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Supplemental Information

Neural Activities in V1 Create a Bottom-Up Saliency Map

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Inventory of Supplemental Information

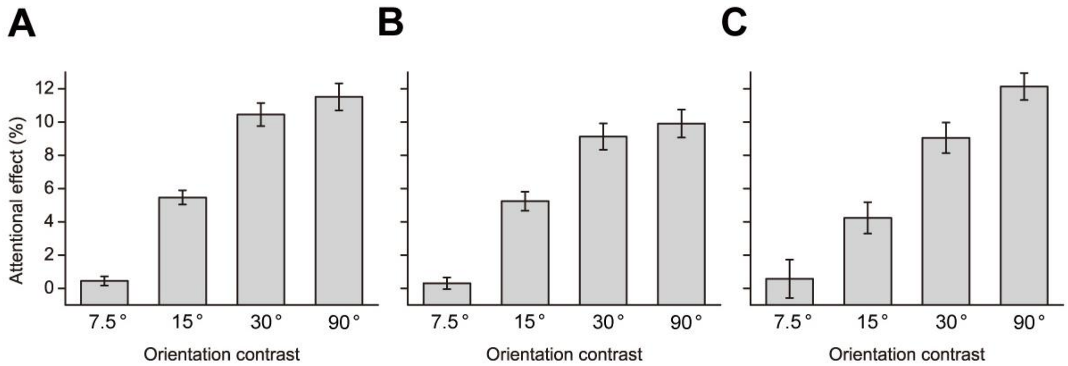

Figure S1. Psychophysical attentional effects. (A) Attentional effect with stimuli presented in the upper visual field. The psychophysical attentional effects for the four orientation contrasts, each quantified as the difference between the performance accuracy of the probe task in the valid and invalid cue conditions. Error bars denote 1 standard error of the mean (SEM) across subjects for each condition. In the supplemental psychophysical experiment, the procedure was similar to that of the main psychophysical experiment except that stimuli were presented in the upper visual field. Eighteen human subjects (9 male, 21-25 years old) participated in the experiment. Four of them participated in the main psychophysical experiment. When there was an orientation contrast between the foreground and the background bars, the invisible foreground region exhibited a positive cueing effect. This was significant when the contrast was 15° or higher (paired t-test 7.5°: t_{17}=1.60, p=0.128; 15°: t_{17}=12.726, p<0.001; 30°: t_{17}=14.596, p<0.001; 90°: t_{17}=14.370, p<0.001). A one-way repeated-measures ANOVA showed that the main effect of orientation contrast was significant ($F_{3, 51}$=120.396, p<0.001). Post hoc paired t-tests revealed that the positive attentional effect increased with the orientation contrast (7.5° vs 15°: t_{17}=8.186, p<0.001; 15° vs 30°: t_{17}=10.596, p<0.001) and saturated at 30° (30° vs 90°: t_{17}=2.371, p=0.179). Similar attentional effects were found when subjects performed a motion direction discrimination task on a probe of moving dots (B), or an orientation discrimination task on a Gabor probe (C).

