Pathway-dependent regulation of sleep dynamics in a network model of sleep-wake cycle - Supplementary Material

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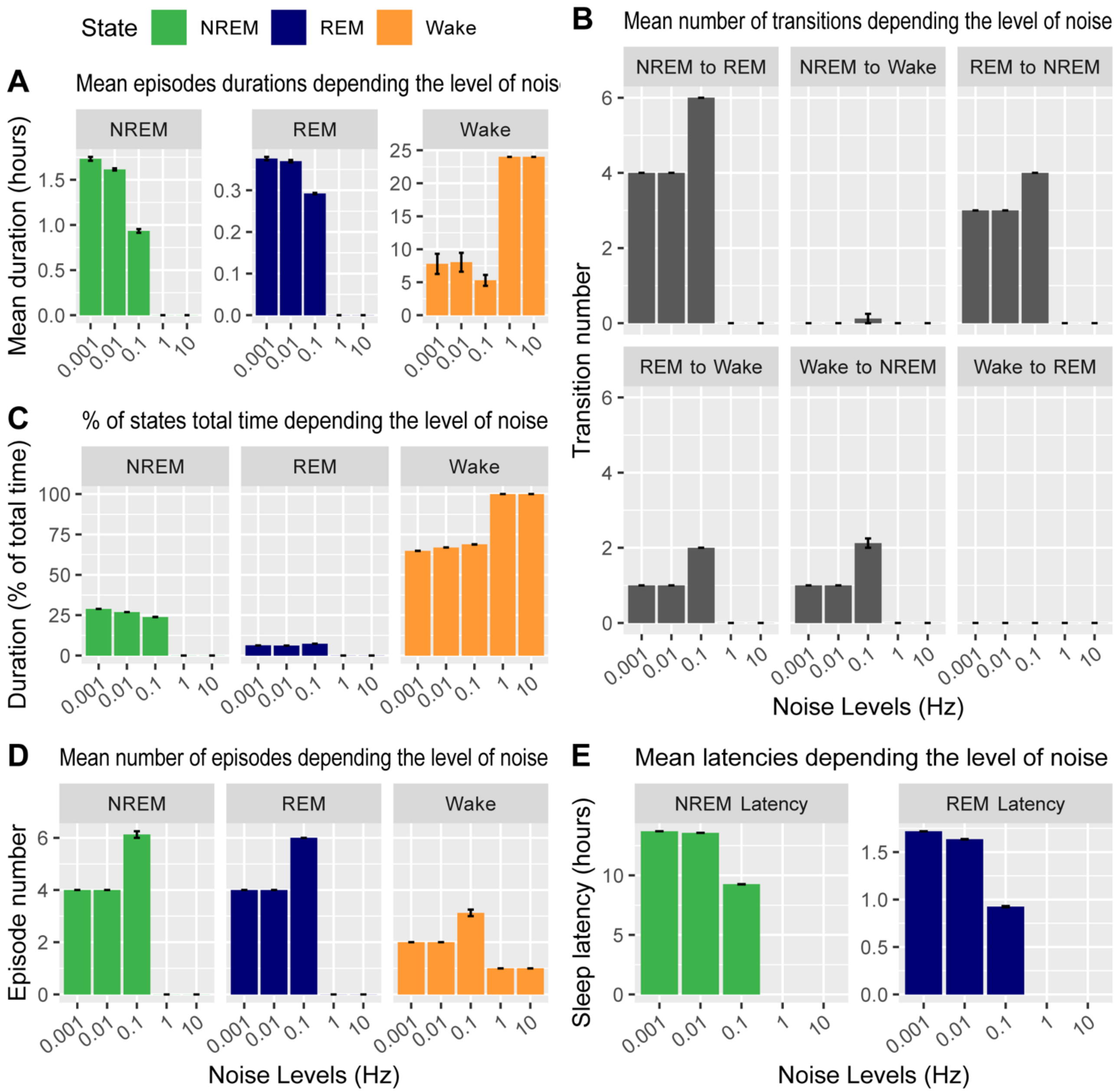

Figure S1: Effect of different levels of noise on the system dynamics. Different values of Gaussian noise (mean of 0.001Hz, 0.01Hz, 0.1Hz, 1Hz and 10Hz were applied during control conditions (n=8 simulations) and the mean duration of the episodes (A), the number of state transitions (B), the percentage of time spent in each state (C), the number of episodes and the sleep latencies were measured.

