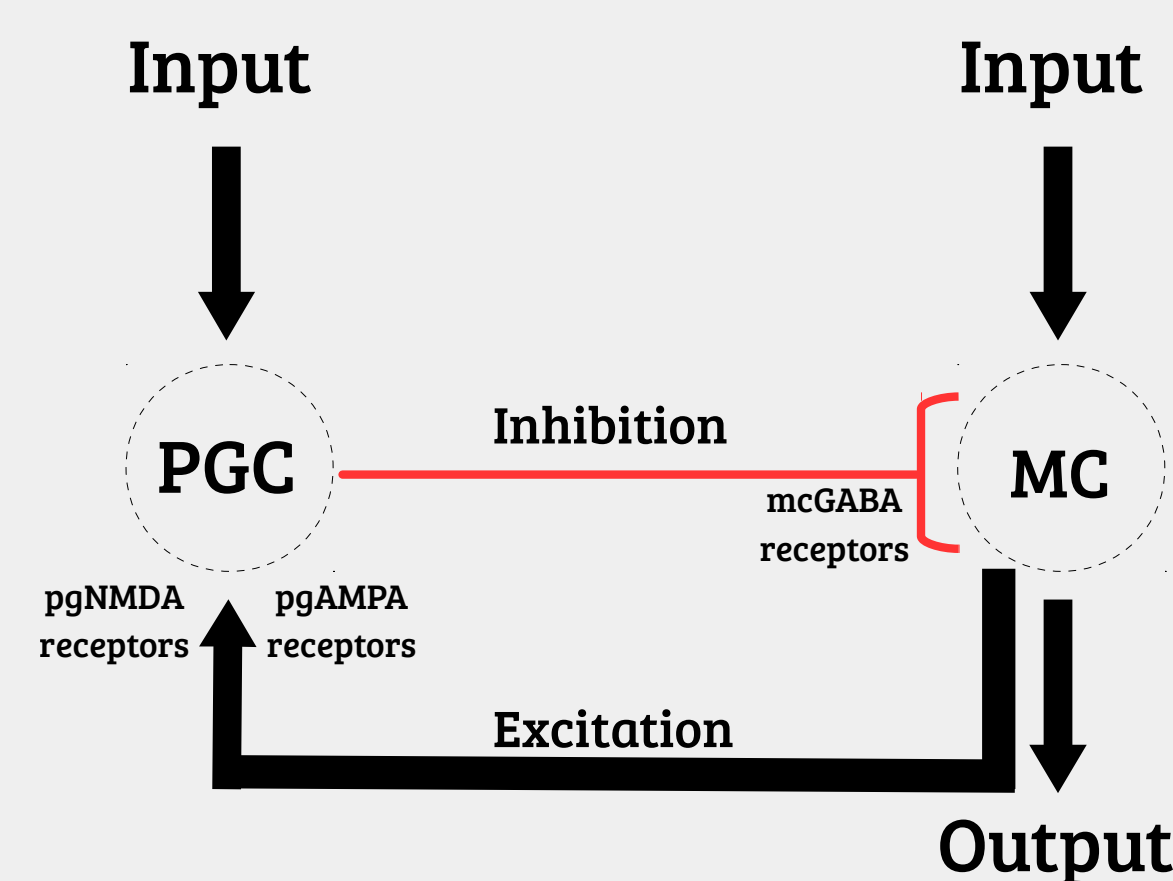


Introduction

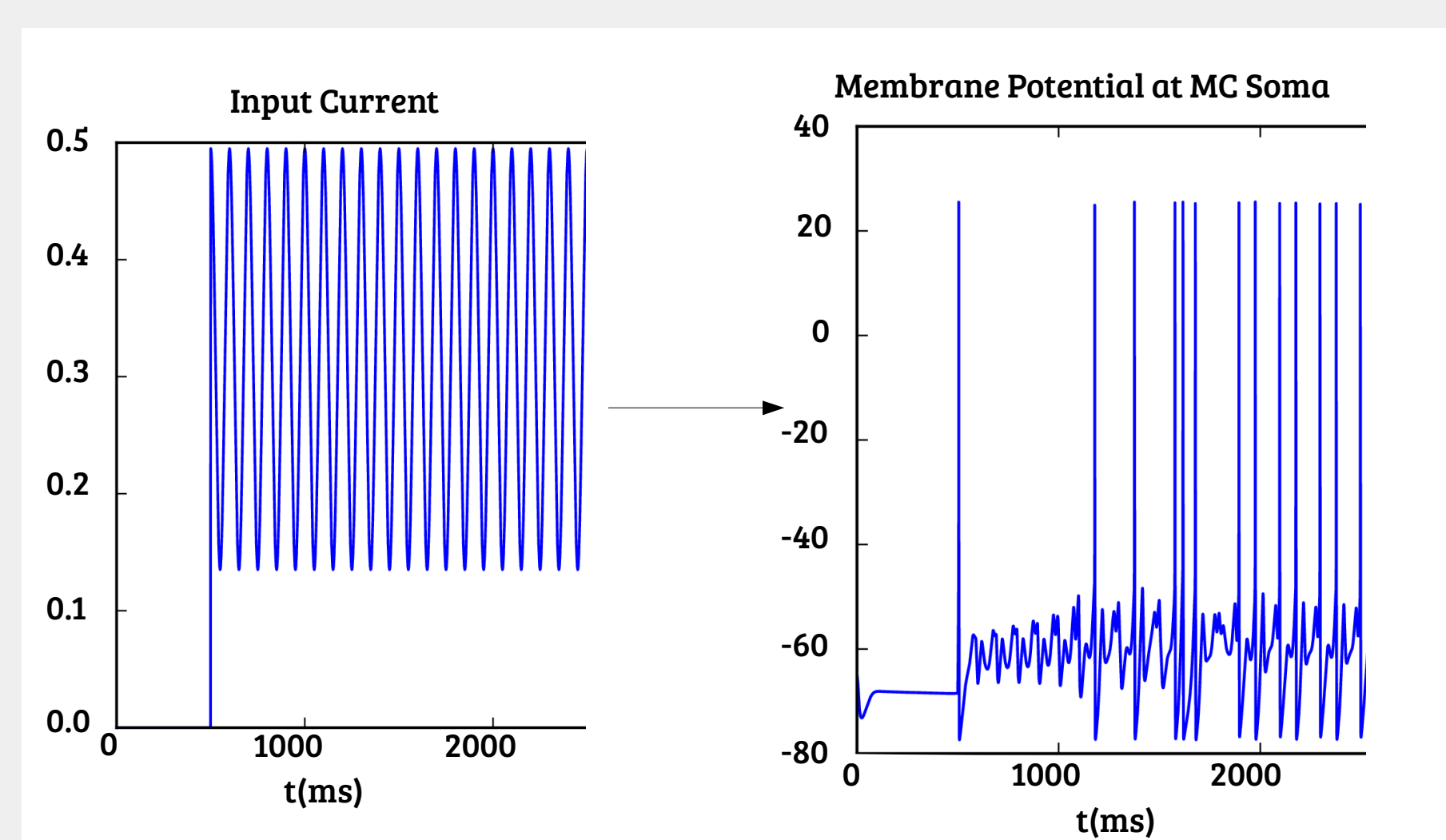
- Recent studies show that the structure of odour stimuli contains information about the olfactory scene [2, 5].
- We investigated whether mitral cells (MCs) in the OB show frequency tuning and, if they do, how different components of the glomerular layer circuitry shape and determine the tuning.

Model



- We used a model of the OB (modified from [4]).
- Modeled MC - PGC (periglomerular cells), focusing on recurrent and feed - forward inhibition in the glomerular layer.

Method



- We used sinusoidal currents of varying frequencies as input, using the equation:

$$y(t) = c \cdot \sin(2 \cdot \pi \cdot f t + \varphi) + 0.18$$

- Where strength of input to MC (c) = 0.45nA and phase (φ) = 0.

Parameter	Iteration Values
PGC Input Strength (i·c)	0.2 0.3 0.4 0.5 0.6
MC - PGC excitation strength (W_{exc})	2.0 4.0 6.0 8.0 10.0
PGC - MC inhibition strength (W_{inh})	1.0 2.0 3.0 4.0 5.0
Frequency (f)	1.0, 2.0, 3.0, ... , 40.0

