Odor identity is encoded by spatiotemporal patterns of activity in olfactory receptor neurons (ORNs). In natural environments, the intensity and timescales of odor signals can span several orders of magnitude, and odors can mix together, potentially scrambling the combinatorial code mapping neural activity to odor identity. Here we show that a front-end adaptation mechanism, recently characterized in *Drosophila* ORNs, enhances coding capacity and 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. 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 transduction downstream of olfactory ion channel activity, dynamically adjusting receptor sensitivity in accordance with the Weber-Fechner law of psychophysics.