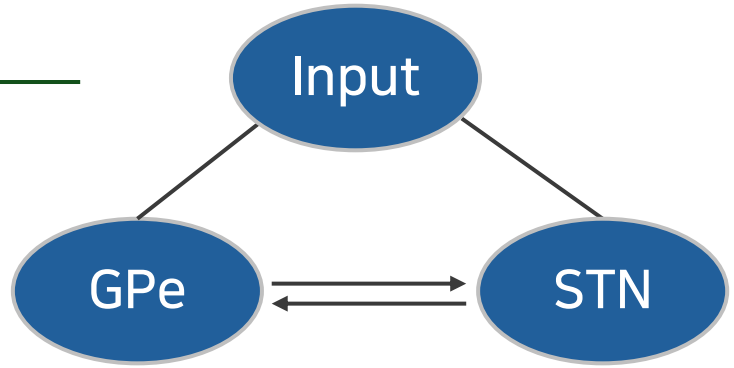
Gpe Parameter

Experiments Result







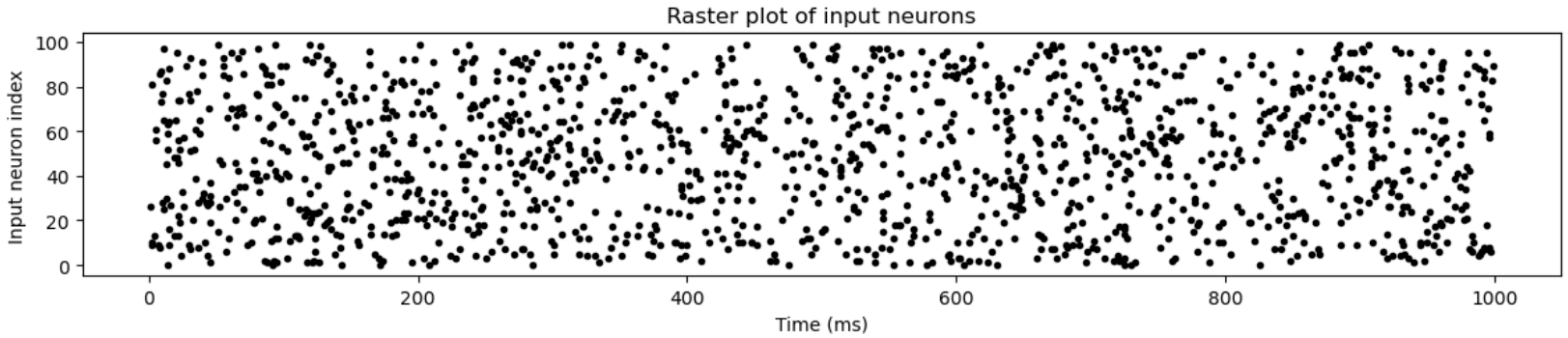


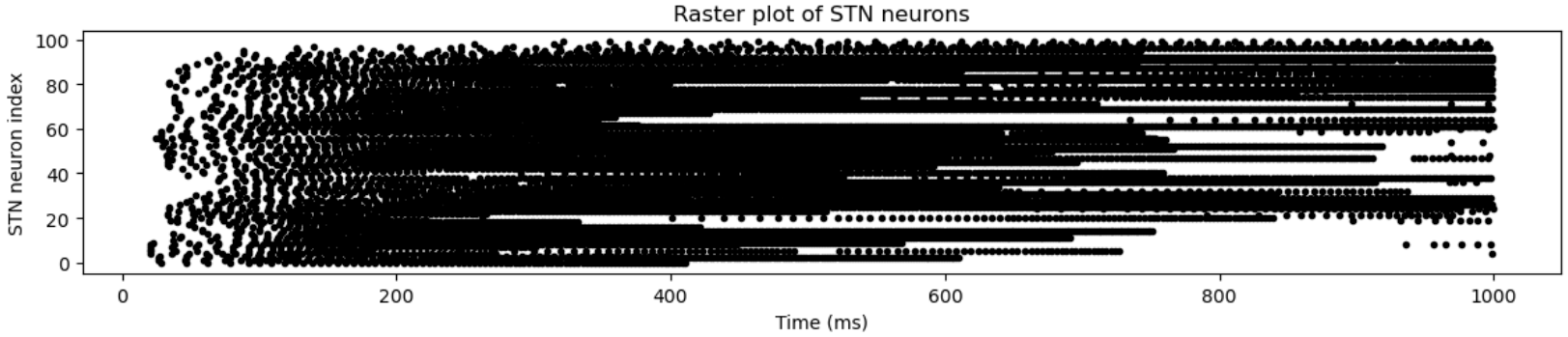
Name	Value
$E^{GPe-STN}$	-84
$g^{GPe-STN}$	0.08
$E^{CTX-STN}$	0
$g^{CTX-STN}$	0.25
$E^{CTX-GPe}$	**-70**
$g^{EXT-GPe}$	0.5

