# Effect of Shadowing Training on Phonological Awareness Development: Difference between Auditory-sequential Learners and Visual-spatial Learners

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**Abstract**

Shadowing methods have a positive impact on listening skill development; however, the effectiveness of shadowing training may depend on learners' cognitive traits. To test this hypothesis, we conducted a lab-based experiment of phonological awareness using near-infrared spectroscopy with a two-week English shadowing treatment. Brain activities and language performance confirmed that shadowing training was more likely to cause a positive improvement in auditory-sequential learners than visual-spatial learners.

## 1 INTRODUCTION

In a previous study, we assessed the differences in phonological awareness development between auditory-sequential and visual-spatial learners. We found that language learners of English as a foreign language that focused on listening skills instead of shadowing training did not have inferior vocabulary, grammar, and reading skills. These learners reported that repeating sounds with their lips after modeling was difficult and that they needed more time to think about the meaning of sounds. Hence, we hypothesized: 1) the learners' cognitive type (auditory-sequential dominance or visual-spatial dominance) affected the accuracy of phonological recognition of spoken language, and 2) the development of accuracy in phonological awareness would enhance the effect of shadowing training and improve listening comprehension.

## 2 LITERATURE REVIEW

Shadowing was originally developed in the United States as a training method for simultaneous translators. Many foreign language teachers have incorporated shadowing into their listening comprehension instruction. However, shadowing does not always contribute to language generation in the brain from the perspective of cognitive science and neuropsychology (Lambert, 1992; Seleskovitch & Lederer, 1989). Kurz (1992) and Tamai (1997) found that shadowing stimulated learners' cognitive abilities such as the short-term memory required for rapid translation and simultaneous processing of information during listening and speaking. Kadota (2007) systematized shadowing instruction and demonstrated that even less proficient learners improved their listening skills by modifying traditional language processing procedures using this training. Other positive effects of shadowing on improving listening comprehension were also reported (Hamada, 2012; Sumarsih, 2017). In the present study, we investigated the effects of shadowing training on learners' listening skill development and how it was affected by their cognitive traits.

## 3 EXPERIMENT

In a previous study, we practiced shadowing instruction using the method reported by Kadota (2007). We found that students with high English proficiency may have difficulty doing shadowing, and hypothesized that its effect could be highly dependent on cognitive traits (Takechi et al., 2015). To test this hypothesis, we first focused on the effect of working memory on the score of shadowing tasks, and conducted a series of memory tests (digit recall, backward digit recall, and word phrase recall) in Japanese college students (n = 92). Although the mechanism by which auditory-sequential and visual-spatial stimuli are sequentially stored in the memory is still unclear (Donalato et al., 2017), some studies found that visual-spatial memory helped backward digit recall (Hoshi et al., 2000; Norris et al., 2019). Thus, we hypothesized that auditory-sequential learners would have better digit recall than backward digit recall, and visual-spatial learners would have equal to or superior backward digit recall than digit recall. Those with low word phrase recall were excluded.

### 3.1 Procedures of Experiment

In our preliminary experiment, we performed near-infrared spectroscopy (NIRS) using a block design to compare three students with primarily auditory-sequential cognition and two students with primarily visual-spatial cognition. However, our procedure did not accurately estimate brain function, as physical movements, such as involuntary facial movements during shadowing, were mixed into the NIRS signals and became measurement noise with a relatively large amplitude.

For the next phase of our experiment, we designed a new protocol. Five learners with auditory-sequential dominant cognition and five learners with visual-spatial dominant cognition were selected, and underwent a two-week English shadowing practice.

To verify the accuracy of phonological awareness and the accompanying activation of the brain, the subject listened to an unfamiliar language (Finnish) and silently clicked the mouse when they recognized a specific phoneme. Activation of the brain was monitored and recorded using NIRS during a series of tasks. By using shadowing as a treatment rather than as direct material for NIRS experiments, it was possible to control the physical movements of subjects and prevent noise due to muscle movements. Shadowing practice as a treatment was conducted in English, and Finnish as an unlearned material was used to verify the accuracy of phonological awareness and the accompanying activation of the brain.

