Hippocampal-prefrontal plasticity seems to reverberate in a thalamic-prefrontal loop:

what else neuromathematics could tell us?

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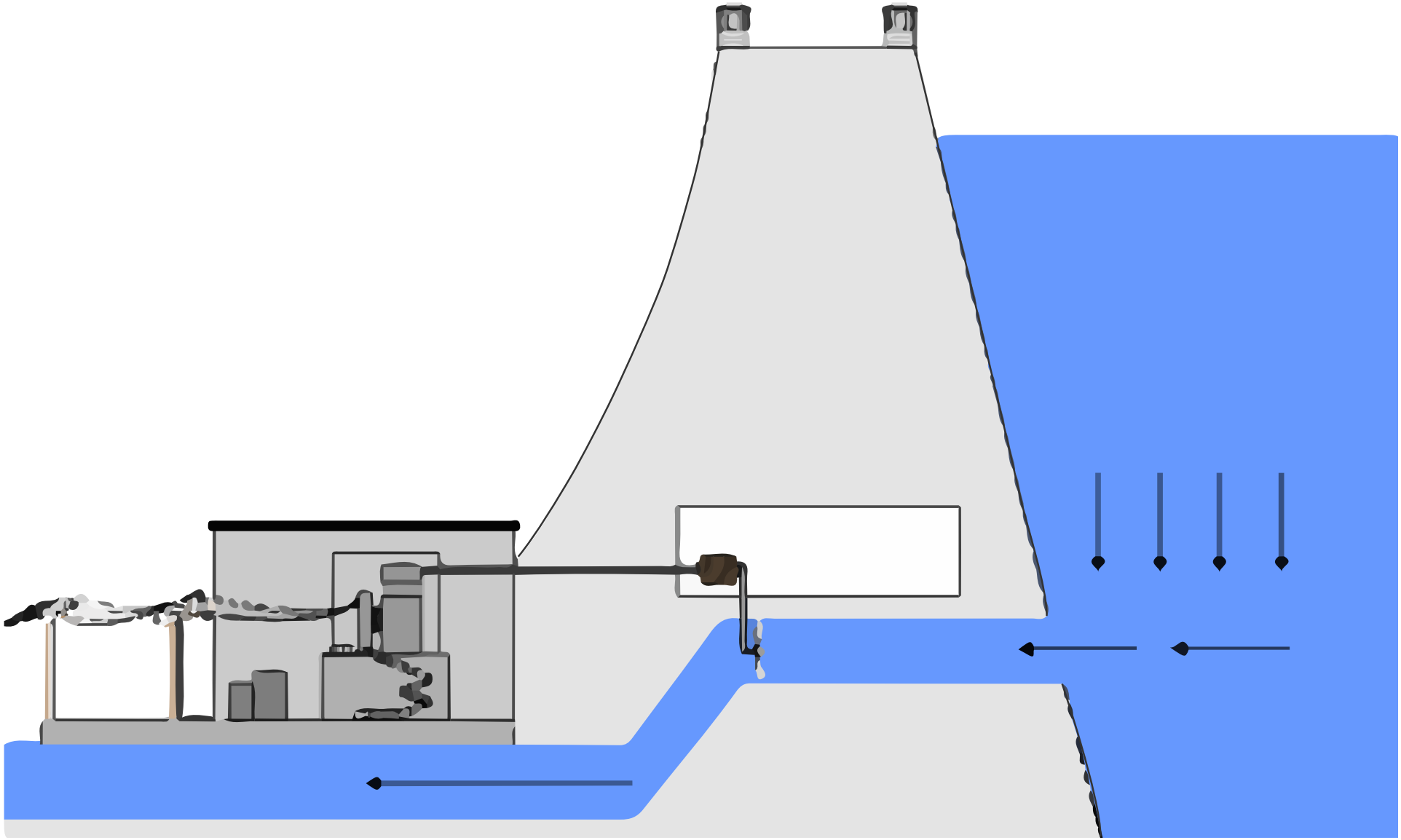
First, the structure:
a particular neural circuit.

Then, its (*hypothetical*) function...
...from a phenomenological perspective.

Lastly, its mathematical exploration...
...and extrapolation.

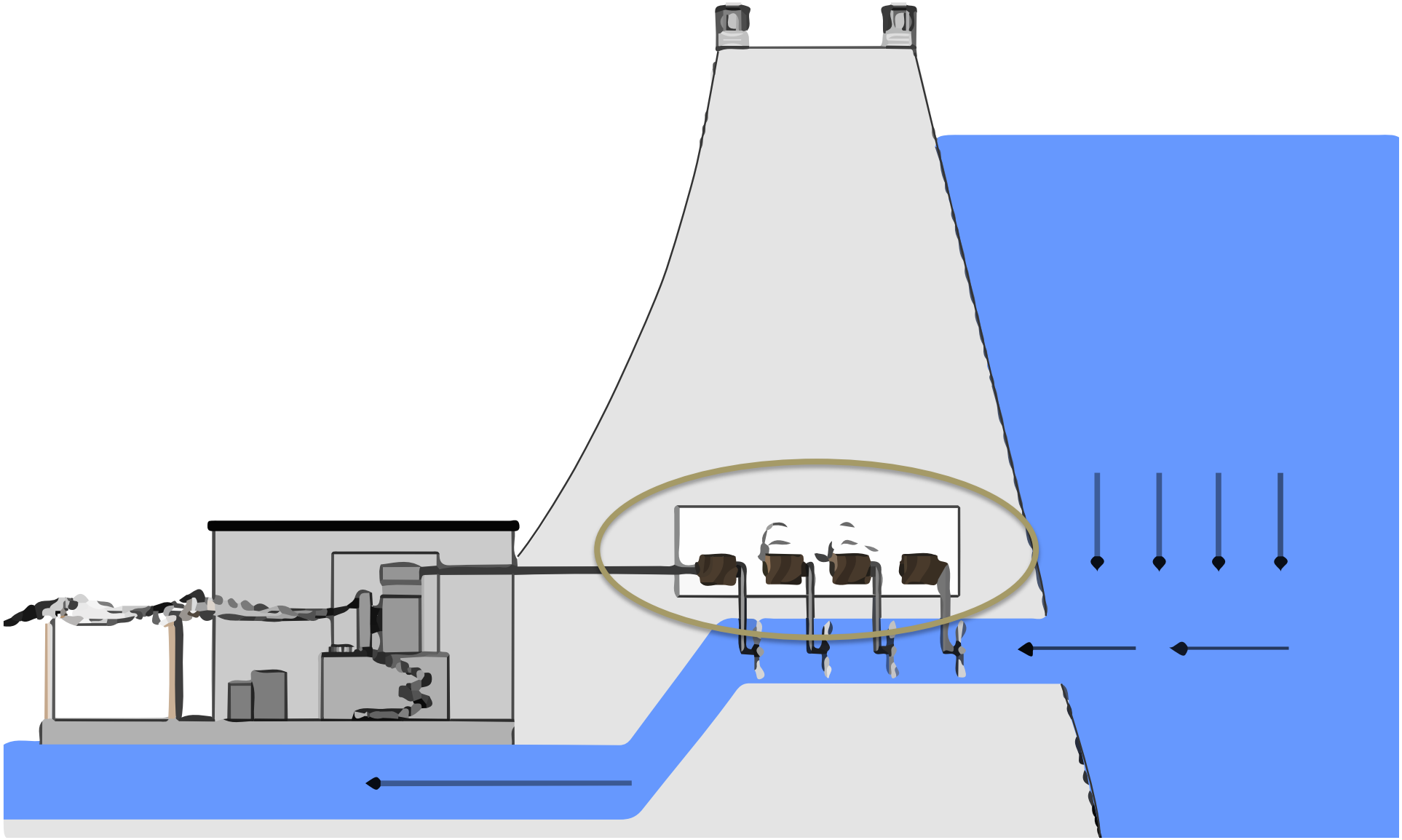
Then, its (*hypothetical*) function...

