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# Neurons membrane potential beats to the rhythm of breath.

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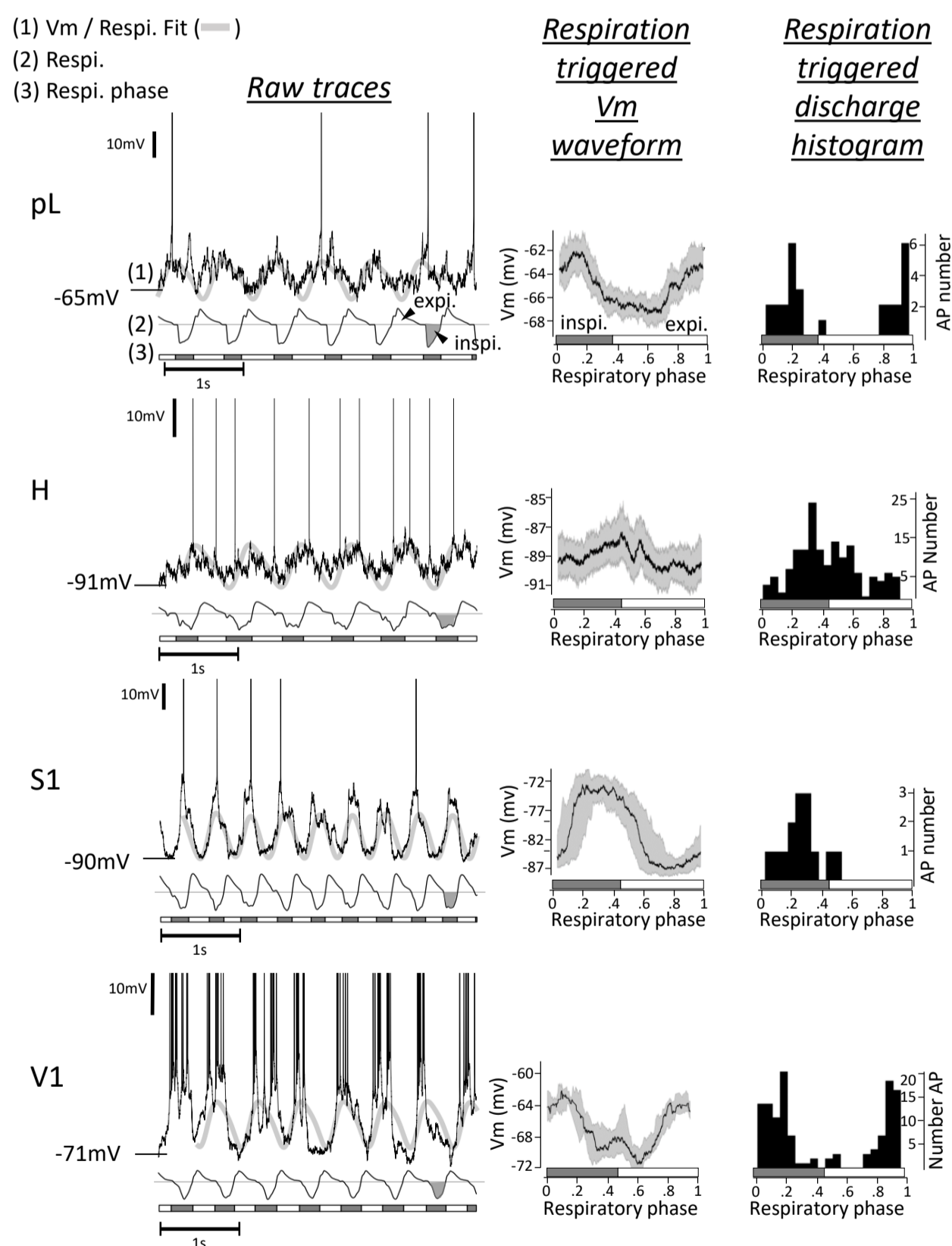
## Introduction

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 ?

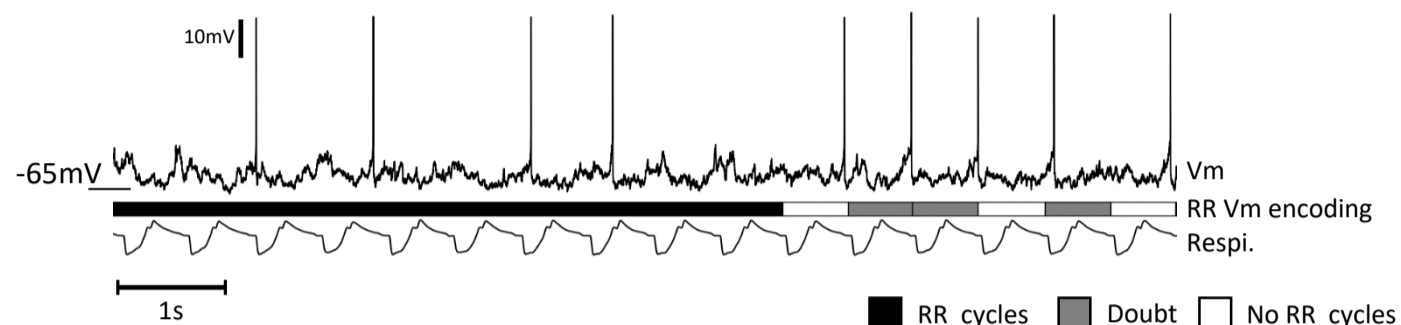
## Conclusions

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.

