ERP Feature of Vigilance

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Abstract: With the accelerated pace of life, fatigue has become a major factor affecting human health. But not a good way to monitor human fatigue. The results of studies to monitor brain waves of people to provide a new method of fatigue. ERP is a major method of brain wave studies, the paper with the subject in three fatigue analysis and comparison of the three states of ERP components.

Introduction

In the early stages of vigilance, blink frequency, the impedance of skin, body temperature and blood pressure and other physiological signals was used to estimate the vigilance. Ergonomics research shows that, when a person is in a state of high alert, and palm skin impedance will decrease, and when people are in a state of fatigue, skin resistance will rise. In the study of Ji et al [1], through the accurate positioning of the face, mouth, nose, eyes, eyes closed, closing time, blink frequency, nodding frequency, face towards, gaze direction and mouth opening degree and other features of vigilance on human research. In fact, people start to study exemplary in the nineteen fifties [2-4], at first, the study starts from sleep problems, and the main difference between waking and sleep research in two different conditions. With the further research, people from wakefulness to sleep is composed of several stages, the analysis of these stages which features becomes the focus of the study; until now, with the expansion of the scope of the study, the traditional from consciousness to further subdivide the sleep state between, which clearly put forward the vigilance.

ERP can observe brain activity in the process of the window; it was found that the ERP component is closely related to many and cognitive process. For example: CNV slow potential components of British neurophysiologist Walter report (contingent negative variation), is closely related with the human to look forward to, preparation, action time orientation, pay attention to mental activity; Sutton proposed P300 is composition of ERP and attention, recognition, decision-making, memory and other cognitive function related to the Kutas&Hillyard first proposed N400 promoted; the brain mechanism of human language processing and understanding. According to the basic characteristic of vigilance, determine which cognitive function including attention, memory, motivation, emotion, cognitive functions such as language, control, ERP experimental analysis.

EEG experiment collected using the analytical tools of ERP components analysis of EEG features under a state of alert, in order to determine the state of alert subjects EEG feature.

EEG acquisition

The EEG data used in this paper is come from BCI Laboratory of Jiangxi University of Technology; the subjects to relax in a quiet shielding room sat an armless chair in front of the computer, watching the screen, do EEG experiment according to experiment the arrangement and the indication screen stimulation. EEG acquisition is the use of 40 Neuroscan amplifier, were obtained by scan4.3 software, right mastoid is reference electrode, and used 1000Hz as sampling rate, band acquisition using 200Hz low-pass, high-pass 0.05Hz and 50Hz notch.

P300 was discovered by Sutton in 1965, its main feature is a forward wave event in about 300 milliseconds, endogenous components mainly and psychological factors related, its physical meaning is mainly reflected in the latency of the subjects of stimuli or classification required time, amplitude said reflected background or memory updates. So the alert analysis can use P300;

EEG is composed by various band waves, the frequency can be divided into $\delta, \vartheta, \alpha, \beta$. The δ, θ is slow wave, occurs mainly in adults sleep; and α, β is fast wave, occurs mainly in people is vigilant and pay attention external stimulus or when the special mental activity.

In this paper, electroencephalogram EEG selected 10 college students as subjects, including five subjects in the morning to do the experiment, five participants did the experiment in the afternoon (not a nap), The stimulus pattern : first, the screen is a second black state, then will randomly appear in a picture, the picture shows 250 milliseconds, then a second black screen, then will randomly appear in a picture, before the experiment, participants will be asked to write tests in a picture number.

Data processing

The ERP components analysis step is:

Step 1, Block larger drift EEG: in EEG acquisition process, such as the subjects movement, wander, outside sound effects, the EEG signal initial there will be large drift, will follow the EEG signal processing impact, so in the EEG before treatment, to remove this a part of the brain electrical signal;

Step 2, Ocular artifact reduction: the EEG signal in the original, because to blink or look right and left, the impact on the eye electric signal, so before feature extraction and classification, to remove the impact of this part, this paper is mainly to remove the vertical eye film;

Step 3, epoch the data, view the stimulus intervals, and generally 10%-20%, -50, is the common value of -100; the spirit of not more than one event to the principle, in this paper, the interception of data in -100~900ms.

Step 4, baseline correction: the segmented data many not at baseline, so this paper conducted a total of two times the baseline correction and a linear correction.

Step 5, artifact reject: EEG signals collected by the class, there is a part of segmented data caused by various reasons is not good, not only for data analysis useless, it will affect the analysis of the data, so to choose a certain window screening, the window is -80~80.

Step 6, average: This article mainly is ERP analysis of EEG signals, so the same stimulation of the brain electrical signal types were stacked.