...from a phenomenological perspective.



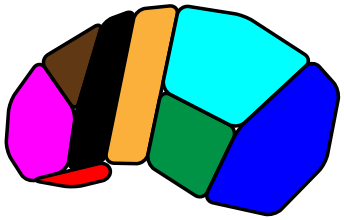
Lastly, its mathematical exploration...

...and extrapolation.

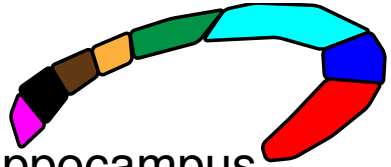


Bueno-Júnior et al. (2012) – PLoS One v. 7

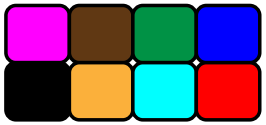
Lopes Aguiar et al. (2013) – Neuropharmacology v. 65



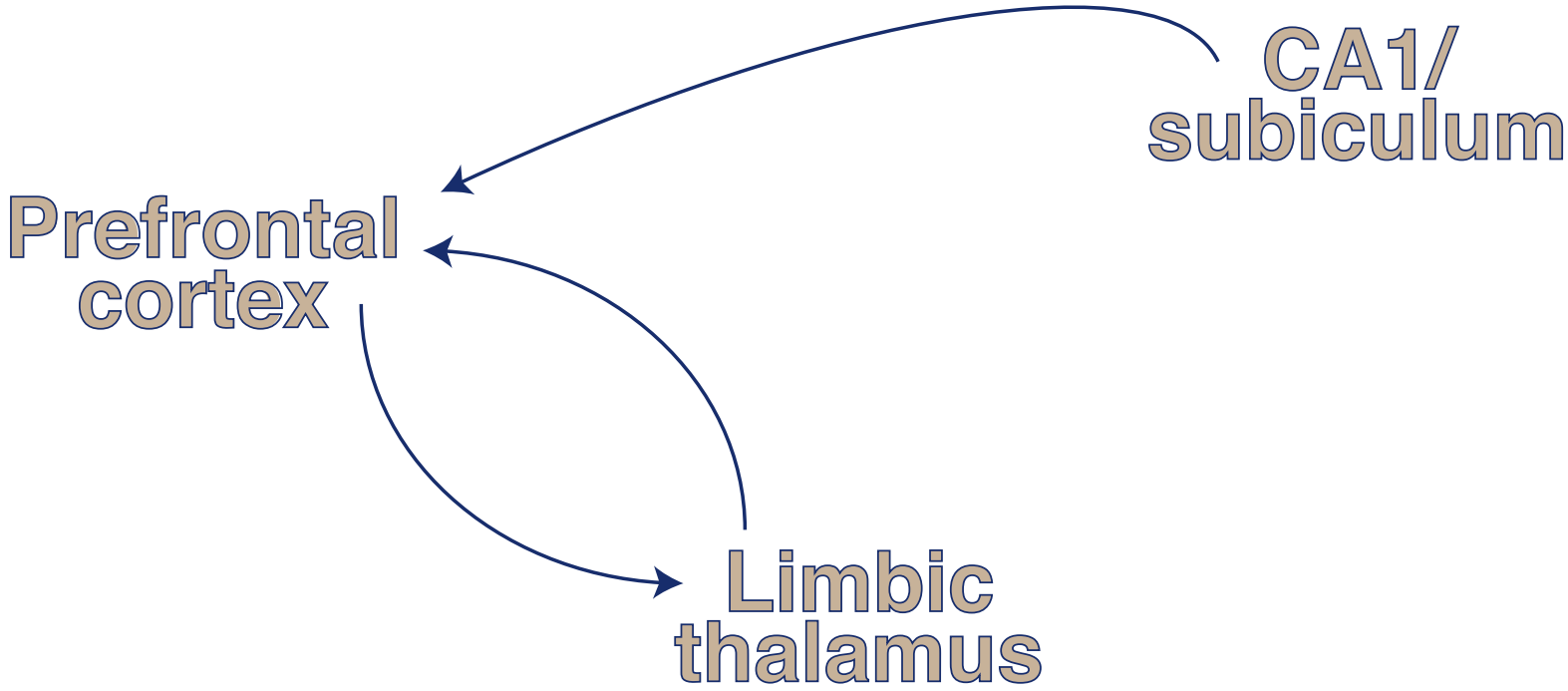
Neocortex



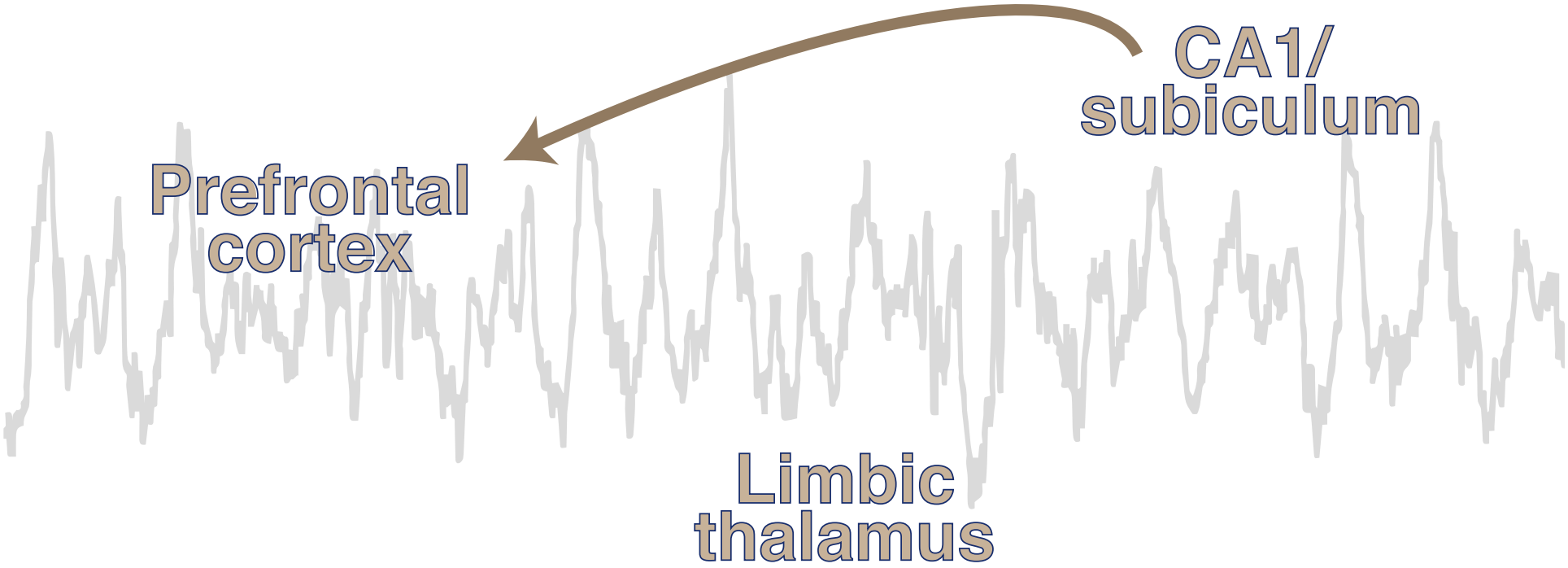
