In a previous paper (Gorur-Shandilya et al 2017), we showed that \textit{Drosophila} olfactory receptor neurons (ORNs) scale their gain inversely with mean odor intensity, according to the Weber-Fechner law. Here we investigate the implications of this front-end mechanism for odor coding capacity in natural environments, where the intensity and timescales of odor signals can span several orders of magnitude, and odors can mix together. We find that ORN adaptation promotes the reconstruction of odor identity from dynamic odor signals, even in the presence of confounding background odors and rapid intensity fluctuations. These enhancements are further aided by known downstream transformations in the antennal lobe and mushroom body. Thus, despite the broad overlap between individual ORN tuning curves, a mechanism of front-end adaptation, when endowed with Weber-Fechner scaling, may play a vital role in preserving representations of odor identity in naturalistic odor landscapes.

Our results, which are applicable to various odor classification and reconstruction schemes, stem from the fact that ORN adaptation is not intrinsic to the receptor involved. Instead it results from olfactory ion channel activity, which dynamically adjusts receptor sensitivity in accordance with the Weber-Fechner law. Hence, a common scaling of the gain with respect to odor intensity across Orco-expressing ORNs is one of the features of ORN adaptation that helps maintain combinatorial coding.