Testing efficient coding: projective (not receptive) fields are the key theoretical prediction. Eizaburo Doi

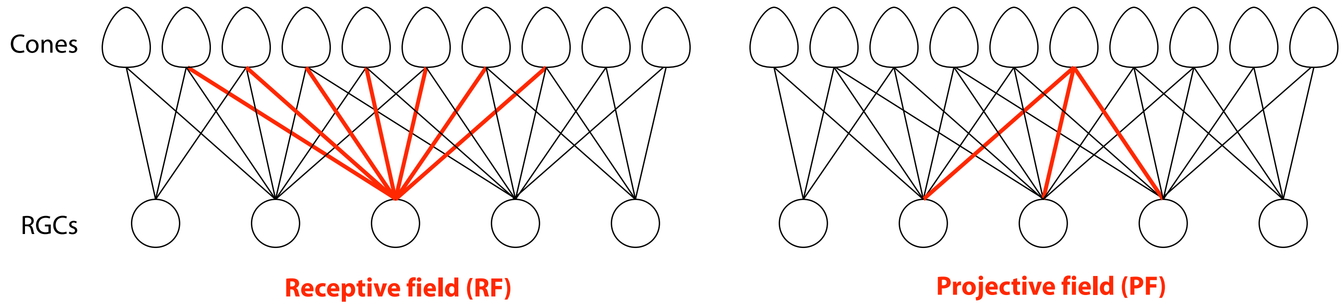

Figure 1. Left: Receptive field (RF) is the weighting pattern from all cones to a particular RGC (red lines). Right: Projective field (PF) is the weighting pattern from a particular cone to all RGCs (red lines).

The inner-products of PFs are the key, unique prediction drawn from the proposed efficient coding model. Let W be the transform matrix whose rows contain RFs. The columns of W are the PFs. Write this in terms of its singular-value decomposition, $W = P\Omega Q'$. The efficient coding solution determines Ω and Q uniquely, but P can be any orthogonal matrix. Thus, efficient coding does not predict unique RFs. But note that $W'W = Q\Omega'P'P\Omega Q' = Q\Omega'\Omega Q'$ (since P is orthogonal), and hence, this is a quantity uniquely determined by efficient coding. The (i,j) entry of W'W is the inner-product of i-th and j-th PFs.

We can interpret the PF inner-products as follows. If i=j, then the inner product is the squared norm of the i-th PF, representing the sum of squares of all the weights of the RGC population emanating from this cone. If i j, then the inner product indicates the similarity in the way two cones are activating the RGC populations.

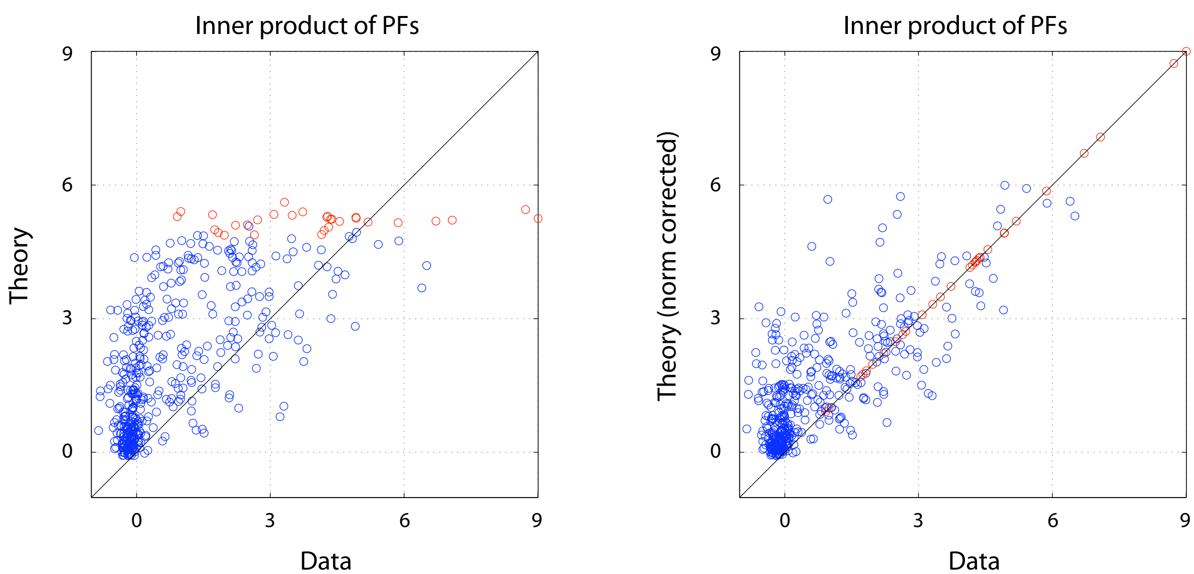

Figure 2. Theory vs. data comparison of inner product of i-th and j-th PFs. Red circle highlights the inner products when i=j (i.e., square norm of i-th PF). When the inner products are compared directly (left), the data show significant variability in the square norm. If the theoretical PF is corrected to have the same norm as the data (right), the fit becomes better. The data variance explained by the theory is 16% (left) and 51% (right), which are computed only with blue points (inner products of different PFs).