Results and analysis

We first filtered EEG signals, the collected signal is the 0.05Hz-200Hz signal between the EEGsignal frequency, this study focused on 2Hz-45Hz, a filter can be described as follows:

$$y(n) = b(1) * x(n) + b(2) * x(n-1) + \ldots + \mathrm{b(nb+1) * x(n - nb)}$$
$$\mathrm{- a(2) * y(n-1) - \ldots - a(na+1) * y(n - na)}$$

Where n-1 is the filter order, Na order feedback filter, Nb filter order is positive.
The filter in the time domain sampling rate according to the following equation:

$$y(m) = b(1)x(m) + z_1(m-1)$$
$$z_1(m) = b(2)x(m) + z_2(m-1) - a(2)y(m)$$
$$\begin{matrix} . & & . & & . \\ . & = & . & + & . \\ . & & . & & . \end{matrix}$$
$$z_{n-2}(m) = b(n-1)x(m) + z_{n-1}(m-1) - a(n-1)y(m)$$
$$z_{n-1}(m) = b(n)x(m) - a(n)y(m)$$

The transfer function of the input and output filter can be defined as:

$$Y(z) = \frac{b(1) + b(2)z^{-1} + \ldots + b(nb+1)z^{-nb}}{1 + a(2)z^{-1} + \ldots + a(na+1)z^{-na}} X(z)$$

When the EEG signal is filtered by the filter, can be seen from Figure 1 enhanced EEG.

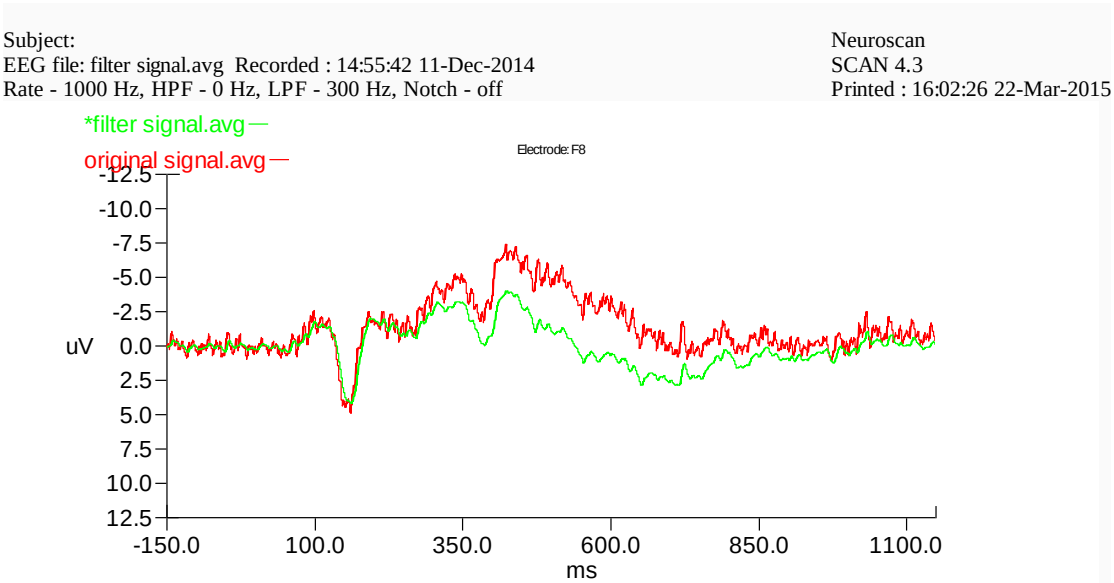

Fig. 1 The comparison between before and after filtering

As shown in Figure 2, the EEG signal comparison of three different fatiguestate, can be seen from figure ERP component to distinguish the EEG signals

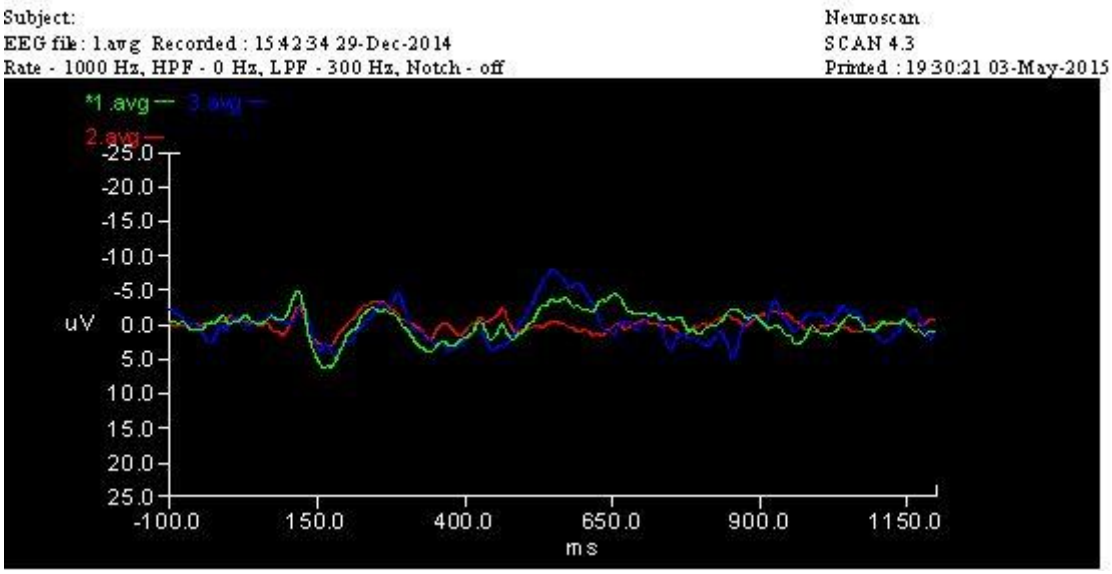

Fig. 2 The EEG signal comparison of three different fatiguestate

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