Analysis and Brain Mechanism of English Learning Characteristics of College Students Considering Self-Efficacy Regulation

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ABSTRACT

In order to explore the relationship between the level of self-efficacy regulation and the physiological response of brain cognition mechanism, this paper studied the ERP and brain inhibitory effect of the self-efficacy regulation level of college students to English vocabulary stimulus from the perspective of cognitive neurology. The purpose of this study is to help college students master English learning methods based on the consideration of Self-efficacy regulation, regulate self-cognition, emotions, and learning activities more systematically, to further improve the effectiveness of English learning. Two groups of college students with low and high self-efficacy regulation ability are selected as experimental subjects and the GO/NO-GO paradigm of biological vocabulary and non-biological vocabulary is selected as the stimulus. The EGG/ERP produced by Neuroscan Company is selected as the brain electrical testing instrument to measure the brain electricity event potentials of N2 and P3 and the digital processing and analysis are conducted on the measurement results. The experimental results show that students with high self-efficacy regulation ability have better response inhibition control ability.

Key Words: Self-efficacy Regulation, College English, Brain Event Potential, Brain Mechanism, Inhibition Control

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Introduction

The English learning of college students is not only related to objective factors such as learning methods, study skills, and learning tools, but college students themselves, as the subjects of learning, play a decisive role in English learning process. Self-efficacy regulation is the cognition of students for their learning state and the self-regulating learning process based on the environment their own conditions (Hsu *et al*., 2007). Self-efficacy regulation is the manifestation of the main subjective feature in college students' English learning. Through self-efficacy adjustment, college students can actively adjust their learning motivation and better perform stimulus-behavior result-strengthening English learning in different learning environment (Yi and Hwang, 2003).

Self-efficacy is the current research focus on educational psychology. Through studies on the characteristics of self-efficacy regulation at different ages and the impact of self-efficacy on English learning, the study on self-efficacy and English learning has achieved many research results from the horizontal and vertical perspectives (Zachariae *et al*., 2003). The self-regulation measurement and research based on motivational subscales, volitional subscales, and strategic subscales have provided basis for the measurement of self-efficacy level at different ages. However, the relationship between the physiological differences of difference of self-efficacy regulation level, the brain mechanism cognition and neuroscience remains to be studied (Dishman *et al*., 2004).

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In order to conduct deeper exploration of the relationship between brain mechanism and self-efficacy regulation, this article conducted a comparative experimental study on the relationship between the two by using the brain event potential signal test. Firstly, this paper summarized the related theoretical basis of the self-efficacy regulation and the Go-No-go mechanism of brain electrical mechanism, and the potential signals N2 and P3 of EEG events were analyzed (Kübler *et al*., 2009). Through the comprehensive settings of experimental subjects, experimental materials, experimental procedures and experimental analysis, a brain mechanism research considering self-efficacy regulation was conducted and the analysis of experimental results was completed through data processing and effective statistics. The results of this research showed that the higher the self-efficacy regulation ability, the better the students' ability to reflect inhibition (Towey, 1994). The paper further validates the effective role of self-efficacy regulation in college students' English learning from the physiological perspective of brain neurological cognition, which has a certain guiding role in the guidance of colleges and universities to implement more reasonable and scientific English learning.

Self-efficacy learning

Overview of self-efficacy learning

The concept of self-regulated learning originated from the 1970s. Studies have shown that learners will spontaneously control their behaviors, emotions, thoughts, and wills in order to achieve certain learning goals, and the regulation their self-behavior, emotions, thoughts, and wills manifested in this process are called self-efficacy regulation. The self-efficacy regulation is mainly reflected in "self"-myself and "automatic"-automatic. The subjective regulation of individuals include many factors that affect their learning, such as participation, perception, action, interaction and thinking (Ghergulescu *et al*., 2014).

The theory of self-efficacy regulation learning can be divided into the following five theoretical foundations:

(1) Operational Theory
Operationalism theory believes that as long as learners have a connection with the environment, the intervention guidance can have advantages. The stimulating-behavior-result-strengthening approach belongs to the nature of operational behavioral perspective. The self-monitoring, self-enhancement and self-guidance are completed in the self-regulation process. Most of the self-regulated learning is closely linked with the environment under the guidance of the operational theory and obtains support and reward through the combination with social expectations (Chien and Chen, 2017).

