Rotatable, three-dimensional computer reconstruction of the macaque monkey brain

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In studying the areas of the monkey brain, including their connexions, it is often desirable to view the entire area at once in the tangential plane. This is awkward in the highly gyrencephalic macaque monkey brain. To overcome it we devised two-dimensional flattened maps of single cortical areas by unbending contour lines in the cortex and aligning them one against the other using appropriate landmarks (Zeki, 1977), an approach which we then used to prepare two-dimensional maps of large parts of the visual cortex (Van Essen & Zeki, 1978). Such reconstructions suffer from two constraints. One is that the unbending of curved surfaces entails some stretching which introduces an error into the final map. The second is that the precise topological relations are sometimes lost, making the maps difficult to follow. To overcome these difficulties we have designed computer programs to reconstruct, in three dimensions, single areas or large parts of the brain. The program uses a least-squares-fit method to stack the sections above each other serially and then plot them on to a TV screen using a matrix transformation (Angell, 1981). Any desired view of the set of sections can be set up and a hidden line algorithm can be included to simplify the resulting image. Perspective or orthogonal plots may be selected, though with the former a perspective distortion is introduced, as in normal viewing. Because the tangential planes of individual areas differ with respect to each other and to the plane of sectioning, the ability to choose any view of the brain means that, using the same data, different areas can be viewed in the tangential plane by appropriate rotation.

The three-dimensional view is obtained by using red-green spectacles and a stereo pair of images. The three-dimensional reconstructions should prove a valuable aid in studying the areas of the cerebral cortex.

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REFERENCES