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ERP Study on the Influence of Priming Effect on Semantic Processing of Chinese-Japanese Later Bilingual Learner

Qiang Wei
School of Education
Jianghan University
Wuhan, China

Hua Dong
School of Education
Jianghan University
Wuhan, China

Ming Jin
School of Education
Jianghan University
Wuhan, China

Shuna Fu
School of Education
Jianghan University
Wuhan,China

Qian Yu
School of Education
Jianghan University
Wuhan, China

Yixin Lin
School of Energy and Power Engineering
Huazhong University of Science and Technology
Wuhan, China

***Abstract*—The mechanism of late bilingual semantic switching is an important issue of foreign language learning. The present study discuss the effects of three types priming conditions (Japanese words, Chinese words and meaningless Symbol) on the bilingual language learners during the perceiving and processing steps by using ERP (Event-Related Potentials). ERP components of N200 and N400 show difference by priming types. In conclusion, both repetition priming and cross-language priming have priming effects, in addition, the processing of Japanese vocabulary need Chinese vocabulary as the medium to achieve semantic representation. The results indicate that creating direct connections between Japanese words and the semantic presentations while learning will be more efficient for Chinese Japanese learners.**

Keywords—bilingualism, semantic priming, ERP

I. INTRODUCTION

Bilingual language learning procedure is widely studied, and two of the most popular topics are the storing and presentation system of the languages. The views towards bilingual language storing system are still inconsistent. Koler proved bilingual language are saved independently[1], while the dual-coding model theory holds that the bilingual language speaker save language in the same system. In 1984, Potter M C, So K F, Eckardt B V etc. came up with a concept mediation model, holding that the concepts presentations in different language system are connected [2]. Some researchers believe that two language systems have the same sense presentation. Thus, the priming effect appears when the same sense collections have been activated. The cross-language priming research paradigm is a better method to reflect the cognitive process of bilingual learning in bilingual experimental research. This is because experiments through translation, naming, etc. are based on explicit memory experiments. In this experiment we used the implicit memory-based masking to prime the research paradigm. [4] According to related research, the two ERP (event-related potential) components of N200 and N400 are related to cross-language semantic processing. Jonathan et al. believe that the N200 component is related to the processing of the stimulus. The N200 mainly reflects the cognitive processing process of the morphological form of the vocabulary, while the N400 more reflects the semantic cognitive processing process of the vocabulary N400 is the "semantic correlation potential". The volatility of the N400 reflects the difficulty of the semantic cognitive processing process of the vocabulary. The greater the difficulty of the task, the greater the amplitude generated at 400 ms [5], so it can be used to examine the theory or model associated with semantic initiation and to understand the timing of language processing.

The purpose of the present study is to obtain a better understanding about the semantic processing procedure of the second language for Chinese-Japanese learners. Besides, the method of semantic processing might indicate the learning stage of bilingual language learners, thus, producing a possible new form to assess students' learning effect for language educators. Vocabulary learning is one of the critical parts and most important difficulty in second language (L2) acquisition [6-7]. Teaching the meaning of word was regarded as a general teaching method of L2 vocabulary acquisition, although the essentiality of word form has also been emphasized by a great number of researches [8]. No matter the meaning or the form of word has been proved to be related to the effect of vocabulary representations [9]. Therefore, to explore a new form of foreign language learning has important meaning.

II. EXPERIMENT

A. Participants

Twenty-five undergraduate student from Jianghan University participated as volunteers right-handed, mean age=20.15 years, range 19-21 years). All participants had

normal or corrected-to-normal vision and were free from any health problems and have no history of brain damage. They have passed the Japanese-Language Proficiency Test (JLPT, The Japanese-Language Proficiency Test, is a test for assessing the Japanese level of Japanese and foreign language learners in Japan and abroad.) for level of N3.

B. Stimulus

The experimental materials were 240 word pairs. The first words of each pair were prime words and the second words of each pair were target words. Eighty prime words of them were Japanese pairs, 80 prime words were Chinese (prime words) and Japanese (target words), and 80 symbols were meaningless (prime words) and Japanese. All the words were chosen from the vocabulary range specified by the JTPL. Before the experiment, we recruited freshman from Jianghan University to evaluate the familiarity of the meaning of those selected words on a five-point Likert scale (1=very unfamiliar, 5= very familiar). The results showed that the familiarity among 3 groups was no difference [F=2.46, P=0.088>0.05]. Each group of words is divided into 40 "true words" and 40 "pseudo words". Chinese "pseudo words" and Japanese "pseudo words" consist of one word in the transformed character. Control the rhyme of the "pseudo word" and balance the rhyme of the pseudo word with the rhyme of the target word.

