Supplementary Materials

This supplement presents results of two additional analyses that support the main conclusion of the paper, that noise correlations contribute only a small amount of stimulus information. Fig. S1 shows that this conclusion is robust to model fit quality, using R^2 as the measure. To assess the influence of model fit, we performed the analyses described in the main text, restricted to cells whose R^2 values were above the median of the general population. This analysis was carried using both the white noise stimuli (Fig. S1, *top*) and the natural scene stimuli (Fig. S1, *bottom*). Fig. S1A shows how the R^2 values for cells in each of these analyzed populations relate to those of the general population shown in the main text: the values for the populations analyzed here are shown in red. Fig. S1B shows the ECFs for the pairs of cells used in this analysis. (The ECFs are typical of those measured for the general population, and, as is shown, they are also well-predicted by the model.) Fig. S1C shows that including correlations via the coupled model results in improved spike train prediction (measured by log-likelihood) compared to the independent model, as was shown for the general population in the main text. Finally, Fig. S1D shows that correlations add little information: for the white noise stimuli (*top*), the coupled model adds a small amount (~8%) of information, while for the natural scene stimuli (*bottom*), the coupled model does not add any significant amount of information. This also parallels the results in the main text for the general population (Fig. 5).

Fig. S2 shows that noise correlations play only a minimal role, even for clusters of cells that have unusually high levels of mutual correlation.   In principle, contributions from such clusters might have been overlooked by the analyses in the main text if they had been "diluted" by contributions from cells with lower levels of mutual correlation. To look for this possibility, we analyzed clusters of cells that had higher levels of correlated firing than was typical for the general population. Four such clusters were identified: two from the white noise condition (*top*), and two from natural scene condition (*bottom*). For each cluster, the ECFs from all pairs of cells are shown in Fig. S2A (*red*). The *shaded area* represents the top decile (90^{th} percentile and above) of ECFs for pairs of cells in the general population – for the clusters analyzed here, a large portion (over one third) of the ECFs are in this range. Fig. S2B shows the R^2 values for the cells in these clusters; they are typical of the values in the general population considered in the main text. Fig. S2C shows the spatial receptive fields of the cells in each cluster, demonstrating (as expected) that the highly correlated clusters have overlapping or nearby receptive field centers. Fig. S2D shows that the coupled model results in improved spike train prediction (measured by log-likelihood) compared to the independent model (adding 10 to 30 bits/s to the spike train prediction). Finally, Fig. S2E shows that the information analyses for these clusters are consistent with what is seen for the full populations. For white noise, the coupled model adds a small amount of additional information; for natural scenes, the coupled model adds no significant information. In sum, even for clusters of cells that exhibit unusually high levels of noise correlations, the correlations add only a small amount of information about the stimulus.

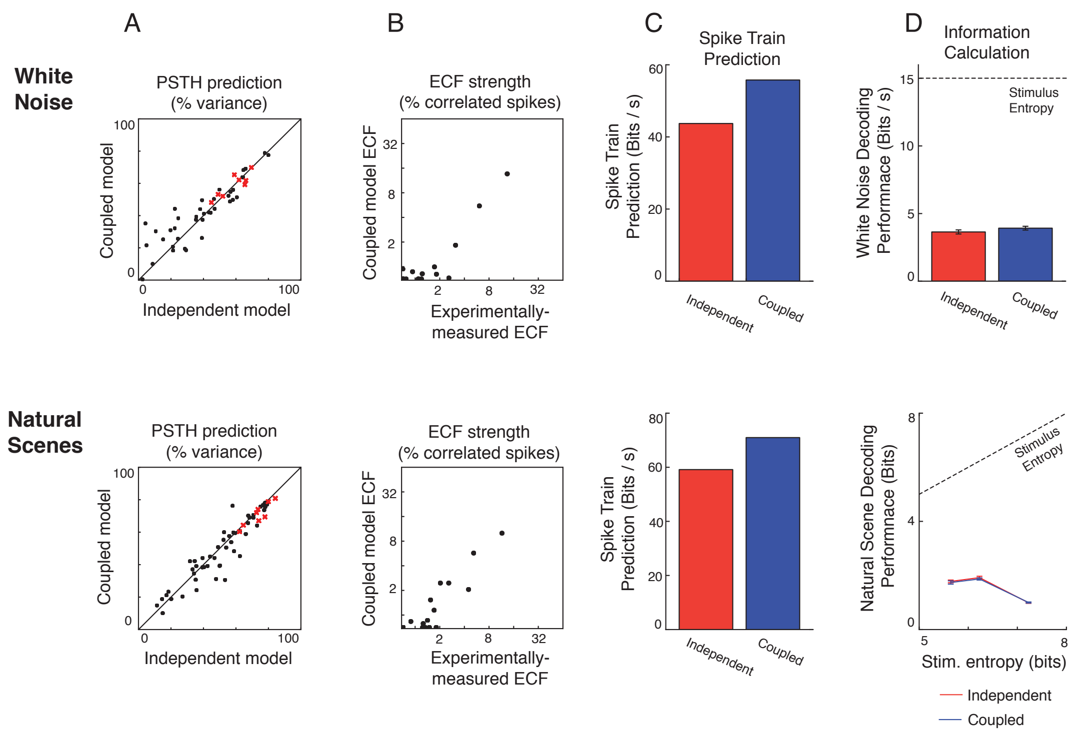

Fig. S1. Information carried by correlations in populations of cells with high R^2. A. R^2 values for all cells in the data set measured using the white noise stimulus (*top*) and the natural scene stimulus (*bottom*). *Red* indicates the population of cells used in this analysis (cells from a single retina with R^2 values above the median for the general population), and *black* indicates the other cells in the general population. **B.** Measured and modeled ECFs for all pairs of cells within the analyzed populations, i.e., the cells plotted in *red* in panel A. Measured ECFs are typical of the general population, and, as shown, they are well predicted by the coupled model. **C.** Quality of spike train prediction for the independent and coupled models, as measured by log-likelihoods. The coupled model is better able to explain individual spike trains, for both white noise and natural scene stimuli. **D.** Information decoded for populations with an independent (*red*) and coupled (*blue*) model. For white noise (*top*) , the coupled model adds a small amount of information; for natural scenes (*bottom*) there is no significant gain in information under the coupled model. These results are similar to those of the general population, as reported in the main text.

