Best Teaching Strategies of English Vocabulary Based on Cognitive Neuroscience

Ye Wei

ABSTRACT

With the development of the times, the continuous deepening of new curriculum reform, and gradual popularity of English teaching, disparities in the regional economy and education spread in China, and thus there appear various problems in the teaching process, especially English vocabulary teaching. Word, as the basic unit of language, is one of the three major elements of language, which plays a major role in the realization of the communicative function of language. Most students use the way of memorizing English words by their root but have no effective way to remember English words. This paper discusses the relationship between cognitive neuroscience and English vocabulary memory, and studies the information source entropy characteristics of EEG signals under different states of vocabulary memorization. This method provides a new idea and tool for the determination of the relationship between cognitive neuroscience and the effectiveness of English vocabulary teaching, and seeks more ways, more organizational forms and methodological strategies so as to help students better memorize vocabulary so that it has broad prospects for development in English teaching.

Key Words: Cognitive Neuroscience, Teaching Strategies, English Vocabulary, Brain Evoked Potential

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Introduction

In the current stage of English teaching, something ridiculous is often found in students' books. The words are filled with dense Chinese characters for the students to memorize (Nilson, 2012). It can be seen that there are still a lot of deficiencies in China's English teaching. With the continuous improvement of teaching methods, our students still use the memory techniques that we have used to memorize English words, which makes us worried. With the continuous development of social economy, the world is getting closer and people pay more attention to learning English. Therefore, in order to enable students to truly understand how to communicate by using English words, teachers need to constantly explore teaching methods in their own classrooms so that students can memorize words more easily and effectively (Lehmann *et al*., 2013). Researches on cognitive psychology, psycholinguistics, artificial intelligence, and artificial neural networks which are core branch subjects of cognitive science have made important progresses, but many difficulties have arisen in the respective research fields, which needs to explore answers in the cognitive activity mechanism in the human brain (Hwang *et al*., 2016). Neuropsychology is to study psychology from the perspective of neuroscience. It has established a quantitative relationship between human perception, memory, speech, thought, intelligence, behavior, and the functional structure of the brain. It has become an interdisciplinary subject between psychology and neuroscience by integrating research results of neuroanatomy, neurophysiology, neuropharmacology, neurochemistry, neurology, experimental psychology and clinical psychology (All *et al*., 2016). As an active exploration of English teaching and research, this paper hopes to facilitate

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students' English learning through the research subject "Research on the Best Teaching Strategies of English Vocabulary Based on Cognitive Neuroscience". At the same time, the author hopes to deepen the English teaching atmosphere and improve English teaching quality in the school by virtue of carrying out the research subject (Sung *et al*., 2016).

Methods

Research object

Subjects are included in accordance with the following standards: (a) subjects have undergone English vocabulary memory imaginative training and experiments before this experiment and learned about brain-computer interface experimental procedures; (b) subjects have normal intelligence; (c) subjects have no history of nervous disease or mental disease; (d) subjects have no brain injury; (f) test scores of subjects in English word memory questionnaire are ≥25 points.

In this study, a total of 3 male healthy subjects who meet the standards voluntarily participate in the experiment, with age ranging from 22 to 23 years old, and all of them are university students.

Experimental design

Based on the basic pronunciation rules of the English words, teaching contents that meet the laws of students' physical and mental development have been developed. "Development of contents" which is not limited to English textbooks but dependent on the current English textbooks, may be teaching contents that students can learn through their own efforts, or that requires hands-on experiences. The development of all word teaching contents will seek not to increase students' academic burden but to focus on cultivating students' interest in English learning so as to improve their English literacy.

The Oddball experimental model refers to the continuous alternate presentations of two or more stimuli, and the probabilities of their presentations are significantly different.

Standard stimuli—large probability

Deviant stimuli—small probability

The subjects are asked to react to the deviant stimuli, so the deviant stimuli are called target or target stimuli.

Classical experimental model for inducing ERP components such as P300, MMN is related to the probability of stimulation.

The design of visual stimuli guidance is shown in Figure 1. The commonly used method of black and white checkerboard overturn stimulation is used to stimulate the visual sense to evoke potentials. At the same time, English vocabulary memory guidance action pictures are superimposed on the graph. In this paper, the superimposed actions are hand-to-hand English vocabulary memory actions.