Hippocampus



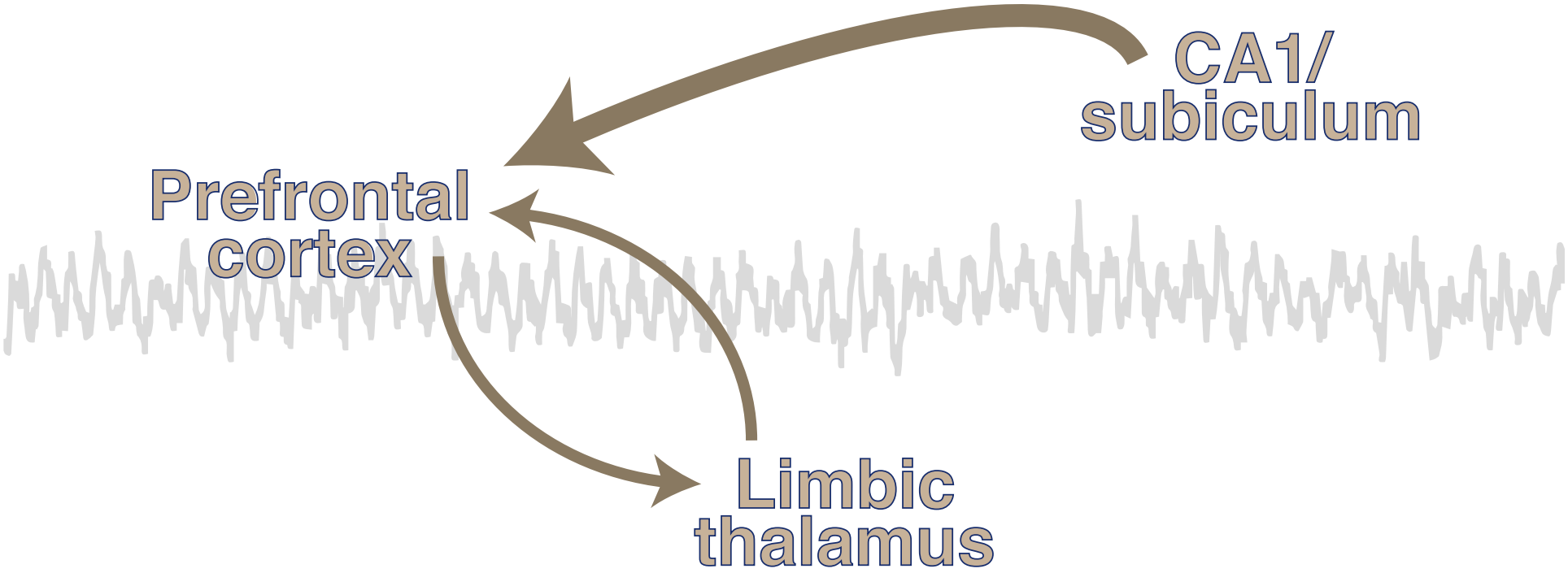
Thalamus


CA1/
subiculum
Prefrontal
cortex
Limbic
thalamus

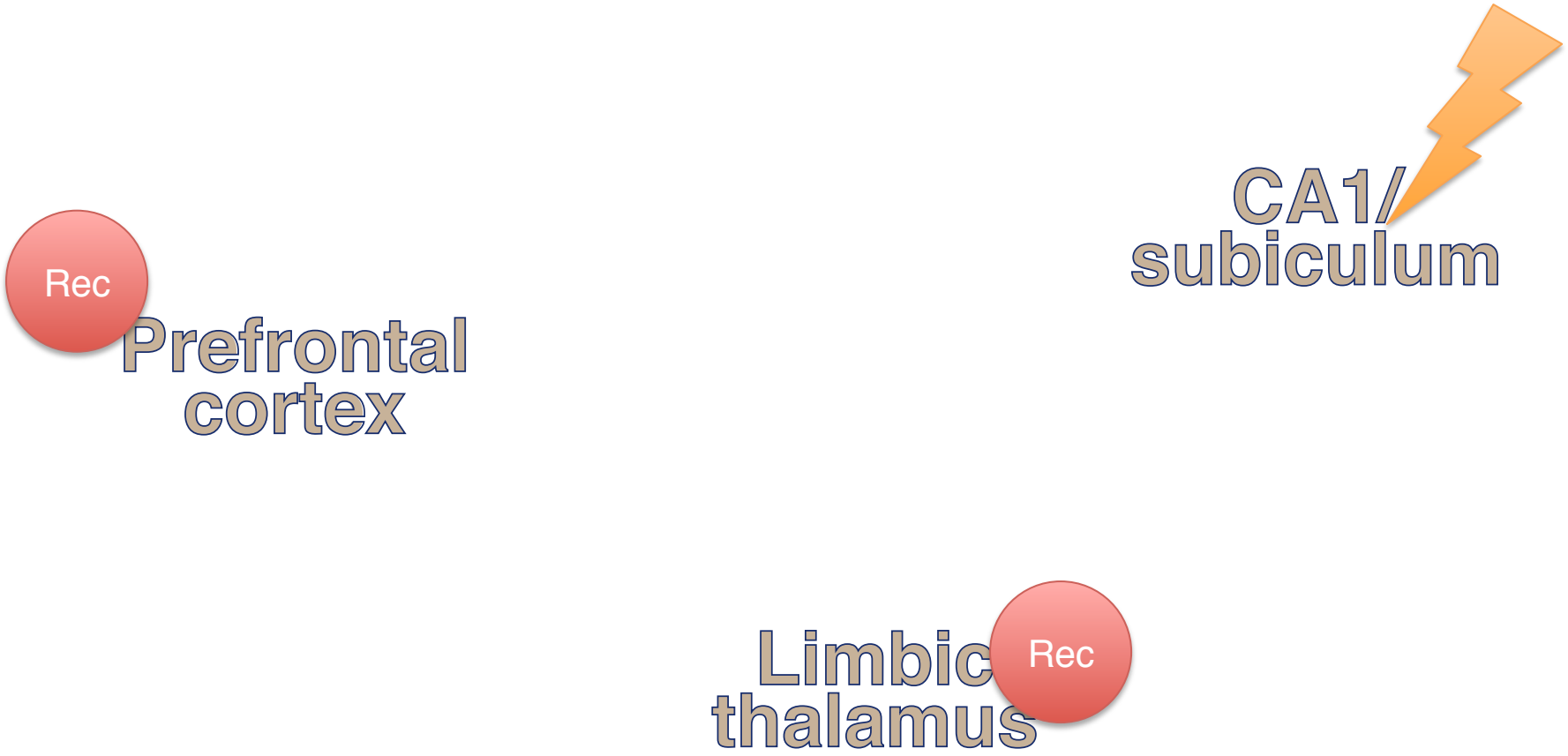
Slow-wave sleep or deep anesthesia

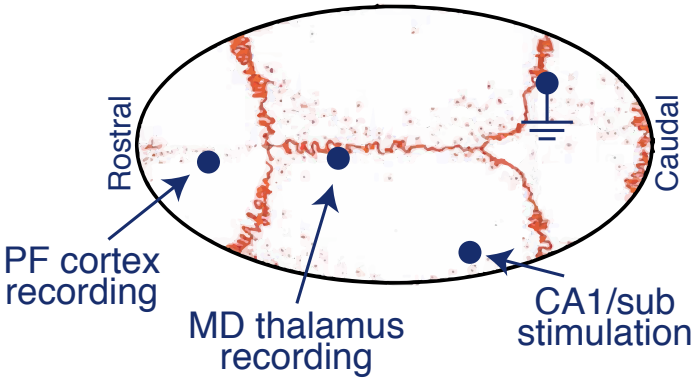


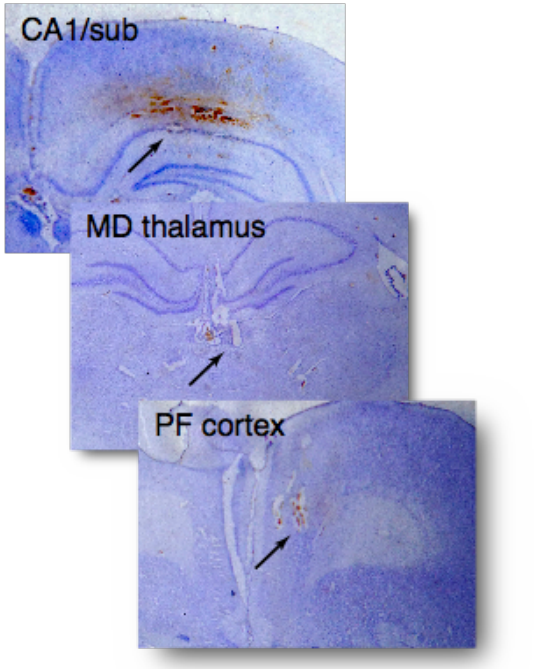
REM sleep or the awake state

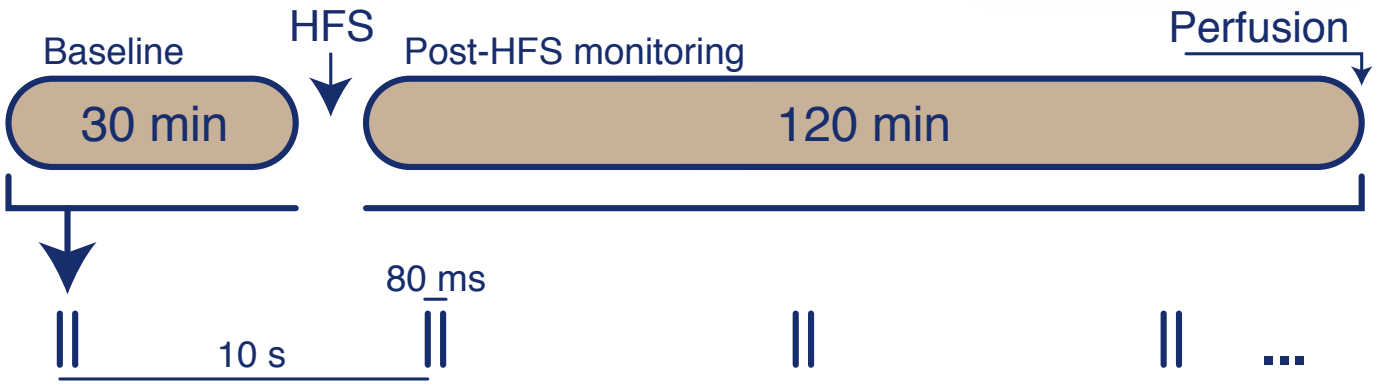


REM sleep or the awake state

