Supporting Information

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SI Text

Tactile Stimulus Fabrication. We machined each stimulus onto the surface of a 20-mm square plastic block (Ultem; General Electric), removing background material to leave a 0.5-mm-wide contour at a relief height of 5 mm. A 1.25-cm stalk on the opposite side of the plastic block served as a handle for the stimulus gripper (see below). The stimuli were positioned such that angle vertices and arc midpoints fell at the center of the square block. The contours extended to the block boundaries to ensure that they extended past the finger pad contact area. The two smallest arcs (1- and 5-mm radius) subtended 135° and continued with straight lines to the block edges.

Stimulator. The stimulator was a servo-controlled linear motor (Baldor Electric Company) mounted onto a magnetic forcer, translating with 0.01 mm precision across a downward-facing horizontal plane on a frictionless air cushion (Aerotech). The linear motor provided 40 mm of vertical travel with an accuracy of ≈1 μm. A small rotary stepper motor (Arsape) attached to the bottom of the linear motor provided stimulus rotation. A pneumatic "gripper" motor (Pisco USA) attached to the bottom of the rotary motor was used to retrieve stimuli under computer control from a cassette containing all of the stimulus blocks.

1. Thakur PH, Fitzgerald PJ, Lane JW, Hsiao SS (2006) Receptive field properties of the macaque second somatosensory cortex: Nonlinear mechanisms underlying the representation of orientation within a finger pad. *J Neurosci* 26:13567–13575.
2. Fitzgerald PJ, Lane JW, Thakur PH, Hsiao SS (2006) Receptive field properties of the macaque second somatosensory cortex: Representation of orientation on different finger pads. *J Neurosci* 26:6473–6484.
3. Pasupathy A, Connor CE (1999) Responses to contour features in macaque area V4. *J Neurophysiol* 82:2490–2502.

