On the cortical mapping function

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Abstract

The retino-cortical visual pathway is retinotopically organized: Neighborhood relationships on the retina are preserved in the mapping to the cortex. Size relationships in that mapping are also highly regular: The size of a patch in the visual field that maps onto a cortical patch of fixed size follows, along any radian and in a wide range, simply a linear function with retinal eccentricity. This is referred to as *M*-scaling. As a consequence, and under simplifying assumptions, the mapping of retinal to cortical location follows a logarithmic function along a radian, as already shown by Schwartz (1980). The *M*-scaling function has been determined for many visual tasks and is standardly characterized by its foveal threshold value together with the eccentricity where that value doubles, called E_2. The cortical location function, on the other hand, is specified by a logarithmic function, or its inverse, an exponential function, with empirically determined parameters. Here we aim to bring together the psychophysical and neuroscience traditions and specify the cortical equations in terms of the parameters customary in psychophysics. The resulting cortical-location function is applied to data from a number of fMRI studies. One pitfall is discussed and spelt-out as a set of equations, namely the frequently employed omission of a constant term in the exponential or logarithmic function. That omission renders the equations undefined in the retinotopic center and meaningless in the center's vicinity. As a final point, the equations are extended to describe the cortical map of Bouma's Law on visual crowding.

Keywords: Cortical map, log mapping, cortical magnification, area V1, *M*-scaling, E_2 value, retinotopy, Bouma's Law, crowding

Teaser

The inverse-linear M-scaling function in the visual field translates into an exponential location function in V1. We specify the latter in terms of the E_2 parameter customary in psychophysics. The pitfall of dismissing the constant term in the location function is discussed. Equations are extended to describe the cortical map of Bouma's Law on crowding.