Inventory of Supplemental Information

Figure S1, related to Figure 1.
Figure S2, related to Figure 2.
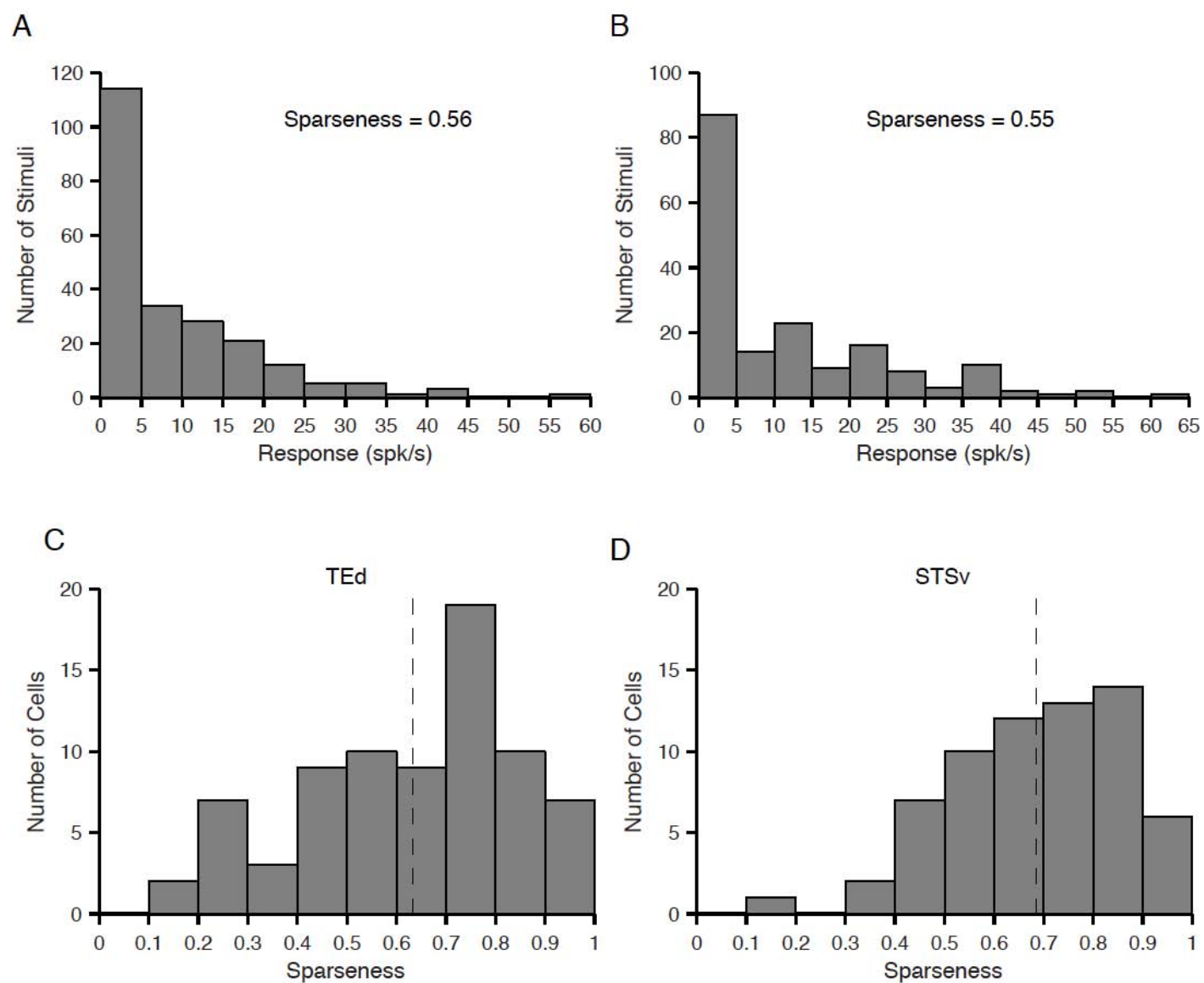**Figure S3, related to Figure 3.**

SUPPLEMENTAL DATA

Figure S1, related to Figure 1. Sparseness analysis to measure selectivity of responses in TEd and STSv. (A) Response distribution for the first (cyan) example TEd neuron in Fig. 1C and D. The sparseness value of 0.56 was calculated according to the standard formula Sparseness = {1 − [($\sum r_i/n$)^2/$\sum(r_i^2/n$)]}/[1 − (1/n)], where r_i is the response to the ith stimulus out of n samples (Vinje and Gallant, 2000). (B) Response distribution for the first (cyan) example STSv neuron in Fig. 1E and F. (C) Distribution of sparseness values for 76 TEd neurons. Average sparseness was 0.63. (D) Distribution of sparseness value for 65 STSv neurons. Average sparseness was 0.69. Average sparseness in TEd and STSv was not significantly different (t(139) = 1.56, p = 0.12).