(2) Phenomenological Theory
The phenomenological theory was founded in the mid-1990s, whose view originated from determinism and behavioral natural orientation theory. The phenomenological theory believes that the "student-centered" approach should be followed in the learning process and that each student has the potential achieve improvement and self-development, fully exerting his subjective initiative.

Phenomenological theory attaches great importance to the internal experience of students or the role of self-perception in self-regulated learning, which points out that in the process of education, teachers use socially recognized methods of education to improve the external environment of students' learning and can effectively help students eliminate inferiority, doubts and other uncertainties, thus effectively building self-confidence. However, this theory ignores the effect of the external environment on self-regulated learning (Heng and Mansor, 2010).

(3) Will Theory
Will theory holds that will is the determinant in self-efficacy regulation. The will manifested in the series of psychological processes of choice, decision, and execution emphasized the learners themselves to play the role as the behavior subject and the executor of the activities. In addition, some scholars believe that will theory is related to metacognition and can indirectly promote students' advantages in management strategies of learning tasks (Yamamoto, 2012).

(4) Social cognitive theory
This theory is based on the theory of social learning, emphasizing the influence of social environment on learners, and believes that under the influence of social environment, learners can improve their learning ability through imitation, self-efficacy, and self-enhancement.

Social cognitive theory believes that learners can receive the influence from parents, peers, and teachers in the growing environment, which have a decisive influence on their self-efficacy.

(5) The theory of verbal self-guidance
Self-directed theory emphasizes that learners themselves are the key of self-efficacy improvement and believes that language plays an important role in self-efficacy regulation. Through the three stages of social speech, self-centered speech, and internal speech, the socially interacted verbal guidance and reaction can be realized. A whole set of verbal training programs and reading comprehension teaching procedures is used to develop students' self-regulated learning ability.

Development status of self-efficacy regulated learning

(1) Foreign studies
Foreign scholars apply self-efficacy learning to different fields of study, such as medical and nursing learning, and physical education. The levels of self-efficacy adjustment are grouped by motivational subscales, volitional subscales, and strategic subscales. Through the implementation of functional scales and motivational strategic learning scales, effective index predictions are made on the use of students' cognitive strategies, the use of metacognitive strategies, and academic efforts and planning.

(2) Domestic studies
There are many dimensions of self-efficacy regulation, and each dimension also changes with age. In addition, there is a significant relationship between self-efficacy regulation ability and learner's academic performance, schools' overall performance, and teachers' overall evaluation. There is significant difference between excellent and unsuccessful students. Self-efficacy regulation has been widely recognized for its importance to learning based on the support of various theories and researches at home and abroad. The study based on self-efficacy regulation and brain mechanism can open up new areas of self-efficacy research and provide scientific guidance for the improvement of English learning.

Go/No-go tasks

Self-efficacy learning and Go/No-go tasks

An important aspect of self-efficacy learning is the self-monitoring ability, and monitoring ability is related to inhibitory control capability. Inhibitory control capability is a process that inhibit irrelevant or disturbing stimulus and impulsion and has certain evolutionary significance. The Go/No-go task is one of the main ways of behavioral response control inhibition. Therefore, the Go/No-go task is used as a stimulus in this paper (Rubia *et al*., 2001).

Go/No-go tasks typically include two forms of stimulus: high frequency stimulus such as "equilateral triangle" or letter "B" and low frequency stimulus such as "inverted triangle" or letter "D". Go/No-go tasks respond to high-frequency stimulus but does not respond to low-frequency stimulatus (Kawashima *et al*., 2001).

In the Go/No-go paradigm, the frequency of stimulus (the ratio of high-frequency and low-frequency stimulus), the presentation of stimulus, and the requirements of the response (for example, some subjects are required conduct button response to stimulus, and some are required to conduct loosening button reaction to No-go stimulus), the presentation mode of the paradigm and the type of stimulus all affect specific experimental process. However, the cognitive processes and inhibitory processes examined in a task with different forms are all consistent, which requires that the individual does not make reaction, namely the inhibitory control of the reaction (Simmonds *et al*., 2008).

Brain mechanism study of Go/No-go tasks

The Go/No-go task activates the left side of the exercise aid, the frontal gyrus and the anterior cingulate. The brain electricity event potential ERP technique is used to select No-go N2 and No-go P3 as the measurement objects to analyze the inhibition process in the No-go experiment (Simmonds *et al*., 2012).

