Project number　78

The Neural Correlates of Learning Semantic and Formal Noun Classes

［1］Research group

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Expenditure report of research funds：
MRI fee – 90,000 YEN
Consumables 10,000 YEN

［2］Research setup

The purpose of this study is to investigate the neural correlates during the actual learning process as the brain learns rules that rely on social/semantic or phonological information. Behavioral studies suggest that there are individual cognitive differences in the learning process for each of these important linguistic structures, and, if there are unique brain-related individual differences found, this could have important implications for designing pedagogical strategies in the field of language education. In addition, the focus on examining learning in real time could reveal important individual differences in brain activation that can predict successful learning of these types of rules.

The research schedule is summarized in the table below.

Summary of Joint Research Program	
April–August 2020	• Hypotheses/Experiment Design Discussed • Extensive Literature Review Done • Early behavioral experiment conducted
June-December	• fMRI Experiment Design Completed • Behavioral results accepted for publication • fMRI style pilot study conducted
January – February 2021	• Preparation for fMRI experiment i.e. adaptation of behavioral studies for fMRI • Set up fMRI protocol (See Figure 1)
March 2021	• Conducting fMRI experiments • Acquiring brain data of 37 participants

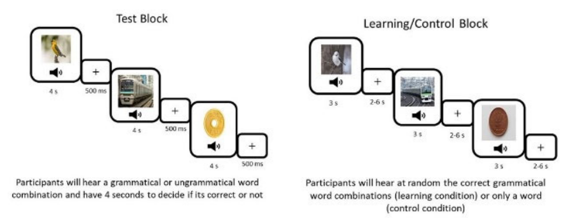

Figure 1

［3］Research outcomes

（3－1）Results

Results of the brain data of fMRI experiments are not yet completed; however, behavioral results indicate not only gradual learning over time but also individual differences in learning particularly for the early stages of learning. Due to these behavioral results, we are excited about what will be revealed during fMRI analysis.

（3－2）Future perspectives

The present study can help bridge the gap between cognitive neuroscience and the educational sciences, particularly language education. The present study can help language educators (not just of English, but languages in general) understand the individual differences and similarities that affect language learning and thereby allow collaboration between cognitive neuroscientists, educational specialists, and teachers to develop different pedagogical strategies that can be tested empirically in the classroom. With this, the burgeoning field of Educational Sciences can move forward to find the best strategies empirically validated pedagogies to educate students.

［4］List of Papers

(1) Aikhenvald, A. (2000). *Classifiers: A typology of noun categorization devices*. Oxford, UK: Oxford Press.

(2) Binder, J.R. & Desai, R.H. (2011). The neurobiology of semantic memory. *Trends in Cognitive Sciences, 15*(11), 527-536.

(3) Dardon, D. & Jeong, H. (2021). Working memory trumps language aptitude in learning semantic-based linguistic category rules. *Studies in Language Sciences*.

(4) Dardon, D. & Tanabe-Ishibashi, A. (2020). Working memory hinders learning semantic noun classes but aids in learning phonological ones. *Tohoku Psychologica Folia, 78*, 19-33.

(5) Karuza, E.A., Emberson, L.L., & Aslin, R.N. (2014). Combining fMRI and behavioral measures to examine the process of human learning. *Neurobiology of Learning and Memory, 109,* 193-206.

(6) Kepinska, O., de Rover, M., Caspers, J., & Schiller, N. (2017). On neural correlates of individual differences in novel grammar learning: An fMRI study. *Neuropsychologia, 98,* 156-168.

(7) Kepinska, O., de Rover, M., Caspers, J., & Schiller, N. (2017). Whole-brain functional connectivity during acquisition of novel grammar: Distinct functional networks depend on language learning abilities. *Behavioral Brain Research, 320,* 333-346.

(8) Legault, J., Grant, A., Fang, S., & Li, P. (2019). A longitudinal investigation of structural brain changes during second language learning. *Brain and Language*, *197:* 104661.

(9) Nevat, M., Ullman, M., Eviatar, Z., & Bitan, T. (2017). The neural bases of the learning and generalization of morphological inflection. *Neuropsychologia*, *98*, 139-155.

(10) Opitz, B., & Friederici, A.D., (2003). Interactions of the hippocampal system and the prefrontal cortex in learning language-like rules. *NeuroImage*, *19*, 1730-1737.

(11) Opitz, B., & Friederici, A.D., (2004). Brain correlates of language learning: The neuronal dissociation of rule-based versus similarity-based learning. *The Journal of Neuroscience*, *24*(39), 8436-8440.

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(13) Roberts, L., Alonso, J.G., Pliatsilkas, C., Rothman, J. (2018). Evidence from neurolinguistic methodologies: Can it actually inform linguistic/language acquisition theories and translate to evidence-based applications? *Second Language Research, 34*(1), 125-143.

(14) Tagarelli, K., Shattuck, K., Turkeltaub, P., & Ullman, M. (2019). Language learning in the adult brain: A neuroanatomical meta-analysis of lexical and grammatical learning. *NeuroImage, 193,* 178-200.

(15) Yang, J., & Li, P. (2012). Brain networks of explicit and implicit learning. *PlosOne, 7*(8). doi: 10.1371/journal.pone.0042993