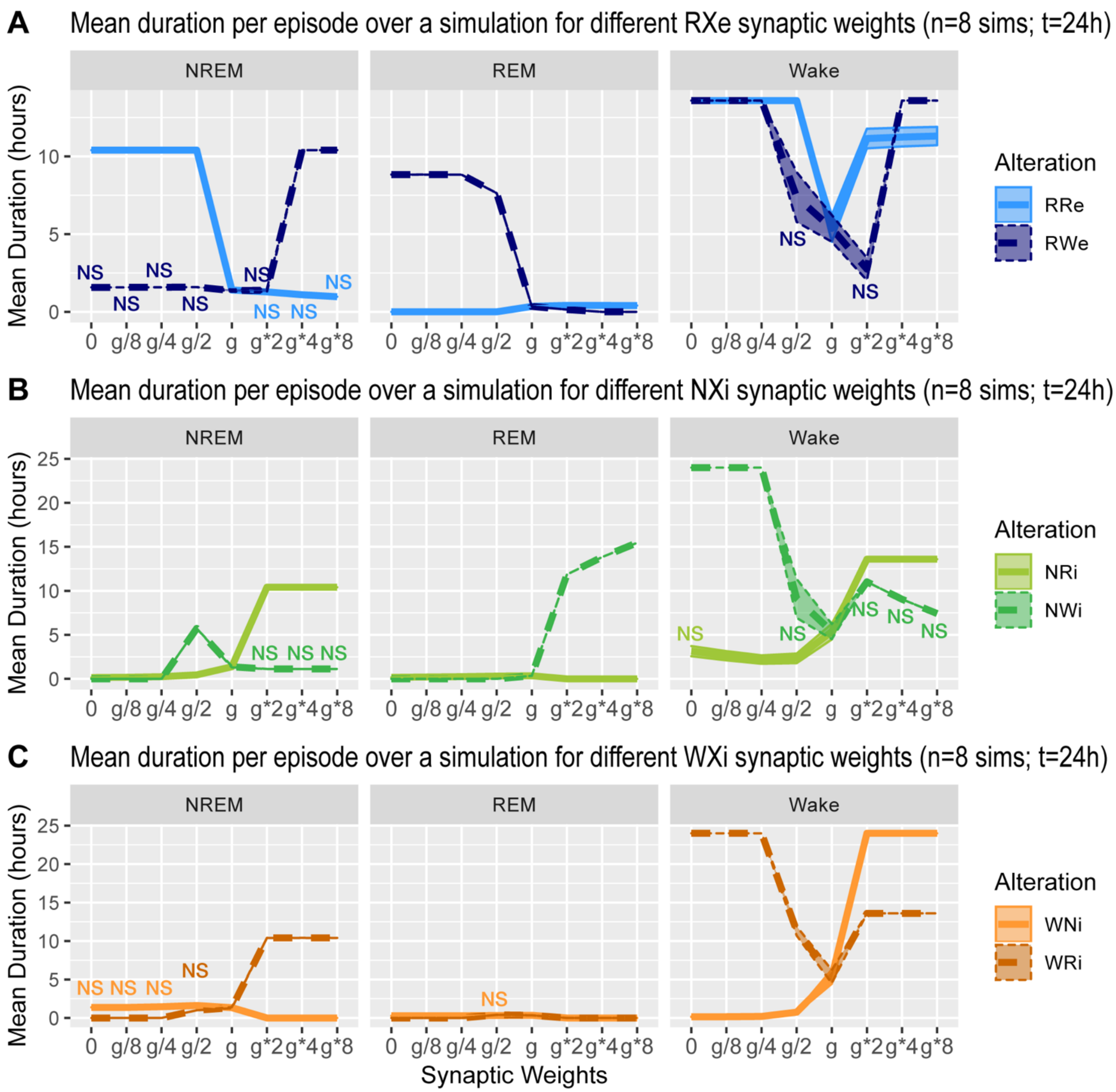

Figure S2: Mean episodes duration for different synaptic weights. The mean duration of each state as a function of synaptic weights for alterations in the REM (A), NREM (B) and (Wake) populations output pathways. Data presents mean ± s.e.m. NS, non-significant (one-way ANOVA).

