**S2 Appendix.   Integrating for infinite SOL-neurons.** The computational model can also be described as a linear combination of the outputs of the POL-OP units. We can merge the SOL and TCL layers, in one by integrating for infinite SOL-neurons. Therefore, the output of each TCL neuron is given by:

$$r_{\text{TCL}}^k = \sum_{j=1}^{n_{\text{POL}}} W^{j,k} \cdot g^j(\theta_t, \phi_t) \cdot r_{\text{POL}}^j$$

where $W^{j,k}$ is the weight of the synapse connecting the input, $j$, and the output, $k$. The weights of the model are given by the equation below:

$$W^{j,k} = -\frac{n_{\text{TCL}}}{2 \cdot n_{\text{POL}}} \cdot g^j(\theta_t, \phi_t) \cdot \sin\left[\left(\phi_{\text{TCL}}^{\text{pref}}\right)^k - \alpha^j\right]$$

where $\left(\phi_{\text{TCL}}^{\text{pref}}\right)^k$ is the preference angle of the $k^{\text{th}}$ TCL-neuron. This equation is the result of integrating the two processing steps (SOL and TCL) to one by assuming infinite SOL-neurons. The processing would look like this:

$$r_{\text{TCL}}^k = \sum_{\xi=1}^{n_{\text{SOL}}} W_{\text{TCL}}^{\xi,k} \sum_{j=1}^{n_{\text{POL}}} W_{\text{SOL}}^{j,\xi} \cdot g^j(\theta_t, \phi_t) \cdot r^j$$

where

$$g^j(\theta_t, \phi_t) = \exp\left\{ -\frac{1}{2}\left[\frac{\sin(\theta_g - \theta^j)\cos(\theta_t) + \cos(\theta_g - \theta^j)\sin(\theta_t)\cos(\phi_t - \phi^j)}{\sigma_g}\right]^2\right\}$$

$$W_{\text{SOL}}^{j,\xi} = \frac{n_{\text{SOL}}}{n_{\text{POL}}} \cdot \sin\left[\alpha^j - (\phi_{\text{SOL}}^{\text{pref}})^\xi\right]$$

$$W_{\text{TCL}}^{\xi,k} = \frac{n_{\text{TCL}}}{2 \cdot n_{\text{SOL}}} \cos\left[(\phi_{\text{TCL}}^{\text{pref}})^k - (\phi_{\text{SOL}}^{\text{pref}})^\xi\right]$$

Integrating for $\delta = \left(\phi_{\text{SOL}}^{\text{pref}}\right)^\xi$ in the limit where $n_{\text{SOL}} \to +\infty$ we have:

$$W^{j,k} = \lim_{n_{\text{SOL}} \to +\infty} \sum_{\xi=1}^{n_{\text{SOL}}} W_{\text{TCL}}^{\xi,k} W_{\text{SOL}}^{j,\xi}$$

$$= \lim_{n_{\text{SOL}} \to +\infty} \frac{n_{\text{TCL}}}{2 \cdot n_{\text{POL}}} \sum_{j=1}^{n_{\text{CBL}}} \cos\left[\left(\phi_{\text{TCL}}^{\text{pref}}\right)^k - \delta\right] \sin\left(\alpha^j - \delta\right)$$

$$= \frac{n_{\text{TCL}}}{2 \cdot n_{\text{POL}}} \cdot \frac{1}{180°} \int_0^{360°} \cos\left[\left(\phi_{\text{TCL}}^{\text{pref}}\right)^k - \delta\right] \sin\left(\alpha^j - \delta\right) d\delta$$

$$= -\frac{n_{\text{TCL}}}{2 \cdot n_{\text{POL}}} \cdot \sin\left[\left(\phi_{\text{TCL}}^{\text{pref}}\right)^k - \alpha^j\right]$$

Using this model we get almost the same result as the two-layered one.