

Project number 85

# Neurocognitive Foundations of Successful Second Language Learning: Roles of Cognitive, Experiential and Sociopsychological Individual Differences

## [ 1 ] Research group

Principal Investigator (PI) :

Kazuya Saito

(University College London)

Host researcher at IDAC :

Motoaki Sugiura

Hyeonjeong Jeong

(IDAC Tohoku University)

Co-investigator :

Adam Tierney (Birkbeck, University of London)

Andrea Revesz (University College London)

Yuichi Suzuki (Kanagawa University)

Expenditure report of research funds :

Subject's honorarium 200,000 YEN

## [ 2 ] Research setup

Developing good second language (L2) proficiency skills plays an increasingly key role in career- and academic-related success in a globalized world. According to previous literature, however, the outcomes of EFL education in Japan are subject to a great amount of individual variability: Some learners can achieve considerably advanced L2 proficiency, while others remain heavily foreign-accented, even if they engage in the same amount and type of L2 instruction and practice activities. By interfacing both education and neuroscience perspectives, and taking different research methods (cross-sectional, longitudinal), we take an exploratory approach to examine which neurocognitive functions underlie successful L2 learning.

In Phase 1, we completed the ongoing cross-sectional project wherein we behaviorally examined the perceptual-cognitive profiles of 80 students at Tohoku University. In Phase 2, we then proceeded to examine how Japanese learners can

improve L2 English phonological skills when they engage in different types of training and how such training gains could be tied to learners' perceptual-cognitive individual differences (i.e., aptitude-treatment interaction). In Phase 3, we have launched an fMRI experiment in order to track their neural activities among a total of 40 students at Tohoku University when they engaged in different types of training. The first part of the data was collected and submitted to a series of preliminary analyses. Depending on the findings, we plan to further expand the scope of the dataset.

## [ 3 ] Research outcomes

### ( 3 – 1 ) Results

In Phase 1 (n = 80 participants), the cross-sectional analyses showed that those with more advanced L2 phonological proficiency likely had not only greater memory but also more precise auditory processing abilities. In Phase 2 (n = 100+ participants), the longitudinal analyses showed that Japanese speakers equally benefited from a range of contrastive training methods. For example, gains were similar whether the treatment was delivered explicitly or implicitly and whether the treatment comprised speech vs. non-verbal stimuli. However, we also found that those with more precise auditory processing yielded substantially large training gains especially when they were exposed to auditory training.

In Phase 3 (n = 40 participants), the fMRI analyses showed that different brain areas were activated when participants engaged in two different types of training, speech vs. auditory training. Speech training was operationalized as intensive exposure to L2 English phonemes. Auditory training was operationalized as intensive exposure to synthesized non-verbal sounds which varied in the key frequency areas in English vowels (1200-1600 Hz). Some emerging patterns were observed:

- Speech training increased not only STS (phonological network) but also STG (auditory network) to some degree.
- Auditory training led to greater STG activation (than speech training) and transfers to change in STS activation.

### (3 – 2) Future perspectives

In addition to the ongoing papers, the team will write a few academic papers to summarize the outcomes of the international collaborations in top-tier journals in L2 education (e.g., *Studies in Second Language Acquisition*) and cognitive psychology (e.g., *Cognitive Science*). This proposed project will allow the team to test the validity/feasibility of the research framework, strengthen the record of collaboration, and apply for large-scale research grants in the near future (e.g., JSPS Bilateral Grant; ESRC Standard Research Grant).

At every phase of manuscript writing and grant application, PI and CIs' postgraduate students will be involved. They will receive training, which will in turn help develop their future career.

### [4] List of Papers

\*indicates PI's student collaborators

#### Phase 1 – cross-sectional investigations

(1) Saito, K., \*Haining, C., \*Suzukida, Y., Dardon, D., Suzuki, Y., Jeong, H., Revesz, A., Sugiura, M., & Tierney, A. (in press). Does domain-general auditory processing uniquely explain the outcomes of second language speech acquisition, even once cognitive and demographic variables are accounted for? *Bilingualism: Language and Cognition*.

(2) Saito, K., \*Suzukida, Y., \*Tran, M., & Tierney, A. (2021). Domain-general auditory processing partially explains L2 speech learning in classroom settings: A review and generalization study. *Language Learning*, 71, 669-715. <https://doi.org/10.1111/lang.12447>

(3) Saito, K., \*Macmillan, K., \*Kroeger, S., \*Magne, V., \*Takizawa, K., \*Kachlicka, M., & Tierney, A. (in press). Auditory processing as a bottleneck for spoken vocabulary and grammar attainment

beyond the critical period. *Applied Psycholinguistics*. <https://doi.org/10.1017/S0142716422000029>

#### Phase 2 – training studies

(1) Saito, K., \*Hanzawa, K., \*Petrova, K., \*Suzukida, Y., \*Kachlicka, M., & Tierney, A. (in press). Incidental and multimodal high variability phonetic training: Potential, limits, and future directions. *Language Learning*.

(2) Saito, K., \*Petrova, K., \*Suzukida, Y., \*Kachlicka, M., & Tierney, A. (under review). Training auditory processing promotes second language speech acquisition. *Journal of Experimental Psychology: Human Perception and Performance*.

(3) \*Shao, Y., Saito, K., & Tierney, A. (in press). How does having a good ear promote instructed second language pronunciation development? Roles of domain-general auditory processing in choral repetition training. *TESOL Quarterly*. <https://doi.org/10.1002/tesq.3120>

#### Phase 3 – fMRI investigations

(1) Saito, K., \*Haining, C., \*Takizawa, K., Dardon, Y., Jeong, H., Kachlicka, M., Petrova, K., Liu, C., Sugiura, M., & Tierney, A. (in progress). Differential effects of auditory and speech training in adult second language speech learning: An fMRI study.