Sub-health Screening Management of Employees Based on Brain Evoked Potential Analysis

Zhenyao Ma

ABSTRACT

The difficulty in concentrating attention is one of the clinical manifestations of sub-health status. In order to use the event-related potentials (ERP) technology to reveal the health status of employees, this study selects a classic clinical experimental paradigm continuous operation test. Brain evoked potential experiment is adopted to examine the changes in attention in electrophysiological indicators under different conditions and behavioral indicators such as reaction time are comprehensively analyzed. The results show that the Brain evoked potential indicator and behavioral indicator under single and dual task have different degrees of difference. In particular, the amplitude of P300 in Brain evoked potential is significantly different, which can represent the changes of attention objectively and sensitively. It can be seen that the detection means of sub-health status of employees can use the reaction time and Brain evoked potential as a supplement to objective physiological indicators.

Key Words: Sub-health of Employees, Management of Employees, Experiment Research, Brain Evoked Potential Analysis

DOI Number: 10.14704/nq.2018.16.5.1359 **NeuroQuantology 2018; 16(5):801-805**

Introduction

ERPs can be interpreted as: changes in Brain evoked potential when a certain stimulus is applied or removed in a part of the sensory system or the brain, or changes of potentials in the brain area in the presence of a certain psychological factor (Van Bommel *et al*., 2014). ERP is caused by the electrical activity of a large number of neure caused by stimuli events. The ERP by brain processing (brain mechanism) is the result of combined action of many factors (Dong *et al*., 2013). That ERP is different under different conditions shows that the brain processing is different; but if the ERP is the same under different conditions, it may be a stimulus event that causes a lot of information processing in the brain. However, the strength or direction changes of the neure cancel out with each other and the recorded ERP does not change, so it does not indicate that the brain mechanism is the same (Hu, 2013). Brain evoked potential signal varies depending on the position of the scalp, so the subject is required to wear an electrode cap in collection of ERP. The location of the electrode on the electrode cap to record scalp discharge is set according to the 10-20 international Brain evoked potential recording system (Zeng *et al*., 2013).

As for the ICI questions that P300 reflects on specific cognitive processes, the hypothesis proposed by Donchin based on their experimental results is widely supported by researches of psychophysiology.

The incubation period of P300 is prolonged with the difficulty of the task increasing, so the incubation period may reflect the time required for the evaluation or classification of the stimulus (Lu *et al*., 2013); The amplitude of P300 is inversely related to the stimulation probability (stimulation probability is small and amplitude of P300 is high), so it can be

Corresponding author: Zhenyao Ma
Address: School of Economic and Management, Zhoukou Normal University, Zhoukou 466001, China
e-mail ✉ zhenyaoma2011@aliyun.com
Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.
Received: 28 March 2017; **Accepted:** 4 May 2018

inferred that the amplitude of P300 may reflect the update of background or working memory representation, or that P300 is related to template matching (Meng *et al*., 2013). Some researchers have pointed out that P300 may be related to the completion of processing.

Concomitant negative wave CNV is one of the components discovered in ERP components earlier by Walter and Coope. The relevant research results have been published in Nature. Concomitant negative wave reflects a comprehensive mental preparation state in stress or emergency, which is related to psychological factors such as expectation, conation, motivation, attention, arousal and orientating reaction (Run *et al*., 2014).

Wei Jinghan *et al.,* put forward the hypothesis of CNV's psychological load increase, believing that CNV reflects an increase in psychological load when the task is completed. From the nature of psychological factors, this psychological load consists of expectation, orientating reaction, attention, motivation and other factors (Yao *et al*., 2013).

For the problem that the subjective self-rating scale of employees' sub-health may fraud and the problem of sub-health diagnosis: how to determine when there is no clear disease information and no organic changes, this paper adopts cognitive neuroscience approach to explore employees' sub-health rating issues based on the concept of "non-subjectiveness". The amplitude of P300 in the Brain evoked potential indicator can objectively and sensitively show the changes in attention (Yu *et al*., 2013). The incubation period of CNV can reflect the preparation of attention resources for the completion of the task, that is, the Brain evoked potential indicator can objectively represent rensity of attention in "brain" work (Zhang, 2013). From the perspective of brain load (cognitive load), this research result provides an effective and non-subjective ERP screening indicator for the key problem of the sub-health management of employees, "how to diagnose when there is no clear disease information and no organic changes?"

