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Research Article

Cognition and Education Management Method of Withdrawal Reaction for Students with Internet Addiction Based on EEG Signal Analysis*

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Abstract

This paper takes the cognition and education management method of withdrawal reaction for students with internet addiction as the research objective and adopts the research methods of literature method, brain science experiment and data analysis. This paper also introduces the EEG signal analysis method and use nonlinear dynamic analysis method and event-related potential technology, performing collection and data arrangement of EEG signals, SPN and P300 waveforms of prefrontal lobe of students with Internet addiction, analyzing behavioral characteristics and neurological changes in brain of students with Internet addiction from the perspectives of behavioral and EEG data. On this basis, the management method of withdrawal education for students with Internet addiction is proposed.

Keywords

Students with Internet Addiction • EEG Signal Analysis • Nonlinear Dynamics • Educational Management Method

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The continuous development and popularization of computer technology and network technology have brought about earth-shaking changes in people's learning, life, and work. However, the Internet is a "double-edged sword". That is to say, Internet, characterized by its convenience, richness and education. Has given people great convenience, (İskender, & Akin, 2010) but at the same time, it has also exerted a negative impact on people's behavior and value, especially the Internet addiction of college students, bringing about many problems to college education.

Internet addiction (Chou & Hsiao, 2000) refers to the repeated and excessive use of the Internet by Internet users in non-addictive material conditions, thereby causing damage to their psychological, physical and social functions. Internet addiction mainly includes (Bai, Lin, & Chen, 2001) online game addiction, internet information addiction, cyber porn addiction, internet social addiction and mobile internet addiction. In recent years, with the increasing number of Internet addiction groups, dominated by student groups, it has exerted a negative impact on the physical and psychological development of students and the harmony and stability of society. Internet addiction has been recognized as a serious problem of Internet behavior and has attracted wide attention of people. The cause of student Internet addiction (Shang, Wen, & Wu, 2009) are not only related to the attractiveness of the Internet itself, the impact of the Internet environment and social environment on students, but also related to the poor self-control ability and fragile psychological state of students. Many researchers at home and abroad have performed prevention and withdrawal on students with Internet addiction from the perspective of medicine, psychological prevention and team counseling (Zhou, Li, & Zhu, 2013). However, at present, the standard for Internet addiction strategies and diagnosis have not been unified in foreign countries and the cognition and educational management method of the withdrawal reaction of students with Internet addiction are still in the exploration stage.

Based on the above analysis, this paper attempts to introduce the method of EEG signal analysis on the basis of referring to domestic and foreign related researches to study the cognition of students with Internet addiction. This paper uses the nonlinear dynamic analysis method and event-related potential technology (ERPS) to collect and analyze the EEG data during the resting state and gambling experiment and use the comparative analysis to explore the decision-making obstacles of students with Internet addiction and reveal the neurological changes in brain of students with Internet addiction. On this basis, the withdrawal and educational management method of students with Internet addiction is proposed in order to provide a new reference for the withdrawal of students with Internet addiction.

Research on Decision-Making Obstacles of Students with Internet Addiction Based on Nonlinear Dynamics

Nonlinear Feature Extraction Based on EEG

Studies have shown that the brain neural network of is a nonlinear and dissipative dynamic system. The chaos of EEG signals of students with Internet addiction and students in the control group can be represented

by the correlation dimension and Kolmogorov entropy that reveal the nonlinear dynamic characteristics of the system (Dong, & Zhou, 2010).

Correlation dimension

The dynamic characteristics of EEG can be represented by the correlation dimension D_2 and the degree of freedom of EEG signals can be measured by the correlation dimension of attractor. Moreover, the correlation dimension D_2 is very sensitive to changes in EEG and is suitable for studying the EEG signals of students with Internet addiction (Pezoa-Jares, & Espinoza-Luna, 2013). This paper selects the classical G-P algorithm to calculate the correlation dimension D_2, as is shown in formula (1):

$$D_2 = \lim_{r \to 0} \frac{\partial \log C_m(r)}{\partial \log r} \tag{1}$$

In this formula, m is the embedding dimension; r is the radius of the hypersphere; and $Cm(r)$ is the correlation integral.