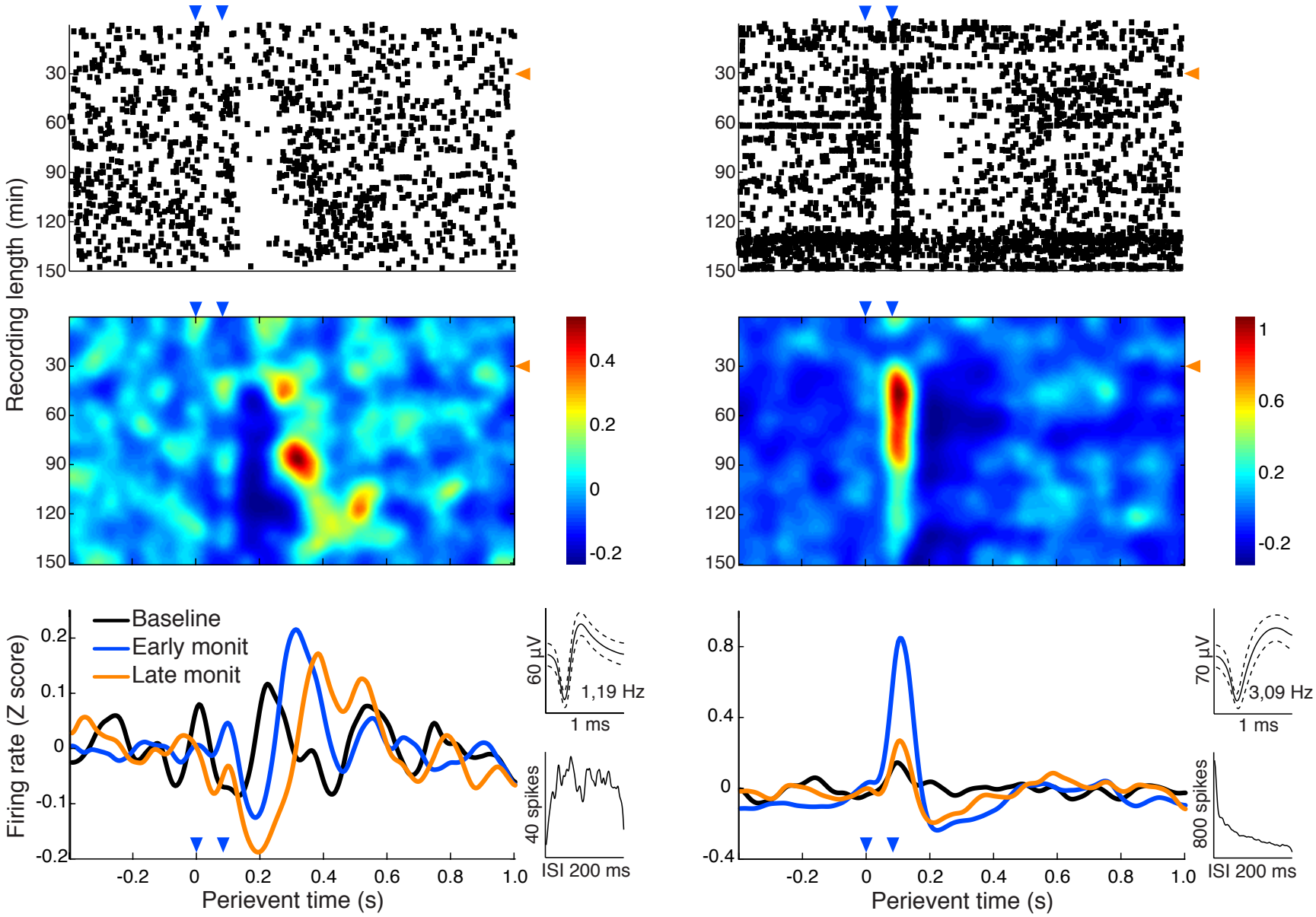

Rec
Prefrontal cortex
CA1/ subiculum
Limbic thalamus
Rec

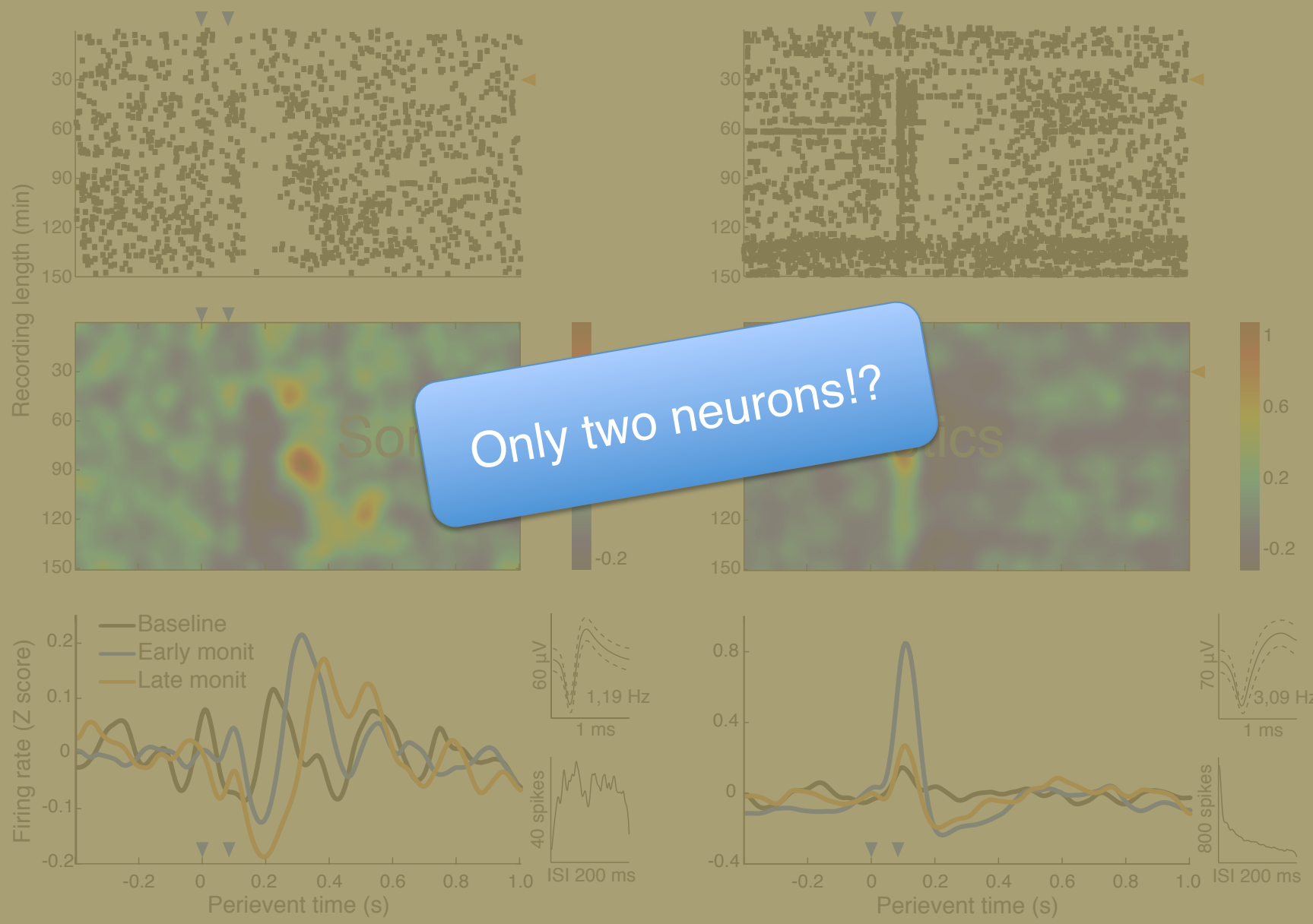

Rostral
Caudal
PF cortex recording
MD thalamus recording
CA1/sub stimulation

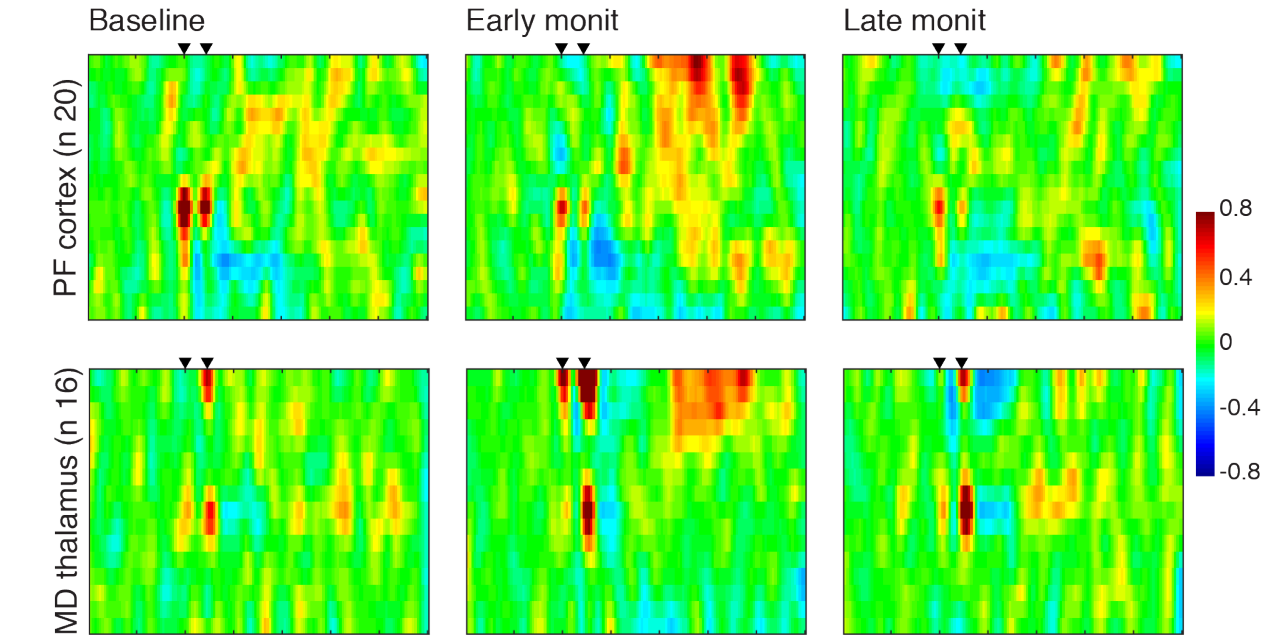

CA1/sub
MD thalamus
PF cortex

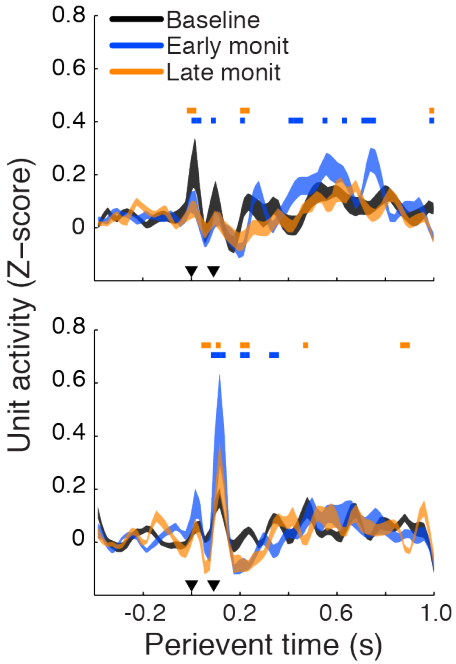

Baseline
HFS
Post-HFS monitoring
Perfusion
30 min
120 min
80 ms
10 s
...