TABLE Ⅰ EXPERIMENT CONDITIONS

conditions	**PJ**	**PC**	**PM**
Prime words	Japanese（いす）	Chinese(唱歌)	meaningless words(@#)
Target words	Japanese（いす）	Japanese(そら)	Japanese(そば)

C. Procedure

There are 80 trials for each condition, for a total of 240 trials in present study. Participants were instructed to judge whether the word was true or pseudo on the presented words, by press the buttons "z", “x" by left hand. Where the "z" means "true word" and "x" means "pseudo word". Each word was randomly presented. In each trial, the gaze point was presented by 50 ms, followed by a 15 ms prime word (eg, “chair”) and then following by a masking stimulus “###” of 200 ms. The target Japanese word were presented by 2000 ms. The participant was required to make a true and pseudo judgment on the vocabulary within the 2000 ms. The experimental program automatically runs into the next trial if there is no response within 2000 ms.

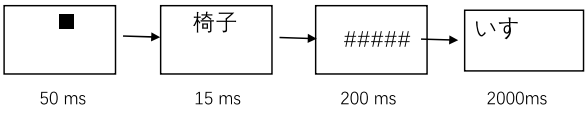

Fig.1 Procedure of behavioral ERP experiment

III. RESULT

A. Result of Behavioral Test

The result of one-factor ANOVA reveals significant difference on reaction time among three different priming conditions. [F(2,10) =44.66, P<0.001]. To figure out the difference between each of two conditions, we played paired t-test. As is shown in table Ⅰ, priming words by Japanese is significant slower than priming by non-meaning words. Besides, priming by Chinese brings significant shorter reaction time than that by meaningless words.

B. Event-related Potential Results the Analysis of ERP Data

As the grand average waveform of FCz shown in Fig.2, we define the negative component at 250-500ms in all conditions as N400. The result of two-factors repeated measurement analysis of variance shows significant main effect of the conditions [F(2,48)=5.28, p=0.008<0.05]. The main effect of electrode is no significant.

TABLE Ⅱ THE REACTION TIME DIFFERENCE (MS) OF THREE CONDITIONS

conditions	**mean±SD**	**t**	***p***
Japanese – non-meaning	-54.32±64.36	-4.13	< 0.001
Japanese – Chinese	61.13±105.86	2.83	< 0.001
Chinese – non-meaning	-115.44±107.12.46	-5.28	< 0.001

C. Analysis of RMS

The RMS of amplitude in P200 and N400 is played to remove the effect of electrode, and the result is shown in Fig.2. We can find out an obvious negative component at 200-260ms in Japanese and Chinese priming conditions, while no such component appears in non-meaning words priming condition. As is stated by the earlier researcher, this component is associated with early recognition and processing of view information. To further find out the difference between Japanese priming and Chinese priming conditions, we also displayed a paired t-test on the latent period of P200 component, and it turns out that it is significant shorter in Japanese priming conditions than that in Chinese priming conditions (t= -3.02, p=.008< 0.05).

D. Analysis by Topographic Mapping

The Root-Mean-Square result (Fig.3) shows more activation from 234 ms to 266 ms in Chinese priming condition at frontal lobe. We regard this period as the font processing procedure, since it takes more time to recognize the font from different language systems. In addition, we can clearly figure out the difference of the variation of energy from 300 ms to 400 ms among three conditions. In Chinese priming condition, the brain is less activated than the Japanese and non-meaning words priming conditions. It takes more power to prime by the second language, and the activation of frontal lobe indicates the semantic processing procedure.

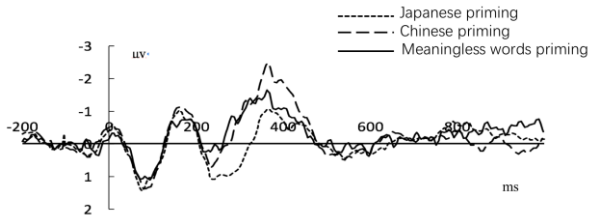

Fig.2 Grand average wave in different conditions at FCz channel

IV. Discussion

In our study, we regard Japanese priming by Japanese as repeated priming paradigm, while Japanese priming by Chinese is regarded as translated priming paradigm. Compared to non-meaning words priming, in which the meaning of priming words has no relation to the meaning of target words, Japanese and Chinese words priming conditions bring significant priming effects. The differences among the three types of priming are revealed in the behavioral results. The significant shorter RT in Japanese priming than in non-meaning words priming can help us define the existence of repeated priming effect, and the significant shorter RT in Chinese priming can define the existence of cross-linguistic priming effect. However, the asymmetry of cross-linguistic priming effect is also discovered by other researchers [10]. It is proved that priming by first language is significant quicker than priming by the second language [11]. As the behavioral result shows, the RT in Chinese priming is significant shorter than in Japanese priming conditions. This might be attributed to the lack of proficiency on Japanese, and the subjects need to translate Japanese into Chinese as medium to prime. The ERP results have also confirm the priming effect in both repeated priming and cross-linguistic priming. In addition, the analysis of N400 shows that cross-linguistic priming apparently involves more efforts than repeated priming method. It means that bilingual language learners tend to translate an unfamiliar language into what they are familiar with to understand the words, though this processing procedure might be painstaking and time-consuming. The evidence showed that both the translation equivalents and shared concept would be activated effectively even though under masked priming conditions [12]. Thus, building direct connections between languages and semantic presentation might be helpful for the bilingual language learners.