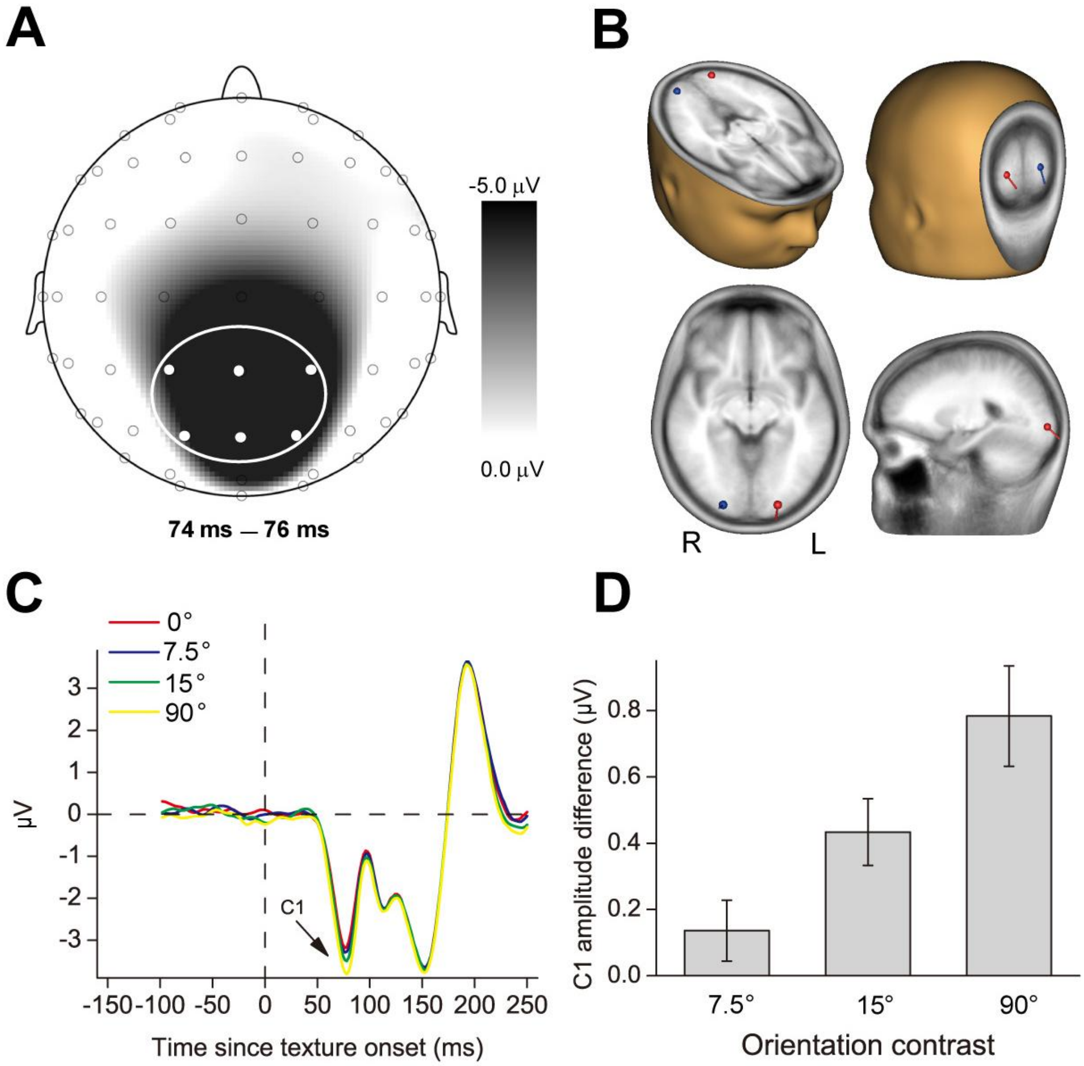

Figure S2. ERP results with stimuli presented in the upper visual field. (A) C1 topography in response to the masked texture stimuli averaged over all orientation contrasts and subjects. Posterior electrodes, including CP1, CPz, CP2, P1, Pz and P2 (within the white ellipse), had the largest C1 amplitudes. (B) Dipole modeling of intracranial sources of the C1 component. A symmetrical pair of dipoles located in V1 (Talairach coordinates: ±22, -91, -5) could account for 90% of the variance in the C1 scalp voltage distribution over the interval 65-85 ms after texture stimulus onset (R: right hemisphere; L: left hemisphere). (C) ERPs averaged over the six electrodes and all subjects in response to the masked texture stimuli. (D) C1 amplitude differences between orientation contrasts 7.5°, 15°, 90° and 0°. Error bars denote 1 SEM calculated across subjects for each condition. In the supplemental ERP experiment, the procedure was similar to that of the main ERP experiment except that stimuli were presented in the upper visual field. Subjects are those who also participated in the supplemental psychophysical experiment. Two of them were excluded because of frequent eye blinks. C1 amplitude differences were submitted to one-way repeated-measures ANOVA, which showed that the main effect of orientation contrast was significant ($F_{2,\ 30}$=25.782, p<0.001). Post hoc paired t-tests revealed that the C1 amplitude difference increased with the orientation contrast (7.5° vs 15°: t_{15}=4.086, p=0.003; 15° vs 90°: t_{15}=4.247, p=0.002)

