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Neurons membrane potential beats to the rhythm of breath.

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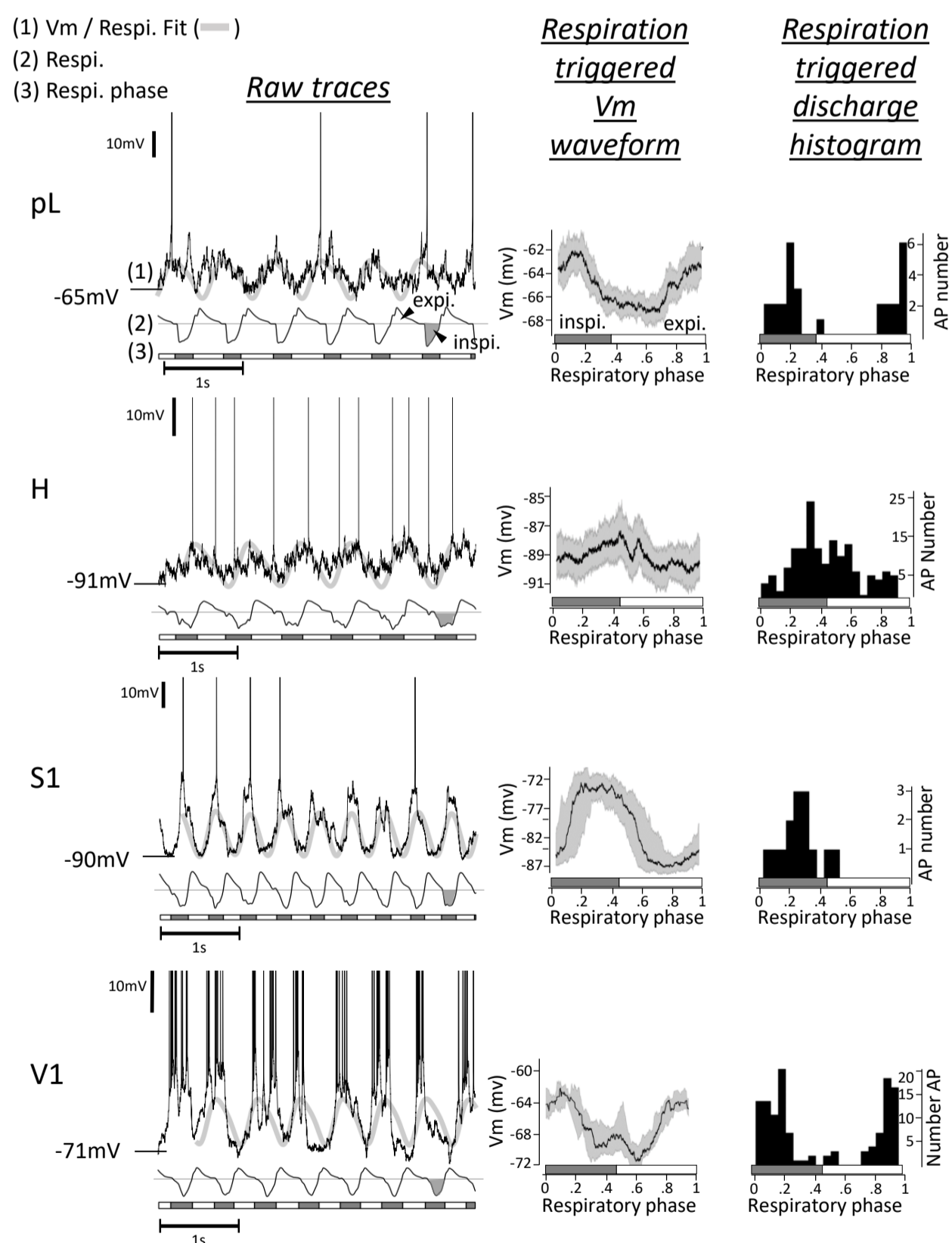
Introduction

Respiratory rhythm has recently emerged as a key element in the cortical dynamics, since an increasing number of studies have shown a global entrainment of LFP activities by the respiratory rhythm. This observation has been done in rodents as well in humans, and in a large set of brain areas (cortical and limbic areas). Since this question has been tackled in non-olfactory structures almost exclusively through LFP analysis, the mechanisms underlying such respiratory modulation cannot be fully understood. To carry on understanding, we performed intracellular and LFP co-recordings in four non-olfactory brain areas : Hippocampus (H), and the somatosensory (S1), primary visual (V1) and prelimbic cortices (pL), in anesthetized rats.