Kolmogorov Entropy

The Kolmogorov entropy K_2 (Dong, Devito, Huang, & Du, 2012) is one of the important indexes characterization of chaotic system, which can reflect the dynamic evolution of the system state and it is widely used in the study of EEG signals. The value of K_2 varies with different power systems. When $K_2>0$, it means that this is a chaotic system and the larger the K_2 value, the more complicated the system is. The computational formula is as follows:

$$K_2 = \lim_{r \to 0} \lim_{m \to \infty} \frac{1}{r} \ln \frac{C_m(r)}{C_{m+1}(r)} \tag{2}$$

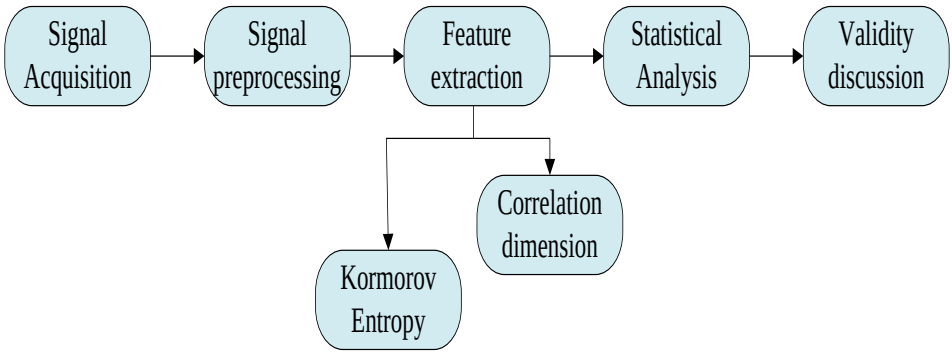

Figure 1. Experimental flow diagram

Experimental Materials and Methods

Because students with Internet addiction have been exposed to the Internet for a long time, the function of the prefrontal cortex has been inhibited and their decision-making ability has also been affected to a certain extent. In order to explore the pathological changes in the prefrontal cortex of students with Internet addiction

and provide more effective method for Internet addiction withdrawal, this paper carries out the EEG signal experiment on students with Internet addiction through nonlinear dynamic analysis method, Figure 1 shows the schematic diagram of the experimental flow (Hinić, Mihajlović, Spirić, Dukić-Dejanović, & Jovanović, 2008).

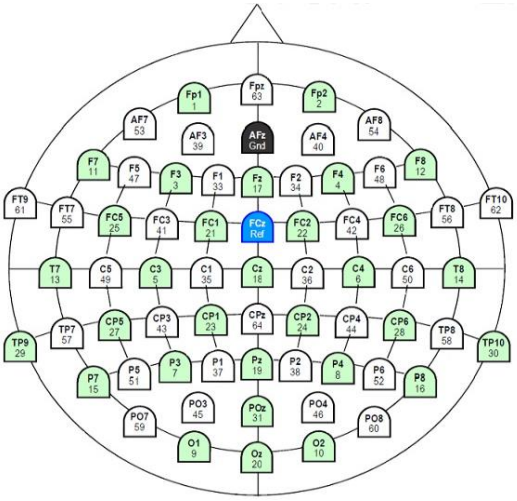

Figure 2. Lead position map used in experiments

This paper selects 42 students with Internet addiction and 42 normal students as experimental subjects, including 20 males and 22 females in each group. After the experiment preparation and introduction of experimental procedures, the subjects wear the 64-lead electrode cap. Figure 2 shows the position map of the leads used in the experiment. The EEG data under resting and eyes closed state in a soundproof laboratory at room temperature of 25°C is collected. The experimental duration is 6 minutes for each subject. Figure 3 shows the photograph of the subjects when collecting the EEG data. After data collection, the nonlinear feature extraction is conducted on the EEG data after the preparation of data processing, denoising and filterin. Figure 4 shows the comparison diagram of EEG signals before and after the denoising.