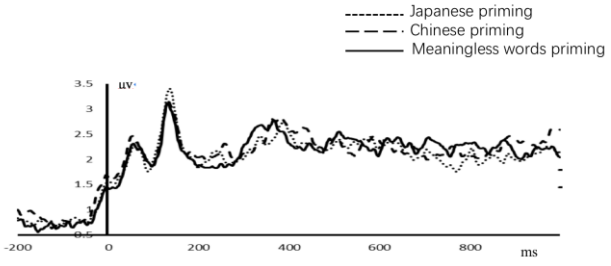

Fig.3 Root Mean Square value of all EEG channels in different conditions

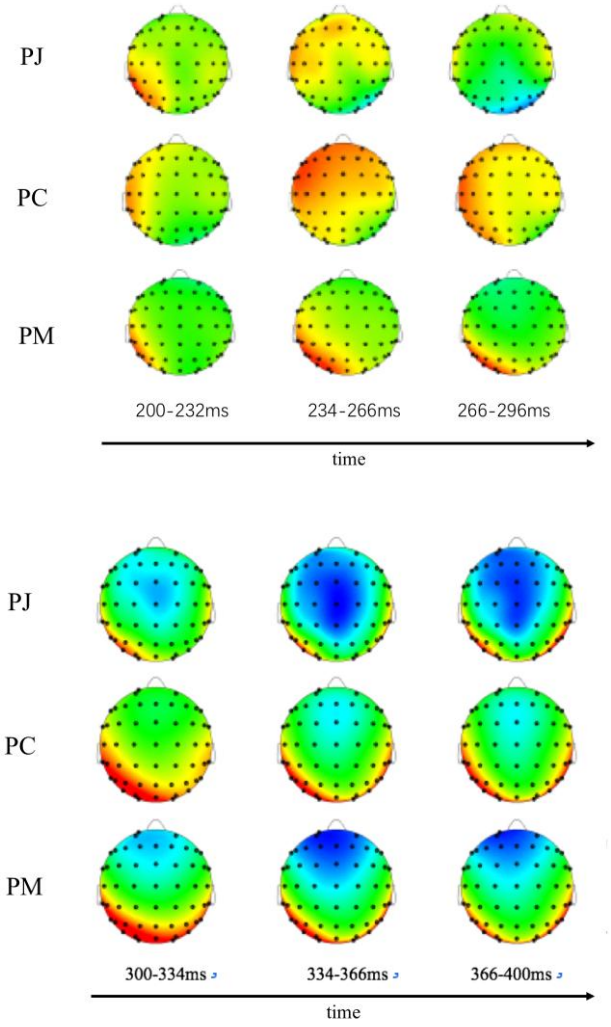

Fig.4 Topographic map at 200-400ms in three types of priming conditions: priming by Japanese words (PJ), priming by Chinese words (PC), priming by meaningless words (PM)

V. Conclusion

The experimental results show that the repeated of Japanese vocabulary helps Japanese learners to judge the semantics of Japanese vocabulary. The presentation of Chinese vocabulary also promotes the judgment of Japanese vocabulary, and the effect is better. In addition, Japanese learners in China often use the semantics of Chinese vocabulary as a medium to help judge the semantics of Japanese vocabulary when processing Japanese vocabulary, and accordingly, the reaction time increase. This judging method can also be attributed to the lack of proficiency in Japanese. In that case, strengthening the connections between Japanese words and its Chinese meaning can shorten the "translation" time. However, the most effective way of bilingual language learning will be cutting the "translation" procedure to form the semantic presentation directly.

In addition, for Chinese Japanese learners, when judging Japanese vocabulary and Chinese vocabulary, they first process the glyphs and then process the semantics. Thus, emphasizing the writing of Japanese vocabulary is also helpful in the teaching procedures.

Through the research results, we suspect that learners may use the mother tongue as a medium to encode the new language by means of "translation" to achieve learning.

However, The result of present study recommend that educators use the characteristics and laws of student learning and use the foreign language (L2) as the medium of learning (rather than the learner's native language) to carry out learning activities. Such a teaching arrangement can reduce the errors generated by two languages during the conversion process, and is more conducive to the students to understand the new language. The L2 vocabulary is used as a starting point to connect the new vocabulary to establish the L2 vocabulary and concept system.

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