We conducted a block design experiment with rest-task-recovery as one trial (Fig. 1). We divided the task into three periods: before shadowing practice, 2-3 weeks after the start of shadowing practice, and 4-5 weeks later. Five trials were performed. In the rest section and the recovery section, the subject looked at a cross-shaped optotype (FT) that appeared in the center of the monitor for 10 seconds. In the task section, after presenting the target speech consisting of one word with the target phoneme, we randomly presented five different words, one word with the target phoneme and four words with similar but different phonemes. The outline of the experiment is shown in Figure 2. The subject was instructed to immediately click the mouse when he/she heard the target phoneme. NIRS signals were measured on

36 channels using LABNIRS (Shimadzu Corporation) in the prefrontal cortex and the left lateral temporal cortex so as to include Broca's area and Wernicke's area.

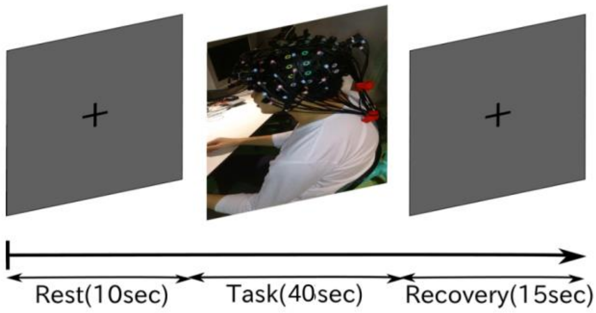


Fig. 1 Rest-task-recovery design

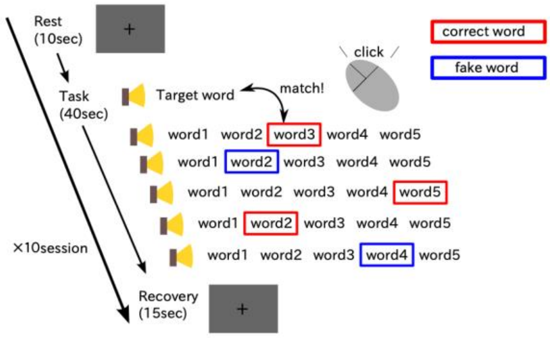


Fig. 2 Outline of the experiment

3.2 Results

Figure 3 shows the NIRS signal results. The left column shows learners who had auditory-sequential dominant cognition, and the right column shows those with visual-spatial dominant cognition. The visual-spatial dominant cognition group tended to have lower brain activation than the auditory-sequential dominant cognition group. In addition, the auditory-sequential dominant learners improved their scores in the listening test after shadowing practice, but the visual-spatial dominant learners did not show any significant changes. Thus, the auditory-sequential dominant cognition group phonologically processed language information more efficiently. On the other hand, only slight changes were observed in the learners with visual-spatial dominant cognition.

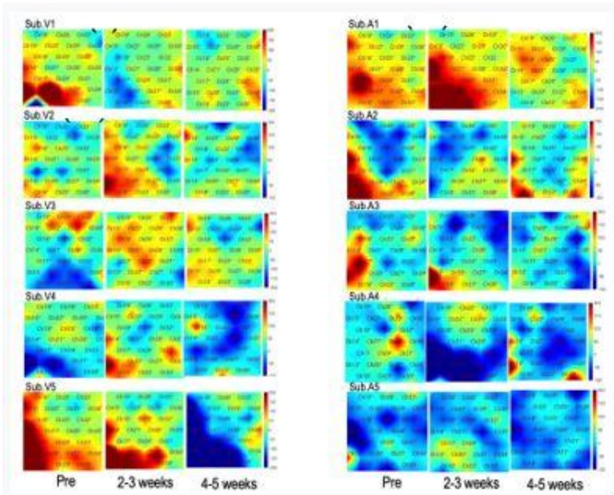


Fig.3 Results of analyzing NIRS signals

## 4 CONCLUSION

Our results suggest that the optimized technique for developing listening skill differs by learners' cognitive dominance. Accurate awareness of phonemes is essential for language learners to achieve high-level listening comprehension. Thus, visual-spatial learners are disadvantaged in the classroom setting. Teachers should know that under the same condition of accurate phonetic recognition training, a certain portion of learners may be disadvantaged due to their cognitive traits. If future experiments confirm the results of this experiment, a listening learning method that is beneficial for visual-spatial learners should be developed. Further studies using techniques that measure cognitive patterns more precisely, such as biosignature analysis, or that have more subjects are necessary.

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