FULL-FIELD TWO-DIMENSIONAL V1, V2, AND V3 VISUOTOPY REPRESENTED BY A QUASICONFORMAL MAP COMPLEX[*†]

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May 4, 2003

Abstract

The 2-dimensional visuotopic mapping in primate area V1 can be modeled in the central 20° by the complex logarithm $w = \log(z+a)$ from visual to cortical coordinates, which is accurate to within 10–15%. However, most applications of this model have used the 1-dimensional derivative known as the *magnification factor*. Magnification factor is a function of both eccentricity and polar angle and is different along each meridian, even for a locally isotropic (i.e., conformal) mapping. Therefore, it is insufficient to characterize visuotopic mappings. We have extended the complex logarithm mapping function to the peripheral representation by including a second logarithmic singularity, yielding a conformal dipole mapping *dipole* mapping $w = \log[(z+a)/(z+b)]$. In recent work, we fit a *quasiconformal* generalization of this model to semi-quantitative data for areas V1, V2, and V3 that included topographic anisotropy in the form of *rotational shear* (Balasubramanian et al., *Neural Networks*, 15:1157–63, 2002). Here, we show a good quantitative fit ($r^2 \approx 0.90$) of this quasiconformal model to our own computer-flattening of V1 and V2 macaque data (with V3 represented semi-quantitatively), obtained from the Van Essen group web site, based on a single dipole mapping with one parameter controlling the shear in each area, dorsal and ventral. The results show that full-field V1, V2, and V3 visuotopy can be accurately fit to a single map "complex" whose conformal component is identical. The observation that V1, V2 and V3 have a common topographic structure suggests that map complexes, consisting of joint mappings coupled by shared boundary conditions, may be a general feature of receptotopically organized cortex. This work represents the first quantitative fit to full-field, 2-dimensional visuotopic structure in striate and extra-striate visual cortex.

[*]Presented at Society for Neuroscience 33rd Annual Meeting, New Orleans, on November 12, 2003. Abstract number **818.18**.

[†]Support Contributed By: NIH/NIBIB EB001550-01

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