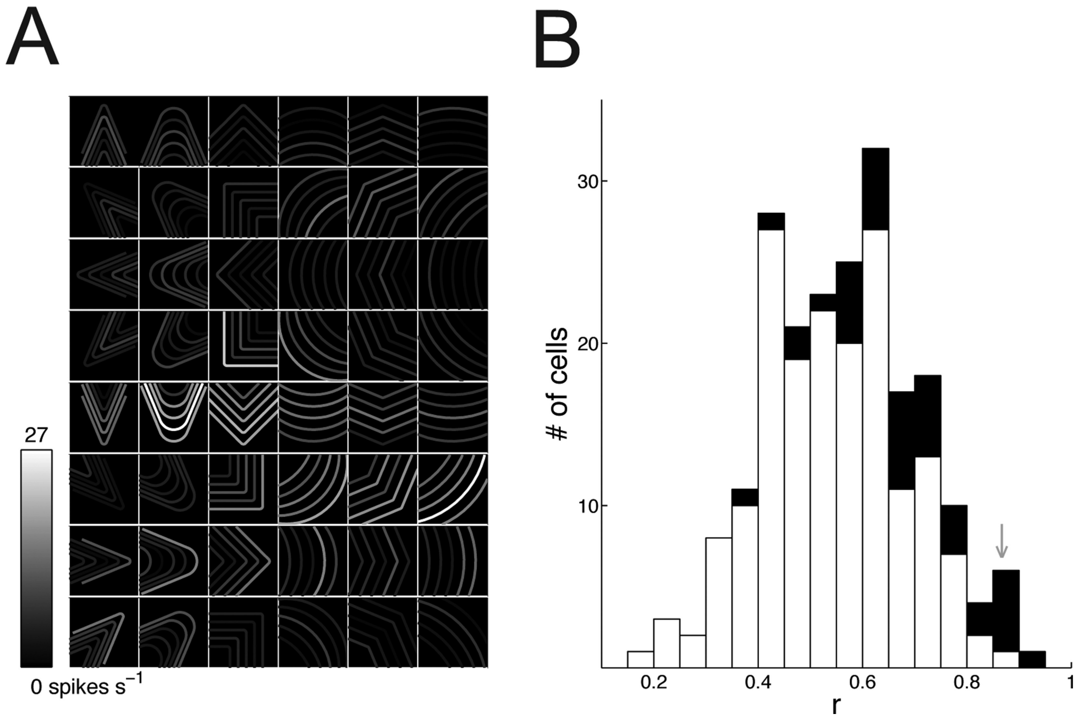

Fig. S1. Position consistency of SII responses. (*A*) Example neuron from Fig. 1*B*. Embossed tactile stimuli (shown here as white icons) were indented into the distal finger pad of a monkey performing a distraction task. Each stimulus was repeated at five positions uniformly spanning 4 mm. Gray-level indicates average response to each stimulus (see scale bar). As expected, response levels changed depending on stimulus position with respect to the skin contact patch. However, strong responses remained confined to the 270°–315° curvature range. (*B*) As a measure of consistency across stimulus position, we computed, for each neuron, the correlation between the response pattern at the center position (used in other analyses and figures) and the average response pattern across positions. Histograms show number of neurons with (filled) and without (open) significant tuning for curvature direction (randomization test, $P < 0.05$; see *Materials and Methods*). Center/average correlation for the example SII neuron (green arrow) was 0.87. The average correlation for tuned neurons was 0.68. This is consistent with previous reports of SII response consistency both within finger pads (1) and across pads (2). Position consistency of V4 contour responses has been demonstrated previously (3).

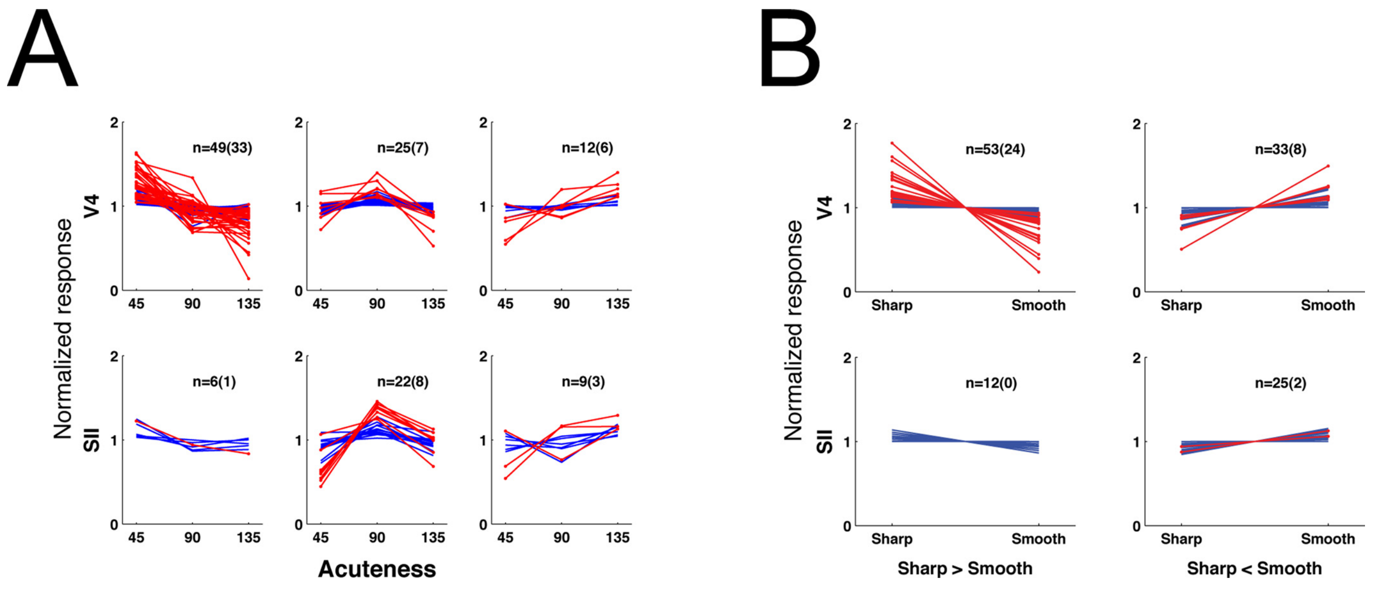

Fig. S2. Tuning for curvature acuteness and sharpness in visual and somatosensory neurons tuned for curvature direction. (*A*) Sensitivity to curvature acuteness. Averaged, normalized responses to different levels of acuteness (45°, 90°, and 135°) are shown for the V4 (top row) and SII (bottom row) neurons exhibiting significant curvature direction tuning (see *Materials and Methods*). Neurons are plotted in the left, middle, or right column depending on whether they responded maximally to the 45°, 90°, or 135° acuteness level. Responses of neurons significantly modulated by curvature acuteness (one-way ANOVA, $P < 0.05$) are shown in red. Inset numbers indicate the neuron totals in each category, with significant cells shown in parentheses. V4 neurons are strongly biased toward acute (45°) curvature. SII neurons are weakly biased toward 90° curvature. (*B*) Sensitivity to curvature sharpness. Averaged, normalized responses to sharp angles and smooth curves are shown for the V4 and SII curvature-tuned neurons. Neurons are plotted in the left or right column depending on whether they responded maximally to the sharp or smooth stimuli. Responses of neurons significantly modulated by curvature sharpness (two-tailed, paired *t*-test, $P < 0.05$) are shown in red. Inset numbers indicate the neuron totals in each category, with significant cells shown in parentheses. V4 neurons show more significant tuning for sharpness. The lack of sensitivity in SII may relate to spatial acuity and receptor spacing (see *Discussion*).

