BRAIN MECHANISM OF JAPANESE LANGUAGE LEARNERS IN PSYCHOLOGICAL EPIPHANY PROCESS: AN ANALYSIS BASED ON ELECTROENCEPHALOGRAM TEST

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Abstract

Psychological epiphany is an important topic in brain neuroscience. However, there is little report on the brain mechanism in psychological epiphany process of Japanese learning. Drawing on heuristic theory, this paper carries out an electroencephalogram (EEG) experiment of Japanese language teaching. The experiment consists of three phases, namely, pre-test, learning and post-test. Based on the measured EEG data, the author analyzed the brain mechanism in the preparatory phase, problem-raising phase and the mastery phase of Japanese language learning. The results show that, in the preparatory phase before the experiment, archetype inspiration helps the neural network to process, integrate and fuse the information, thus solving the issues arising in Japanese language learning; in this phase, negative deflection is common in the event related potentials (ERP) of the brain under the presence of psychological epiphany, but not common in the absence of psychological epiphany; the negative components of ERP, originating from the anterior cingulate gyrus, enhance the efficiency Japanese language learning and solve issues of psychological epiphany, through the suppression of irrelevant thoughts and promotion of the acquisition of key information.

Key words: Psychological Epiphany, Preparatory Phase, Brain Mechanism, Difference Wave.

INTRODUCTION

In the history of human sciences, “psychological epiphany” has been basically recognized by the scientific community as a unique way for addressing scientific issues involved in this field (Subramaniam, Kounios, Parrish et al, 2014; Nakagawa, Fujimura, Okuyama et al, 2009).

In the study of “psychological epiphany”, scientists have discovered that subjects own or have acquired the knowledge relevant to issues in the preparatory phase, which will be able to facilitate the resolution of psychological epiphany issues (Butterfield, 2004; Sultana, Perluigi, & Butterfield, 2006; Abidargham & Laruelle, 2005). Regardless of whether the "psychological epiphany" emerges consciously or unconsciously, any form of preparatory phase promotes the generation of psychological epiphany (Tangpong, Cole, Sultana et al, 2007; Mills, Dong, Wang et al, 2010). Study finds that the preparatory phase includes two dimensions, i.e. the brain preparations before the issues are seen; long-term cognition process from the occurrence of issues to adaptive learning, up to the moment when the issues get resolved based on the archetype heuristic theory. As for the preparation of this process (Lichtneckert & Reichert, 2005; Nakagawa, Manley, Gean et al, 2011), there are still much less involvements in the studies (Annuinziata, 2003).

This study traces the preparatory phase for the resolution of issues and analyzes how the Japanese language inspiration is subjected to various phases under the brain preparation...
conditions and what’s the cerebral mechanism in this process with a study case, for example, the word-guessing game of Japanese education, by an experiment (Aleshin, Zeng, Bourenkov et al., 1998; Pappius, 1991). It is of great significance for future study on the internal mechanism and cognitive process of human brain.

EXPERIMENT METHOD

Experimental materials

200 anagrams used in Japanese language education are sampled as experimental materials. The conundrum is controlled within 20 Japanese syllables in length. One commonly used Japanese word is used as the answer and the riddle appears randomly. The volunteers who are all students learning Japanese language, have no mental disorder by health examinations, participate in the experiment. They should screen data generated for statistical analysis in order to ensure the data availability.

Experiment procedure

This experiment is mainly divided into three phases, namely, test 1, learning and test 2, the test process is shown in Fig. 1. Before the question appears, “Ready” will be displayed to prompt the subjects to prepare in advance, that is, Ready 1; if the question is answered wrongly or if subjects do not know the answer, “+” will be displayed, reminding them that the system is about to enter the learning phase, that is, Ready 2; After the learning phase, the "+" will be displayed again, prompting them to answer the original question again, that is, Ready 3.