Methods

This experiment chooses to manipulate the memory load through experiments so as to affect the concentration of attention of the homologous subjects. The purpose of this experiment is to use the design of the subjects to easily find the subjects, as well as to use a small number of subjects to obtain a large amount of experimental data. The selected subjects are graduate students at Southwest Jiaotong University, including six boys and six girls with the age ranging from 24 to 27 years old. All subjects are selected from healthy people with no various diseases. All of them had normal vision and right-handedness. They did not participate in Brain evoked potential experiments before and each will obtain 100 yuan test fee. Brain evoked potential signals are collected by an electroencephalograph and a 64-lead electroencephalography cap from BP Company in Germany. Electrodes are placed according to the 10-20 international system and reference electrodes are mastoids on both sides of the head.

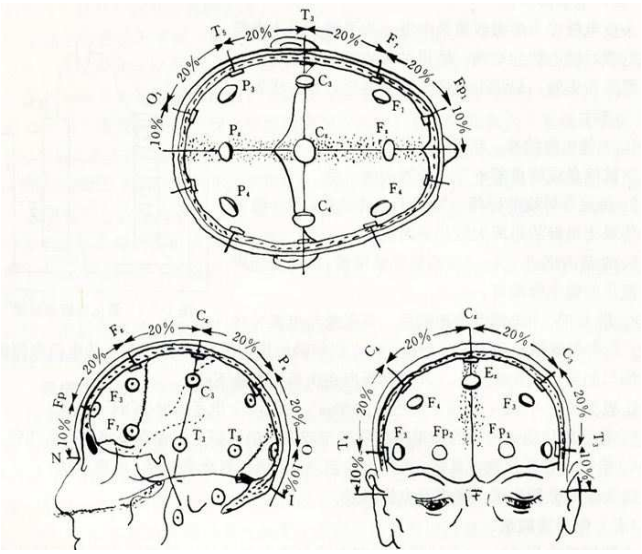

Figure 1. 0-20 International Brain evoked potential recording system potential location

The procedure used in the experiment was compiled by E-prime software. The type of experiment is subject experiment. The experimental process mainly includes the single task and the dual task. The single task is only the CPI task while the dual task is to add the N-back task to the single task. CPT task is taken as a single task. First, a random string of numbers appears in the center of the screen and a number appears one time. If you see the number 0, you need to pay attention to whether the following number is odd number. If it is an odd number, press the "f" key and will not react for the even number. The stimulus presentation time is 200ms. The number 0 and odd numbers account for 25% and it is the same with the number 0 and even numbers. Other background numbers make up 50% with a total of

128 pairs. Dual task is to add N-back task to the single task. The sequence of the stimulus presented on the screen is: a prompt for N value appears, telling the subjects the location of the letters that need to be remembered; then, the CPT task appears and the presentation way is exactly the same as that in the single task; after that, a letter appears in the center of the screen, and the subjects are required to judge whether the letter is the one that they need to remember. If yes, press the "f" key, if not, press the "j" key. The value of N in the dual task is 1, 2, and 3. The presentation time of letters is 500ms, the presentation time of number is still 200ms, and the interval between stimuli is 1500ms.

Results and discussion

Behavioral data results

The key reaction results of the subjects are collated. Details are shown in Table 1.

