Threshold Response and Force Model

If the threshold force of the olfactory receptor were known, then it would be easy to find threshold concentrations for all flavor materials. The theory does not predict how the flavor stimulus influences the threshold force and the response of the olfactory system to that force. What is assumed is that a receptor or a bundle of receptors is sensitive to a molecular force exerted by the flavor molecules in their vapor state. This molecular force is composed of components F_x, F_y, and F_z with the magnitude of the force given by the vector magnitude:

(9) magnitude of **F** = $|F| = (F_x^2 + F_y^2 + F_z^2)^{1/2}$

It can be assumed that the receptor is sensitive to one or all of these component forces. Several possible response function can be hypothesized:

a. The threshold response R requires a finite magnitude of F,

(10a) $R = f(|F_t|)$

b. The threshold response requires a finite magnitude of each component of F,

(10b) $R = f(F_x, F_y, F_z)$

where $F_x > F_{xt}$, $F_y > F_{yt}$,$F_z > F_{zt}$.

c. The threshold response requires selective conditions of F,

(10c) $F_x = -F_y \quad F_z > 0$

(10d) $F_x > F_y + F_z$

(10e) $F = f(F_x, F_y F_z)$ and $R = g(F)$

The functionality of equations (10) can be complex but may not be important to obtaining concentration thresholds as long as the g vector components are known. The exact function for the response versus flavor concentrations above the threshold may be predicted from equation (10). (Logarithmic and Michaelis-Menten type equations have been suggested.) Presently the theory for threshold value prediction will be only applied to finding flavor threshold values and not sensitivity to flavor concentrations above this threshold.

Force Model

- A molecule in the gas phase (odorant) makes contact with the olfactory epithelium via a retronasal pathway.

- The primary stimulus of a receptor is assumed to be via mechanical and thermal energy mechanisms.

- Kinetic and rotational energy transfer is involved during impact and docking of odorant with a receptor.

The molar threshold force is defined as:

[1] $$\mathbf{F}_t = m_t \mathbf{g}_f$$

where $\mathbf{g}_f$ is a vector depending only on the molecular properties of the odorant and m_t is the threshold mass per mole.

Next: Dimensional Analysis