EEG record and analysis

The ERP system is used for recording and analysis, when continuous records are completed, data will be processed offline (Maki & Dumas, 2009; Dejda, Seaborn, Bourgault et al., 2011; Qiu, Li, Luo et al, 2006). Here the ERP triggered by the preparatory phase before the question is presented is analyzed. Regardless of right or wrong answers to the questions, EEGs of different preparation types, for example, the above three, are superimposed (Johnston & Silverstein, 1985; Naskar, Sood, Goyal et al, 2011). On the premise of whether the subjects resolve the relevant issues after the re-test, the EEGs are divided into the two phases, i.e. "preparation with psychological epiphany" and "preparation without psychological epiphany". Choose electrode position for each preparation phase and then perform the factor variance analysis with analysis factors including the type of preparatory phases and electrode point (Rosenberg, 2017; Ashkan, Rogers, Bergman et al, 2017).

ANALYSIS OF RESULTS

Behavior results

We can learn from acquired data that the mean value of right answers that can be provided in the first round of test is 15, which shows psychological epiphany has not yet emerged in this phase. There are 144 questions that subjects should attempt to answer, but fail. Therefore, the remaining questions they should answer in the second round of test is 1,611, that is, entering the last process for statistical analysis. The average number of questions needed to be answered by each subject is 124, while the average comprehension rate of the subjects reaches 89%. When the raised question appears once more, the average number of right answers provided by the subjects is 69±15%; the average response time is 1866±421ms; the average number of unsettled questions within the required time is 56±20.

In the retest, we should set up a process, that is, after the subject determines the answer and before the right answer is displayed, their

Figure 1. Riddle rendering process of test-study-test
experiences are evaluated as strong, general, or impassible types. Perform statistical analysis of settled issues (with psychological epiphany) and unsettled issues (without psychological epiphany). The results show that there are significant differences between subjects with and without psychological epiphany. The average score of those with psychological epiphany is 1.31±0.26, while those without psychological epiphany is 1.68±0.31, t=−6.1, p<.001, which suggests there is a certain differential and effect in the cases of psychological epiphany and none.

 **ERP data analysis**

 **Ready 1**

In the case of Ready 1, the subject never received any hint, that is, there is no task relevant stimulus. It is derived from the difference wave curve (see Fig. 2~3) that as for the right (with psychological epiphany) and wrong (without psychological epiphany) answers they come out in the second round of test, N1 and P1 and other early components can be triggered in the early stages of the first preparation for answers. However, the main effect of the task type does not emerge obviously. Afterward, within the range of 900~1500 ms, the “preparation with psychological epiphany (correct answer)” leads to more negative ERP deflection than ”preparation without psychological epiphany (correct answer)”. Divide 900~1500ms into 6 windows, i.e. 900~1000, 1000~1100, 1100~1200, 1200~1300, 1300~1400, 1400~1500, respectively. The average amplitude factor is repeatedly measured by ANOVA with the results as shown in Table 1.

It can be seen from the results of variance analysis that the main effect does not reach a significance level within the range of 900-1000ms of preparation type, but does within the following range of 1000-1500ms. It is suggested that there is a less of negative ERP deflection triggered by preparation with psychological epiphany than without psychological epiphany. In addition, the main effect of the electrode position is also very significant within the range of 1000~1500 ms. But adversely, the interaction of electrode position with preparation types is not obvious at all windows.