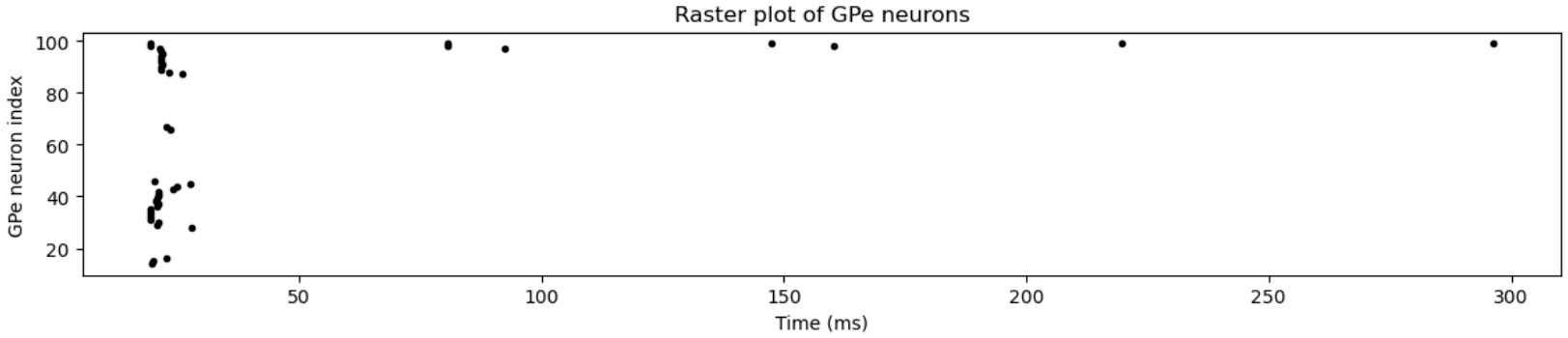
Synaptic model parameter

- 3종류의 네트워크를 모두 연결한 결과이며 연결 관계에 따른 action potential의 차이를 확인
- 특히, Gpe의 경우 일부 구간의 뉴런만 활성화된 것을 확인할 수 있음

