Analysis of Healthy People's Attention Based on EEG Spectrum

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Abstract— To study the human brain through EEG monitoring device the time required into the concentration. EEG data collected from a large number of healthy subjects. EEG record of each participant must be recorded twice on the same day, and one is in a relaxed state, another is state of fatigue. The hardware of EEG devices had optimized in order to strengthen the anti-interference capability. Recording software had redesigned, the EEG recording data show concise and clear. The experiment mainly observe three EEG curves (theta/alpha/beta). The results of the experiment revealed that the time required is very close of most human's brain achieves the concentration of attention, but there are a few shows excellent qualities. However, there were that a small number of participants unable achieves the status within the time specified in the experiment. We believe that use of EEG technology can provide a reference when selecting talents, such as selection of shooting athletes in sports field.

Keywords-EEG; attention; statistical method; experiment; numerous participants

I. INTRODUCTION

In 1875, the British physiologist Richard Caton from animal brain recorded in the weak current. In 1924, Hans Berger, who was a German neurologist, succeeded in recording the first human electroencephalogram (EEG) [1]. Brain electrical activity has closely relationship with brain state, is very important in the comprehension of the human brain information processing approach.

EEG finds its powerful analysis of diverse complicated problems occurring in Medical Science, Criminology [2], Biology [3], Brain Science, etc. To name a few, using EEG feature to determine whether the suspects were lying [2]; EEG technology as a means to study the special behavior of mammals [3]; Use of EEG technology to control electronic equipment [4]-[5].

According to IFSECN (International Federation of Societies for Electroencephalography and Clinical Neurophysiology) classification, the frequency of EEG from low to high is divided into four categories: Delta (0.5~4Hz), Theta (4~7Hz), Alpha (8~13Hz), Beta (14~30Hz). Alpha represents one of the most sober, stable and focused state. Beta represents the emotional involvement, it is in a tense, anxious or excited, nervous brainwave. Theta represents in a light sleep it is rarely appears when healthy awake. Delta represents sleep state.

Healthy adults in the waking state there is no Delta wave, but it is seen normally in babies and some continuous-attention tasks [6].

In the field of Medical Science, many works have been done with EEG focusing on a disease called ADHD, where some papers [7]-[8] point out that the theta/beta ratio is very active in the ADHD group. This means the theta/beta ratio have a very close relationship to human being's ability of attention.

Beyond the field of Medical Science, EEG recording device tends to be low-cost and portable, and high quality recording of EEG data, which equipment is much easier to obtain for university even family[9]-[11].

In studies related to attention, scholars are more concerned by the behavior of the brain is highly focused [12], and the effective method to improve concentration, such as integrative body–mind training (IBMT) [13], neurofeedback game [14], and so on. In this paper, we focus on a very interesting problem that how long are people able to achieve the concentration of attention in two different situations: relaxation and fatigue. With the use of EEG recording device, we collected EEG data from 3281 participants. The EEG recording device placed in the exhibition hall of science and technology which open to the public. Exhibition Hall daily average number of spectators at around 150, including students, workers, professors, retirees, and so on. We invited the day to visit the first group of spectators to participate in project (state of relaxation). When the spectators after seeing the exhibition of all, participate in the tests again (state of fatigue). Experiment lasted about half a year. Based on the collected data, some statistical analysis is done and a distribution graph is made.

II. METHOD

A. Subject

Invited participants are the day to see the exhibition of the guests. Participants were 3281 people (42%females, 58%males) from all trades. They ranged in age from 14 to 70. The subjects of volunteers participated and agreed to cooperate with the project. By health-related questionnaires in the form of excluding subjects who suffer from mental or neurological disorders, or are currently undergoing drug treatment. We declined some in good health, but when the device monitored their EEG signals weaker participants.