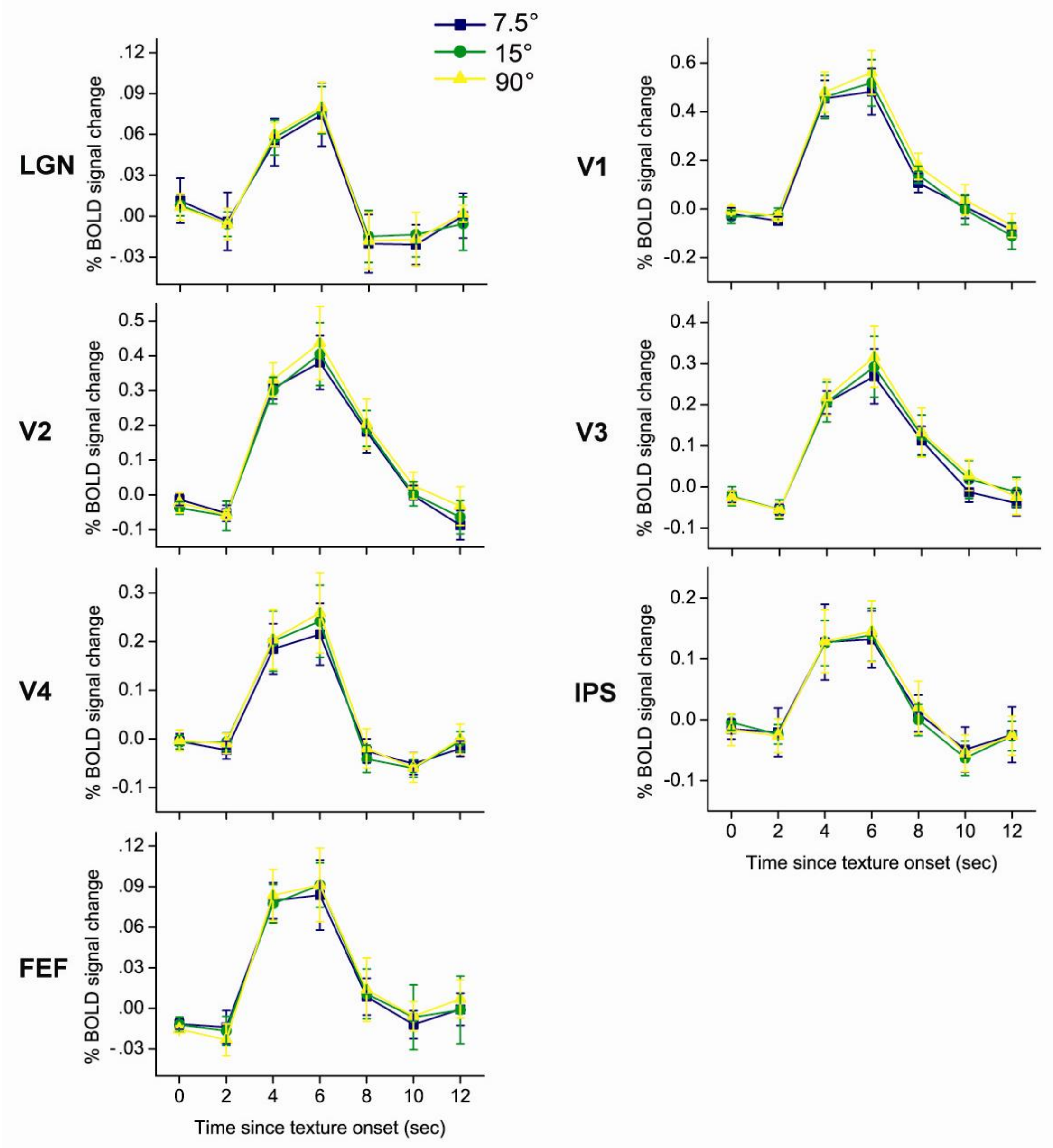

Figure S3. fMRI results in LGN, V1-V4, IPS and FEF. In the supplemental fMRI experiment, the procedure was identical to that of the main fMRI experiment. Six human subjects participated in the experiment. All of them were subjects of the main fMRI experiment. Time of repetition (TR) for fMRI scanning was increased to 2 sec, so the whole brain was covered (TE: 30 ms; TR: 2000 ms; FOV: 186 × 192 mm^2; matrix: 62 × 64; flip angle: 90; slice thickness: 5mm; gap: 0 mm; number of slices: 30, slice orientation: coronal). Similar to the main fMRI experiment, LGN, V1-V4, IPS and FEF were defined by a localizer scan and retinotopic mapping scans. Talairach coordinates of rLGN, lLGN, rFEF and lFEF were (20±1, -26±1, -1±0.4), (-22±1, -25±1, -1±0.4), (33±3, -9±2, 46±0.4) and (-35±3, -11±2, 45±1) respectively, consistent with previous studies (Berman et al., 1999; Chen et al., 1999; Connolly et al., 2002; Kastner et al., 2004; Luna et al., 1998; O’Connor et al., 2002; Paus, 1996). Unlike other ROIs, FEFs in two hemispheres could be activated equally well by stimuli presented in either the left or the right visual field in the localizer scan. Thus, instead of presenting data in ipsilateral and contralateral ROIs like the main fMRI experiment, we presented event-related BOLD signals according to the magnitude of orientation contrast (similar to the ERP experiments). The