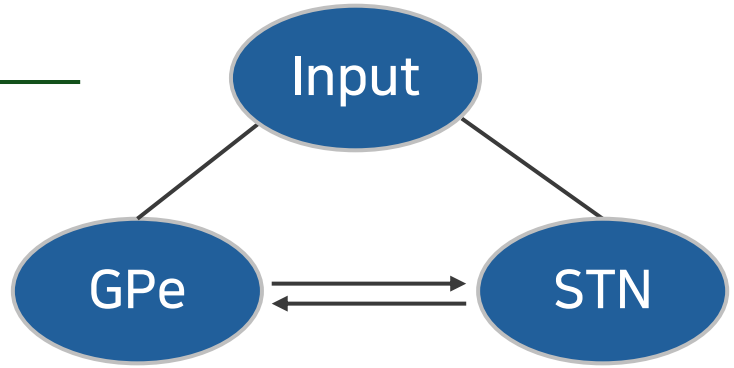
Experiments Result







- 시뮬레이션 시간을 1000ms에서 1000ms로 변경했을 때 패턴



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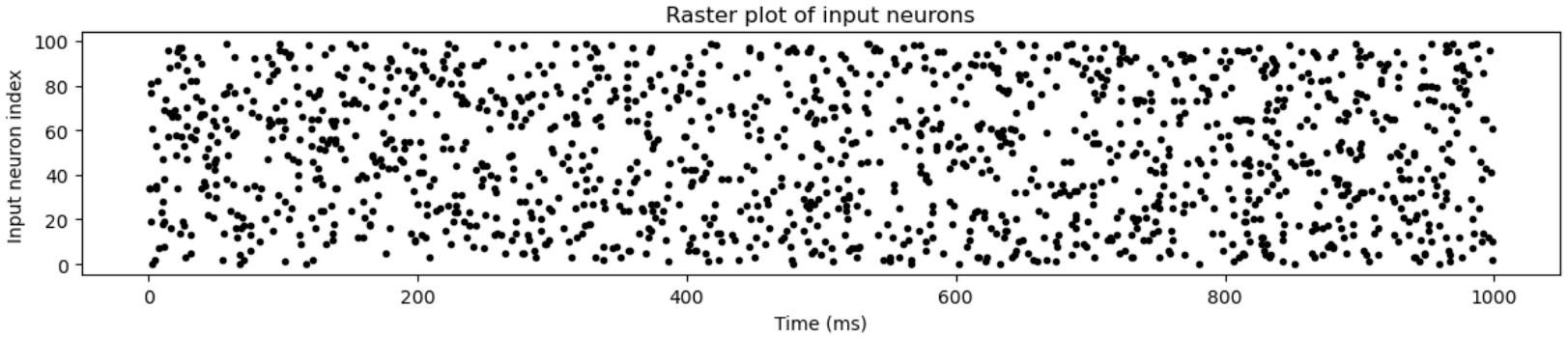
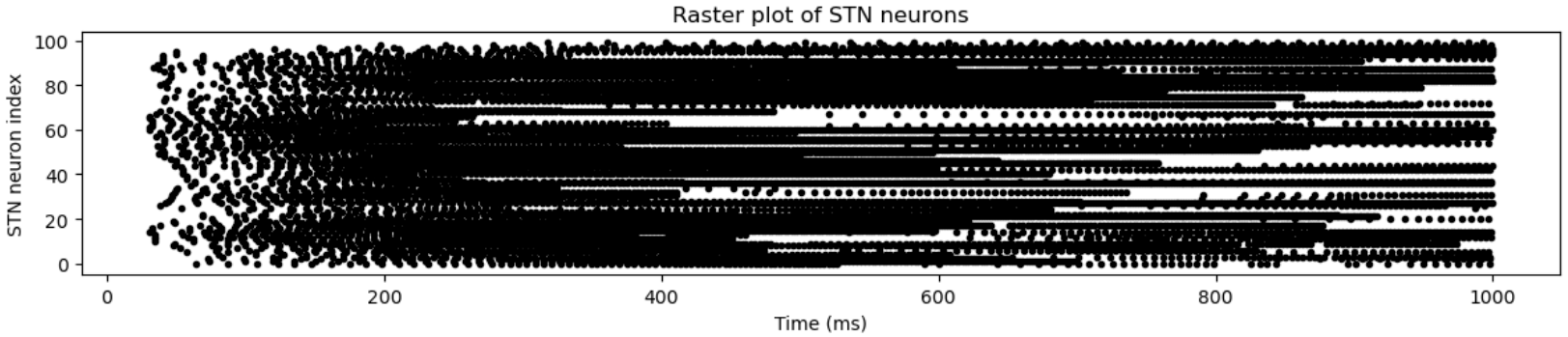
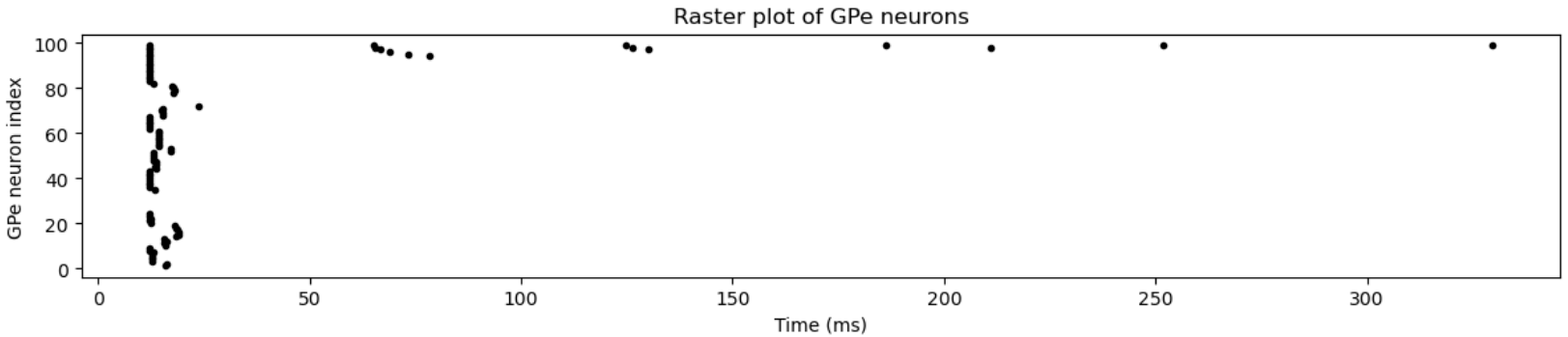
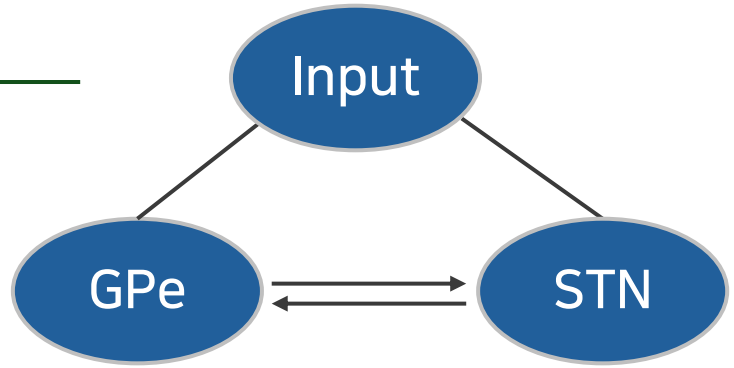
Synaptic model parameter

Experiments Result









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Synaptic model parameter

- 시뮬레이션 시간을 1000ms에서 1000ms로 변경했을 때 패턴
- 도파민에 대한 파라미터 α를 0.1에서 0.9로 변경