B. Apparatus

The International Federation of Societies for Electroencephalography and Clinical Neurophysiology (IFSECN) has recommended the conventional electrode

setting for 21 electrodes (10–20 system), as depicted in Fig .1. EEG sampling device were optimized in order to adapt the subject and electrodes setting according to standard 10-20 system (Fig .1). Since the content is relatively simple, so EEG monitoring device does not require a lot of electrodes. Electrodes of device include single frontal (central) electrode (Fz), two frontal (lateral) electrodes (F7, F8), two Mid-temporal electrodes (T3, T4), and two reference electrodes (A1 and A2, connected respectively to the left and right earlobes)[15]. Because the device was placed in a public environment, minimizing electromagnetic interference was one of the issues that must be considered. The device detected wave compared with the wave which has been identified correctly, to ensure that the device of the monitoring function is normal (Fig .2). EEG recording software was developed for this project, it can display clear and concise project test data (Theta/Alpha/Beta rhythm; Attention span; Meditation span) [16].

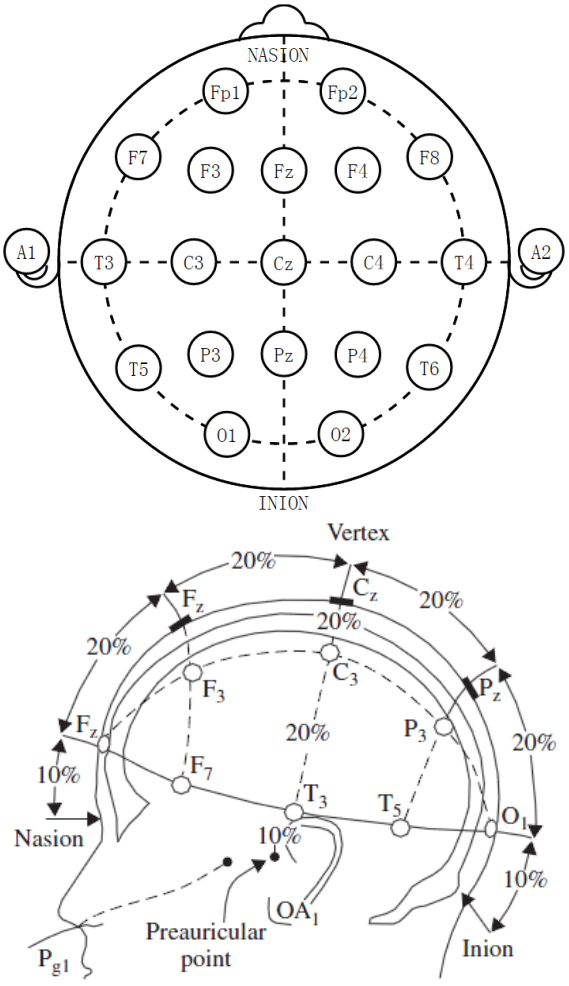

Figure 1. Conventional 10–20 EEG electrode positions for the placement of 21 electrodes

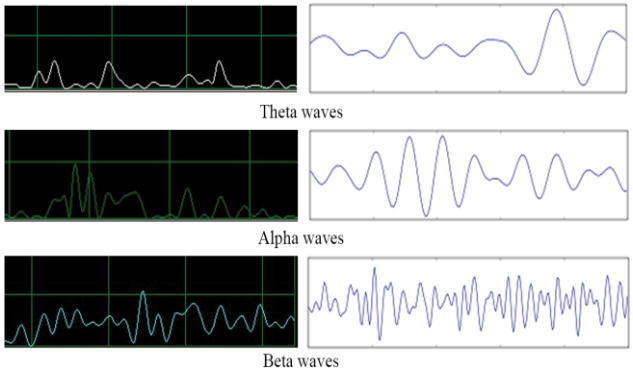

Figure 2. Monitoring data (Left) and known-good waveforms (Right)

C. *Experiment design*

EEG recording time at 9AM to 6PM, and only record Theta/Alpha/Beta rhythm. When the subjects are in a state of relaxation, alpha wave (8-15Hz) is the key point of observation. In the state of concentration, Beta wave (14-30Hz) is the key. Theta wave (4-7Hz) as judged two mental states of reference. Every Participants conducted in two different status of test which the brain into focus: (1) relaxation; (2) Fatigue. We had prepared a number of books, including Literature, Art, Arithmetic, etc. Participants can choose a book which the subject prepared for help them as quickly as into attention state. Of course, participants can also use their own methods, or help each other. Every participant's need to record their EEG pattern before starting experiment as a reference. Relaxed state of testing for the most part at 9 o'clock in the morning, and confirm that physical and mental state is more relaxed when the participants after a night of rest. When the first record had finished, participants can continue to see the exhibition or do their own work. If feels tired, return and completed the second test.