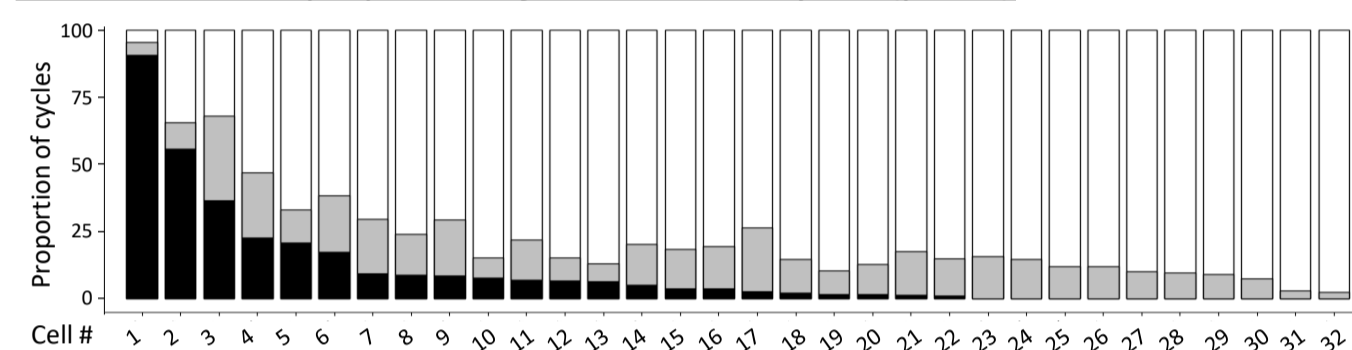
## Result 2 : Brain-wide quantification of Vm RR oscillations

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.)

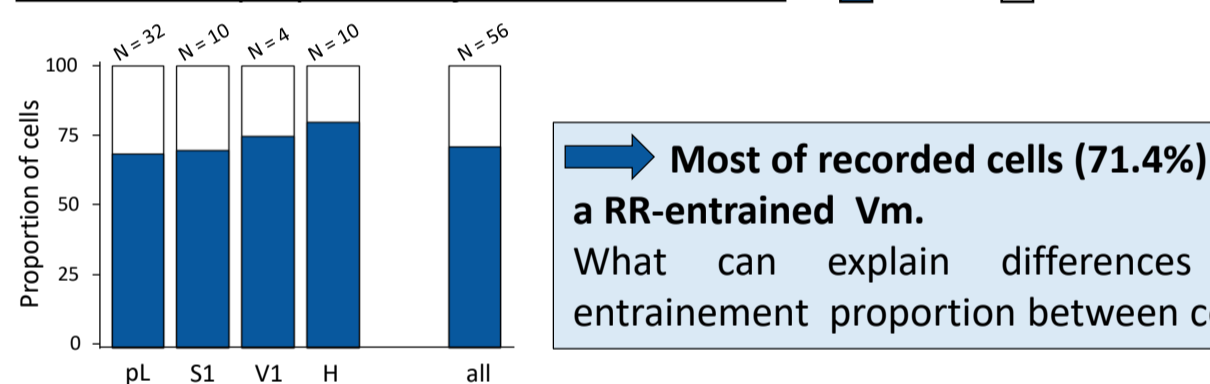


### Structure-wide : proportion of RR entrained cycles (pL ex.)



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

### Brain-wide : proportion of RR entrained cells

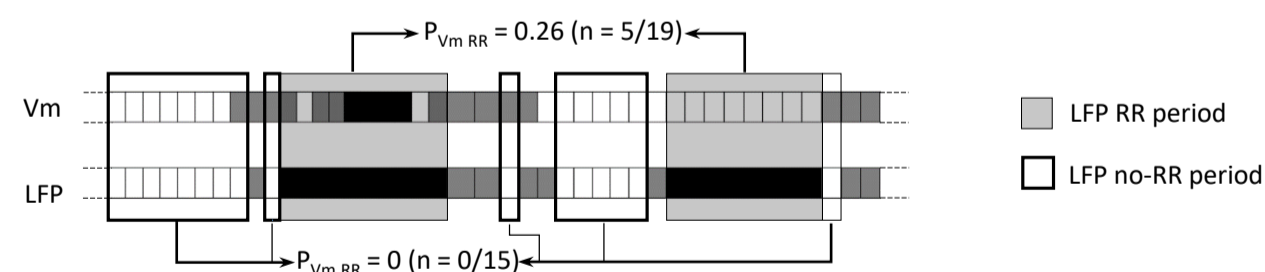


➔ Most of recorded cells (71.4%) exhibited a RR-entrained Vm.  
 What can explain differences in RR-entrainment proportion between cells ?

## 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