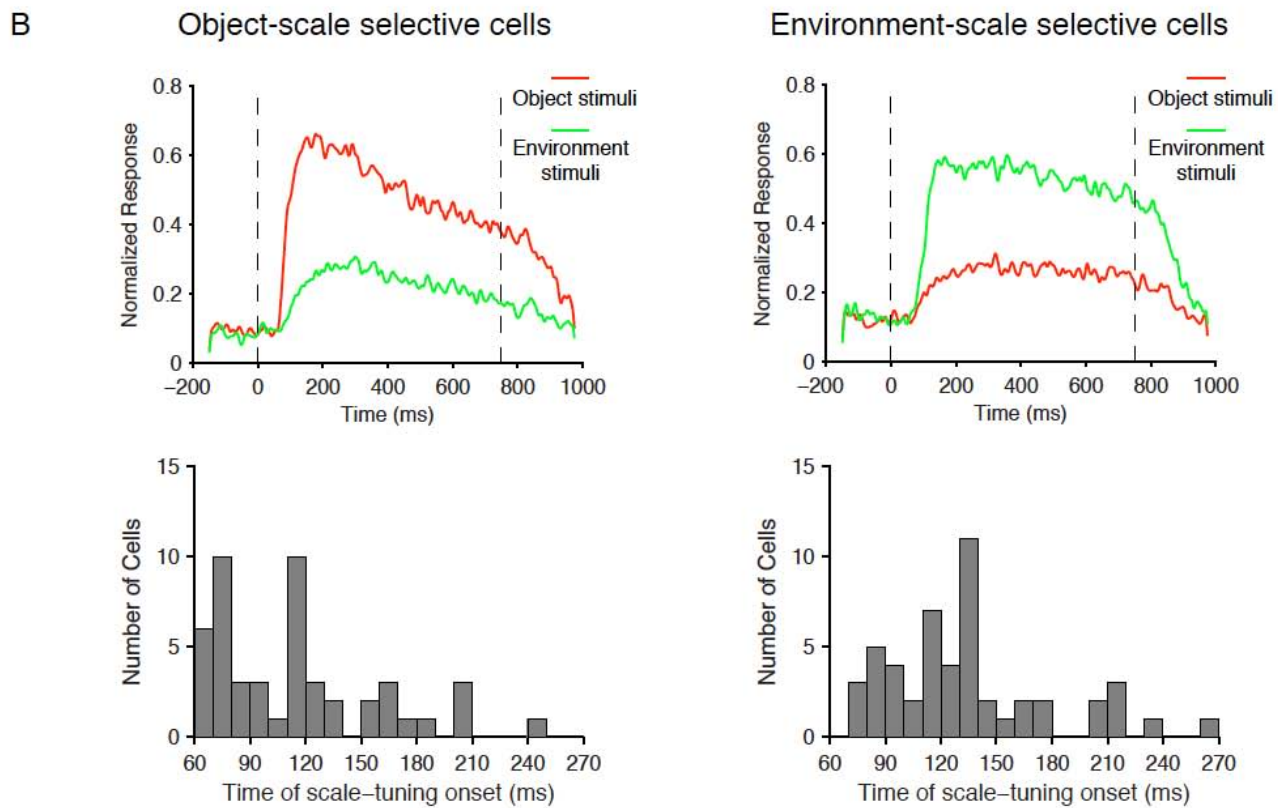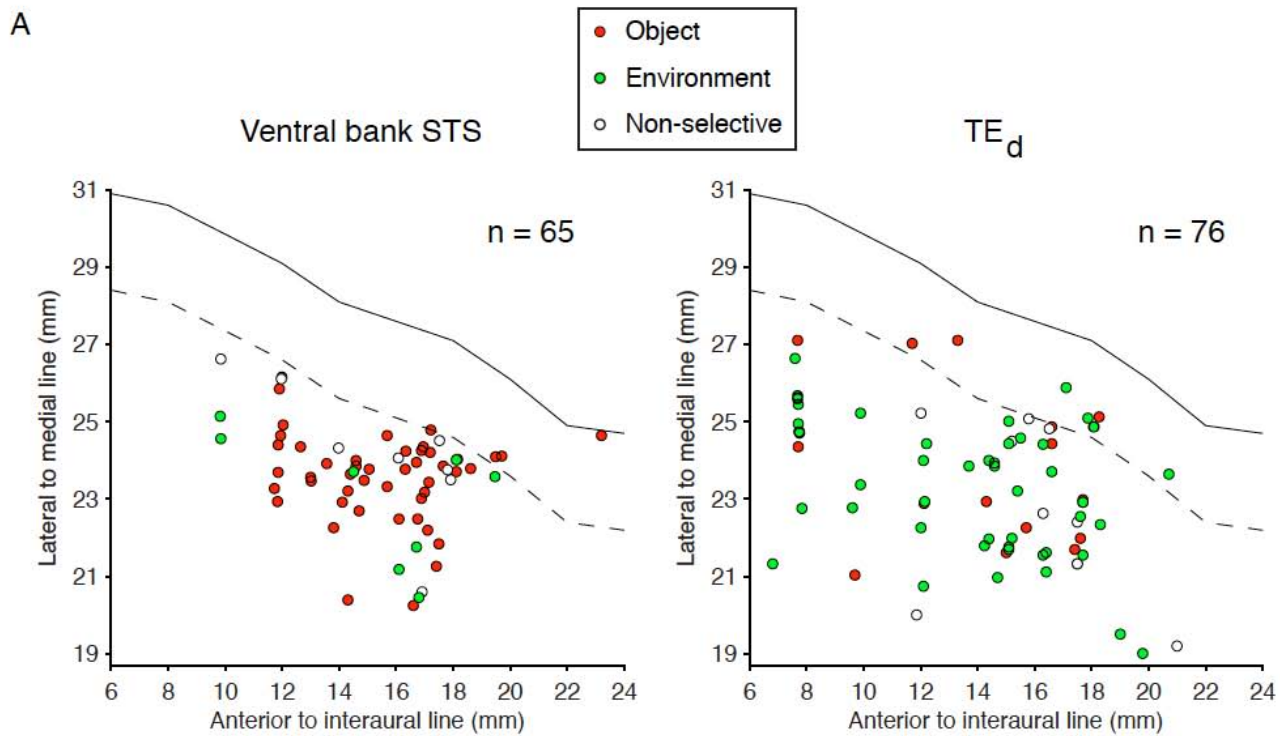
Figure S2, related to Figure 2. (A) Stereotaxic recording positions of cells from STSv (left) and TEd

(right) in the horizontal plane. In each panel, the area between the dashed and solid lines

corresponds to the lip of the STS. Color indicates neurons with significant selectivity (Wilcoxon rank sum test, $p < 0.05$) for objects (red) or environments (green). There were no significant trends in object/environment selectivity in either the anterior-posterior direction (TEd: $r = -0.12$, $p = 0.31$; STSv: $r = -0.04$, $p = 0.75$) or the medio-lateral direction (TEd: $r = -0.075$, $p = 0.52$; STSv: $r = -0.10$, $p = 0.43$). Likewise, there were no significant trends in sparseness in either the anterior-posterior direction (TEd: $r = -0.18$, $p = 0.12$; STSv: $r = -0.052$, $p = 0.68$) or the medio-lateral direction (TEd: $r = -0.072$, $p = 0.54$; STSv: $r = 0.17$, $p = 0.17$). (B) Temporal evolution of object selectivity in STSv and environment selectivity in TEd. These analyses are based