D. *EEG Recording and Data Processing*

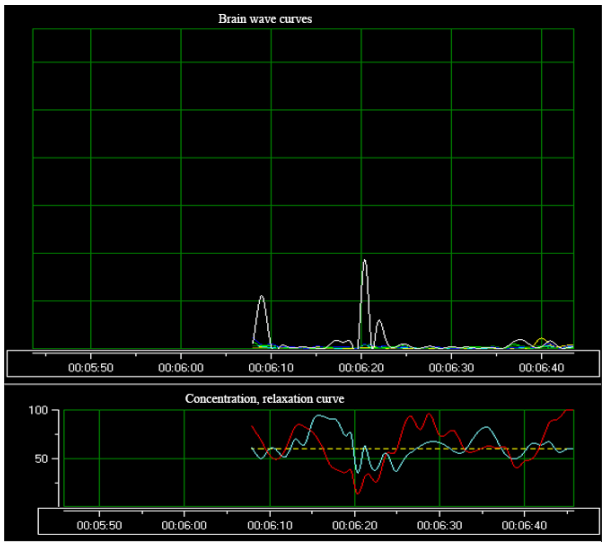

Figure 3. Wave appears that monitoring has begun

Recording software interface consists of two parts, as show in Fig .4 and Fig .5. The upper section displays real-time detection of brain events. The lower section is the concentration curve which is concluded after on the comprehensive analysis of the EEG data. While the device receives EEG signal, brainwave appears on the monitor interface (Fig .3).When the brain enters the relaxed state, alpha wave (green line) the most obvious (Fig .4). At the same time, each curve of the lower section away from the yellow reference line. We prompt participants to experiment start and recording starting time. While the participants achieve the concentration of attention status, beta curves (white curve) dominant position, and the concentration curves fluctuates up and down near the yellow dotted line (Fig .5). If the curve which continued until after the experiment, then we think the participant achieves the concentration and recording time data which the wave start. Calculate the time difference, this difference is our most concerned about data. The data that we want to get the result, namely how long does brain achieve the state of concentration.