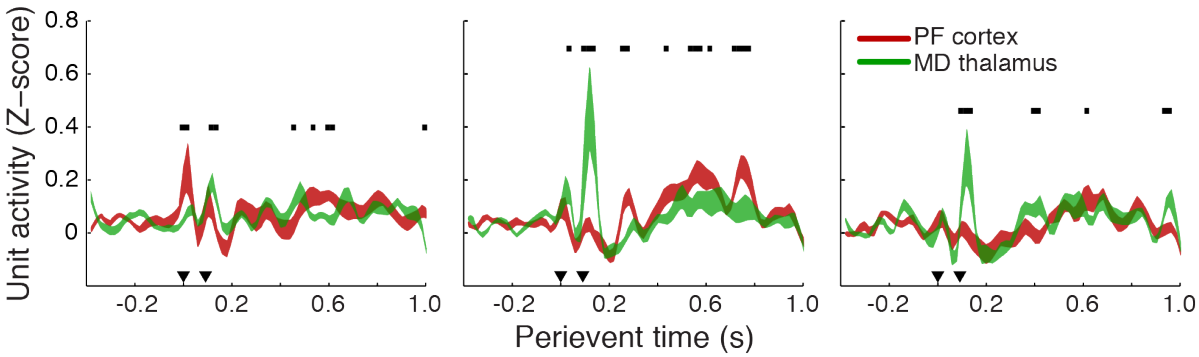
Some descriptive statistics

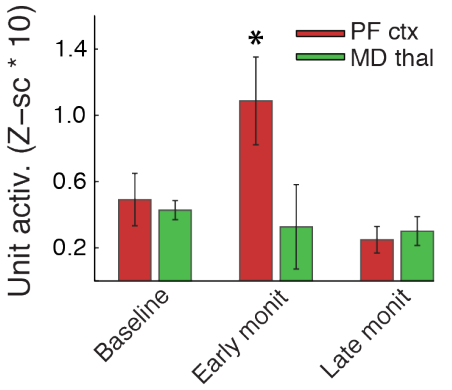

PF cortex
MD thalamus
Recording length (min)
30
60
90
120
150
0.4
0.2
0
-0.2
1
0.6
0.2
-0.2
Baseline
Early monit
Late monit
Firing rate (Z score)
0.2
0.1
0
-0.1
-0.2
0.8
0.4
0
-0.4
60 µV
1,19 Hz
1 ms
40 spikes
ISI 200 ms
70 µV
3,09 Hz
1 ms
800 spikes
ISI 200 ms
-0.2
0
0.2
0.4
0.6
0.8
1.0
Perievent time (s)