Figure 3. Internet addiction students brain data collection

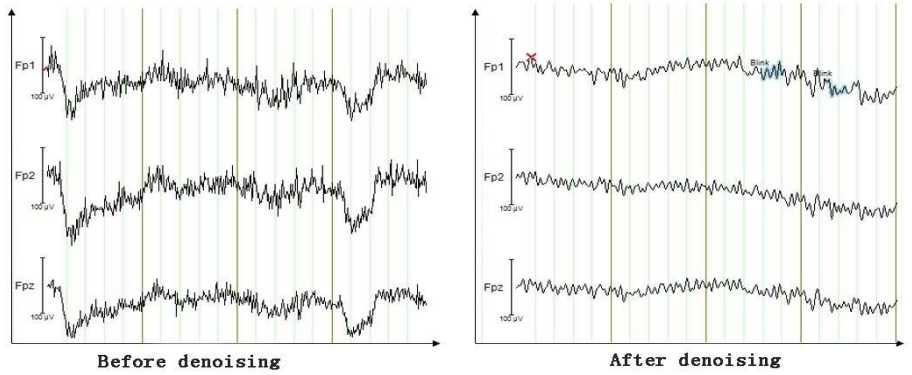

Figure 4. Comparison of before and after denoising of EEG signals collected by experiment

Nonlinear Dynamic Feature Extraction and Statistical Analysis

The prefrontal lobe is an important brain area involved in the plan and strategy. This paper uses the MATLAB tool to calculate the eigenvalue of the electrode potentials of Fp1, FpZ and Fp2 in the prefrontal cortex of the students with Internet addiction and the control group (Levin *et al*., 2007). Figure 5 and Figure 6 show the histogram of the eigenvalue of the Kolmogorov entropy and correlation dimension of the three potentials of students with Internet addiction and the control group. It can be seen from the figure that the eigenvalue of the three potentials of students with Internet addiction is higher than that of the control group.

In order to further determine the difference in the eigenvalue of EEG signals in the prefrontal cortex between these two groups, the SPSS19.0.0 is used to statistically analyze the eigenvalue of the subjects in these two groups. Table 1 shows the T test results of nonlinear dynamic characteristics. It can be seen from the table that the p value is all less than 0.05, indicating that there is a significant difference between the eigenvalue of the subjects in these two groups.

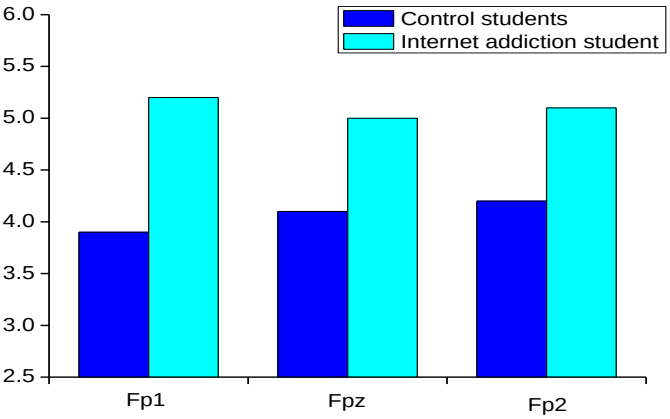

Figure 5. Correlation dimension

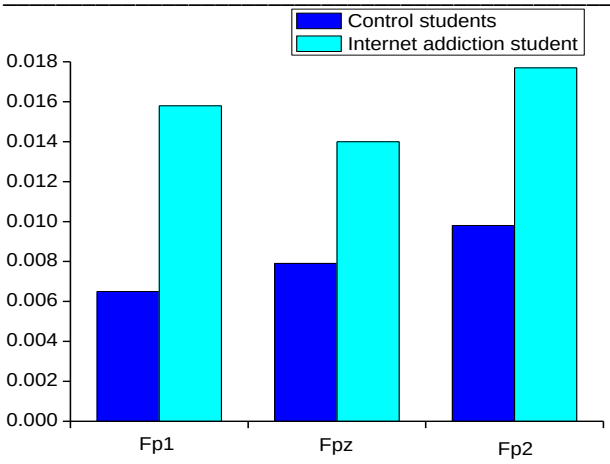

Figure 6. Colmogorov entropy

Table 1
Nonlinear Dynamics Characteristics T Test Results

Electrode position	T test result p value	
	D_2	K_2
Fp1	0.000	0.000
FpZ	0.000	0.002
Fp2	0.000	0.015

