A Model of V4 Shape Selectivity and Invariance

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Supplemental Materials

Supplemental Figure S1: This figure illustrates the evolution of the fitting algorithm, measured by mean squared errors, as more afferent subunits are added to the model. As mentioned in the Materials and Methods section, the dataset is randomly split into 6 cross-validation folds, distinguishing training (thin lines) and test (thick lines) errors. To select the best non-overfitting model, the minimum average test error criterion is used (method 1). To measure the generalization performance of the model, the elbow of the training error was found in each fold and the testing error was computed (method 2). This example is for the C2 unit in Figure 3.

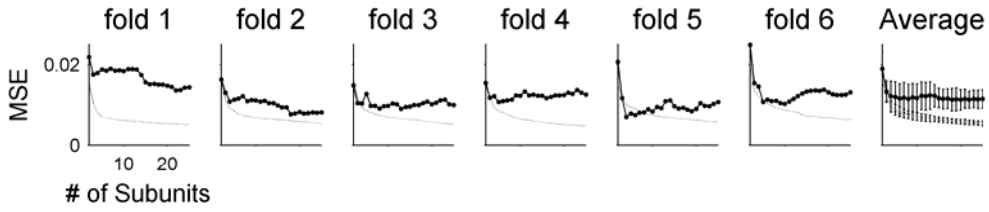
Supplemental Figure S2: Summary of the fitted parameter values. The order of the fitted 109 C2 units is sorted according to the number of C1 units corresponding to the number of fitted parameters, minus 3 sigmoid parameters. Distributions of (A) four orientations, (B) three sizes, and (C) synaptic weights of the afferent C1 units are shown. Note that smaller sized C1 units (finer resolution in 4x4 grid) are more represented, but the model fits using only those smaller units produced larger training and test errors (results not shown), indicating some mixture of scales is necessary to model V4 neurons. The parameters in the sigmoid transfer function Eq. 2 were rather constant across all 109 C2 units: $\alpha = 32.1 \pm 0.9$, $\beta = 1.1 \pm 0.1$, and $s = 1.1 \pm 0.1$.

Supplemental Figure S3: The number of C1 subunits and the goodness of fits (average correlation coefficients between the responses of the model C2 unit and V4 neuron on test sets in 6-fold cross-validation, and their standard deviations) are plotted. There was a significant correlation of 0.47 ($p < 0.001$) between these two quantities, meaning that in general, better fits were obtained by using more C1 afferent subunits.

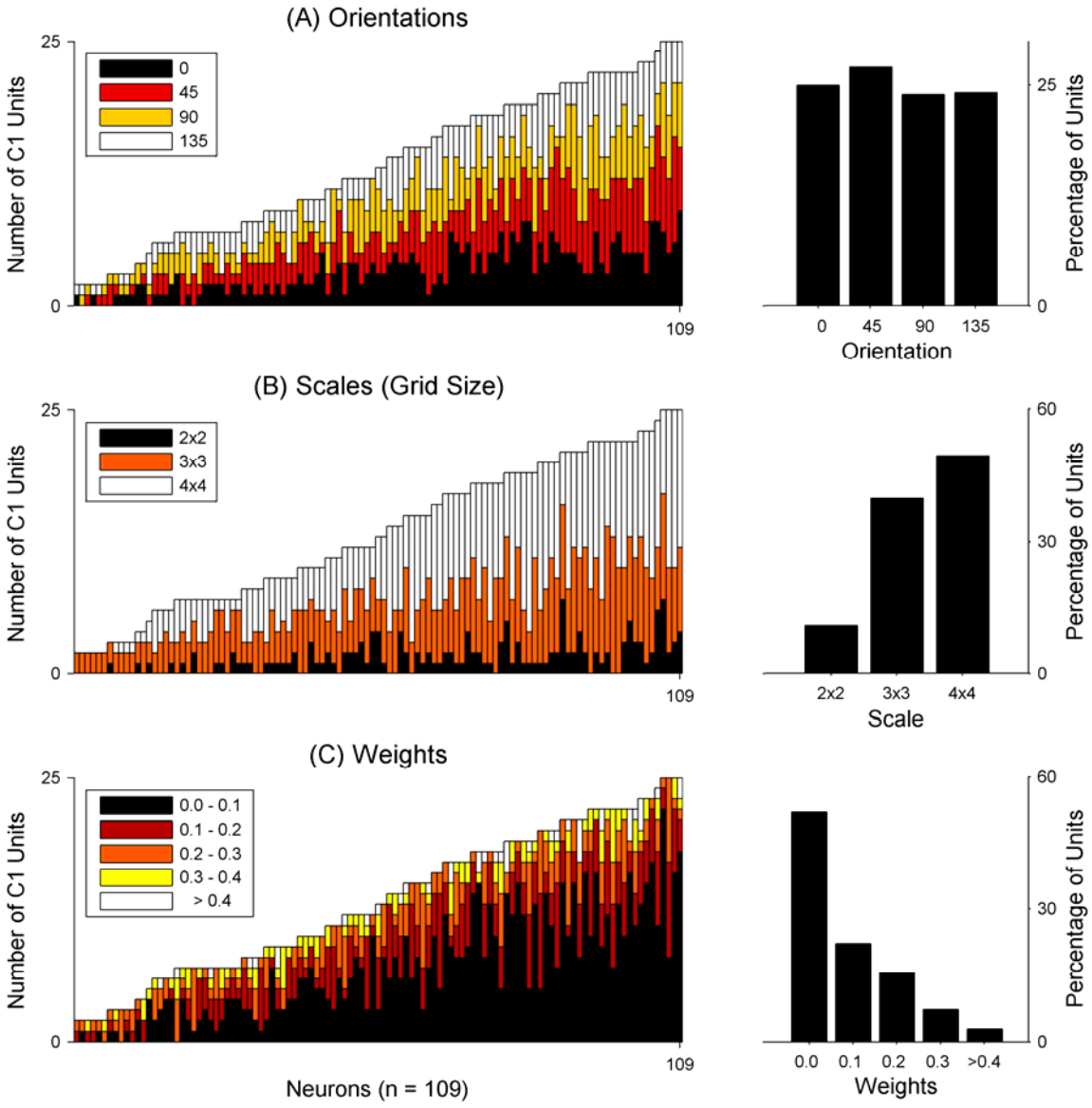
Supplemental Figure S4: (A) Configuration of the C1 units for the two example neurons in Figures 3 and 4, using the model with 8 possible orientations, instead of 4. (B) The distribution of train and test correlation coefficients, corresponding to Figure 5, and (C) the corresponding distribution of number of C1 afferent units, corresponding to Figure 9A. For computational efficiency the maximum number of C1 afferent units was 10, instead of 25. Note that similar model configurations, as well as overall good

