Mammalian Olfactory System: Feed-Forward
Mammalian Olfactory Bulb Input
The LFP gamma oscillation predicts M/T cell firing patterns
Individual pyriform cortex pyramidal cells spike in response to a few input mitral cell spikes summated in a short time window (~10 ms)

Franks and Isaacson, *Neuron* 2006
Behavior modulates oscillations

Rojas-Líbano et al., Front Behav Neurosci 2014
Behavioral context modulates oscillation power and type

Jennifer Beshel

1 sec

gamma filtered data

Beshel et al., *J Neurosci* 2007

Claire Martin

Martin et al., *J Neurophysiol* 2007
Beta oscillations, odorant volatility and sensitization

Catherine Lowry Franssen

Lowry & Kay, *J Neurophys* 2007
More than just frequency differences

Without centrifugal input, gamma increases.

Without centrifugal input, beta disappears.
More than just frequency differences

Gray & Skinner, Exp Brain Res 1988

Fig. adapted from Freeman, 1975

Excitatory
Inhibitory

MC- mitral cells
GC- granule cells
ORN- olfactory receptors
JG- juxtaglomerular cells
Beta oscillations require an intact network

Martin et al., *Eur J Neurosci* 2006
Rats sample ~1 sniff longer for go/no-go than 2-alternative choice.

No differences in sampling times and performance at the end of training; differences emerge upon rule transfer.

8 odor sets varying in volatility and 2DG glomerular map overlap, including ‘extreme’ odor set. 3 sessions for each odor set.
Rats sample ~1 sniff longer for go/no-go than 2-alternative choice.

No differences at the end of training; differences emerge upon rule transfer.
Stereotyped sequence of oscillatory states:

2-4 sniffs of gamma followed by beta oscillations at >250 ms.
Rats manipulate the dynamics (flow) of the first 2 sniffs to target specific odors.
Identifying and extracting gamma and beta bursts
Gamma and beta in time and frequency
Burst onset histograms show temporal precision

Rats doing both tasks

- go/no-go
- 2-alternative choice

Time (sec)

Odor sample
Gamma and beta dominate in different behavioral epochs

Gamma power is elevated during initial odor sampling

Beta power is elevated after ~250 msec
Fast and slow gamma dominate in different behavioral epochs

Fast Gamma (80-100 Hz; presumed tufted cells)

Slow Gamma (60-80 Hz; presumed mitral cells)
Fast and slow gamma dominate in different behavioral epochs

2 curves from 2 experiments (between, n=8, and within, n=3, subjects)
Temporal relationships among all 3 frequency bands

Experiment 1 (rats do 1 task)

Experiment 2 (rats do both tasks)

Beta scaled by 0.5 for display
Summary

• Rats sample ~1 sniff longer in the GNG task
• Beta oscillations begin after ~250ms of sampling and are tied to the exit from the odor port
• First 2-3 sniffs show strong gamma
• Fast gamma is strongest in the first 2-3 sniffs (tufted cells?), when gamma is strongest
• Slow gamma dominates after the first few sniffs (mitral cells?), when beta is strongest
• Fast gamma and beta appear to supplant each other