- Parameter combinations: PGC input strength, MC - PGC excitation strength and PGC - MC inhibition strength.
- Constructed frequency tuning curves and then extracted the peak resonance frequency (fig 3).
- Extracted the resonance strength of the tuning Q (fig 4), measured as:

$$Q = \frac{(F_{max} - F_{min})}{\langle F \rangle}$$

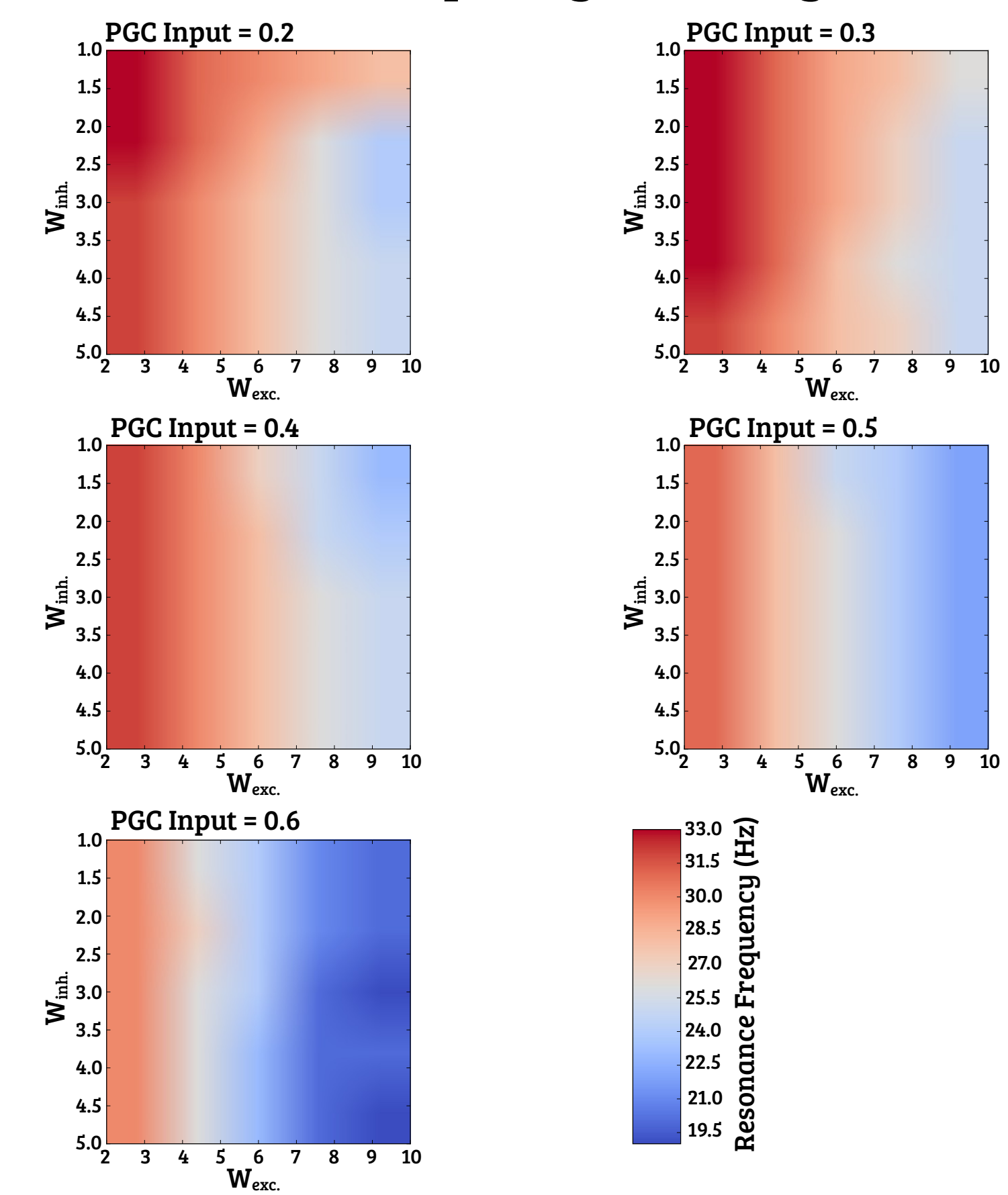
- F_{max} and F_{min} is maximum and minimum firing rate.
- $\langle F \rangle$ is mean firing rate over all measured frequencies.

References

- [1] J. N. Brea, L. M. Kay, and N. J. Kopell. Biophysical model for gamma rhythms in the olfactory bulb via subthreshold oscillations. *Proceedings of the National Academy of Sciences*, 106(51):21954--21959, 2009.[2] A. Celani, E. Villermaux, and M. Vergassola. Odor landscapes in turbulent environments. *Physical Review X*, 4(4):041015, 2014.[3] G. Li and T. A. Cleland. A two-layer biophysical model of cholinergic neuromodulation in olfactory bulb. *Journal of Neuroscience*, 33(7):3037--3058, 2013.[4] M. Schmuken, V. Bahr, and R. Huerta. Exploiting plume structure to decode gas source distance using metal-oxide gas sensors. *Sensors and Actuators B: Chemical*, 235:636--646, 2016.