Previous studies have shown that the discharge activity of brain neurons can be reflected by EEG signals and the correlation dimension is related to the activity of neurons. Combined with the statistical results of the correlation dimension in this paper, it indicates that the activity of neurons of students with Internet addiction in the prefrontal cortex at the resting state is higher than normal students and that the correlation of neurons is reduced (Balconi & Finocchiaro, 2016). In addition, as mentioned above, when $K_2>0$, the system is a chaotic system, and the larger the K2 value is, the more complicated the system is. Combined with the statistical results of the Kolmogorov entropy, it can be seen the degree of chaos of students with Internet addiction in the prefrontal cortex is higher than that of normal students in the resting state and the loss rate in information transmission also increases, which have all resulted in the suppression of brain function, thus influenceing the decision-making ability (Han *et al*., 2011).

Research on Decision-Making Obstacles of Students with Internet Addiction Based on Event-Related Potentials

The Internet addiction of students is considered to be an inadaptable decision-making behavior resulting from impaired risk decision-making behavior. Event-related potential technologies (ERPs) can conduct detailed exploration of the processing of reward expectation and outcome evaluation. Studies have shown that SPN is often used as an index of reward expectation and that P300 is often used as an index in the outcome evaluation stage (Kim *et al*., 2017). Therefore, in order to better understand the behavioral performance of students with Internet addiction and normal students in the control group, this paper uses the gambling task experiment which

is widely used in neuroscience research to observe the reward expectation enhancement and outcome feedback of these two groups.

The experimental process

Through screening, 17 students with Internet addiction and 17 normal students in the control group are selected as the experimental subjects, including 7 males and 10 females respectively. Subjects wear the 64-lead electrode cap and the experiment is performed in a soundproof laboratory at the room temperature of 25°. In the experiment, the subjects adopt appropriate sitting posture and are asked to select the number 9 (low risk option, win or lose 9 points) or 99 (high risk option, win or lose 99 points) by pressing the key after a crossing appears on the screen. After the participants make the choice, a crossing will appear on the screen with a duration of 2000ms and then the score obtained or lost will be presented, lasting for about 1000ms. After a random interval of 900-1100ms, the next round of experiments will be started. A total of 400 experiments are performed and the experimental process is shown in Figure 7 (Evins *et al*., 2005). After the experiment, the preprocessing and filtering processing are conducted on the collected data, obtaining the final required experimental data.