**Table 1. Analysis of average wave amplitude between 900ms and 1500ms**

| Times(m/s) | Electrode position | Preparation type | Preparation type=Electrode position |
|-----------|--------------------|------------------|-------------------------------------|
|           | F | P  | F  | P  | F  | P  |
| 900~1000  | 2.677 | ns  | 2.827 | ns  | .651 | ns  |
| 1000~1100 | 3.041 | .05 | 5.86 | .032 | .917 | ns  |
| 1100~1200 | 3.1  | .043 | 7.657 | .017 | .807 | ns  |
| 1200~1300 | 3.823 | .027 | 5.655 | .035 | .895 | ns  |
| 1300~1400 | 3.605 | .029 | 7.852 | .016 | .582 | ns  |
| 1400~1500 | 3.305 | .032 | 7.486 | .018 | .754 | ns  |

**Figure 2. Difference wave 1 (psychological epiphany and no psychological epiphany)**

**Figure 3. Difference wave 2 (psychological epiphany and no psychological epiphany)**
Table 2. Analysis of average wave amplitude 150~850ms and 950~1500ms

| Times(ms) | Electrode position | Preparation type | Preparation type+Electrode position |
|----------|--------------------|------------------|------------------------------------|
| 150~300  | 2.677              | ns               | .001                               |
| 300~750  | 4.071              | .005             | 15.132                             |
| 750~850  | 4.271              | .003             | 6.184                              |
| 950~1100 | 4.15               | .004             | 11.033                             |
| 1100~1500| 6.731              | .000             | 12.794                             |

Ready 2
This phase is such that subjects fail to solve the issues in the first round of attempt, and thus require learning resolution to issues as mentioned in previous phase. It is the brain preparation for Japanese language learning. According to the difference wave curve (see Fig. 4~7), it can be found that in the early of preparatory phase, whether there is psychological epiphany (the second answer is correct) and no psychological epiphany (the second answer is wrong) N1 and P1 and other early component can emerge. Afterwards, within the range of 150-850ms and 950-1500ms, the “preparation without psychological epiphany” triggers less of negative ERP deflection than the “preparation with psychological epiphany”. Divide 150~850ms and 950~1500ms into five windows, i.e. 150~300, 300~750, 750~850, 950~1100, and 1100~1500, respectively. The factor repetitive measures analysis of variance is performed for the average wave amplitude at the five windows, as shown in Table 2.

Figure 4. Difference wave 3 (psychological epiphany and no psychological epiphany)

From variance analysis results, it turns out that the main effects of the preparation type in the range of 150-850ms and 950-1500ms can reach significant levels, which suggests that in

Figure 5. Difference wave 4 (psychological epiphany and no psychological epiphany)

Figure 6. Difference wave 5 (psychological epiphany and no psychological epiphany)
Table 3. Analysis of average wave amplitude 350~1500ms

| Times(ms)  | Electrode position | Preparation type | Preparation type×Electrode position |
|-----------|---------------------|------------------|-------------------------------------|
|           | F       | P       | F       | P       | F       | P       |
| 350~700   | 1.346   | ns      | .881    | ns      | 1.501   | ns      |
| 700~900   | 1.324   | ns      | .931    | ns      | .905    | ns      |
| 900~1500  | 2.919   | .026    | .026    | ns      | 1.093   | ns      |

Figure 7. Difference wave 6 (psychological epiphany and no psychological epiphany)

Ready 3
This phase is such that subjects learn the resolutions to original questions and prepare to answer them at the second attempt. According to the difference wave curve, it is clear that in the early time of this phase, N1 and P1 and other early components can be triggered for correct answer (with psychological epiphany) and the wrong answer (without psychological epiphany) in the second round of test, but throughout the course, ERPs, whether there is an psychological epiphany and no psychological epiphany, have no significant distinction. We made statistics according to 3 windows as divided above, i.e. 350~700ms, 700~900ms, 900~1500ms, respectively, the factor repetitive measures analysis of variance is conducted for its average amplitude, see Table 3.

As shown in Table 3, the main effect of the preparation is not obvious in the range of 350~1500. It is suggested that before preparing for the second time to resolve the issues, there is an insignificant distinction between the cases where psychological epiphany emerges or not.

