Medical Xpress

Study highlights the key role of the prefrontal cortex in regulating REM sleep

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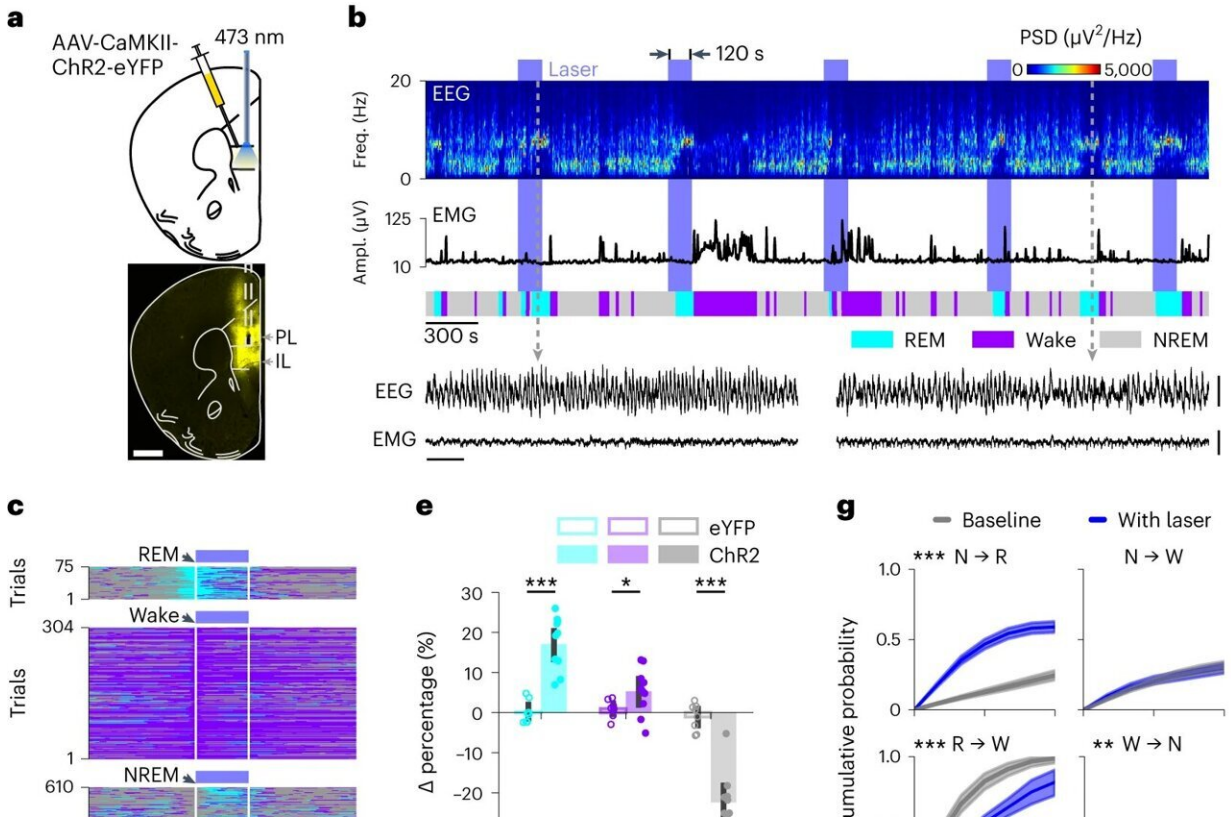

Optogenetic activation of mPFC Pyr neurons triggers REM sleep. **a**, Top: schematic of optogenetic activation of mPFC Pyr neurons. Bottom: expression of AAV-CaMKII-ChR2-eYFP (yellow) in mPFC of a C57BL/6J mouse. Dashed lines, optic fiber tract. Scale bar, 500 μm. Brain atlas image adapted with permission from ref. [61]. **b**, Example open-loop stimulation experiment. Shown are EEG spectrogram, EMG amplitude, brain states, and EEG and EMG raw traces at an expanded timescale for two time points (gray lines). Scale bars, 1 s and 0.5 mV. Blue patches, 120-s laser stimulation intervals (473 nm, 5 Hz). **c**,

Brain states in all stimulation trials from $n = 11$ mice aligned by the laser onset at $t = 0$ s. Trials were sorted depending on the brain state at laser onset (arrows). **d**, Percentages of brain states before, during and after open-loop stimulation. Blue patch, laser stimulation interval. Two-way RM ANOVA comparing the mean percentage of each brain state between the laser and preceding 120-s baseline interval (interaction, $P = 0.0000$); *t*-tests with Holm–Bonferroni correction; baseline versus laser: REM, $P = 0.0000$; wake, $P = 0.0093$; NREM, $P = 0.0000$. $n = 11$ mice. Lines, averages across mice; shadings, 95% CIs. **e**, Changes in the percentage of each brain state (difference between preceding 120-s baseline and laser interval) induced by laser stimulation in ChR2 and eYFP mice. Mixed ANOVA with brain state as the within-subjects factor and virus as the between-subjects factor (interaction, $P = 0.0000$); *t*-tests with Holm–Bonferroni correction; eYFP versus ChR2: REM, $P = 0.0000$; wake, $P = 0.0321$; NREM, $P = 0.0000$. ChR2, $n = 11$; eYFP, $n = 8$ mice. Bars, averages across mice; dots, individual mice; error bars, 95% CIs. **f**, Top: laser-trial-averaged EEG spectrogram (normalized by the mean power in each frequency band; Methods). Bottom: time course of δ (0.5–4.5 Hz), θ (6–9.5 Hz) and γ power (50–90 Hz) before, during and after laser stimulation. Two-way RM ANOVA comparing the mean power in each frequency band between the laser and preceding 120-s baseline interval (interaction, $P = 0.0000$); *t*-tests with Holm–Bonferroni correction; baseline versus laser: δ, $P = 0.0000$; θ, $P = 0.0006$; γ, $P = 0.0000$. $n = 11$ mice. Lines, averages across mice; shadings, 95% CIs. **g**, Cumulative probabilities to transition from brain state X at laser onset ($t = 0$ s) to state Y within the laser interval (blue) and the 120-s baseline interval preceding laser onset (gray). Bootstrap; N → R, $P = 0.0001$; R → W, $P = 0.0001$; N → W, $P = 0.9274$; W → N, $P = 0.0042$; $n = 11$ mice. Shadings, 95% CIs. **h**, Graph summarizing relative changes in the cumulative transition probabilities between baseline and laser interval (Methods). A value of 1 indicates no change between baseline and laser. The edges for wake → REM and REM → NREM transitions were omitted, as these types of transitions were not observed in the dataset. Solid and dashed lines indicate significant and nonsignificant changes in the transition probabilities, respectively. See Supplementary Table 1 for detailed statistical information. *P

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