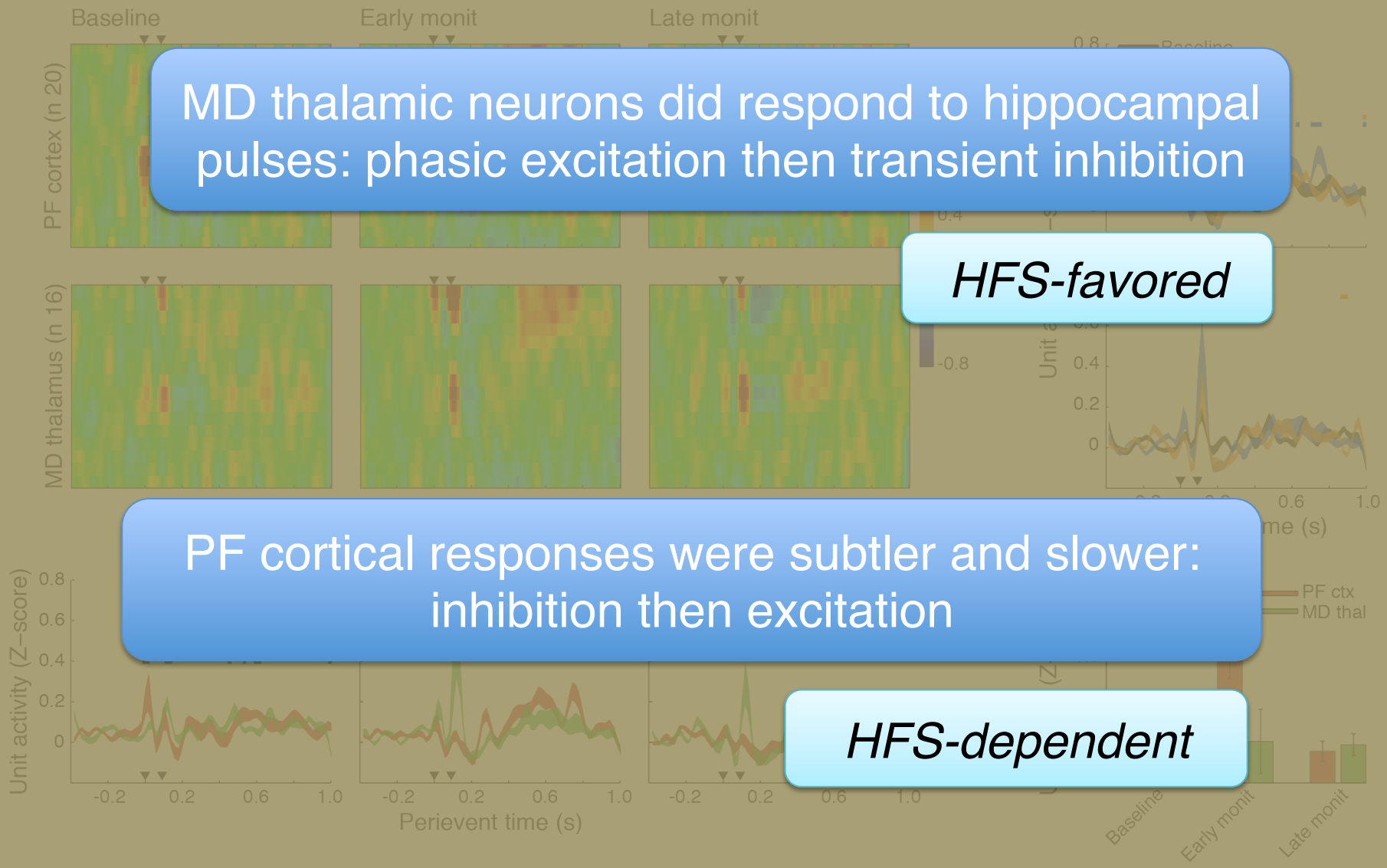

PF cortex
MD thalamus
Recording length (min)
30
60
90
120
150
1
0.6
0.2
-0.2
Only two neurons!?
Baseline
Early monit
Late monit
Firing rate (Z score)
0.2
0.1
0
-0.1
-0.2
0.8
0.4
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1.0
Perievent time (s)
60 µV
1,19 Hz
1 ms
40 spikes
ISI 200 ms
70 µV
3,09 Hz
800 spikes


Baseline
Early monit
Late monit
PF cortex (n 20)
MD thalamus (n 16)
0.8
0.4
0
-0.4
-0.8


Baseline
Early monit
Late monit
Unit activity (Z−score)
0.8
0.6
0.4
0.2
0
-0.2
0.2
0.6
1.0
Perievent time (s)


Unit activity (Z−score)
0.8
0.6
0.4
0.2
0
PF cortex
MD thalamus
-0.2
0.2
0.6
1.0
Perievent time (s)


Unit activ. (Z−sc * 10)
1.4
1.0
0.6
0.2
*
PF ctx
MD thal
Baseline
Early monit
Late monit

