Patterns of Ocular Dominance Domains and Cytochrome Oxidase Blobs in Striate Cortex of The Prosimian Primate Galago

J F Olavarria, H. Qi, V. A. Casagrande, J. H. Kaas. Dept. of Psychology, University of Washington, Seattle, Dept. of Psychology Vanderbilt University, Nashville

Figure 1: ODCs in layers 3 and 4, and CO blobs in layer 3, ipsi to injection of WGA-HRP

Introduction

Previous anatomical studies of ocular dominance columns (ODCs) in V1 of galagos did not investigate the overall tangential arrangement of eye-specific input in different cortical layers of V1. Likewise, studies using optical imaging of intrinsic signals have not provided information on the pattern of ODCs in layer 4 and deeper layers because this technique detects mostly activity patterns of neurons in the superficial layers. Here we demonstrate the patterns of ODCs across the cortical layers following intraocular injections of the transneuronal tracer WGA-HRP, and correlate these patterns with the array of CO blobs in tangential sections of the flattened cortex.

Methods

Adult galagos received intravitreal injections of 1mg of the transneuronal tracer WGA-HRP in 20 ul of saline. After 4-5 days, the patterns of ODCs and CO were demonstrated in tangential sections of the flattened cortex by TMB and CO histochemistry, respectively. Images of these patterns were carefully aligned in Photoshop CS5 using radial blood vessels, tissue borders and penetrating marks made in the flattened cortex in regions close to V1. Thresholded images were analyzed using ImageJ.

Results

Figure 1. WGA-HRP labeling in layers 3, 4, 6 ipsilateral to the intraocular injection of WGA-HRP, and CO blobs in layer 3.

A: Galago brain showing the location of V1 in the right hemisphere. **B:** Outline of the unfolded and flattened right V1. The large outlined area is the region shown in C, D, E; the smaller box indicates the analyzed area in Fig. 2. **C:** Pattern of ODCs in layer 3. ODCs appear patchy, resembling the pattern ODCs revealed with optical imaging methods in galago (Xu et al., 2005) and owl monkey (Kaskan et al., 2007). On average, these labeled patches occupy about 30% of the analyzed area. **D:** ODCs in layer 4. Labeling forms interconnected bands, similar to the patterns of ODCs in the cat (Anderson et al., 1988). The width of ODCs is about 300 um. On average, these labeled bands occupy 56% of the analyzed region, suggesting some overlap between right and left ODCs. **E:** pattern of CO blobs in superficial cortical layers. On average, CO blobs occupy about 38% of the analyzed area, and their density is about 4 CO blobs per mm². **F:** Lower magnification image showing patchy labeling in layer 6. The size and arrangement of the patches resemble those in layer 3.

Figure 2. Correlating CO blobs and ODC patterns in layers 3 and 4 shown in the box in Fig. 1. **A.** Illustrates that CO blobs (red) are not aligned with the pattern of ODCs in layer 3 (green), and that many CO blobs straddle the border between right and left ODCs. **B.** Illustrates that ODCs in layer 3 (green) overlap with ODCs in layer 4 (black), suggesting that patches in layer 3 outgrow radially from limited regions of ODCs in layer 4. **C.** Illustrates that CO blobs are not centered on ODCs (black). Instead, many CO blobs overlap black and white territories indicating that they straddle the border of right and left eye ODCs. This suggests that many, if not all CO blobs receive input from both eyes. Scale bar = 1 mm.

Figure 3. Pattern of ODCs contralateral to the injected eye. Same case as in Fig. 1. **A.** Pattern of ODCs in layer 4. Thresholded image is shown in **C.** **B.** Pattern of CO blobs in layer 3. Thresholded image is shown in **D.** Patterns in C and D are superimposed in **E.** As in the ipsilateral hemisphere (Fig. 2), CO blobs are not centered on ODCs and straddle the borders of right and left eye ODCs.

Figures 4 and 5. Data from additional cases showing ODCs and CO blobs ipsilateral to the eye injected with WGA-HRP. The results are consistent with results shown in Figs. 1 and 2. Scale bars = 1 mm.

Figure 3

Figure 4

Figure 5

Conclusions

1. Pattern of ODCs in galagos is different in superficial vs. deeper cortical layers
2. CO blobs are not centered on ODCs, supporting the view from previous studies in primates and cat that the alignment between CO blobs and ODCs in macaque is not a general feature of mammalian V1
3. CO blobs receive input from both eyes