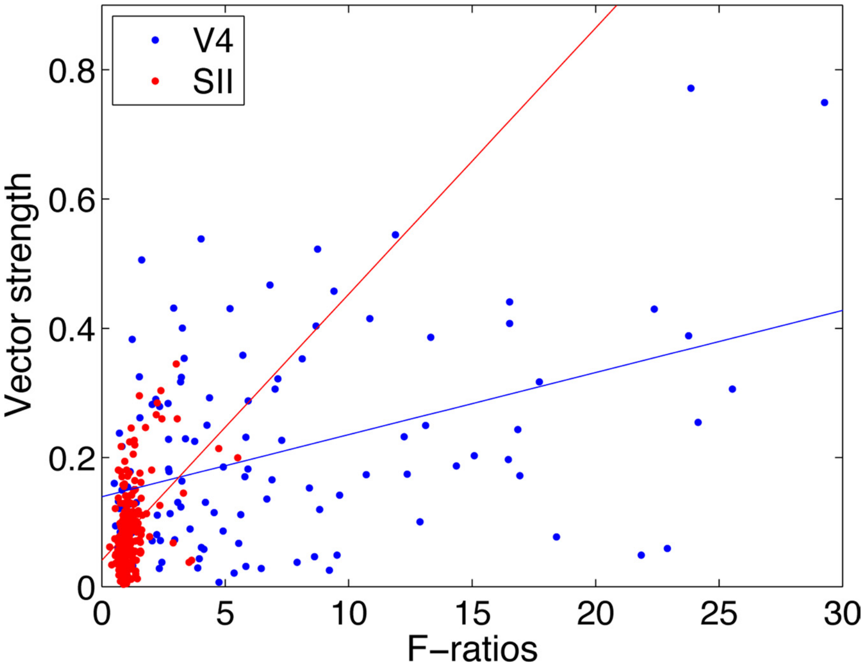

Fig. S3. Distribution of response consistency and curvature direction tuning strength. Distribution of F-ratios (ratio of between-stimulus variance to within-stimulus variance) and vector strength (curvature direction tuning index) for 124 V4 (blue) and 210 SII (red) neurons. Blue and red lines plot the linear relationship between response consistency and curvature direction tuning strength for V4 and SII neurons, respectively. V4 responses were much more consistent than SII responses. For neurons with similar response consistencies (F-ratios), SII tuning (vector) strength is comparable. The slope of SII tuning strength vs. F-ratio is steeper (0.04) than the V4 slope (0.009).

