Response to a stimulus orthogonal to $S_{\text{max}}$.

Response to a stimulus of constant contrast.

Response to a stimulus orthogonal to $S_{\text{max}}$.

Response to a stimulus of constant contrast.

Response to a stimulus orthogonal to $S_{\text{max}}$.

Response to a stimulus of constant contrast.

Accelerating Nonlinearity

Linear

Compressive Nonlinearity

Hyperselective (Fan equation)

$\Phi$ (degrees away from the vector)
The figure shows the relative falloff in response as the stimulus is moved away from the optimal stimulus Smax and the stimulus contrast is held constant. We show the relative falloff for a linear neuron and three types of nonlinearity. a) shows a response surface for a linear neuron (past a threshold of 0). b) shows the response of an accelerating non-linearity, c) a compressive non-linearity and d) a hyper-selective neuron. A stimulus of constant contrast is represented as a circle in state-space. The falloff in response, as one moves along the circle, is represented in (a) for each of the four response types. We show this figure to distinguish our approach of hyper-selectivity from a similar concept of “advanced selectivity” proposed by Tsai and Cox (2016). They describe “advanced selectivity” as a state where the falloff in response is faster than expected of a linear neuron. As shown in figure (e), our hyper-selective neurons do fall faster than that of a linear neuron. However, a neuron with an accelerating non-linearity also falls below the linear curve.

In our measure of hyper-selectivity, we consider the response to a stimulus that is orthogonal to the optimal stimulus. As shown in (f), for this family of non-linearities, only the hyper-selective neuron shows a falloff in response when an orthogonal stimulus is added. For all of the neurons with planar non-linearities, there is no change in response when an orthogonal stimulus is added to the preferred/optimal stimulus. We would also like to note that on this graph (b), an invariant/tolerant neuron would show an increased response when an orthogonal stimulus is added to the preferred stimulus.

We should also note that these graphs represent just two dimensions of a high dimensional space (256 dimensions for a 16x16 space). For the large majority of dimensions, the neuron will not show curvature. For two neurons that are widely separated, there will be no interactions. For such neurons, there will be no curvature, and there will be only planar non-linearities.