Anatomical Parcellation of Cortical Language Sites

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Anatomical labeling of cerebral cortical stimulation (CSM) sites is necessary for intelligent computer querying of a rich and unique experimental database examining neural substrates underlying human language production. To this end, we have developed a parcellation scheme for the lateral surface of the human cerebral cortex. We then compared results generated utilizing this approach to those generated using an alternative method implemented in the Talairach Daemon.

Mapping brain functional anatomy using electrical stimulation of cerebral cortex in awake neurosurgical patients provides a unique window into the neurological substrate underlying human language. The complex and varied nature of data sets collected during these procedures has necessitated development of sophisticated experiment management systems (EMS) http://sig.biostr.washington.edu/projects/brain/ for storage and analysis of demographic, behavioral, neurophysiological, functional MR and neuroanatomical data. The precise anatomical location of each CSM site has proven to be the single data point which best links all other data types. Whereas graphical representations of CSM sites plotted on 3-D MR-based reconstructions are needed for visualization and quantitative analysis, efficient retrieval necessitates assignment of text-based anatomical labels to the CSM sites.

To this end, we have developed a scheme to parcellate the lateral surface of the human cerebral cortex into thirty-seven subdivisions, labeled using Foundational Model of Anatomy (FMA) expansion of NeuroNames terminology[1] (Fig.1) Each CSM site is assigned to the appropriate parcel by an expert, using anatomical landmarks visible on the cortical surface. Once parcellation assignments are made for each CSM site, it is possible to generate queries of the EMS database across patients based primarily on anatomical parcels of interest, as presented in a companion poster by Z. Tang et al.
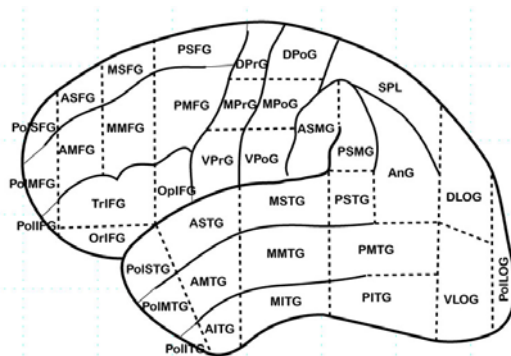

Figure 1. FMA parcellation of lateral cortical surface

To test the efficacy of this parcellation method we compared, on thirty-one patients, labels generated using our method versus those generated using the Talairach Daemon (TD) http://ric.uthscsa.edu/projects/, access to which we have incorporated in our EMS. Out of a total of 511 CSM sites compared, only 306 sites (60%) were assigned to the same cortical gyrus by both the TD and the extended NN parcellation scheme. Agreement was as high as 92% in one patient, and as low as 19% in another. We attribute these differences to the considerable individual variation of cortical surface landmarks which demarcate gyral boundaries. Because TD relies on relatively distant deep brain landmarks (AC–PC plane) to coregister brains, we submit that the TD technique is disadvantaged with regard to determination of cortical gyral boundaries when compared to our parcellation technique, which relies on visual inspection of cortical surface landmarks on each individual brain. In future work, we will extend our analysis to determine what factors affect the degree of agreement between these and other anatomical assignment techniques.

[1] Martin, R. F., Mejino, J. L. V., Bowden, D. M., Brinkley, J. F. and Rosse, C. (2001) Foundational Model of Neuroanatomy: Implications for the Human Brain Project. In Proceedings, AMIA Annual Fall Symposium, pages 438-442, Washington, DC.