DISCUSSION
The “test-learn-test” experiment is cited hereof to analyze what’s the preparations of the coupling between psychology and brain under different stimuli in various phases, from the first occurrence of issues in Japanese language learning, the handling the issues in the course of learning, to the solution of the issues. This process will be divided three types of preparations, i.e. three preparatory phases respectively before all relevant stimuli appear; before learning the answers from the time when they have answered wrongly in the first place; before making the second answers after learning. Additionally, according to the final answers given by subjects, these preparatory phases can be classified: the "preparatory phase with psychological epiphany" that corresponds to right answers and "preparatory phase without psychological epiphany" that corresponds to wrong answers. The differential wave curve in both cases is plotted to explore the cranial nerve mechanisms under various preparatory states.

First, for Ready 1, that is, the brain preparations in the case when the task relevant stimuli have not occurred. Before the first test, the psychological preparations of subjects should be similar to each other. However, experiment shows that within 1500ms before the first question is presented, the "preparations without and with psychological epiphany" can all trigger early components such as N1 and P1 in the early stage, but the main effect of preparation type is not obviously. In the range of 1000 ~ 1500ms, “preparation without psychological epiphany” have less negative ERP deflection than the “preparation with psychological epiphany”.

In the experiment design, archetype inspiration also plays a certain role in solving issues in Japanese language learning, mainly manifested as the information treatment, integration and connection, that is, to associate and integrate the information about current issues with key heuristic information in archetype anagrams. Assume that in the early stage of preparation, neural network that acts on different information linkage and integrates cognitive processing can be activated in advance, it will facilitate the learning and acquisition and integration of information about issues in the next step.
Next, for Ready 2, that is, after the failure to settle the issues at the first attempt, it is required to go to the process before learning phase for preparation. Comparing and analyzing the difference waves of the preparations “without psychological epiphany” and “with psychological epiphany”, negative ERP deflection triggered by the former is less than by the latter within 1500ms, 150~850ms and 950~1500ms before the archetype issue occurs, mainly activating the forehead. It is found by further analysis that the negative components generated mainly concentrate on the cingulate anterior cingulate (AAC), which suggests that in the preparatory phase before the psychological epiphany, AAC has played a very important role. It may involve in cognitive supervision whose mechanism can inhibit irrelevant thinking and become a prerequisite for focusing attention on the learning of archetype issues. It can encourage the subject to acquire more information about archetypes to a greater extent. In addition, important factors for improving the archetype learning efficiency include the choice and transformation of strategies required to address the issues since there are multiple types of information in the archetype issues, many of which are useless for the solution to these issues. Only the heuristic information therein is the key to solving the problems, so that the supervision over this information can affect the acquisition of key heuristic information. AAC also plays an important role in breaking the mindset since the learning phase can be accessed after the second preparation. However, during the first test, the subjects have acquired certain information about archetype issues, formed a certain thinking model before the learning that produces an impact on the solution of the issues. If the thinking set will be able to broken and relevant brain areas to be activated before learning of archetype, the archetype learning efficiency will be improved to facilitate the resolution of psychological epiphany issues.

CONCLUSION

This paper analyzes the difference wave curves in the cases when there is psychological epiphany or no psychological epiphany in the preparatory phase by the "test-learn-test" three-phase experiment to probe into subject’s neural mechanism of the cerebral preparation under different stimuli at different phases.

In the preparatory phase before the test, archetype inspiration plays a certain role in solving issues in Japanese language learning, mainly manifested as the information treatment, integration and connection. Assume that in the early preparatory phase, neural network that acts on different information linkage and integrates cognitive processing can be activated in advance, which will facilitate the learning, acquisition and integration of issue relevant information in the next steps.

In the preparatory phase for the archetype learning of the brain, there is more negative ERP deflection caused by psychological epiphany than by non-psychological epiphany, and the negative component mainly lies in the anterior cingulate gyrus which has played a very important role in this phase, including the inhibition of irrelevant thinking, intervening the acquisition of key heuristic information, breaking the mindset, in order to improve the efficiency of archetype learning, and facilitate the solution of the psychological epiphany issues.

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