Mechanisms and functions of respiration-driven gamma oscillations in the primary olfactory cortex

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Introduction

Gamma oscillations are believed to underlie cognitive processes by shaping the formation of transient neuronal partnerships on a millisecond scale.

These oscillations are coupled to the phase of breathing cycles in several brain areas, possibly reflecting local computations driven by sensory inputs sampled at each breath.

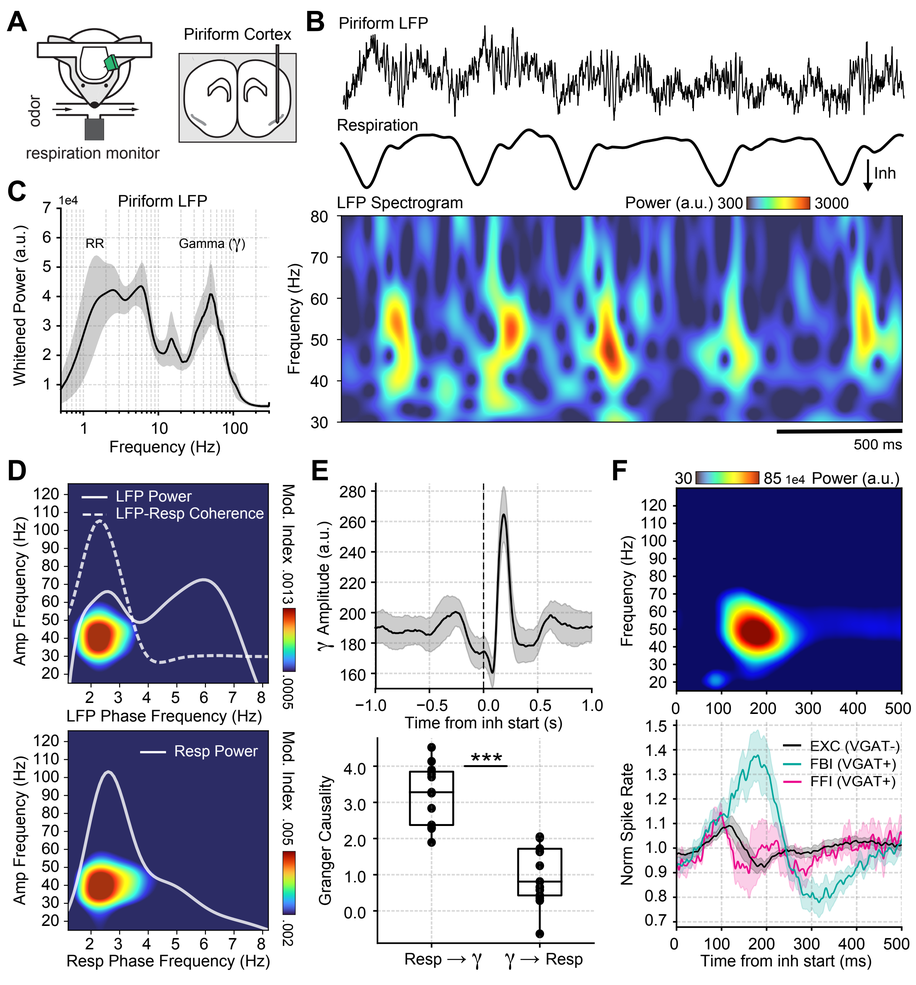

Figure 1. Respiration drives feedback inhibition-based gamma oscillations in the piriform cortex.

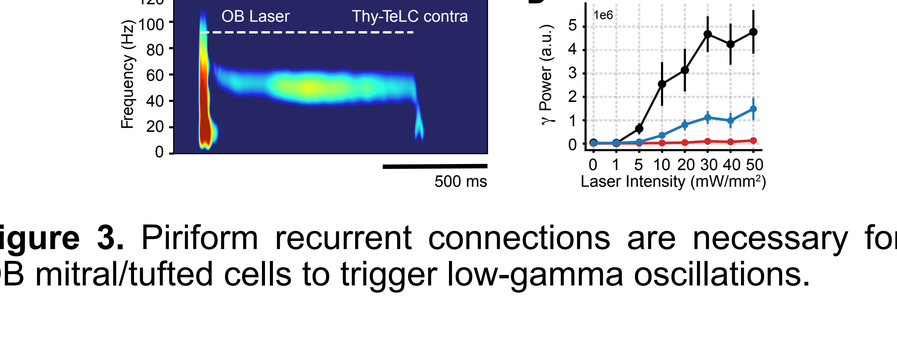

Figure 2. Respiration-driven gamma oscillations depend on recurrent connections within the piriform cortex.