(1) N2
N2 is a negative potential, a negative wave within 150-400 ms after the onset of the stimulus. Among them, the stimulus can be letter stimulus and LED stimulus. Through many experiments, the plastic negative components are tested in neurological tests. And in many experiments, the negative N2 components are greater in the No-go experiment compared with the Go experiment, indicating that the inhibition process of the stimulus response is more easily to occur in the No-go implementation.

(2) P3
P3 is a positive potential and its manifestation is roughly a positive wave in the 300-600ms range. P3 is more a manifestation of the inhibition mechanism, and the amplitude of the forehead P3 is larger in the No-go experiment. The maximum of P3 appears at the center of the parietal bone under the Go condition. However, in other experiments, P3 is also detected in the No-go experiment (Ciesielski *et al*., 2004).

Experimental study on the brain mechanism of self-efficacy regulation

EEG experiments are conducted in the same paradigm to explore different feedbacks on the brain electrophysiological mechanisms of students with different levels of self-efficacy. The ability to conduct inhibitory control is studied through the Go/No-go paradigm. The experimental indicators are No-go N2 and No-go P3. N2 is the negative component that appears in the frontal area and P3 is the positive component that appears in the frontal center. The experimental hypothesis is that students with high level of self-efficacy can have stronger control and inhibitory ability on stimulus and interference, and thus have larger No-goN2 and No-goP3 in terms of test indicators.

Experimental methods

(1) Experimental Subjects
13 college students with high self-efficacy regulation ability were selected, referred to as high group, and 13 college students with low self-efficacy regulation ability were selected, referred to as low group. There were 6 males and 7 females in the high group; and there were 7 males and 6 females in the low group. The experimental subjects had no history of mental illness. Before the experiment, the experimental procedure was described and the experimental subjects participated in the experiment in a relaxed state.

(2) Experimental materials
English words were selected as the stimulus. English vocabularies were divided into two categories: 30 biological vocabularies and 30 non-biological vocabularies and there was no significant difference in familiarity, vocabulary stroke, and word frequency between these two vocabularies.

(3) Experimental procedure
The experimental program was shown in Fig. 1. The clues were firstly presented for 500ms and the clues were biology; a specific English vocabulary appeared at random intervals of 400-600ms, such as the biological vocabulary "penguin" or the non-biological vocabulary "ocean" shown in Figure 1. The Go paradigm experiment was performed in the biological vocabulary group, and the No-go paradigm experiment was performed in the non-biological vocabulary group. The vocabulary stimulus lasted for 800ms. The next set of vocabulary experiment was conducted after an interval of 500 ms.

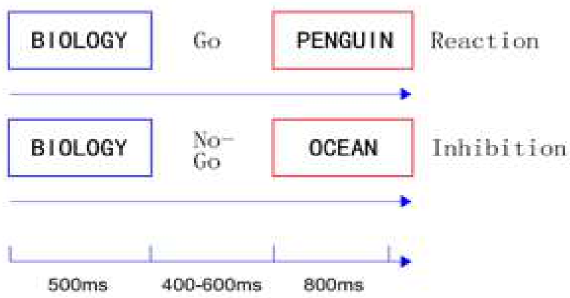


Figure 1. The procedure of the experiment

(4) EEG record
The EEG recording instrument was the EGG/ERP system produced by the Neuroscan. The electrode distribution was as shown in Figure 2 in line with the international standard. The scalp resistance was 5KΩ; the sampling rate was 1000Hz; and the analog filter bandpass was 0.15~100Hz.

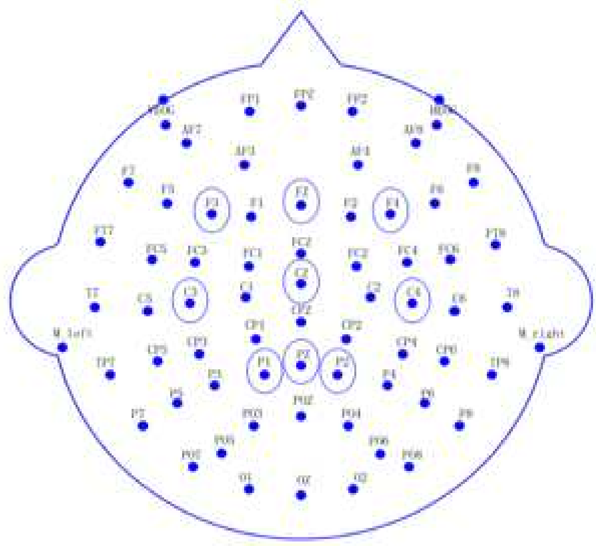


Figure 2. The electroencephalogram recording electrode map

(5) Data processing and statistics methods
Through the process of signal segmentation, baseline correction, and artifact removal processing, and the potential signal of the brain electrical event after superposition. The F3, FZ, F4, C3, CZ, C4, P1, PZ, and P2 electrodes in the electroencephalogram record were selected for the statistical analysis of peak latency and mean amplitude over the time window of 200-400 ms and 400-650 ms.

