Project 45

Exploring the Role of Gestures in Communication as Related to Aging

［1］ Research group

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Expenditure report of research funds :
Magnetic Resonance Imaging (MRI) costs for data acquisition for brain imaging studies: 90,000YEN
.Consumables: Laboratory consumabels 10,000YEN

［2］ Research setup

1) Purpose of Joint Research:

The purpose of the joint research is to explore how gestures contribute to communication, particularly in the context of aging and second language acquisition. The current study focuses on the role of gestures in adult populations, especially in second language communication, using brain imaging techniques (fMRI) to understand the neural mechanisms involved. Our research aims to provide insights into how gestures enhance communication effectiveness, particularly for older adults and second language learners, and to develop strategies to optimize their use.

2) Outline of Joint Research:

Roles and Responsibilities:

- Conduct literature reviews and develop theoretical frameworks.
- Design experimental stimuli (sentences, videos with actors performing gestures in Japanese and English).
- Pilot test and revise stimuli based on feedback.

Conduct fMRI experiments, collect and analyze data. Interpret findings, write reports, and present results.

3) Methodology:

- Experimental Stimuli: Create sentences and videos with actors performing gestures in both Japanese and English.
- Pilot Testing: Test stimuli with a small group of participants and revise based on feedback.
- fMRI Experiments: Conduct experiments in September and November to collect neural data.
- Data Analysis: Analyze fMRI data to understand neural activity related to gesture processing.
- Comparative Analysis: Compare gesture use and neural responses between native and second language speakers.

4) Timeline:

Months 1-3: Literature review and hypothesis formulation.
Months 4-5: Create experimental stimuli (sentences, videos with actors performing gestures in Japanese and English).
Month 6: Pilot test stimuli and revise based on feedback.
Months 7-8: Prepare for fMRI experiments.
Months 9-10: Conduct fMRI experiments in September and November.
Months 11-12: Collect and analyze data.
Months 13-14: Interpret findings, write reports, and present results.

5) Frequency of Joint Research Meetings:

Weekly: Progress updates and problem-solving discussions.
Monthly: In-depth reviews of milestones and adjustments to the plan.
Quarterly: High-level strategic meetings to assess overall progress and alignment with objectives.

Summary Table

Aspect	Details
Purpose	Explore the role of gestures in communication, focusing on aging and second language acquisition.
Objectives	Understand how aging and second language use affect gesture processing and develop strategies to improve communication.
Roles	Assign tasks to each team based on expertise (e.g., literature review, experimental design, data analysis).
Methodology	Create experimental stimuli (sentences, videos with actors performing gestures in Japanese and English), pilot test, conduct fMRI experiments, and analyze data.
Timeline	14-month plan with key milestones for literature review, stimuli creation, pilot testing, fMRI experiments, data analysis, and reporting.
Resources	Funding, fMRI equipment, and facilities for experiments and data analysis.
Communication	Weekly updates, monthly reviews, and quarterly strategic meetings.

［3］Research outcomes

（3－1）Results

Data from 35 participants were analyzed, excluding those with head movement ≥ 3 mm or comprehension accuracy <70%. For comparisons between gesture and non-gesture conditions in both L2 (English) and L1 (Japanese), significant activation was found in the bilateral posterior middle temporal gyrus (MTG), left middle occipital gyrus and left superior occipital gyrus (FWE-corrected at the cluster-level $p<0.05$). Although no significant interaction effect was observed between gestures and languages, substantial individual differences in recall performance were evident. To quantify recall performance, participants' number of correctly recalled words was converted into d' prime scores, a reliable measure of memory sensitivity that accounts for both hits and false alarms in recall tasks. The English-with-gesture d' prime recall scores showed significant positive correlations with brain activity in the left posterior MTG (FWE-corrected for small volume $p<0.05$), suggesting that this region is uniquely associated with L2 recall performance. In contrast, no such correlation was found for Japanese-with-gesture recall scores, implying that gestures have a different impact on neural processing for L1 and L2 speech comprehension.

These results align with previous neuroimaging studies on multimodal processing, demonstrating that the posterior MTG and the middle occipital gyrus are involved in gesture-speech integration in both L1 and L2 contexts. These regions support the integration of auditory and visual stimuli during communication. However, our findings also highlight a critical distinction: while gestures contribute to speech processing in both languages, they have a greater impact during L2 speech processing by specifically enhancing the retention of L2 spoken information through recruitment of the left posterior MTG. This suggests that gestures play a unique and pivotal role in L2 learning, particularly in supporting memory encoding and recall, which are essential for language acquisition.

Our study provides novel insight into the neural basis of gesture-related memory enhancement in L2 learning. The specific activation of the left posterior MTG in L2 recall performance emphasizes the importance of incorporating gestures as an integral tool in second language acquisition (SLA). Gestures may not only aid in comprehension but also enhance long-term retention, indicating their potential as a pedagogical tool in L2 instruction. By integrating gestures into the classroom, educators may improve memory retention and recall in L2 learners, ultimately leading to better language learning outcomes. Future research should further explore how gesture processing interacts with cognitive memory mechanisms in L2 contexts, particularly in diverse populations and learning environments.

（3－2）Future perspectives

1. Large Project Development:
   - Study metaphoric and iconic gestures with abstract/concrete speech in diverse conversational scenarios (e.g., storytelling, problem-solving).
2. International Conferences:
   - Present at HBM 2025 (Brisbane) and JSLS 2025 to share findings on gesture-speech integration and SLA.
3. Overseas Collaboration:
   - Work with Dr. Andrea Revesz (UCL) to deepen understanding of gestures in SLA.
4. Gesture Research Group:
   - Form a multimodal SLA research group to study gestures, speech, and other modalities (e.g., facial expressions).
5. New Research Areas:
   - Integrate eye-tracking, EEG, and VR to explore multimodal communication and cognitive processes.

［4］List of research achievements

1) Jiaxin Yan, Victoria-Anne Flood, Motoaki Sugiura, Hyeonjeong Jeong, The Role of Gesture in Second Language Acquisition: an fMRI study, Society for the Neurobiology of Language, 16th Annual Meeting, Brisbane, Australia, October 24-26, 2024, https://www.neurolang.org/