Figure 3. Piriform recurrent connections are necessary for OB mitral/tufted cells to trigger low-gamma oscillations.

Objectives and Dataset

We investigated the mechanisms and functions of gamma oscillations in the piriform (olfactory) cortex of awake mice to understand their dependence on breathing and how they relate to local spiking activity.

We analyzed recordings generously made available by Bolding and Franks (http://crcns.org, pcx-1 dataset).

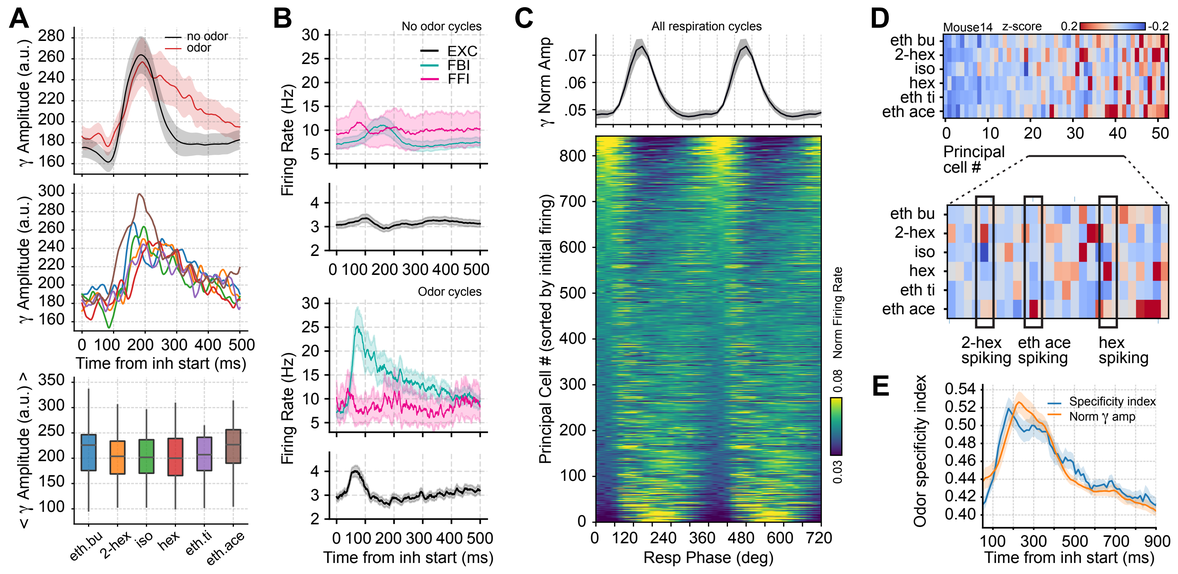

Figure 4. Respiration-driven gamma oscillations relate to single-cell spiking specificity to odors.

