Functional Neuroimaging of the Normal Brain: A Study of Language Processing

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This thesis project evaluates two functional imaging technologies in the assessment of human language processing. We studied 25 neurologically normal right-handed individuals, each of whom was evaluated with magnetoencephalography (MEG) and functional magnetic resonance (fMRI) during performance of simple language tasks.

We outline a procedure for determination and evaluation of language dominance using MEG, based solely on the properties of the evoked biomagnetic fields. In this analysis we describe a field-strength lateralization pattern that favors the left hemisphere, showing higher RMS field strength in the left hemisphere compared to the right hemisphere (on the order of 50 fT higher at latencies of approximately 400 milliseconds).

We carried out a comparative evaluation of language-specific protocols using the fMRI and MEG functional imaging techniques. We observed general agreement between the techniques as regards to the cortical regions most significantly activated during language tasks (e.g., inferior frontal lobe, posterior temporal-parietal lobe, and pre-motor cortex). The two techniques also generally yielded similar results regarding the relative distribution of fMRI and MEG activated volumes across the two cerebral hemispheres, resulting in positive average lateralization indices (LI) for language tasks – indicative of left-dominant activation. An analysis of fMRI/MEG activation cluster displacement in the vicinity of left Brodmann Area 22 demonstrated a grand average mismatch displacement of 24.7 ± 11.1 millimeters.

A separate evaluation of equivalent current dipole source-characteristics revealed left-dominant trends in source characteristics that were well correlated with averaged LI values (favoring the left hemisphere). The spatial asymmetry in source distribution across hemispheres was complemented by results showing similar task-dependent asymmetry in equivalent current dipole source strength, and latency of activation.

We additionally evaluate MEG source-propagation patterns to delineate time-course activation on three representative subjects.