Analysis of brain mechanism physiological data
(1) N2 amplitude
Table 1 shows the average and standard deviation of the N2 amplitudes in different experiments.

Table 1. Experimental average N2 wave average and standard deviation for different experimental missions

Experimental task	Average (μv)	Standard deviation(μv)
Go	1.856	0.926
No-Go	-0.299	0.966

It can be seen from the table that the experimental tasks showed significant main effects, including material differences between FZ and CZ, between F4 and CZ ($p<0.05$), and between C3 and P1 ($p<0.01$).

Table 2. N2 amplitude average and standard deviation of different electrodes

Location of the electrodes	Average (μv)	Standard deviation(μv)
F3	1.879	1.003
FZ	1.287	0.888
F4	0.854	1.038
C3	0.542	0.939
CZ	0.683	1.067
C4	0.195	0.964
P1	0.692	1.035
PZ	1.879	1.000
P2	2.105	0.934

The experimental tasks showed the same significant difference as the wave amplitude during the incubation period. The main effect of electrode factor was significant, with $F(8,192)=10.127$ and $p<0.01$. Also, there was a significant difference in the incubation period between P2 Go and No-go tasks, with $F(1,24)=12.179$, M_{go}=249ms, SD_{go}=10ms, $M_{no\text{-}go}$=296ms, and $SD_{no\text{-}go}$=13ms.

(2) P3 amplitude
Table 3 and Table 4 display the experimental data of P3 waveform amplitudes and the distribution at different electrodes.

There was a significant difference in P3 amplitude in the high and low self-efficacy adjustment group, and the amplitude of P3 in the high self-efficacy adjustment group was higher than that in the low self-efficacy adjustment group.

Table 3. Experimental average P3 wave average and standard deviation for different experimental objects

Experimental task	Average (μv)	Standard deviation (μv)
High self-regulatory group	12.667	1.132
Low self-regulatory group	7.832	1.131

Table 4. P3 amplitude average and standard deviation of different electrodes

Location of the electrodes	Average (μv)	Standard deviation (μv)
F3	11.804	0.891
FZ	11.320	0.927
F4	11.780	1.092
C3	9.567	0.866
CZ	7.915	1.206
C4	8.676	1.065
P1	7.442	1.001
PZ	11.872	0.868
P2	11.676	0.844

(3) Time-correlated potential ERP waveform and topographic map
Figure 3 shows the ERP waveform of electrode point F3. The solid line represents the waveform result of the Go paradigm experiment, and the blue solid line represents the waveform result of the No-go paradigm experiment. The time window was chosen between -100 and 700 ms.

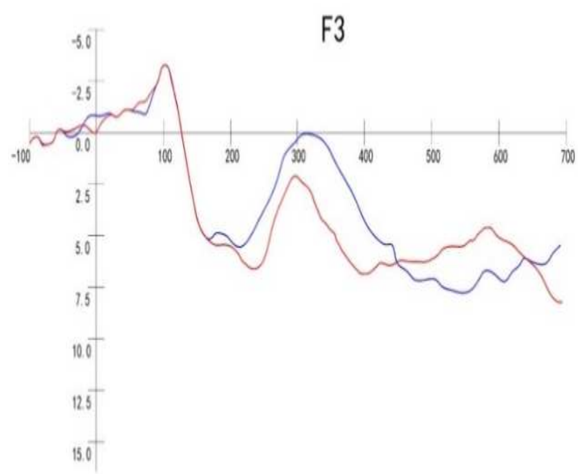
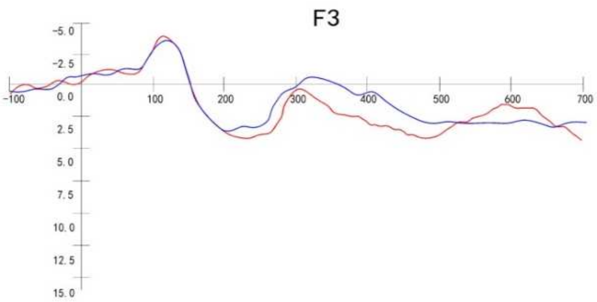


