Effectiveness of Analysis with NIRS for Japanese EFL Learners

Rumi Tobita

Life Systemics
Ashikaga Institute of Technology
Tochigi, Japan
email : rtobita@ashitech.ac.jp

Abstract—This study examined the effectiveness of analysis with near-infrared spectroscopy (NIRS) for English as a foreign language (EFL) training from the viewpoint of brain science. The experiment presented in this paper analyzed the amount of blood flow in the brain while learners were training to improve their English conversation skills. The experiment attempts to clarify the preferable combinations of learners' characteristics when teaching English conversation by examining relationships between the brain activities of learners and the different types of training materials. The data suggested that the analysis using NIRS enabled to propose an effective course design for EFL learners.

Keywords-NIRS; brain activities; EFL; English conversation skill; ATI.

I. INTRODUCTION

In the light of the ever increasing globalization and internationalization of our society, the development of English communication skills is considered crucial in Japan. However, it has been noted Japanese students' English skills were declining [1]. Therefore, designing and developing an effective course design to meet ELF goals for acquiring English communication skills has been a critical need. To solve this concern, the present study examined the effectiveness of analysis using NIRS for EFL listening training from the perspective of brain science to propose a well-matched combination of leaners' characteristics and listening training to create an effective course design for EFL learners.

II. INSTRUCTIONAL STRATEGY

In the field of educational technology, Aptitude-Treatment Interaction (ATI) is an important element in planning to develop an effective course design. As ATI's concept and theoretical framework suggest that instructional strategies' effectiveness for individuals depends upon their specific abilities and optimal learning is achieved when the course design matches the learner's aptitude [2]. More suitable training needs to be applied to the less motivated EFL learners [3]. Although the effectiveness of various teaching methods and materials has improved, an assessment based on traditional paper and pencil tests has revealed its limitations [4]. Recently, brain activity has become subject to monitoring by technologically innovative instruments [5]. These technologies provide data that reveals the results of teaching and learning; therefore, these data can be utilized to assess the effectiveness of EFL teaching in Japan.

III. APPLYING NIRS TO COURSE DESIGN

The present study uses NIRS to analyze the amount of blood flow in the brain while learners were learning English. It then examined the relationship between brain activities and learning outcomes to identify the most effective combinations of learners' characteristics and English conversational skills teaching materials.

NIRS is widely recognized as a practical non-invasive optical technique to detect the hemoglobin density dynamics response during functional activation of the cerebral cortex, as shown in Figure 1 (a). The primary application of NIRS to the human body uses the fact that the transmission and absorption of NIR light in human body tissues contains information about changes in hemoglobin concentration. When a specific area of the brain is activated, the localized blood volume in that area quickly changes [6].
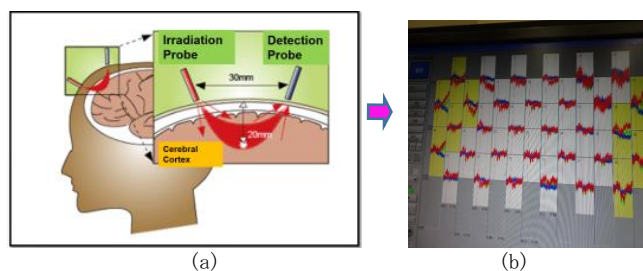

(a)   (b)

Figure 1. (a) Route of near-infrared (modified from Shimadzu)
and (b) Detected Channels : specific area of the brain

The greater the amount of blood flow, the greater the hemoglobin oxygenation increases; measuring the amount of blood can thus indicate the state of brain activation caused by differences among teaching materials, as shown in Figure 1 (b). This experimental technique indicated the well-matched combination of listening materials and training for EFL learners.

IV. ATI BASED EXPEIRMENT USING NIRS

The purpose of this study is to examine the effectiveness of analysis with NIRS by comparing the cerebral parts' activities for the effective course design for EFL learners by proposing the well-matched combination of EFL learners' characteristics and English conversation trainings. To resolve this purpose, ATI based experiment was planned examining the interaction of learners' aptitudes, materials and tasks as Figure 2.

Session 1   (interval: one week)   Session 2

| Rest（1 min.） | | Rest（1 min.） |

Listening Training: using slower speed material （4 min.）
→
Listening Training: using faster speed material (4 min.）

Rest（1 min.）   Rest（1 min.）

COMPREHENSION QUESTION& QUESTIONAR

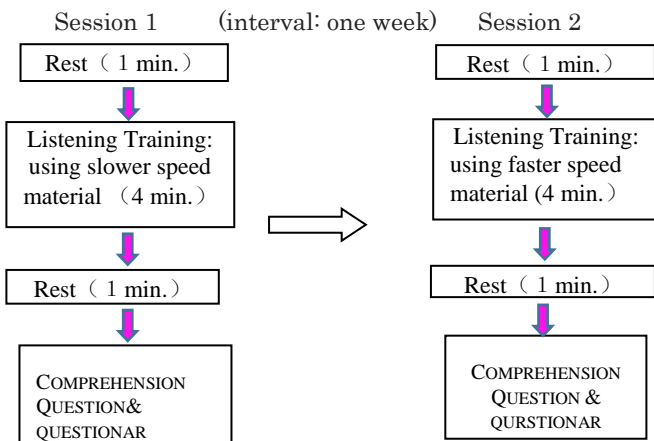COMPREHENSION QUESTION & QURSTIONAR

Figure 2   Experimental Protocol

Twelve participants of this experiment were divided into two groups; group A as higher level of proficiency (5 males) and group B as lower level of proficiency (7 males) assessed by Test of English for International Communication (TOEIC) scores. Each participant took part in two sessions and they were given different listening materials and tasks in each session.

V. RESULTS AND CONCLUDING REMARKS

Comparing the average amount of change per second of Deoxy-Hemoglobin and Oxy-Hemoglobin in each channel during the training (see Figure 3), several significant interactions between learners' characteristics and trainings were found, as shown in TABLE I.

TABLE I. SIGNIFICANT RESULTS

Aptitude: Proficiency	Treatment: Speed of Material	Brain Activation	Average of Quiz Score(/15)
Group A: Higher	Faster	Activate	6
	Slower	Moderate or None	12
Group B: Lower	Faster	Moderate or None	1
	Slower	Moderate	5

In Group A, regardless of their high score of the quiz results, if the material was too easy or not interesting to them, the brain activity was moderate during their listening activity, as shown in Figure 3(a). In contrast, if the material was rather difficult for them, active brain activity was detected, as shown in Figure 3 (b). In Group B, if the task was too difficult, brain activity was similar to Figure 3 (a).
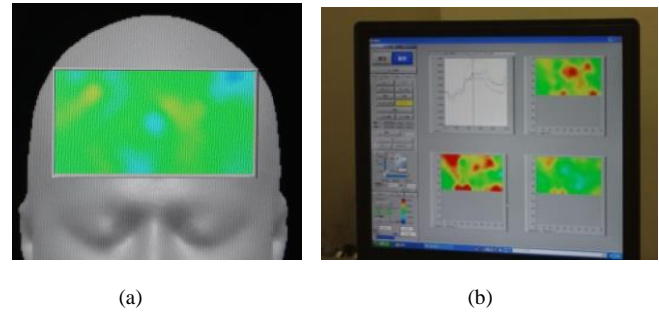

(a)   (b)

Figure 3. Brain Activities : (a) Moderate Activity (b) Active Activiry

These results showed that teachers' ideals are not always enough to create effective training program, and it could be said that using analysis of NIRS for effective course design could be a very useful method.

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