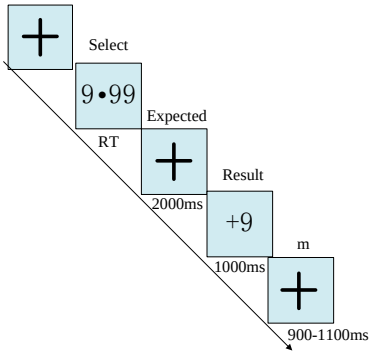

Figure 7. Experimental flow diagram

Analysis of Experimental Results

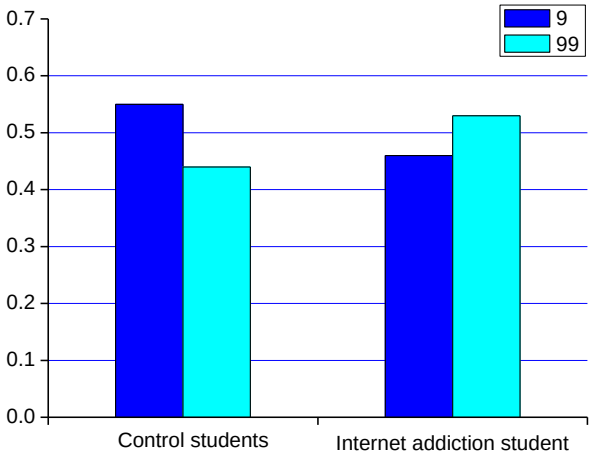

Figure 8. Selection ratio

Behavior Data

Figure 8 and Figure 9 show the statistical results of the proportion and time of the selection of students with Internet addiction and students in the control group. It can be seen from the figure that compared with the control group, the average proportion of high-risk options for students with Internet addiction is significantly higher and that the decision-making time is significantly shorter, showing a significant difference. In the control group, the time of high-risk selection is shorter than that of the low-risk selection and the main effect of the average decision-making time between groups is significant ($F(1,19)=12.28$, $p= 0.004$). Through the analysis of behavioral data, it can be seen that Internet addiction can affect the risk adjustment of behavior choice, which has posed obstacles to the risk management capability. They are not willing to spend more time adjusting their own decisions and consider the bad consequences caused by high risks but only pursue the reward of high risks (Parvaz, Aliaklein, Woicik, Volkow, & Goldstein, 2011).

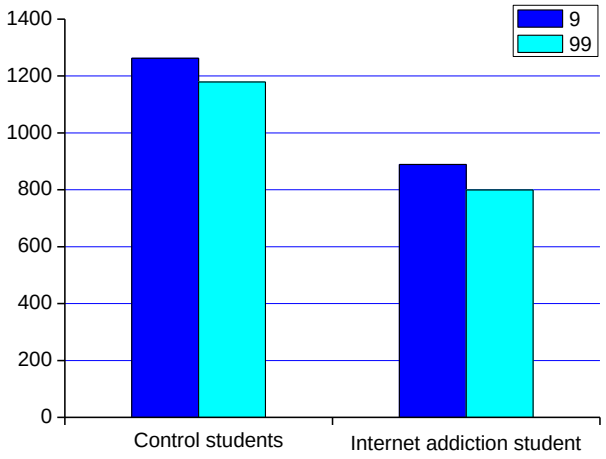

Figure 9. Selection period

EEG data

(1) SPN

Figure 10 shows the SPN waveforms and BEAM of the left and right brain regions induced in the period from decision-making to feedback by the subjects. The statistical analysis of the obtained data reveals that the main effect of SPN components and high and low risk difference in the left and right brain regions within the group is significant. The main manifestation is that the average amplitude induced by the right brain region is higher than that of the left brain region, but the amplitude induced by the right side of students with Internet addiction is higher, indicating that the expectation for reward is higher. However, the main effect of the SPN of high and low within the group is not significant.

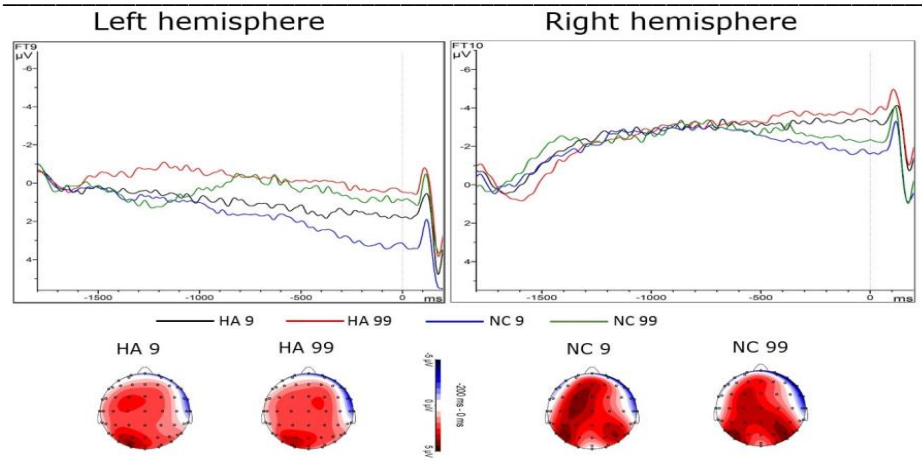

Figure 10. SPN components (HA for internet addiction students, NC for control students)

(2) P300

Figure 11 shows the average waveform of the P300 induced in the period from decision-making to feedback by the subjects. It can be seen from the Figure that the amplitude of P300 waveform induced by high risk is higher, showing a significant main effect. And the amplitude of P300 component induced by reward is higher than that by loss. Compared with students in the control group, the amplitude of P300 component induced by students with Internet addiction is lower, indicating that they cannot effectively handle the results of their choices and cannot evaluate the reward and penalty in a suitable manner.