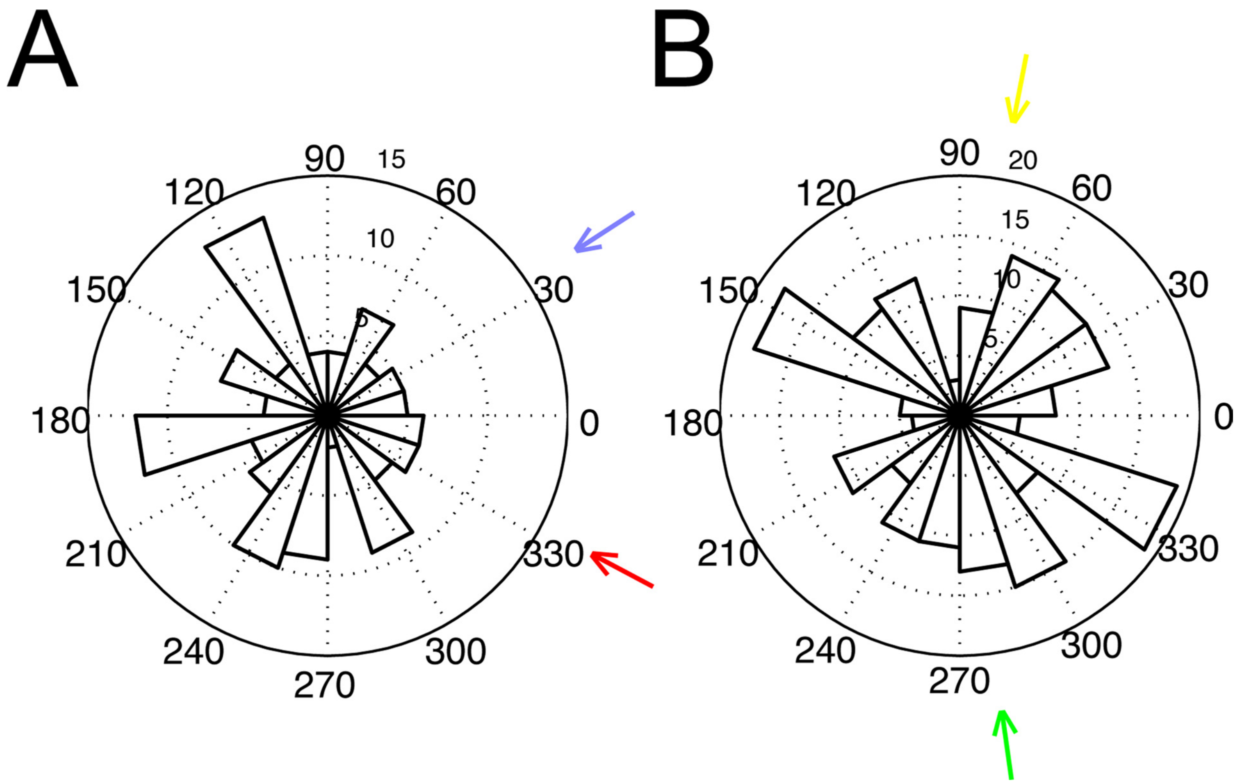

Fig. S4. Distributions of curvature direction tuning peaks (μ values of fitted von Mises functions). (*A*) V4 distribution, including example neurons from Fig. 1 (blue arrow) and Fig. 2 (red arrow). V4 tuning peaks were uniformly distributed (Rayleigh test, $P = 0.41$). (*B*) SII distribution, including example neurons from Fig. 1 (green arrow) and Fig. 2 (yellow arrow). SII tuning peaks were uniformly distributed (Rayleigh test, $P = 0.40$).

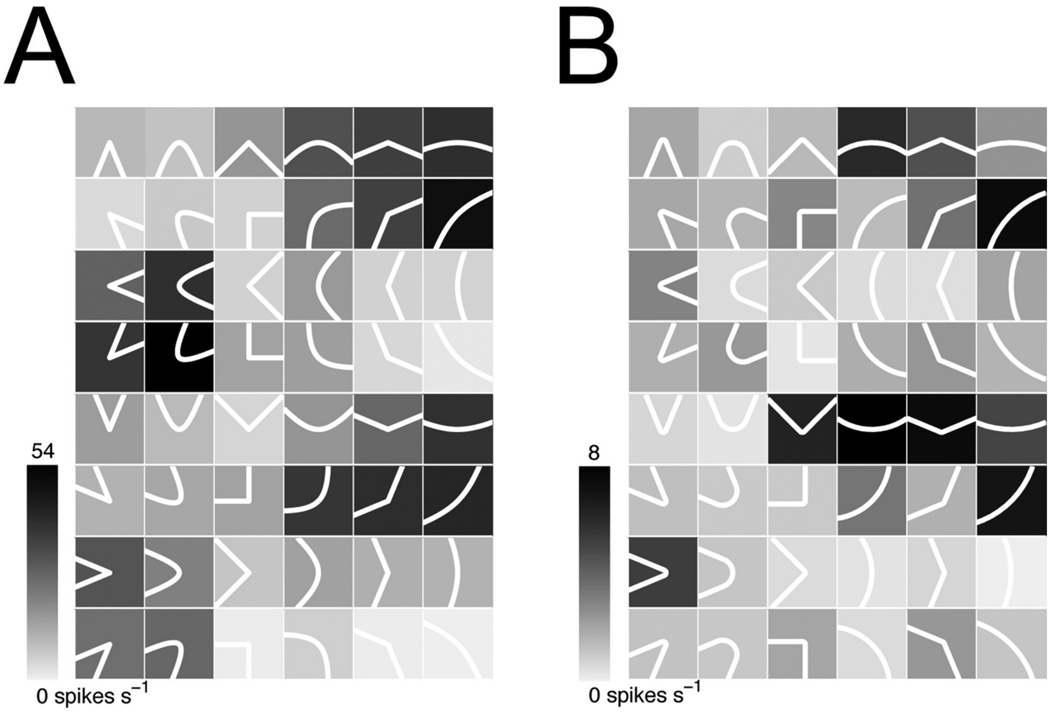

Fig. S5. Tuning for orientation in visual and somatosensory cortex. Conventions and methods as in Fig. 1. (*A*) Example V4 neuron. This response pattern exhibits the four staggered peaks expected on the basis of tuning for a component orientation within contour fragment stimuli (see Fig. 2*B*), in this case slightly counterclockwise from horizontal. (*B*) Example SII neuron, also tuned for component orientations slightly counterclockwise from horizontal.