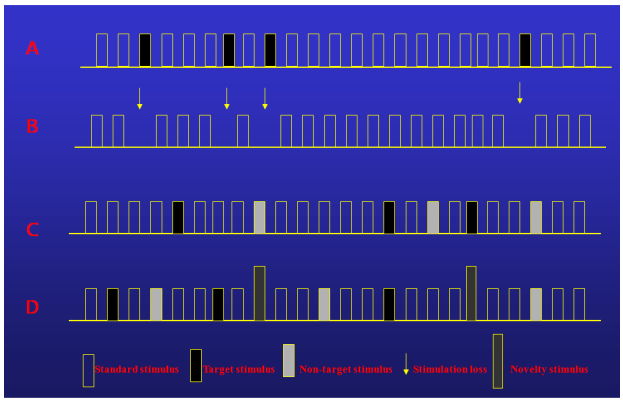

Figure 1. Classic paradigm 1—Oddball signal structure

Transient VEP and visual stimuli are lock-time synchronization, and the transient VEP signal can be detected accurately by properly designing the timing relationship of the target stimuli (Willingham *et al*., 2015). Therefore, the transient VEP is used as the control signal in this paper. To distinguish the visual evoked potentials caused by different stimuli, the starting moments of the stimulating targets must be different. Thus, the same-frequency compound stimuli method is used to design the graphic stimulus module starting flickering in order. And the flickering frequency and duration are ensured to be consistent so that the target stimulus flicker can be distinguished in timing sequence as shown in Figure 2. In order to avoid interference, the flickering modules of other target stimuli have already started to flicker for the first time before the second flicker of the first flicker module starts. The flickering frequency and duration of the stimulating targets are consistent, so they will produce the same evoked potentials. And according to the strict lock-time relationship between the stimulating targets and the evoked potentials, the VEP by the corresponding stimulating targets can be identified.

This paper adopts the cross-path delay response experimental model to clarify the brain mechanism of attention and non-attention conversion, and puts forward a new concept of

"plasticity of attention filter". Then it studies the attention of visual space in different scopes and clarifies the early adjustment mechanism of visual search. Through the latest technology combining with ERP and fMRI, it reveals the brain activity and neural mechanisms of advanced thinking such as language, imagination, insight, and counting. In this article, the stimulation frequency is set to be 3Hz, which is not likely to cause visual fatigue. In order to avoid disturbance of English vocabulary memory superimposed on the stimulus graph on the visual evoked stimuli, the frequency of the English vocabulary memory guidance action is set as one-third of the frequency of the graph stimulating frequency, namely 1 Hz.

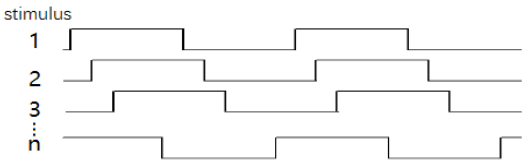

Figure 2. Synchronous frequency synergy stimulation timing sequence

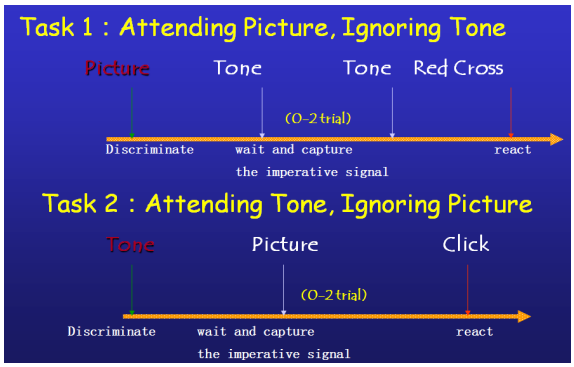

Figure 3. Experimental procedure of cross-path delay response paradigm

The experiment records the brain evoked potential signal of English vocabulary memory for 100 times, and the experimental data is preprocessed and segmented to eliminate obvious abnormal data.

Data collection

In brain neurology, English vocabulary memory is to convert human brain wave to α or θ wave. According to scientific researches, human brain consists of 14 billion nerve cells and 10 times of colloid cells. Brain cells continuously emit energy and superfine current pulsation while constantly scanning and receiving signals inside and outside the body to form wave, which is also called "brain wave" (Barrow *et al.*, 2016). Different brain waves play a different role in regulating humans' mind and body. At present, the International Brain Wave Association has divided brain waves into four types: β wave, α wave, θ wave and δ wave according to different vibration frequencies.