Figure 3. (a) F3 High self-regulatory group



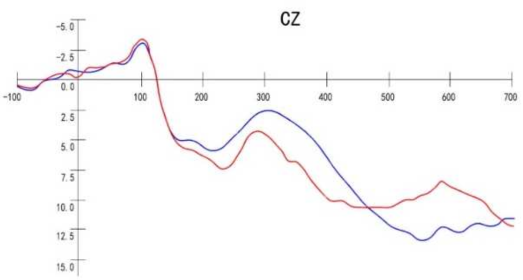
(b) F3 Low self-regulatory group

Figure 3. The ERP waveform diagram of F3

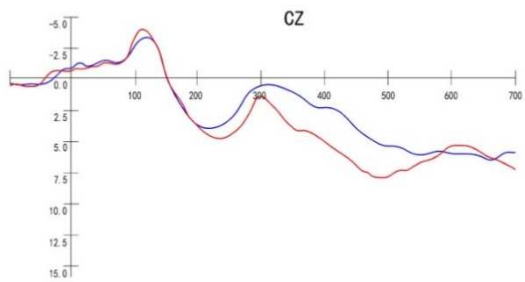
Figure 4 shows the ERP waveform of the test point CZ.

From the significant results of the ERP waveform map, we can see that they are consistent with the statistical results of amplitude and incubation period. The overall wave amplitude development trend of the P3 waveform in the high self-efficacy adjustment group was higher than that in the low self-efficacy adjustment group. In different paradigm test conditions, the amplitudes of No-goN2 were all larger than that of GoN2. Figure 5 shows a brain map.

It can be seen from Figure 5 that the maximum amplitude of N2 was at P1, and that of F3 was at 530ms of the brain map. Also, the maximum amplitude of P3 appeared at F3. Therefore, there is a difference in N2 and P3 between high and low self-efficacy groups.



(a) CZ High self-regulatory group



(b) CZ Low self-regulatory group

Figure 4. The ERP waveform diagram of CZ

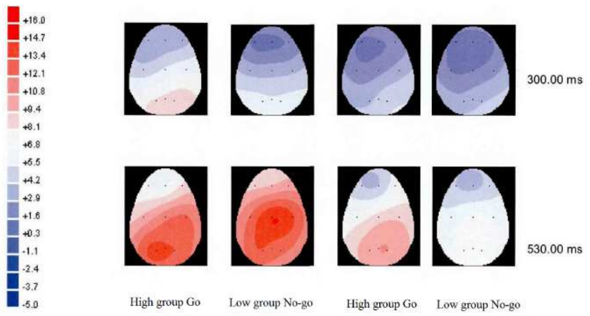


Figure 5. The Brain mapping

(4) Experimental discussion

The indicators used in this ERP experiment study were No-go N2 and No-go P3 and both components showed an increasing trend during the experiment, which reflected the inhibition process. The latency and amplitude of N2 were significantly different in the Go/No-go task. It could also be seen from the topographic map that the amplitude of intragroup P3 with strong self-regulation ability in the No-go test was larger than that in the Go test. From the location of the brain region, the maximum amplitude of N2 occurred in the occipital lobe and the maximum amplitude of P3 occurred in the frontal area. It could be seen from the experimental results and analysis that the experimental prediction was valid, namely that students with strong self-efficacy ability had stronger control and inhibition ability towards stimulus and interference and there were larger No-goN2 and No-goP3 on the test indicators.

Conclusions

By measuring the event potential signal of human brain under different types of stimulus, this paper analyzes the internal relationship between the level of self-efficacy regulation of college students' English learning and the brain mechanism from the perspective of neurology. Based on the elaboration and analysis of relevant theoretical techniques, comparative experiments are conducted. The mean and standard deviation of the amplitude and latency of ERP signals, the waveforms and topographic maps EPR were recorded and analyzed. The main research significance and conclusions of this paper are as follows:

(1) Self-efficacy regulation ability plays a key role in college students' English learning.

(2) The analysis of ERP signal results shows that the higher the self-efficacy regulation ability, the stronger the inhibitory ability towards external stimulus and interference. From the perspective of cranial nerves, it is verified that the

higher the self-efficacy regulation ability, the stronger the anti-interference ability in learning.

(3) The study of college English learning combining the brain mechanism and self-efficacy regulation plays an important role in the guidance the sustainable development of college English.

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