Table 1. Key reaction results in experiment

Number	Task	Hit	Correct negation	False	Missing	Total
1	Single	50	148	2	0	200
2	Single	47	151	2	0	200
3	Single	28	97	3	0	128
4	Single	26	95	7	0	128
5	Single	33	91	4	0	128
6	Single	36	92	0	0	128
7	Single	28	100	0	0	128
8	Single	32	94	2	0	128
9	Single	35	92	1	0	128
10	Single	26	94	8	0	128
11	Single	28	100	0	0	128
12	Single	33	93	2	0	128
1	Double	27	48	33	0	108
2	Double	27	48	33	0	108
3	Double	27	47	34	0	108
4	Double	27	45	36	0	108
5	Double	27	45	36	0	108
6	Double	27	46	35	0	108
7	Double	25	48	33	2	108
8	Double	27	42	39	0	108
9	Double	26	44	37	1	108
10	Double	22	43	38	5	108
11	Double	27	46	35	0	108
12	Double	24	47	34	3	108

The correct hits and correct denials are now classified into correct reaction, and missing report and false report are categorized as false reaction. SPSS 17.0 is used to conduct chi-square test of the frequency of the two types of reactions. The results show that both are significantly different statistically (See Formula 1 and 2). The results show that under the condition of working memory load, the attention of the subjects is not concentrated, and the decrease of the conflict suppression ability result in the increase of false reaction. Under such a circumstance, work efficiency is likely to reduce.

$$Chi\ sauare\ =\ 49.548 \quad (1)$$

$$p = 0.000 \leq 0.05 \quad (2)$$

The results of the previous performance indicator show that under the condition of load, the error rate of the subjects is significantly higher. To further excavate the trajectory of changes in attention, a further analysis in carried out on false reports and hits in the dual task. In Table 2, the reaction time of hits and false reports in dual task is collated.

Table 2. Reaction time of hits and false reports in the dual task

Number	Hit	False
1	439.15	2425.63
2	474.68	2331.63
3	553.04	2810.87
4	402.29	2107.81
5	447.78	2307.63
6	587.00	2426.10
7	679.04	2432.39
8	411.56	1964.51
9	673.79	2623.53
10	522.86	2065.16
11	386.92	3593.49
12	484.38	2419.50
Total	505.21	2459.02

Table 3. Normal distribution test of reaction time of hits and false reports

		Normality test					
	Classification	Kolmogorov-Smirnova			Shaoiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Hit	Reaction time	166	12	200	909	12	208
False	Reaction time	275	12	013	829	12	021

Whether the difference between the reaction time of the two achieves statistical significance still requires SPSS 17.0 for further difference testing. Before the difference test, the two sets of data shall be tested to meet the normal test or not. As shown in Table 3, the reaction time of hit in the dual task does not meet the normal distribution.

Brain evoked potential data

In the ERP components, P300 can belong to the cognitive potential which can express various cognitive activities in the brain, so P300 is used as an Brain evoked potential indicator to study changes in attention in this experiment. In the

data processing settings, the time window is positioned for the first 200 milliseconds and the next 1000 milliseconds when the number 0 appears with a total of 1200 milliseconds of the time window. The waveforms of all the subjects are superimposed for 384 times (32*12), and then the total average waveform is obtained. In this study, only the electricity at three electrodes of the Cz, Fz and Pz midline positions is extracted, and the waveform trend of the three electrode points is relatively uniform, that is to say, the amplitude of the P300 under load conditions is greater.

The amplitude of P300 is the largest at Pz point, so the data of this electrode point is analyzed in general researches. Thus, this research only makes statistical analysis of the amplitude and incubation period of Pz point. The data of incubation period and amplitude of P300 at Pz point are summarized in Table 4 and Table 5.

Table 4. Incubation period data of P300

	Average value	Number	Standard deviation	Standard error
Single task	362.8000	12	87.32239	39.05176
Dual task	379.2000	12	86.14639	38.52584

Table 5. Amplitude data of P300

	Average value	Number	Standard deviation	Standard error
Single task	6.2964	12	2.31517	1.03537
Dual task	8.1746	12	2.62987	1.17611