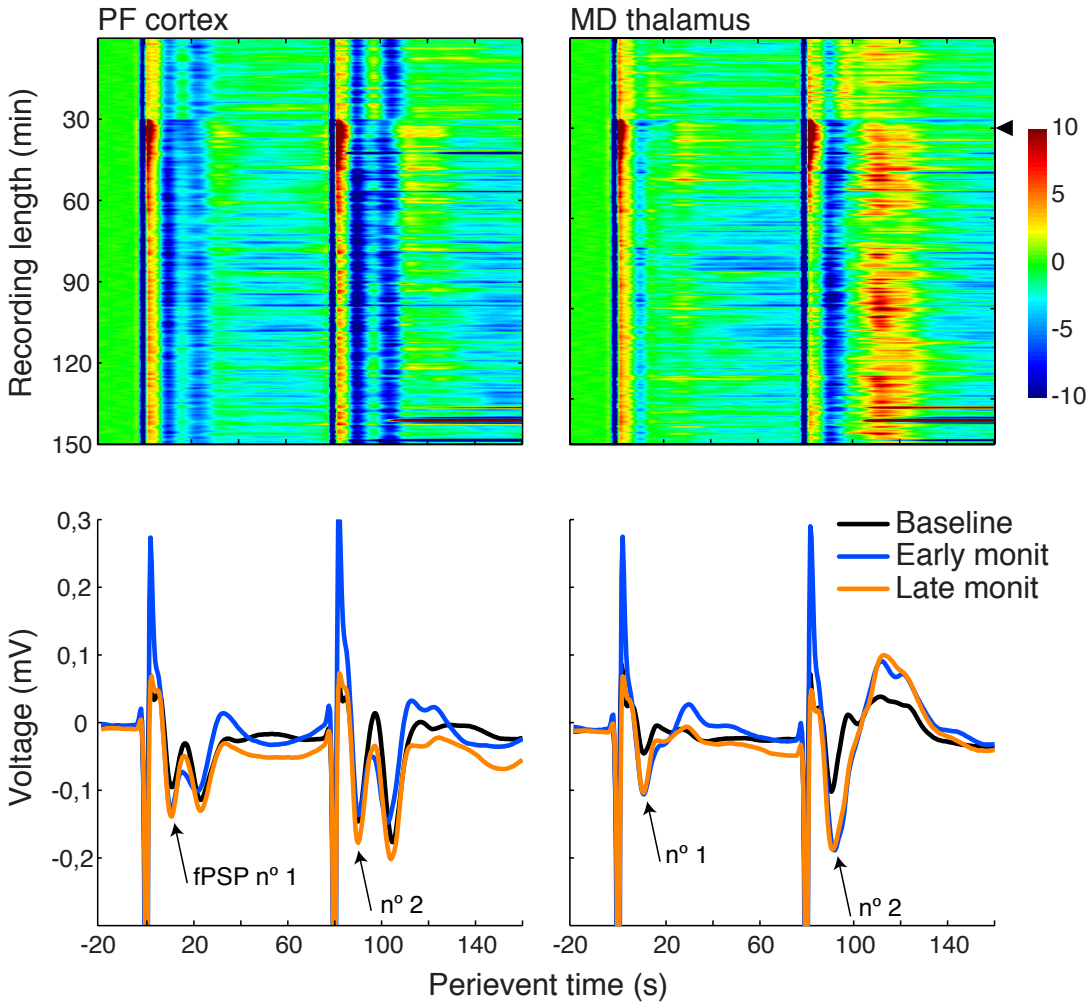


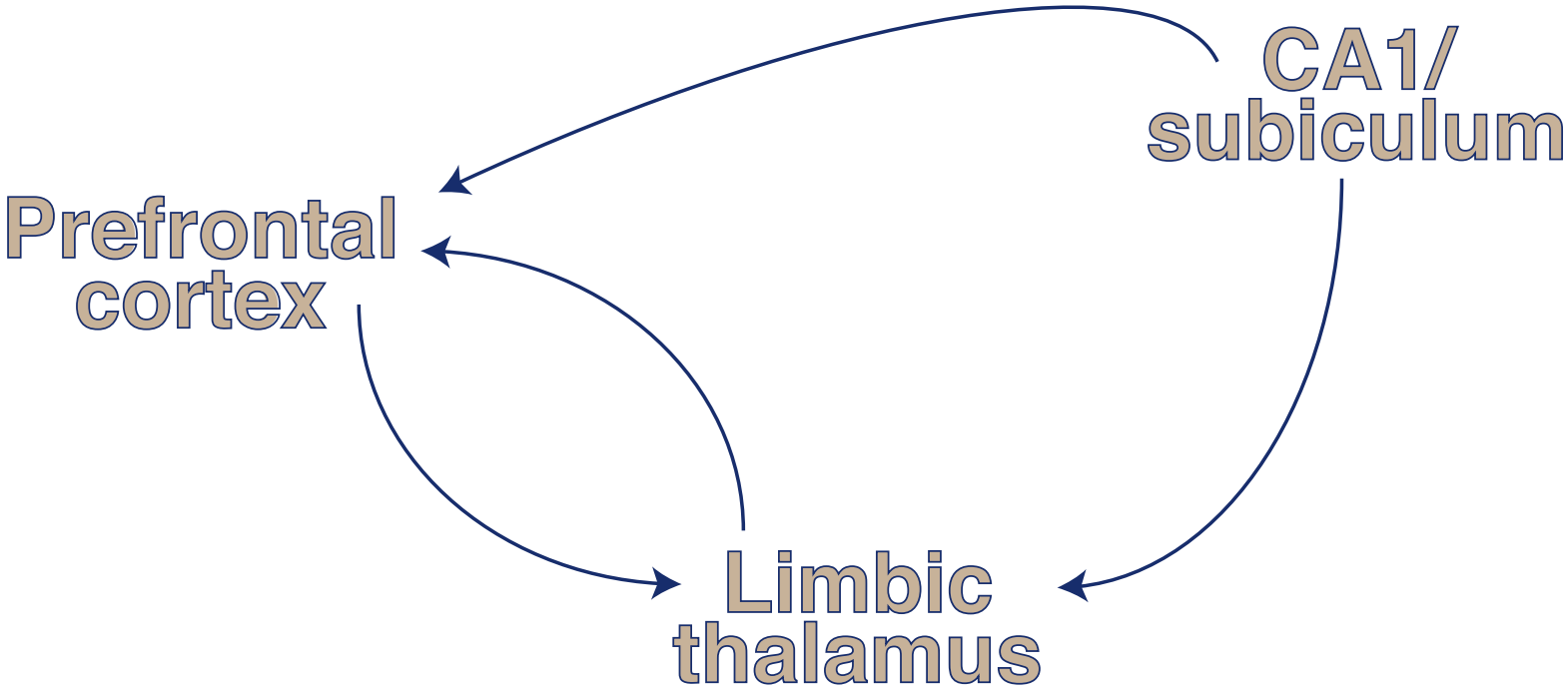
MD thalamic neurons did respond to hippocampal pulses: phasic excitation then transient inhibition

HFS-favored

PF cortical responses were subtler and slower: inhibition then excitation

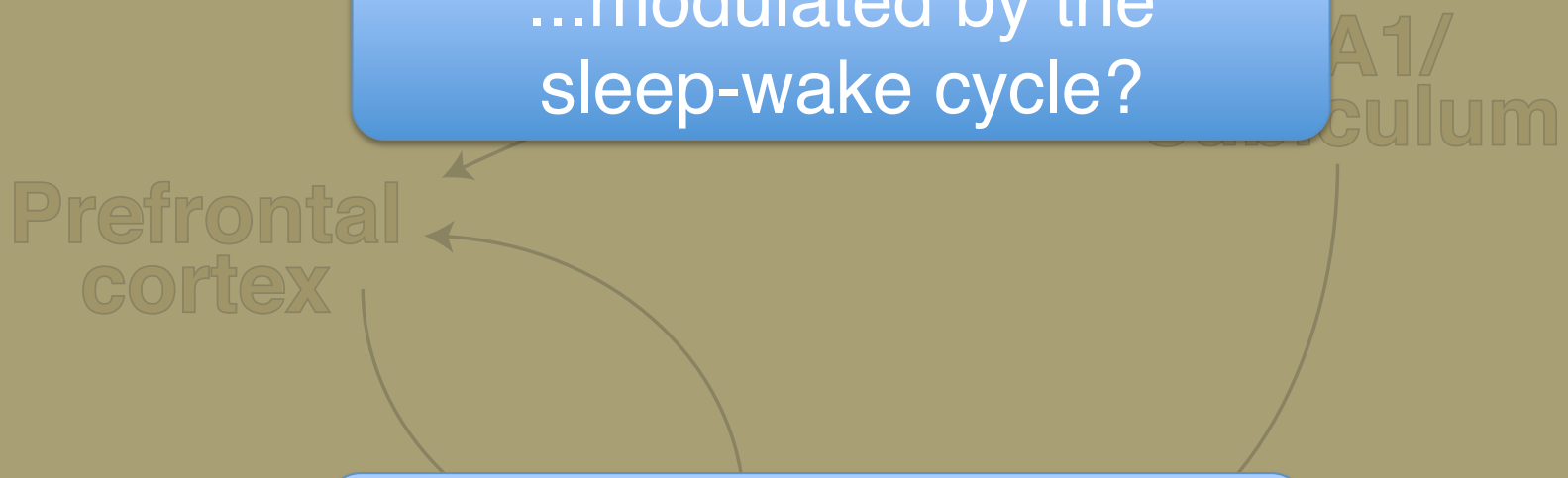
HFS-dependent


PF cortex
MD thalamus
Recording length (min)
30
60
90
120
150
10
5
0
-5
-10
Voltage (mV)
0,3
0,2
0,1
0
-0,1
-0,2
Baseline
Early monit
Late monit
fPSP nº 1
nº 2
nº 1
nº 2
-20
20
60
100
140
Perievent time (s)