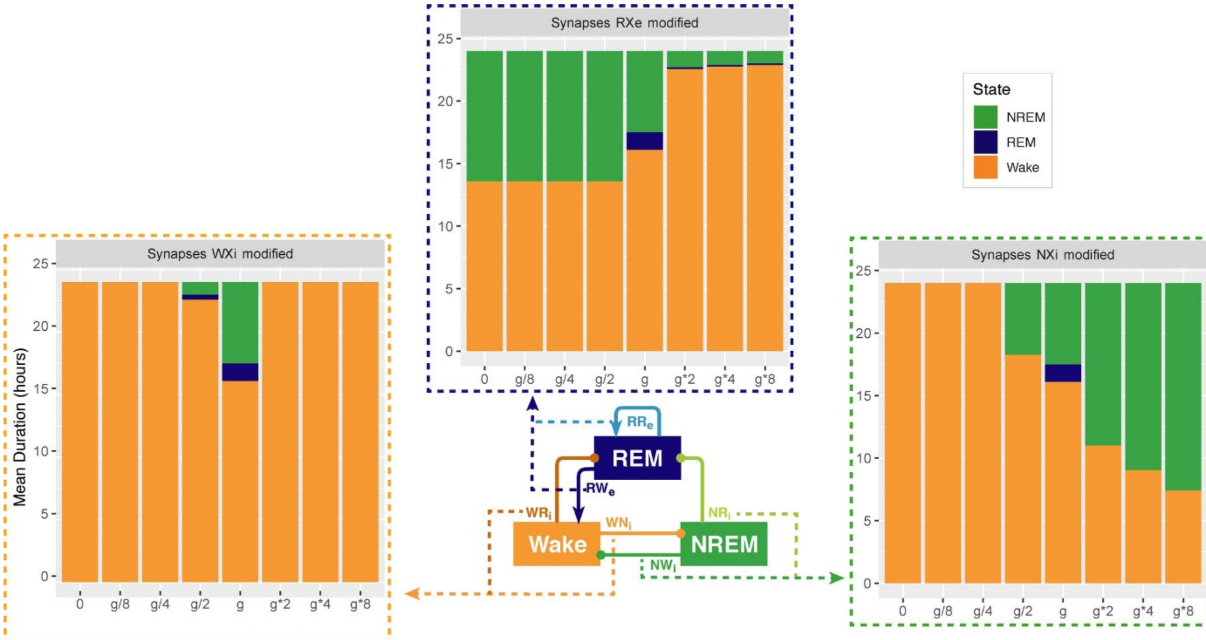

Figure S3: Total duration of each state for different synaptic weights and simultaneous alterations of two-output pathways. Each bar graph represents the total duration of each state as a function of synaptic weights. Here the synaptic alterations were made by two: RRe and RWe (top, blue arrows), NRi and NWi (right, green arrows), WNi and WRi (left, orange arrows) pathway. Each value is an average duration of each state from 8 simulation.

Table S1: Working environment parameters

OS	Mac OS 10.14 (Mojave)
	Windows 10
Programming languages	Python 3.6.8 (Anaconda installation)
	R for Mac OSX 3.5.1 (CRAN-R download)
	GNU Bash 3.2.57
	MATLAB R2018b
Libraries	Numpy 1.13.1 (pip installation)
	Scipy 1.0.1 (pip installation)
	Matplotlib 2.2.2 (pip installation)
	Ggplot2 (CRAN-R download)

Table S2: Parameters of the computational model. The label "See eq" refers to the equations in the Methods section.

Symbol	**Value**	**Unit**	**Description**
F_X	See eq	Hz	Firing rate of the population *X*
$F_{X\infty}$	See eq	Hz	Steady-state firing rate for the population *X*
I_X	See eq	/	Synaptic input function for the population *X*
C_i	See eq	a.u.	Concentration of the neurotransmitter I
$C_{i\,\infty}$	See eq	a.u.	Steady-state function for the release of the neurotransmitter I
W_{max}	6.5	Hz	Maximum firing rate for the Wake-promoting population

N_{max}	5.0	Hz	Maximum firing rate for the NREM-promoting population
R_{max}	5.0	Hz	Maximum firing rate for the REM-promoting population
τ_{W}	1500.10^3	ms	Membrane time constant of the Wake-promoting population
τ_{N}	600.10^3	ms	Membrane time constant of the NREM-promoting population
τ_{R}	60.10^3	ms	Membrane time constant of the REM-promoting population
τ_{RXe}	10.10^3	ms	Membrane time constant of the neuromodulator RXe
τ_{NXi}	10.10^3	ms	Membrane time constant of the neuromodulator NXi
τ_{WXi}	25.10^3	ms	Membrane time constant of the neuromodulator WXi
g_{RRe}	1.6	a.u.	Synaptic weight for the self-connection in the REM-promoting population
g_{RWe}	1.0	a.u.	Synaptic weight for the connection from the REM- to the Wake-promoting populations
g_{WNi}	-2.0	a.u.	Synaptic weight for the connection from the Wake- to the NREM-promoting populations
g_{WRi}	-4.0	a.u.	Synaptic weight for the connection from the Wake- to the REM-promoting populations
g_{NRi}	-1.3	a.u.	Synaptic weight for the connection from the NREM- to the REM-promoting populations
g_{NWi}	-1.68	a.u.	Synaptic weight for the connection from the NREM- to the Wake-promoting populations
α_{W}	0.5	ms^{-1}	Sigmoid slope parameter for the Wake-promoting population
α_{N}	0.175	ms^{-1}	Sigmoid slope parameter for the NREM-promoting population
α_{R}	0.13	ms^{-1}	Sigmoid slope parameter for the REM-promoting population

β_W	-0.4	ms^{-1}	Sigmoid threshold parameters for the Wake-promoting population
β_N	- κ_N * h(t)	ms^{-1}	Sigmoid threshold parameters for the NREM-promoting population
β_R	-0.9	ms^{-1}	Sigmoid threshold parameters for the REM-promoting population
γ_{RXe}	2.0	ms^{-1}	Release scaling for neuromodulator RXe
γ_{NXi}	4.0	ms^{-1}	Release scaling for neuromodulator NXi
γ_{WXi}	5.0	ms^{-1}	Release scaling for neuromodulator WXi
κ_N	-1.5	a.u.	NREM-promoting population firing threshold modulation parameter
h(t)	See eq	a.u.	Homeostatic force
H_{max}	1.0	a.u.	Maximum value for the homeostatic force
τ_{hw}	$34{,}830.10^3$	ms	Time constant of sleep drive build up during wakefulness
τ_{hs}	$30{,}600.10^3$	ms	Time constant of sleep drive decline during sleep
θ_W	2.0	ms^{-1}	Sleep drive threshold