The frequency of β wave is 14 Hz (the number of vibrations within 1 second). When people are awake, β wave is the dominant brain wave. In this state, people's physical and mental energy is consuming very much and quickly fell tired. Without adequate rest, it is very easy to accumulate pressure (this is a common problem for modern people). At this time, the English vocabulary memory is the worst.

The frequency of α wave is 8-14 Hz when the people are conscious but the body is relaxed. Modern science believes that α wave is the best brain wave state for people to learn and think. It provides a bridge between consciousness and sub-consciousness. The frequency of θ wave is 4-8 Hz when people's consciousness is interrupted and the body is deeply relaxed. In this state, the critical or moral filtering mechanism is buried because of the interruption of consciousness, opening the door of the soul and presenting a hyper-suggestibility on the information from the outside world. This is a high-level state of mind, which is often called "quiet" state.

The frequency of δ wave is 0.4-4 Hz. It is a state of deep sleep and unconsciousness. According to scientific researches, δ wave is also the key to developing human's intuitionistic radar system and super mysterious power. δ sleep is a dreamless and deep sleep state, and a normal night's sleep cycle occurs four to five times, Brain evoked potential acquisition experiment with mixed BCI as following figure 4.

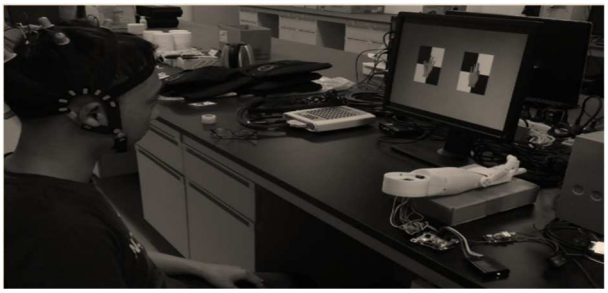

Figure 4. Brain evoked potential acquisition experiment with mixed BCI

Brain evoked potential feature extraction by transient visual sense

Wavelet analysis is an analysis method of time (space) frequency localization. It performs multi-scale analysis of the signal through telescopic

translation operation to achieve a high time resolution of the high frequency part of the signal and a high frequency resolution of the low frequency part. It meets signal analysis of adaptive time frequency to analyze any details of the signal as much as possible.

The basic definition of wavelet transform is obtained after basic wavelet function Ψ(t) has a displacement of τ, and gets inner product with signal x(t) at different scales. It can be expressed by the following formula (1):

$$WT_x(a,\tau)=\frac{1}{\overline{a}}\int_{-\infty}^{+\infty}x(t)\psi^*(\frac{t-\tau}{a})dt, \quad (1)$$

The equivalent frequency domain expression (2) is:

$$WT_x(a,\tau)=\frac{\overline{a}}{2\pi}\int_{-\infty}^{+\infty}x(\omega)\psi^*(a\omega)e^{-j\omega\tau}\,\mathrm{d}\,\omega, \quad (2)$$

Where x(t) and Ψ(t) are both square integrable functions, and x(ω) and Ψ(ω) are Fourier transforms corresponding to x(t) and Ψ(t). The basic wavelet function satisfies the following conditions:

$$\int_{-\infty}^{+\infty}\psi(t)dt=0 \quad (3)$$

$$C_\psi=R\int\frac{\psi(\omega^2)}{\omega}d\omega<\infty \quad (4)$$

The wavelet function waveform is featured in oscillating and rapidly attenuating without periodicity.

The inverse transformation formula (5) of the wavelet transform is:

$$x(t)=\frac{1}{C_\psi}\int_{-\infty}^{+\infty}\frac{da}{a^2}\int_{-\infty}^{+\infty}WT_x(a,\tau)\psi(a,\tau)tdt \quad (5)$$

By transforming the two parameters of scale factor τ and displacement factor a, the continuous wavelet transform can analyze the signal with different resolutions in the time-frequency domain to realize ergodic signal. Among them, the scale factor is the position of the window in the frequency domain and can also affect the shape of the window; the displacement factor is the position of the window in the time domain, and analyzes signals in different time frames.

It is not difficult to convert β wave into α wave at all. As long as a person closes his eyes and breathes gently for about 3 to 5 minutes, the brain wave will be dominated by α wave. It is not difficult to make the brain wave enter into a frequency dominated by α wave, but it is technically difficult to make the brain wave stabilize at the frequency of α or θ waves. In particular, it is technically difficult to deal with the problems when people enter hypnosis (Li *et al.*, 2013).