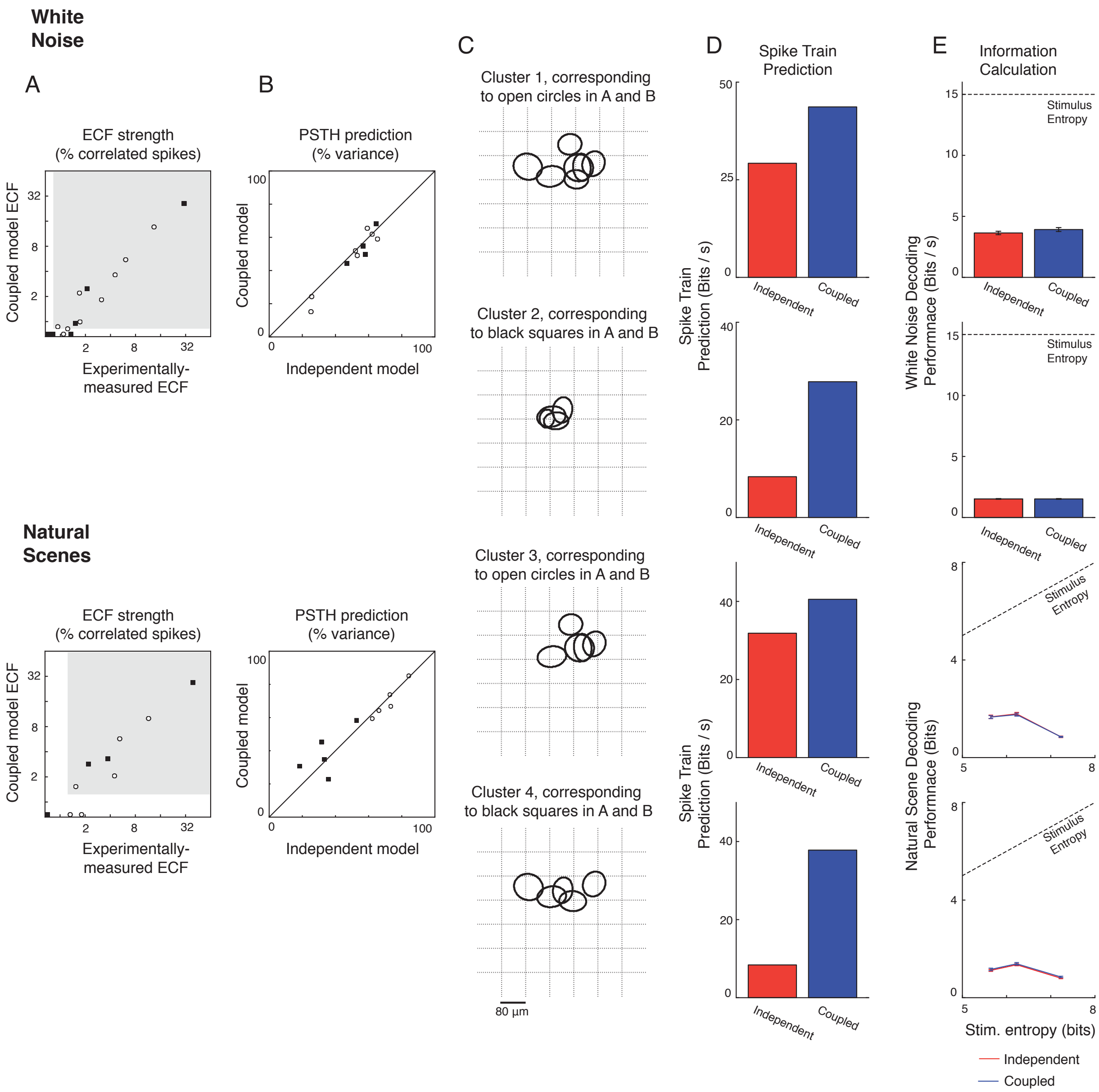

Fig. S2. Information carried by correlations in clusters of cells with high mutual correlations. A. The ECFs for cell pairs in the clusters used in this analysis. The clusters display a higher than typical level of correlated firing: over a third of the ECFs in the clusters are in the top decile (90th percentile and above) of ECFs for the general population, marked by the shaded area. **B.** Goodness of model fit, as measured by R^2. These are typical of the general population. **C.** Receptive field centers of the cells in the clusters. As is typical of correlated cells in the retina, their receptive field centers are overlapping or neighboring. **D.** Quality of spike train prediction for the independent and coupled models, as measured by log-likelihoods. The coupled model is better able to explain individual spike trains, for both white noise and natural scene stimuli. **E.** Information decoded from responses to the white noise stimulus (*top 2 clusters*) and natural scene stimulus (*bottom 2 clusters*). For white noise, the coupled model adds a small amount of information; for natural scenes there is no significant gain in information. These results are similar to what was found for analyses of the general population, as reported in the main text.