population fits can be obtained with a simpler (i.e., less number of fitting parameters) model, using a larger parameter space. The median of the number of afferents in this case was 8**.**

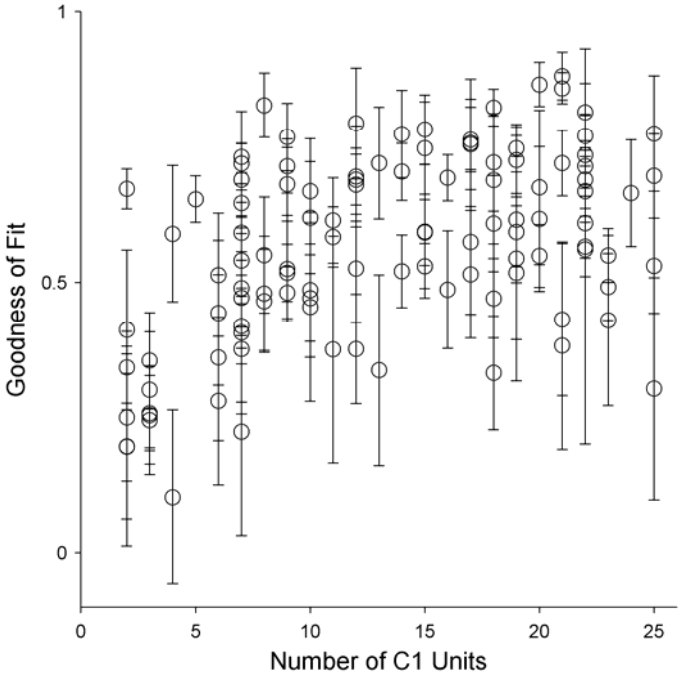
Supplemental Figure S1



Supplemental Figure S2

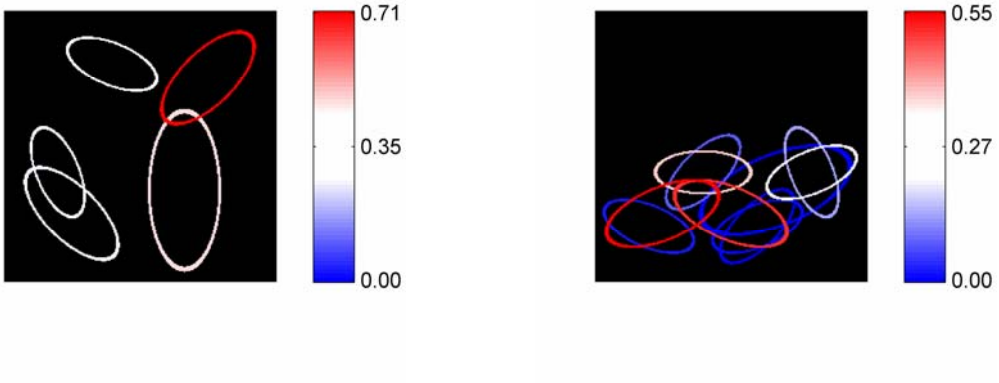


Supplemental Figure S3

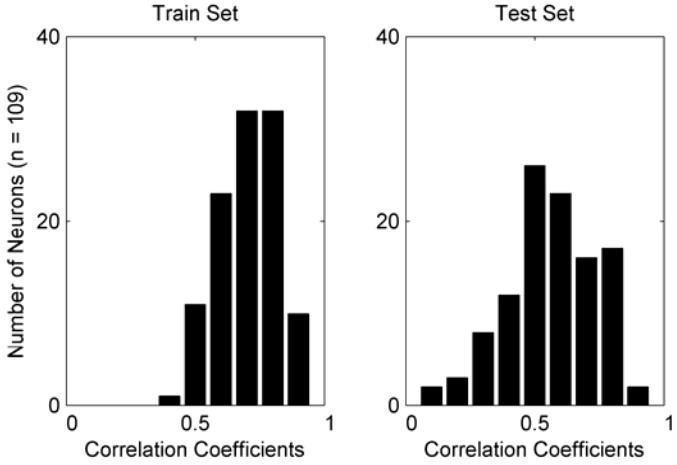


Supplemental Figure S4

(A)



(B)



(C)