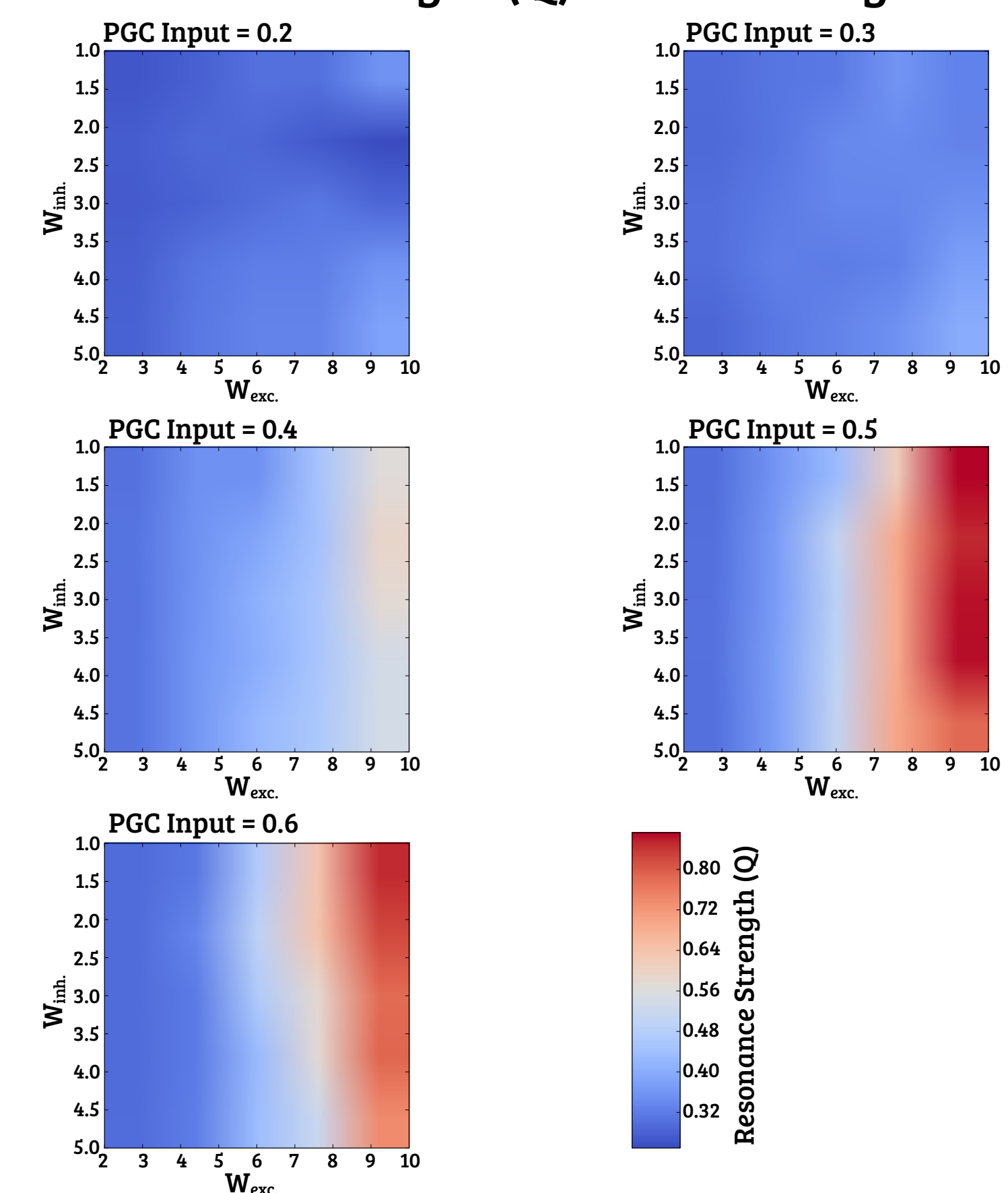
Results

Resonance Frequency of Tuning Curves



- Resonance frequency decreased as the excitation of the PGC increased (both from input and the MC).
- Strength of PGC inhibition onto the MC did not have a strong effect.

Resonance Strength (Q) of the Tuning Curves



- Resonance strength increased with the strength of the excitatory connection, when the PGC received sufficient external input.

Conclusion

- Results suggest the MC can show frequency tuning.
- Therefore, the OB might be able to detect the frequency composition of signals.
- This could be used for olfactory scene analysis.
- However, we only see tuning in a narrow frequency range.