fNIRS-Based Hyperscanning To Investigate Inter-brain Neural Synchronization in Communication-Based Language Therapy for Aphasia

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Aphasia is a stroke-induced language disorder affecting around 1 million people, with 180,000 new cases annually in the United States. Language therapy is the standard behavioral treatment to patients with aphasia for improving functional communication, which is defined as the ability to communicate efficiently and successfully in typical, everyday interactions and situations. While previous neuroimaging studies have identified a correlation between effective communication and inter-brain synchrony (IBS), limited research has explored the impact of IBS on the effectiveness of language therapy for aphasia. Prior efforts to identify individual responses to therapy have not consistently answered the fundamental question: how well individuals improve their functional communication ability during language therapy. Therefore, our project quantifies the extent to which different types of aphasia treatments induce IBS. To achieve this, we constructed a hyperscanning functional Near-Infrared Spectroscopy (fNIRS) system to measure hemodynamic signals between healthy dyads participating in cooperative singing, reading, and naming therapies for aphasia. We then applied MATLAB-based Wavelet Coherence Analysis to compute inter-brain coherence in the bilateral language network using pre-processed fNIRS oxy-hemoglobin signals. Paired with behavioral performance, localized inter-brain coherence reveals a significant correlation between language therapy and the patterns of IBS-induced brain activation. This finding prompts further investigation into whether damage to the IBS region can be repaired and if such improvement may enhance outcomes in aphasia rehabilitation. With the empirical measurement of IBS, our project established the basis for the development of more personalized therapy for individuals with aphasia.