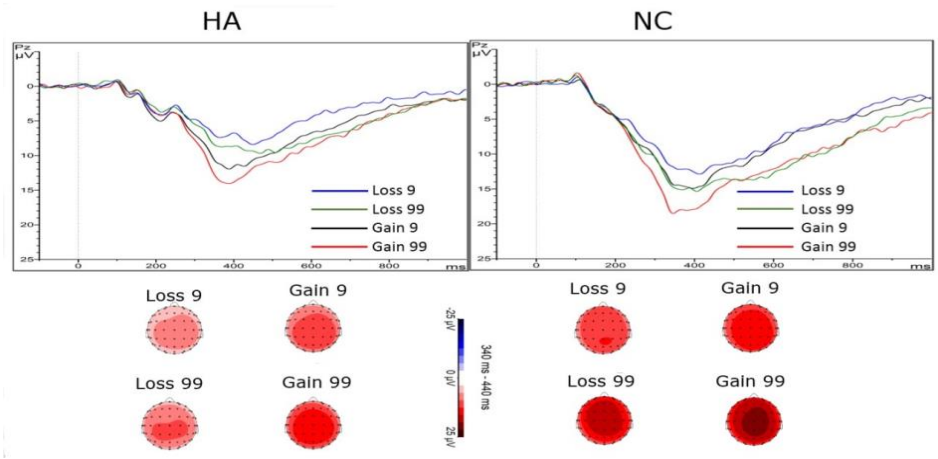

Figure 11. P300 component (HA for internet addiction students, NC for control group students)

Educational Management Method of Students with Internet Addiction

Combined with the research results of decision-making obstacles of nonlinear dynamics and event-related potentials of students with Internet addiction, this paper proposes a management approach of counseling intervention pattern for students with Internet addiction (Torres *et al*., 2013), as follows:

(1) Cognitive counseling of Internet addiction. It allows students to have a correct cognition of their online behavior through questionnaires, helps them analyze the causes of Internet addiction and the harm caused by Internet addiction and enables them to change their Internet behavior from a subjective perspective.

(2) Interference with the Internet behavior of students with Internet addiction is through the method such as interest substitution method, blocking method, token control method and aversion therapy (Froeliger, Modlin, Kozink, Wang, & Mcclernon, 2012).

(3) Establishing new behavior pattern in a timely manner. While conducting the withdrawal on students with Internet addiction, we should create the opportunity for them to participate in normal learning, life pattern and social activities and use a healthy lifestyle to replace their original behavior pattern.

Conclusion

With the increase in the incidence of students with Internet addiction in recent years, Internet addiction has become a common social problem and public health problem. This paper takes the cognition and education management method of withdrawal reaction for students with internet addiction as the research objective and try to analyze from the perspective of EEG signal analysis through referring to relevant literature at home and abroad. The specific conclusions are as follows:

(1) The non-linear dynamic analysis method is used, the EEG data of the subjects on the prefrontal cortex under eye closed state is analyzed. It is concluded that there is a significant difference in EEG signals between students with Internet addiction and those in the control group. The function of the prefrontal cortex of students is affected.

(2) The event-related potential technology (ERPS) is used to collect the EEG data during the gambling task. Through analysis, it is found that the amplitude of P300 and SPN component of students with Internet addiction is both higher than those in the control group.

(3) Combined with the results of EEG analysis between students with Internet addiction and those in the control group, this paper proposes an educational management method for the establishment of counseling intervention model for students with Internet addiction and briefly explains the specific method.

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