SPSS 17.0 is used to conduct a paired sample T test for incubation period and amplitude data respectively. The results show that the incubation period of P300 does not reach significant differences under the two task conditions (see Formula 3 and 4); While the difference in P300 amplitude is statistically significant (see formula 5 and 6). According to the previous literature review, the incubation period of P300 can express the processing time for the stimulation. The statistical analysis results show that the incubation period has a prolonged trend under load conditions, indicating that the attention concentration ability is impaired and the information processing speed slows down because of distraction of attention. The fact that no significant difference is reached may be the reason that no significant damage occurs to the speed of cognitive processing, or a longer period of work can achieve a significant extension in incubation period. The amplitude of P300 in dual task is significantly greater than that in single task. Combining the meaning represented by P300, the author has reason to believe that under the load conditions, more attention resources shall be put in the same task.

t=-0.315 (3)

p=0.768 (4)

t=-4.311 (5)

p=0.013 (6)

The waveforms of the three electrode points all show that the incubation period of CNV in dual task is longer. The specific incubation period of Pz point is shown in Table 6.

Table 6. Incubation period of CNV at Pv point

	Average value	Number	Standard deviation	Standard error
Single task	700.8571	12	158.13436	59.76917
Dual task	532.0000	12	89.39799	33.78926

A paired sample T test is performed on the incubation period of CNV in the single and dual tasks by SPSS 17.0 software. The results show that the difference in incubation period has reached a statistically significant level:

t=3.240 (7)

p=0.018 (8)

According to the experimental results, it is inferred that in the dual task experiment, the subjects need to put in more attention resources, so there is a delay in the preparation of the next stimulus. Or it can be vividly stated that the subjects' attention is distracted for the preparation of next action.

Conclusions and outlook

This paper uses ERP technology to design an experiment based on the continuous operation experimental paradigm and the working memory paradigm so as to study and discuss the typical symptom, namely distraction of sub-health employees. Then the corresponding suggestions are provide for the employees' sub-health screening and management. ERP experimental data shows that the amplitude of P300 can reflect concentration of attention, and incubation period of CNV can reflect the preparation for attention resources used to complete the task. In this

experiment, the concentration of attention and the corresponding Brain evoked potential under the same experimental conditions between sub-healthy patients and normal people haven't been compared. Therefore, in the subsequent studies, it should be further supplemented and improved.

References

Dong X, Zhang A, Cui J. Analysis of the sub-health status and influencing factors of medical staff. Health Soft Science 2013; 27(12): 770-72.

Hu F. Survey and analysis of the subhealth status of CBD white-collar workers in Qianjiang new town of a city and analysis. Chinese Medical Guide 2013; 13: 483-483.

Lu Y, Xu J, Cai Y. A study on the reliability and validity of subhealth assessment of urban residents by subhealth assessment scale. Chinese Journal of Health Psychology 2013; 21(5): 707-10.

Meng S, Run Y, Liu Y. Intercalated, research on sub-health status and influential factors of the medical staff China General Practice 2013; 16(1): 61-64.

Run L, Li C, Su B. Study on the correlation between depression patients with resting state functional magnetic resonance imaging and the severity of depression. Chinese General Practice 2014; 17(7): 800-02.

van Bömmel A, Song S, Majer P, Mohr PN, Heekeren HR, Härdle WK. Risk patterns and correlated brain activities. Multidimensional statistical analysis of fMRI data in economic decision making study. Psychometrika 2014; 79(3):489-514.

Yao G, Tao Y, Xu Y. A preliminary study on the status, causes and adjustment of the sub health of entrepreneurs. China's Health Management 2013; 8: 626-27.

Yu K, Bi J, Huang Y, Li F, Cheng J, Wang T, Wu L, Chen J, Xiao Y, Luo R, Zhao X. Relationship between health-promoting lifestyle and sub-health status in the employees of an enterprise. Journal of Southern Medical University 2013; 33(8):1203-06.

Zeng T, Practising Q, Li Q. The investigation of sub health factors and subhealth risk factors of subhealth of Guangzhou residents. Modern Preventive Medicine 2013; 7: 1294-98.

Zhang L. Brain heart Tongzhi to create a new future of subhealth prevention and treatment-the third National Association of Chinese and Western medicine with the brain and heart association academic exchange. Chinese Medical Information Guide 2013; 28(8): 18.