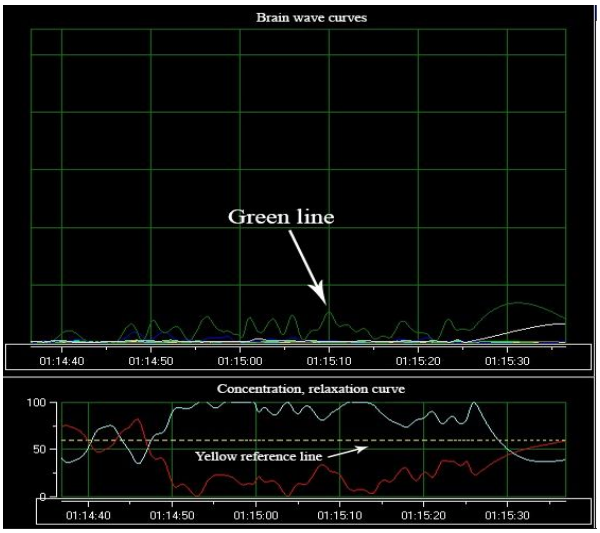

Figure 4. The EEG curve relaxed

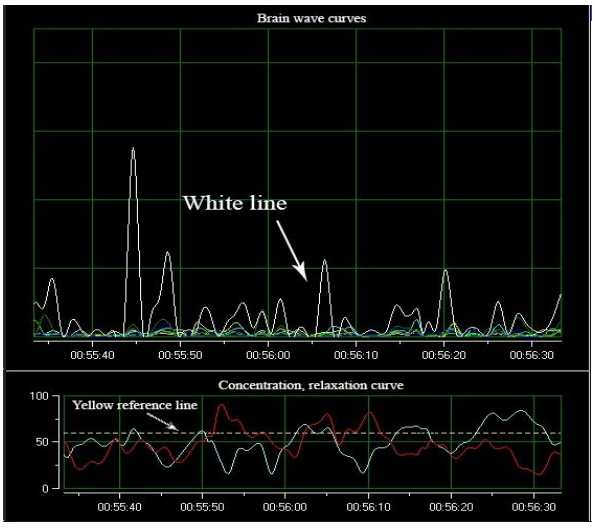

Figure 5. The EEG curve of concentration

To complete the experiment, data processing and data into a column chart (Fig .6 and Fig .7). In the relaxed state (Fig .6), there are 256 participants in less than a minute to achieve the state of concentration. To 15 minutes had not been able to achieve the concentration state of 6 participants. Most participants can reach the state in 2 to 8 minutes. In condition of fatigue (Fig .7), there are 136 participants in less than one minute achieve the state, reduced by 120 persons. However, the 120 men in 1-3 minutes, can also be achieved. Unable to enter the state is still 6 men. Compared two figures, two different mental states differences in the number of subjects was small. Two pictures of trend of data are almost the same.

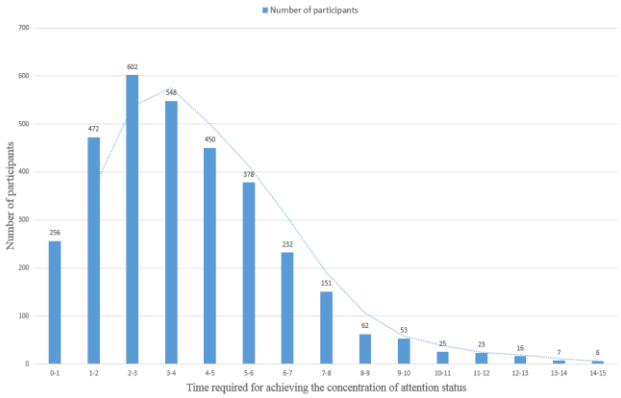

Figure 6. Entering the mental focus needed time statistics in a relaxed state

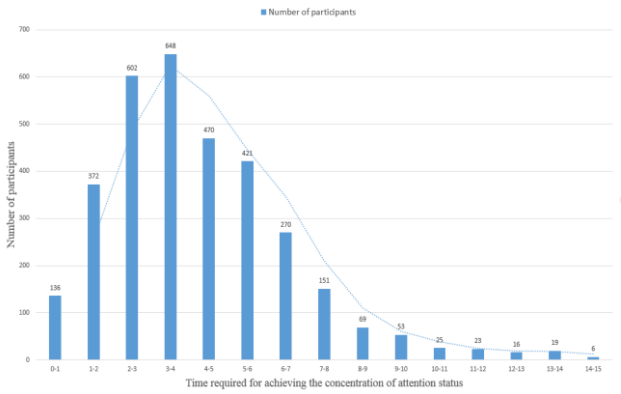

Figure 7. Entering the mental focus needed time statistics in a fatigue state

III. CONCLUSIONS

Most, but not all, Participants need a certain amount of time before they enter the attention state. A small number of participants can immediately into attention when the task start, and in addition a few participants in the time of task is difficult to enter the attention state. We can confirm that there is a small number of human, whether they are in the relaxed state, still in the state of fatigue, can rapidly to the state of mental concentration. In some fields, using EEG monitoring devices can help selecting talent. For example, in the field of sports, it can help to select

excellent shooters. We believe that athletes who mental state relaxed or fatigue, they can be quickly focused, and get good marks in the game. This EEG detection system can also be used for teaching, for monitor attention while the students in the class; or it is used for identifying as attention of drivers. Now our EEG device has been an exhibition used for distinguishing children's attention in the children's exhibition of China Science And Technology Museum.

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