on the population of STSv neurons with a significant bias ($p < 0.05$, Wilcoxon rank-sum test; Fig. 2B) toward object stimuli (left column) and the population of TEd neurons with a significant bias toward environmental stimuli (right column). For each neuron, Gaussian-smoothed (5 ms S.D.) temporal response profiles were averaged across all environment stimuli (subtending $>80°$) and across all object stimuli (subtending $<22°$). These average response profiles were then averaged across neurons to produce the green (environment) and red (object) curves plotted here. In addition, for each neuron, the latency of significant differentiation between objects and environments was determined by finding the first 1 ms time bin in which the two average, smoothed response profiles were significantly different (t-test, $p < 0.05$) and remained significantly different in all subsequent time bins in the stimulus presentation period. The distributions of object/environment differentiation latencies are plotted here as histograms. Both distributions are broad and range down to 70 ms, near the standard response onset latency for anterior IT. However, the mean latency for object selectivity in STSv of 113.6 ms +/- 6.4 ms was significantly shorter than the mean latency for environment selectivity in TEd of 132.5 ms +/- 6.2 ms ($t(97) = 2.13$, $p = 0.036$). The significantly slower development of environment information could reflect (a) the larger visual region over which environmental shape must be integrated, (b) the lower acuity of peripheral visual processing required for environmental shape perception, (c) the lower availability of peripheral visual information in the ventral pathway, (d) late integration of spatial/depth information from dorsal pathway areas, e.g. from FST (floor of the superior temporal sulcus; see Kravitz et al. 2012), or other

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visual processing differences between objects and environments. There were no significant trends in scale-tuning latency in either the anterior-posterior direction (STSv object-selective neurons: r = –0.085, p = 0.57; , TEd environment-selective