Methods

Experiments were performed on freely breathing anesthetized rats. Intracellular activity (or Vm) and LFP were co-recorded. For Vm, sharp electrodes filled with a solution of 2M potassium acetate (Resistance 45-120 Mohms) were used. Respiration was monitored using a pressure sensor placed before the right nostril.

Result 1 : Respiratory-rhythm (RR) can entrain neuron activity in widespread brain areas



➔ We observed that both Vm and spiking discharge could be RR-entrained in all recorded areas.
 To what extent brain areas are sensitive to RR ?

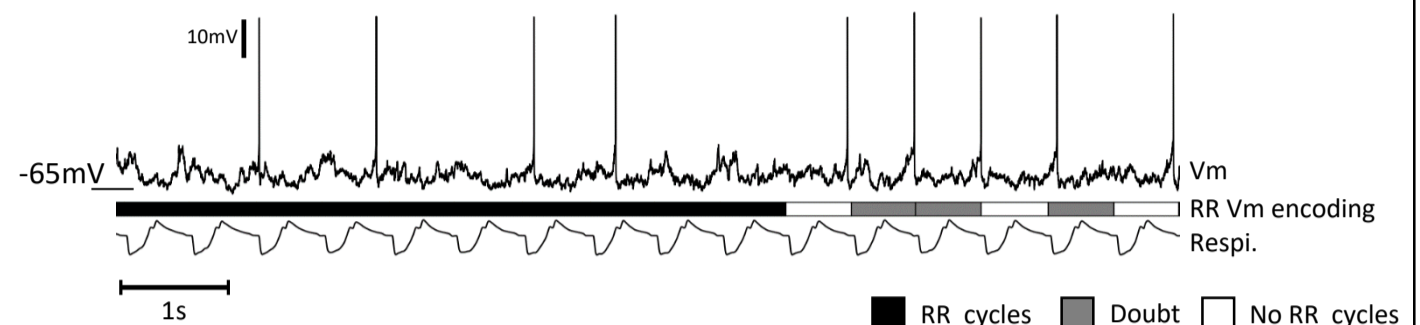
Conclusions

Our results suggest that a respiratory drive of cellular membrane potential exists in a large brain network, influencing temporal discharge pattern. This drive is not unique but varies according to the brain area, LFP dynamics and probably other parameters that remain to be explored.

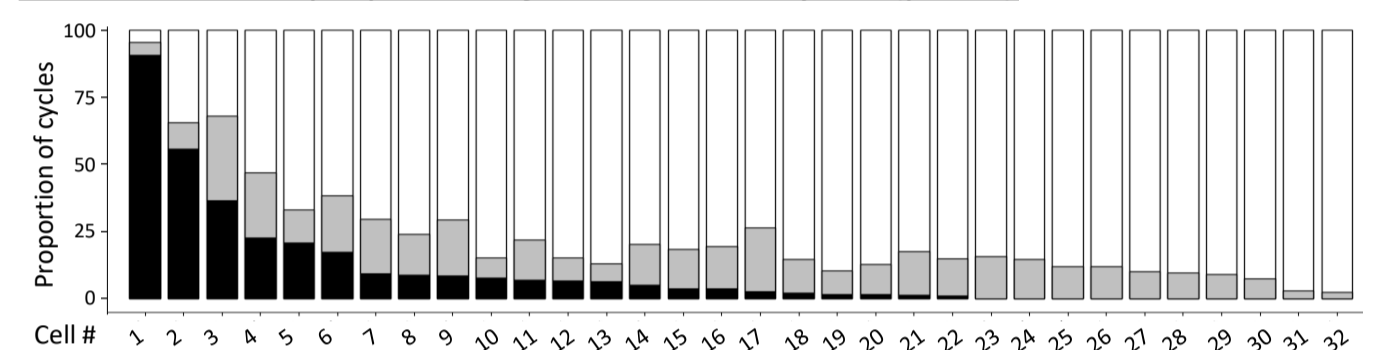
Result 2 : Brain-wide quantification of Vm RR oscillations

To precisely quantify RR entrainment of Vm oscillations, we developed a detection method using respiration triggered waveform Vm (4 respi. cycles sliding windows), and compared to surrogates. This algorithm finally led to a RR encoding of Vm for each respiratory cycles.