Results

The teaching of English words is part of every English class. If students simply follow the teacher to read the words repeatedly, it is difficult to truly grasp the pronunciation of the words. The brain evoked potential signal collected in this paper is the signal evoked by transient visual sense. When related preprocessing is conducted, the brain evoked potential signal needs to be segmented and preprocessed according to the corresponding frequency based on the visual stimulation superposition frequency and the word memory frequency. In this paper, the sampling rate of brain evoked potential signal is 200Hz and the transient VEP is selected as the control signal with 3 Hz transient visual evoked stimulation frequency. The brain evoked potential signal is segmented and preprocessed by 300ms. The event-related synchronized or desynchronized feature signals of English vocabulary memory imagination guided by visual sense are used as the rehabilitation English vocabulary memory control signals. The English vocabulary memory imagination guidance action frequency is 1 Hz and the brain evoked potential signal is preprocessed by 900ms, stimulus interval as shown in figure 5.

The brain evoked potential signal segmentation evoked by transient visual sense is used as a selection control signal for classification and identification; visually guided event-related synchronized or desynchronized feature signals of English vocabulary memory are used as rehabilitation English vocabulary memory control signals for classification and identification. This paper uses 20 groups of brain evoked potential signal evoked by transient visual sense as test sample, and chooses C3 and C4 lead with a total of 40 samples for visual gaze, left and right hand classification and identification.

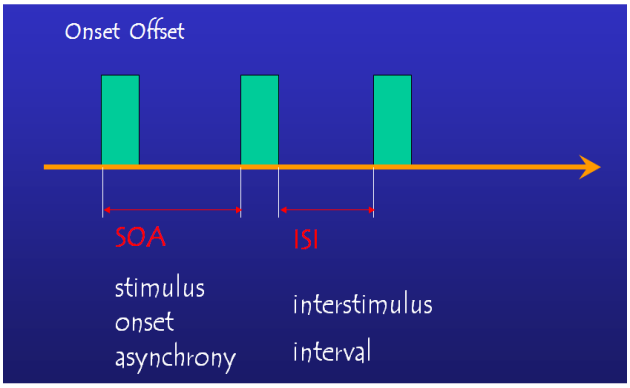

Figure 5. Stimulus interval

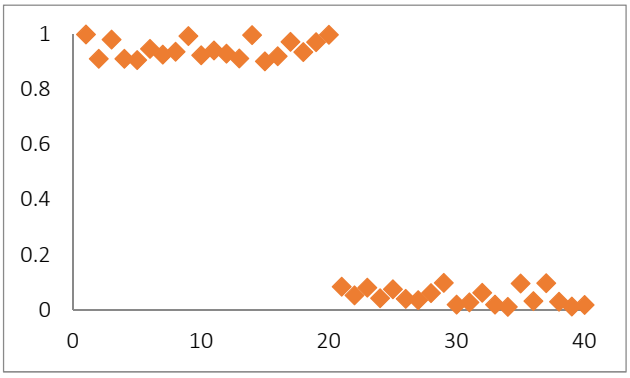

Figure 6. BP network identification results of transient VEP test samples

Figure 6 shows the results of the test samples. The target samples are visual stimuli of English vocabulary memory when gazing at the left hand. In the figure, the target samples are the first 20 samples, and the latter 20 samples are non-target samples (looking at visual stimuli in English vocabulary memory).

Conclusions

This research focuses on the guidance of vocabulary learning in the classroom and emphasizes the method to teach words which is universal but lacks pertinence and creativity. The ultimate goal of learning is to allow students to learnself-regulation and to learn lauguages in their best state so as to achieve the best teaching effect of English vocabulary and promote the overall improvement of classroom teaching. Researches on cognitive psychology, psycholinguistics, artificial intelligence, and artificial neural networks which are core branch subjects of cognitive science have made important progresses, but many difficulties have arisen in the respective research fields, which needs to explore answers in the cognitive activity mechanism in the human brain. The application of brain evoked potential in English teaching and scientific research is still very limited and the application of brain evoked potential in English teaching and scientific research has not yet been seen in China. Therefore, the work in this field requires more efforts by English teaching workers to make brain evoked potential applied in English teaching practice as early as possible so as to provide better help for teachers and students.

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