

Mapping language learning in the brain with fMRI

This talk will present a study that used functional magnetic resonance imaging (fMRI) to investigate second language (L2) learning and processing. There are fundamental questions in applied linguistics about L2 learning and processing that can be elucidated, at least in part, with information about the neural structures that are involved. In particular, are the neurobiological substrates of adult L2 acquisition different from those involved in first language processing? How do they change with increasing exposure and proficiency? Can L2 learning be implicit? How do individual learners differ from one another with respect to the neural bases of language learning? The high spatial resolution of fMRI makes it an excellent tool to help answer these questions.

In this study, 19 native speakers of English (8 female; mean age = 20.6 years) were trained on a subset of Basque words and sentences over the course of three days (approximately nine hours). Training was conducted via forced-choice picture-matching tasks, and learners also completed production and grammatical violation tasks. Continuous behavioral measures were obtained for all tasks, and continuous fMRI data was acquired during all phases of grammar learning, as well as for the word learning and violation tasks on Days 1 and 3.

By the end of training, learners achieved very high proficiency in vocabulary (98% accuracy) and reasonably high proficiency in grammar (82%). Results from the violation task showed that within grammar, syntactic word order was learned quite well, whereas morphosyntactic agreement was more difficult. However, behavioral analyses only tell part of the story. fMRI results demonstrate that L2 processing activates some of the same areas found in native-language processing, as well as additional structures. This suggests that there is not a critical period for the involvement of at least some first language neural structures in late-learned L2, but these structures may not be sufficient for adult L2 learning and processing. Additionally, early reliance on structures like the hippocampus and medial temporal lobe and later recruitment of the basal ganglia suggest that L2 learning and processing may initially depend on explicit mechanisms, but may shift to more implicit processes after sufficient exposure or proficiency. Finally, correlations between behavioral performance and neural activation suggests that the profile of a highly proficient learner might go beyond high performance on behavioral tasks and include activation of neural regions that indicate the automatization of grammar.

Overall, this study demonstrates the utility of using fMRI to address classic research questions that cannot be answered with behavioral methods alone.