Cell-wide : time dynamics of RR Vm encoding (pL ex.)

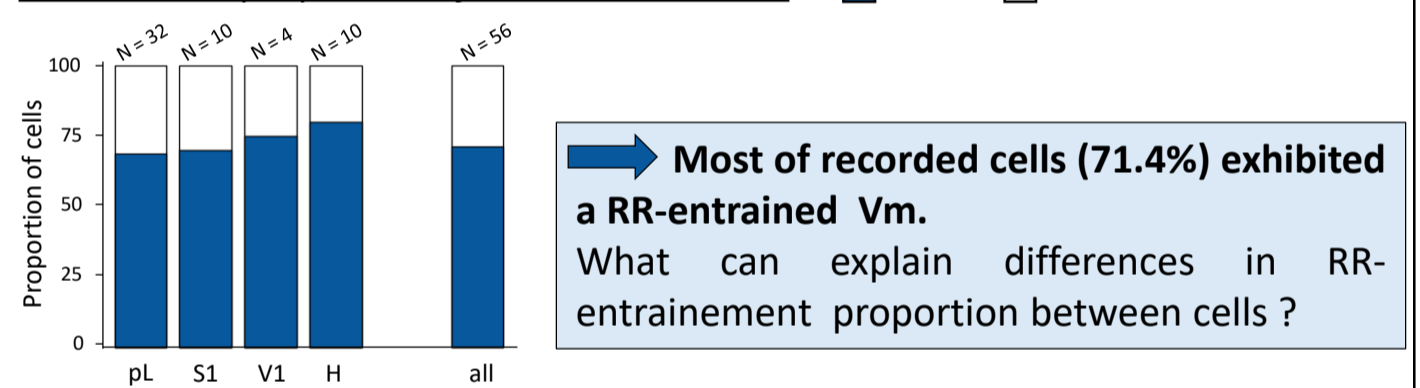


Structure-wide : proportion of RR entrained cycles (pL ex.)



➔ From cell to cell we observed a variable proportion of cycles RR-entrained.

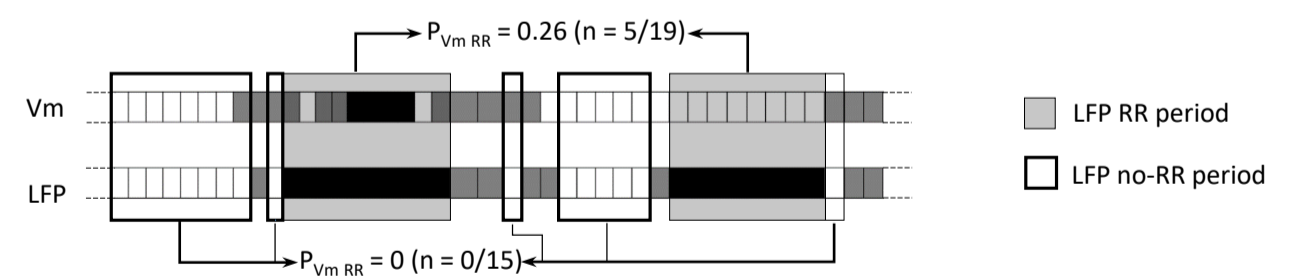
Brain-wide : proportion of RR entrained cells



Result 3 : Vm and LFP entrainment are partly coordinated

We encoded with the same detection method both Vm and LFP. Then we computed the probability for Vm to be RR-entrained as a function of LFP dynamics.

Vm conditional probability computation example



Vm conditional probability by structures