CA1/
subiculum
Prefrontal
cortex
Limbic
thalamus

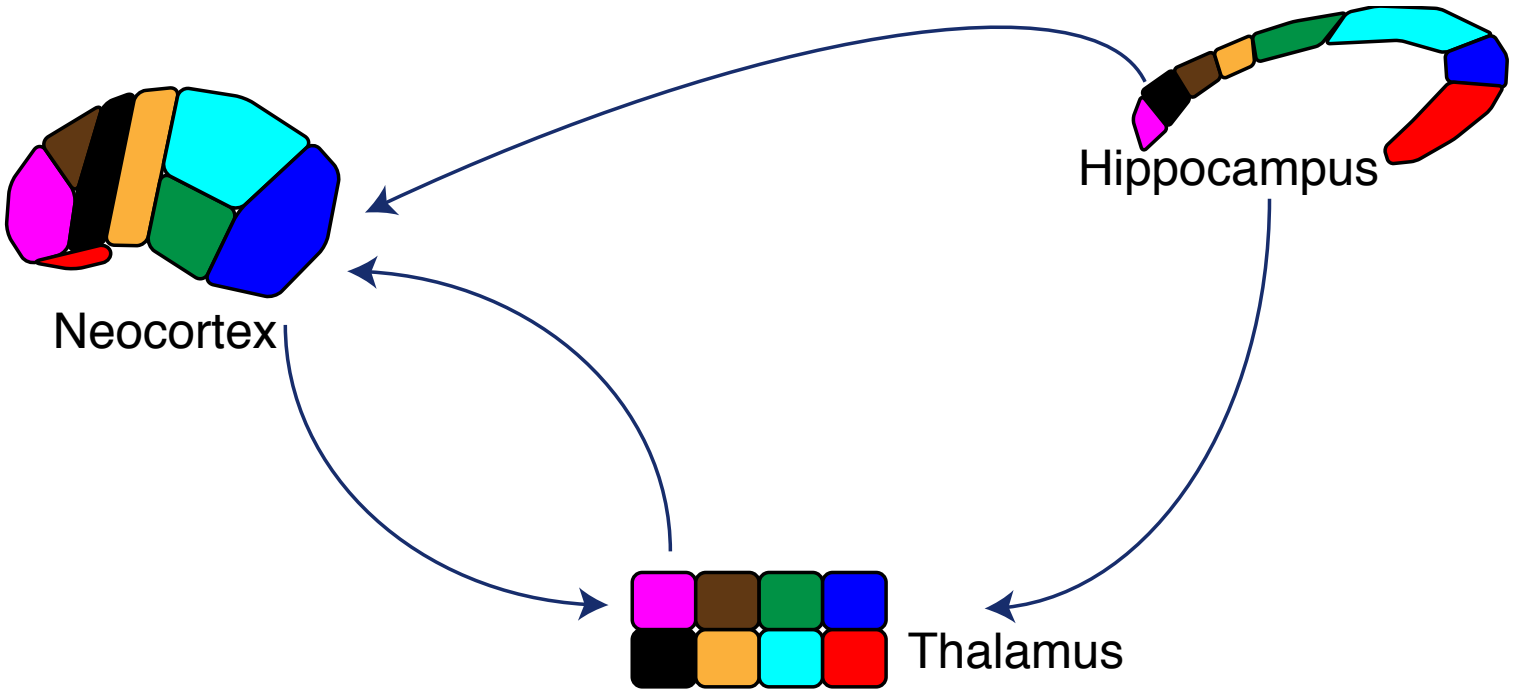
Non-motor (i.e., cognitive) efference copies…?

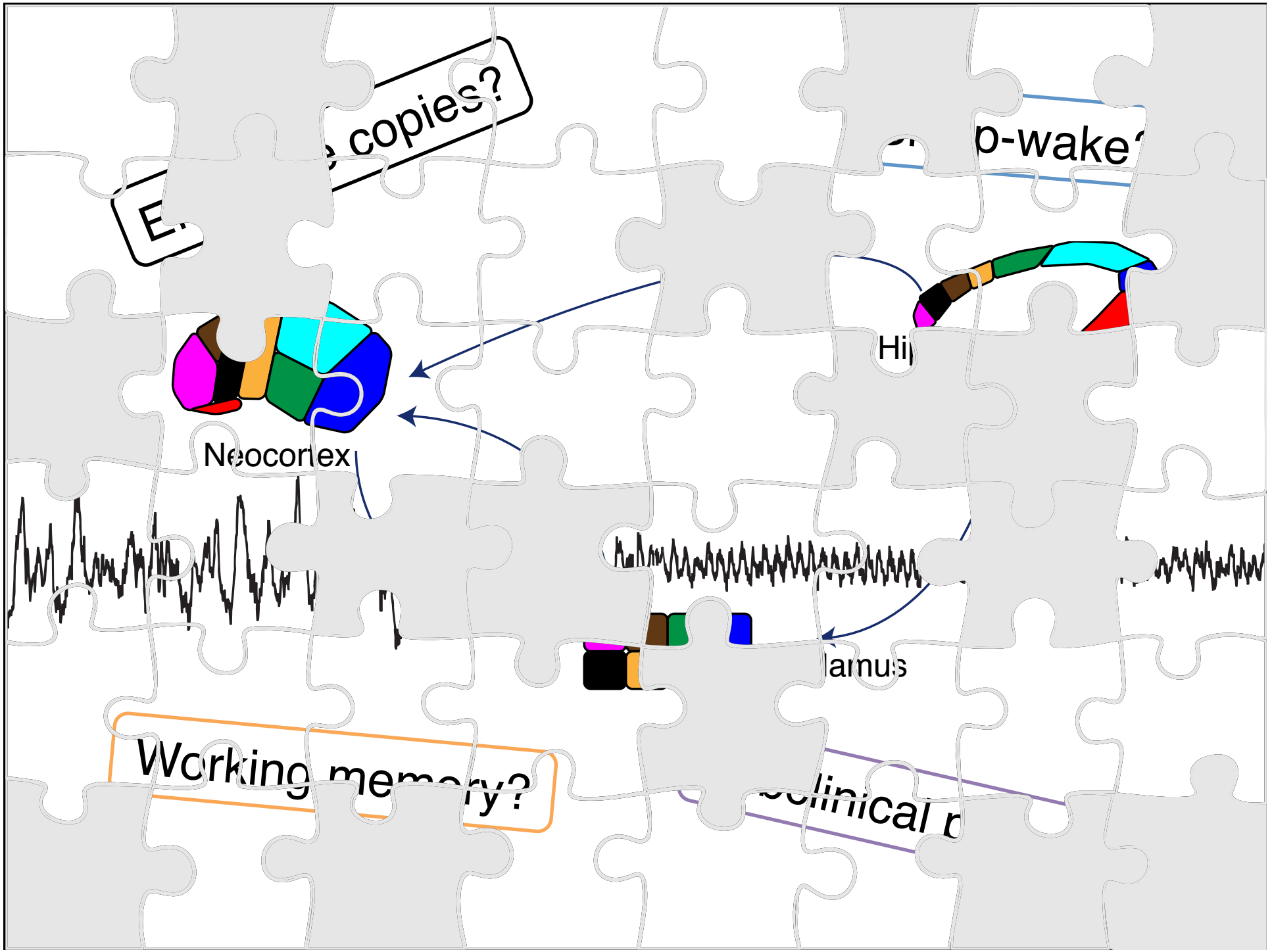
…modulated by the sleep-wake cycle?



Do they have something to do with working memory…?

…or the spread of epileptic seizures?


Hippocampus
Neocortex
Thalamus


copies?
p-wake
Hi
Neocortex
lamus
Working memory?