neurons: r = –0.020, p = 0.89) or the medio-lateral direction (STSv object-selective neurons: r = 0.11, p = 0.46; TEd environment-selective neurons: r = –0.078, p = 0.59).
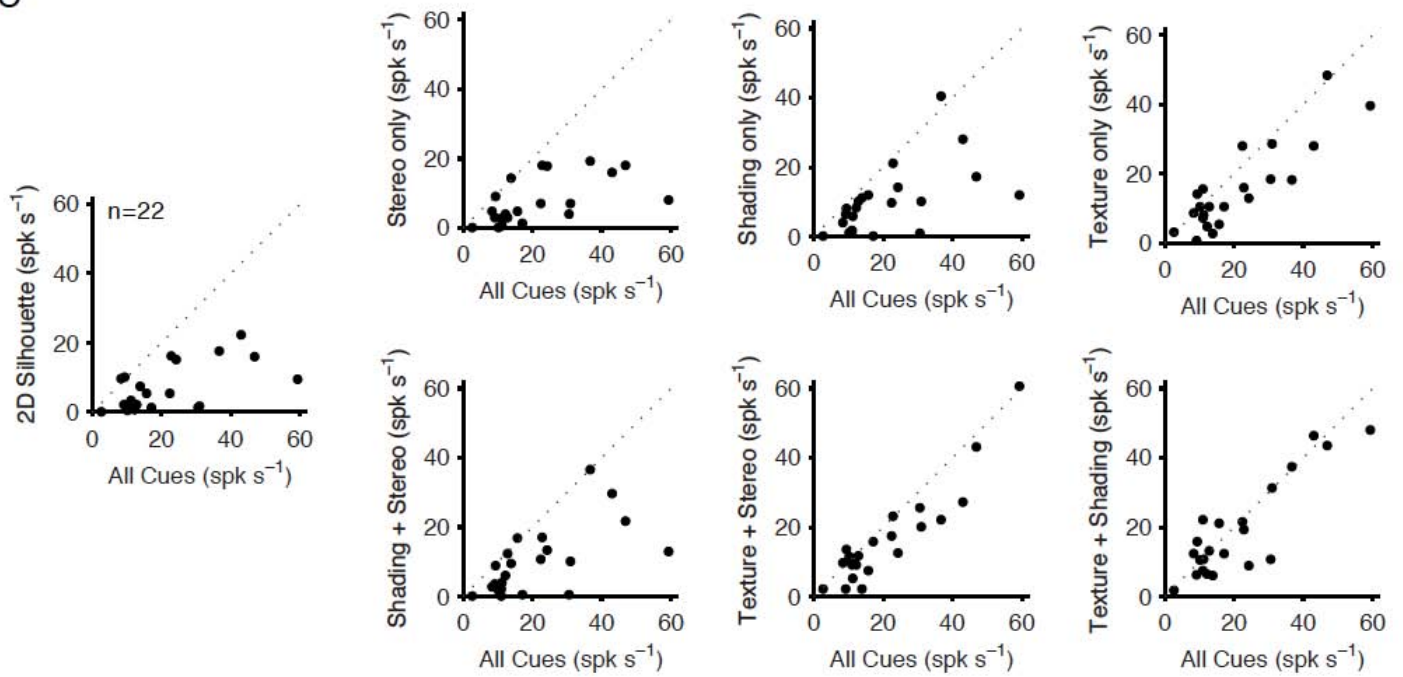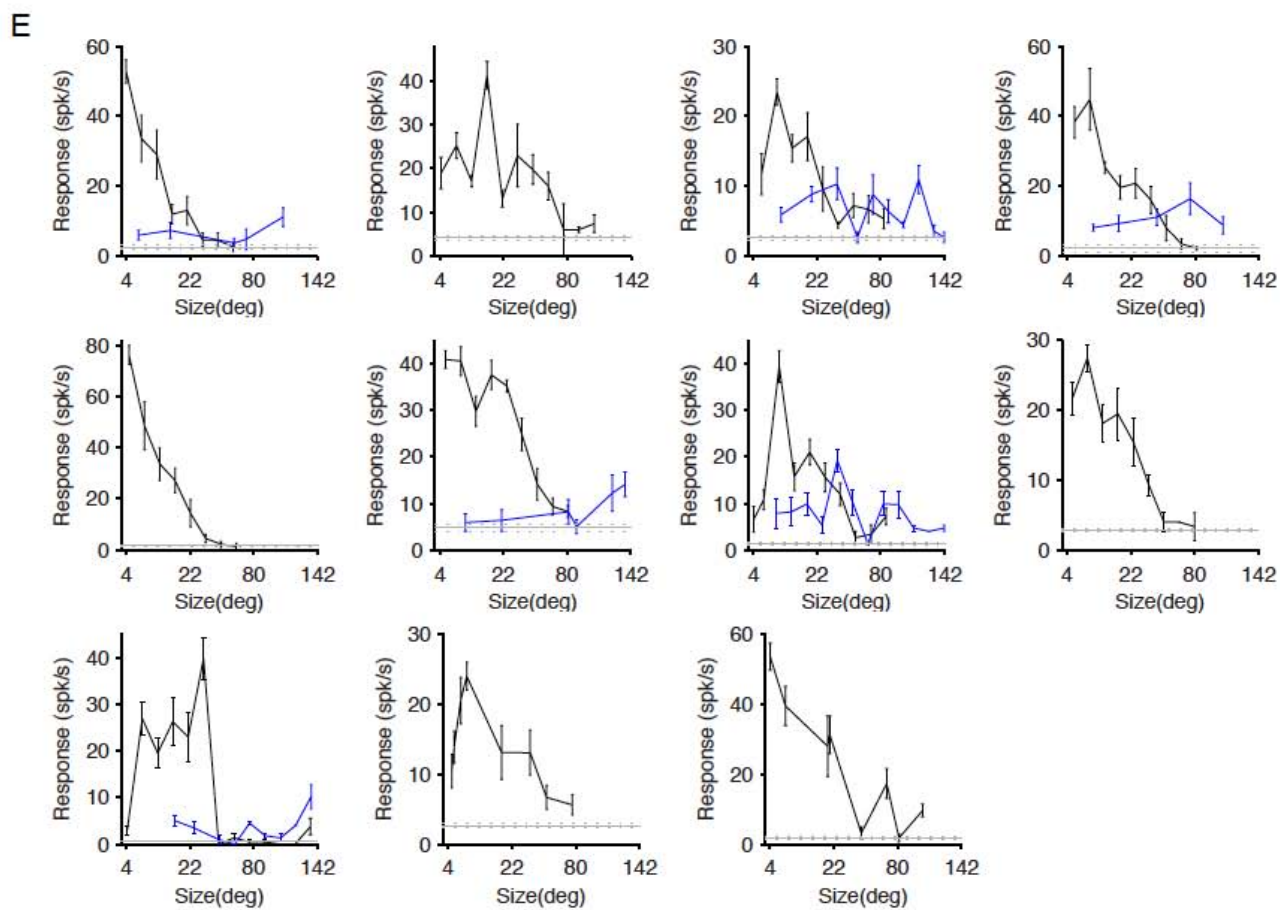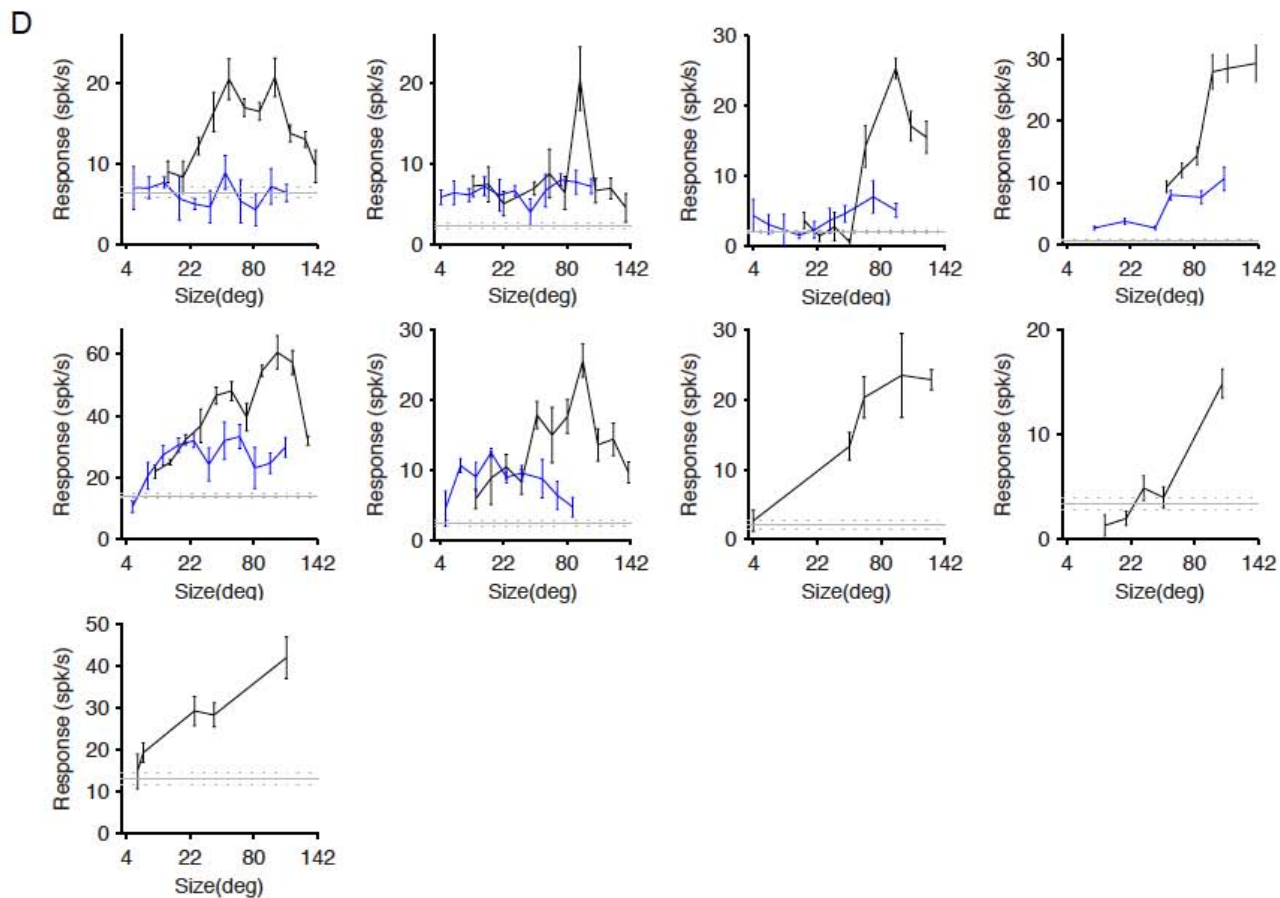
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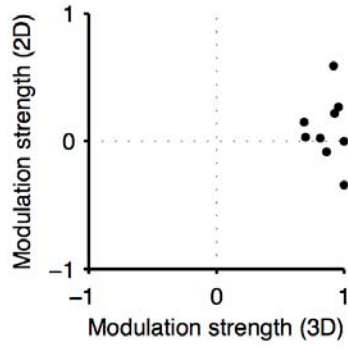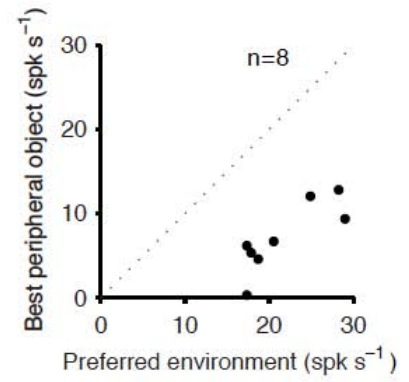
Figure S3, related to Figure 3. Additional control tests. (A) Sensitivity to 3D shape-in-depth vs. 2D shape for STSv neurons. One high-response and one low-response object stimulus were selected from the adaptation experiment. Modulation strength is the response difference divided by the maximum. 3D modulation strength (x-axis) is based on the original stimuli with all depth cues. 2D modulation strength (y-axis) was based on stimuli with no disparity cues, no shading, and either fronto-parallel hexagonal texture, random line texture, or no texture (silhouettes), whichever produced the highest modulation value. As in TEd (Fig. 3A) removing cues for