A NOVEL MRI-BASED METHOD FOR LOCALIZING ELECTROPHYSIOLOGICAL RECORDINGS IN NONHUMAN PRIMATES

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Abstract:
The majority of neurophysiological studies in conscious primates use craniotomies and recording chambers to access the same cortical territory for up to several years. In this technique, stereotaxic references are adequate for coarse positioning of the recording chamber relative to the brain area under study. However, individual anatomical variations, chamber placement errors, and changes over time degrade our ability to localize recording sites using conventional methods, particularly in regions of brain with complex anatomy such as the cerebral cortex. As a result, labs increasingly rely on functional criteria to characterize recording sites. Since functional criteria are rarely standardized, this strategy can make it difficult for the neuroscience community at large to reconcile results obtained from different labs.

We have developed a robust, practical method to localize single unit recordings to within 1mm using magnetic resonance imaging (MRI). After chamber placement, a high-resolution (0.5-0.8 mm^3) T1-weighted MRI is acquired. The image includes the brain and a specially designed, MR-lucent cylinder marking the position, orientation and dimensions of the recording chamber. The affine transformations required to project data from the native MRI into either chamber-aligned or stereotactic views are computed using automated, iterative procedures. Our lab has used this method to generate individualized chamber-aligned atlases (n=15) to guide single unit recording sessions (n=~75) and MnCl injections (n=6). These experiments have provided physiological and MRI evidence that our localization precision, which should scale with our MRI resolution, is <1mm. The new method is particularly suited to single unit/fMRI correlative studies and to the study of functional organization across the cortical surface in relation to gross anatomical features.

Support Contributed By: McDonnell Ctr for Higher Brain Function