peak values of the BOLD signals were submitted to a repeated-measures ANOVA with orientation contrast (7.5°, 15° and 90°) and cortical area (V1-V4, IPS, LGN and FEF) as within-subject factors. The main effect of orientation contrast was significant ($F_{2,\ 10}=31.71$, $p=0.001$), demonstrating that the peak value increased with the orientation contrast. We also found a significant main effect of cortical area ($F_{6,\ 30}=14.963$, $p<0.001$) and a significant interaction between orientation contrast and cortical area ($F_{12,\ 60}=2.237$, $p=0.021$). These results suggested that the effect of orientation contrast varied across cortical areas. This was confirmed in further analysis which showed that the main effect of orientation contrast was significant in V1-V4 (all $F_{2,\ 10}>5.861$, $p<0.05$), but not in IPS, LGN and FEF ($F_{2,\ 10}<2.039$, $p>0.19$). Furthermore, we performed a group analysis and did a whole-brain search with GLM for cortical areas whose activity increased with the orientation contrast. Only early and intermediate visual cortical areas were found.

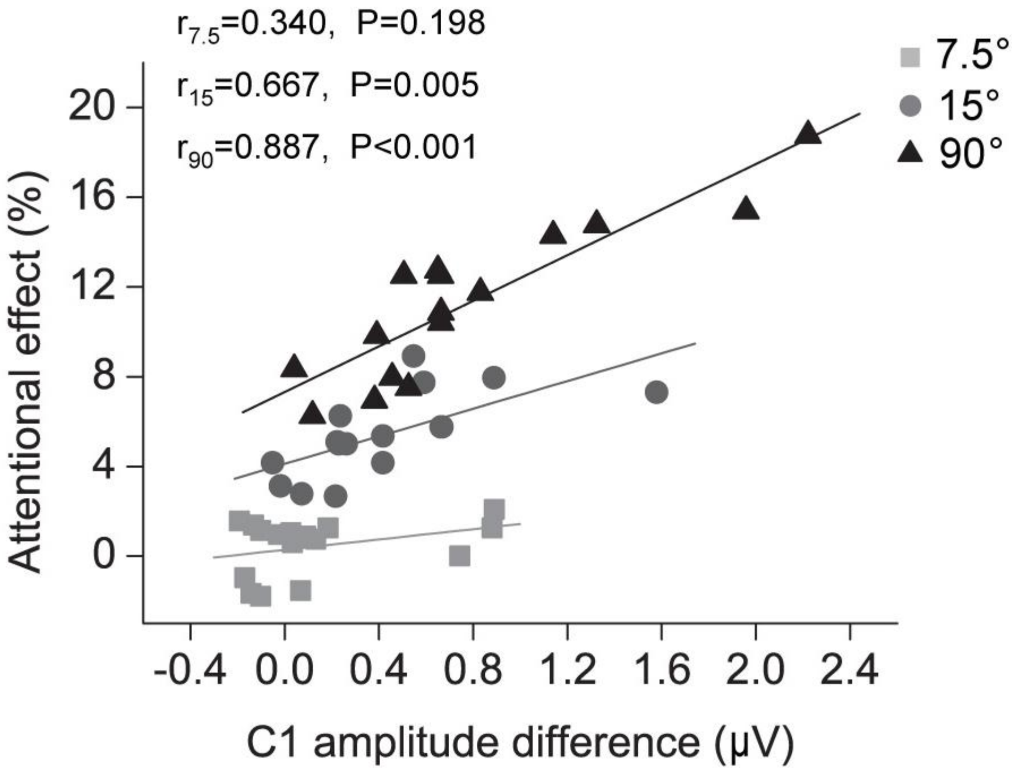

Figure S4. Correlations between the attentional effect and the C1 amplitude difference across individual subjects with stimuli presented in the upper visual field for three orientation contrasts - 7.5°, 15° and 90°.

References

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