shape-in-depth largely abolished differential responses. The average 3D modulation strength of 0.87 was significantly greater than the average 2D modulation strength of 0.095 (paired t-test, $p < 0.0001$). (B) Peripheral object responses of TEd neurons selective for environments. Response to an optimal environment stimulus (horizontal axis) compared to the maximum response to an optimal object stimulus tested at 9 positions in a square grid (centered at fixation with 30° x and y spacing) (vertical axis). (C) Dependency of TEd environment responses on 3D shape cues. Response to an optimal environment stimulus rendered with stereoscopic disparity, shading and texture (horizontal axis) compared various sub-combinations of those cues (vertical axes). (D) Responses (+/- s.e.m.) of TEd neurons selective for environmental shapes (Wilcoxon rank sum test, two-tailed, $p < 0.05$) as a function of stimulus scale. The optimal environment stimulus shape (black) and in some cases the optimal object stimulus shape (blue) were presented at scales ranging from objects to environments. Responses to the optimal environmental shapes declined in the object range to near baseline, showing that they depended on scale, not just shape. Responses to the optimal object shapes did not rise at larger scales, showing that neurons were sensitive to shape, not just scale. These tests are not critical to our conclusions, which rest on the main experiments, but they exemplify how responses depended on both shape and scale. (E) Responses (+/- s.e.m.) of STSv neurons selective for object shapes (Wilcoxon rank sum test, 2-tailed, $p < 0.05$) as a function of stimulus scale. Details as in (D). Responses to optimal object stimuli declined to near baseline in the environmental scale range, showing that they depended on scale, not

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just shape. Responses to optimal environmental shapes remained low at all scales, showing that neurons were sensitive to shape, not just scale.

References

Vinje, W.E. and Gallant, J.L. (2000) Sparse coding and decorrelation in primary visual cortex during natural vision. Science *287*, 1273–1276.