

## WHY DO OLFACTORY NEURONS HAVE UNSPECIFIC RECEPTIVE FIELDS?

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### 1. Context

Biological olfactory receptors are deployed as a population, each responding to a large variety of chemical compounds—that is, they possess highly unspecific receptive fields. The question of whether this property is a physical constraint of chemical transduction, or on the other hand, is beneficial to system performance is unclear.

In this work, we employ the notion of Fisher Information to study how both the distribution and the configuration of the receptive fields within a population of chemosensors affect the optimal detection performance of the system. Unlike previous work, we neither impose a particular shape on the receptive field, nor a homogeneous distribution of receptor specificities across the population. Thus, the individual receptor tunings are free parameters which we adjust using a global optimization scheme.

Our results apply to any population-coded system and suggest two phenomena that might represent general principles of organization within biological sensory systems: maximization of the diversity of tunings (demonstrating entropy maximization) and homogeneity in the distribution of these different responses (which does not depend on the statistics of the input stimuli). In addition, the grade of specificity of the neurons in the optimal configuration depends on the physical constraints of the problem. When normalizing constraints exist each neuron tends to respond to just one chemical compound (as in the specific case of pheromone sensing). However, if normalization is not a constraint, the receptive fields of the neurons are highly unspecific (as in the more general case of odor sensing). These results are compared with other techniques such as Infomax that use Shannon's Information concept instead of Fisher Information.

### References

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