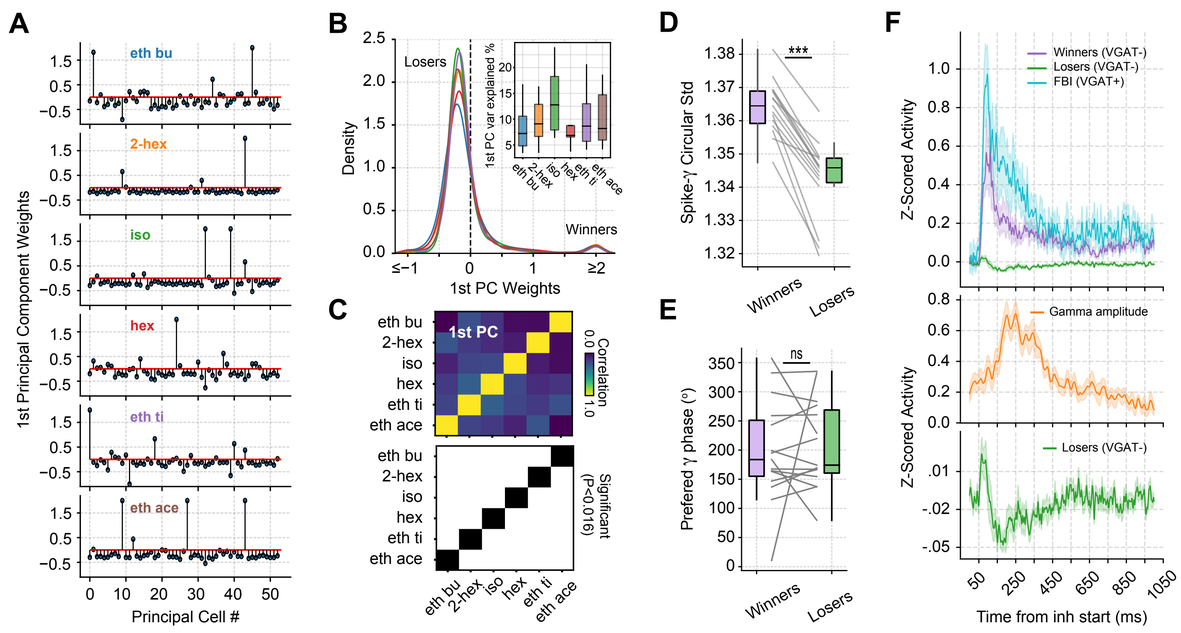

Figure 5. Gamma inhibition determines sparse odor-assembly representations through a winner-take-all computation.

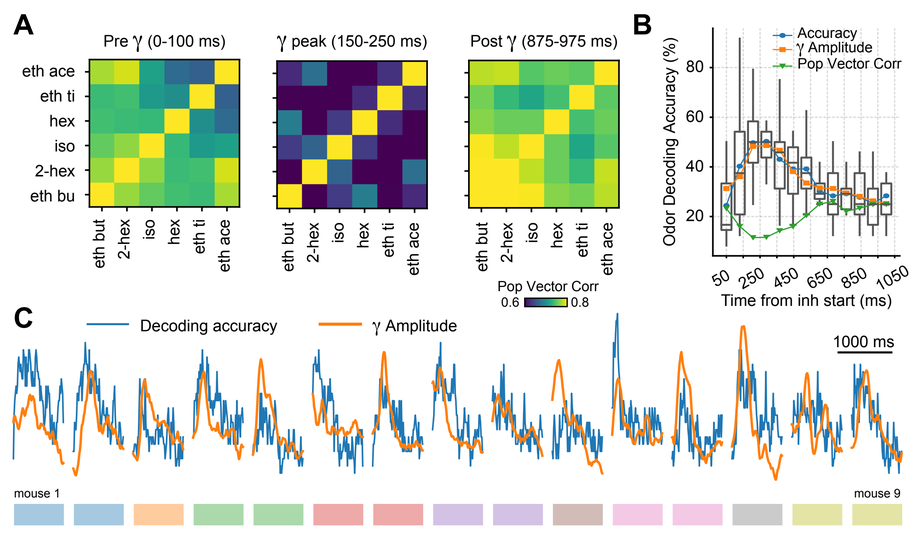

Figure 6. Gamma oscillations provide a privileged window for odor decoding.

Conclusions

1) Following each sniff, olfactory information is processed in the OB and is transmitted to the piriform circuit through mitral/tufted cell spiking.
2) The principal cells that better encode the olfactory stimulus excite feedback interneurons.
3) Feedback interneurons inhibit competing principal cells, causing the field gamma oscillation.
4) This winner-take-all process segregates cell assemblies and dictates a sparse piriform odor representation.