SOCIAL PSYCHOLOGICAL FACTORS FOR TEENAGE ADVENTURES: AN ANALYSIS BASED ON NEUROFEEDBACK MECHANISM

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Abstract

Dangerous behaviors, a.k.a. adventures, are increasingly common among teenagers, facing the fierce competition for higher education and employment. To identify the social psychological factors of teenage adventures, this paper explores the neurofeedback mechanism of teenagers for impulse behavior and response inhibition, using the paradigm NoGo / Go. In the test of the NoGo / Go task, the subjects were classified into high and low impulse groups by scale scores, and the 26 English letters were used as stimuli. The latency, wave amplitude and brain electrical activity mapping (BEAM) of P3 components evoked by the task were recorded at the completion of the task. The results show that the wave amplitudes of the P3 components evoked in the high impulse group at FZ, F3, F4, FC3 and FC4 were lower than those in the low impulse group; the two groups had similar distributions of electroencephalogram (EEG) signals, but the EEG distribution of the high impulse group tended to expand outward, especially in the frontal area; thus, the brain neurons in the frontal area are relatively active, and the teenage adventures may be associated with dysfunction of the frontal lobe. The research results help to reduce the tendency of teenagers of committing adventures.

Key words: Teenage, Adventure, Event Related Potential (ERP), Electroencephalogram (EEG)

INTRODUCTION

As our society has ushered in a new situation, the teenage are under heavy pressures to enter higher schools and compete for employment in the fierce market. To attempt to escape from the stressors, some teenagers resort to "adventures" including employing drugs, indulging in games, drinking alcohol, and even autotomizing themselves. Now these acts have been increasingly common among teenage groups (Jardri, Bartelsvelthuis, Debbané et al., 2014). The term "adventure", originated from a famous American social psychologist (Konno, Togawa, & Itasaka, 1982), refers to behaviors unhealthy and even harmful and dangerous to human life (Rubboli, Ronchi, Cecchi et al., 1997).

It has been proven that teenage "adventures" have a close relation with certain acts in life, such as alcoholism, smoking, violence, etc. (Airan, Meltzer, Roy et al., 2007), which happened almost by acquired learning, will potentially or directly pose a threat to the safety and health of teenage (Manjaly, Bruning, Neufang et al., 2007).

Now, there are seven types of adventures prevalent among teenage in China: A. verbal attack, brawl and other violent acts; B. unsafe sex; C. empyrosis, incised wound, overeating or anorexia and other self-injuries; D. lying, cheating, skip classes and other violations; E. drunkenness, illegal use of drugs, etc.; F. smoking, gambling, theft; G. unsafe driving, destroying property, selling illegal drugs, etc. (Parvaz, Aliaklein, Woicik et al., 2011).

To better comprehend and help teenage to overcome these adventures, we should find out cranial neurofeedback mechanism of teenage against adventures in order to develop targeted...
interventions in these. For this purpose, this paper will borrow from the brain neuroscience methodology, and adopts the NoGo / Go paradigm to explore the cranial neurofeedback mechanism on teenage impulsive behaviors and response inhibition. The study can provide objective clues for us to curb the adventures of teenage groups.

**RELEVANT THEORIES**

*ERPs,* commonly known as the Event-Related Potentials, is potential components formed after the testees get perception, judgment and treatment on external stimuli (such as events heard, seen or felt separately by the auditory, visual senses and by perception) (Zonneville-Bender, Van Goozzen, Cohen-Kettenis et al, 2005). Since testee has no concern with deviant stimuli, or under inattentional condition, there is no significant change in the amplitude of some components of *ERPs.* It is possible to reflect the perception process of the testees to exotic stimuli. Previous studies have demonstrated that the *P3* amplitude is positively correlated with the number of mental resources input; while *P3* latency period can reflect the time required for human brain to process exotic stimuli, which is positively correlated with task difficulty (Roeske, Ludwig, Neuhoff et al, 2011).

There are some studies on teenage’ adventures and cranial neurofeedback, but most of them focus on particular behavior from one perspective of neurofeedback mechanism. For example, Alain et al (Alain, Mcneely, He et al, 2002) based their study on those teenage who tends to abuse the drugs and revealed the fact that, in relation to low-attackers, high-attackers’ frontal lobe brainwaves seem significantly more active; Kouijzer et al. (Kouijzer, Schie, Moor et al, 2010) conducted a survey on young smokers and demonstrated by brain neurofeedback study that there were two types of smoking-like attitude attribute words, i.e. positive and negative attitudes, when associated with temptation-like words, there is an obvious difference appeared in evoked *ERPs* components; Young, K. D et al. (Young, Bellgowan, Bodurka et al, 2013)launched their study on those teenager addicted to the Internet, alcohol and smoke and proved that these three types of subjects have many resemblances in similar neural mechanisms and cognitive bias.

Previous studies have also shown that there is a relationship between response inhibition and impulsivity. It is generally believed that people whose response inhibitions are defective are more likely to initiate high impulses. After long-term studies on patients with ADHD, Rowe (Rowe, Robinson, & Gordon, 2005) found that their impulsive behaviors were often caused due to inadequate response inhibition, while it is true for heroin and alcohol addicts, and those who are predisposed to be violence. Further, by studying the brain neural mechanisms of children with ADHD, Lewis et al. (Lewis, Lamm, Stieben, et al, 2006) discovered that the *P3* amplitude of *ERPs* in patients might be lower than that in normal people; Hobson et al. (Hobson, Saunders, Al-Khindi et al, 2014) focused on the brain neurofeedback mechanism of violence actors and argued that the amplitude of *ERPs* in attacker was lower and their latency period was extended. Liu, Xiao, Li et al, (2015) studied male teenage with violent aggression and found from the test of auditory *ERPs* that the *ERPs* *P3* had a significantly prolonged latency period. It is generally believed that the brain’s assessment of stimulus information is slower, leading to an overlong processing time, so that there is a certain cognitive impairment; Kujawa, Kessel, Carroll, et al (2017) bound up in the schizophrenic patients with impulsive violence and found from their brain electrical nerves that their violent behaviors could have connection with abnormal discharge features of patients similar to those with brain epilepsy. The abnormal brain discharge stimuli may arouse such behaviors as destruction and beating of the patient population.

Scholar Chorlian, Rangaswamy, Manz et al. (2013) proposed based on the study and analysis of many pertinent literatures that impulsion refers to the active inhibition mechanism under the framework of cognitive psychology and behavioral neuroscience, and further divided it into behavioral and selective impulses. By far, there are two paradigms, NoGo and Go, used for measuring impulsive behaviors, where stimulus required to test the response is target / Go stimulus, otherwise, it is the non-target/NoGo stimulus. Both of stimuli have identical probability, while the effect of stimulus probability on *ERPs* can be exclusive to greatly save test time. However badly, the components generated from differences between high and low probabilities will not be available (Mayston, Harrison, & Stephens, 2010). In the test, there are
usually two stimulus modes, one needs to be guided by clues, and the stimuli required for testees to make response and no response based on given clues are 1/2; the other is simple NoGo / Go task, i.e. the test should be performed in strict accordance with the procedures required above.

In the test where NoGo / Go task should be fulfilled, the testee needs to make respond to Go stimulus, while suppressing response to NoGo stimulus (Bortolon, Capdeville, & Raffard, 2015). Other similar studies focus more on the difference in the wave amplitude and latency period between N2 and P3 components evoked by NoGo task. N2 generally appear at 200-400 ms, and P3 often at 300-600ms. It is generally believed that NoGo-N2 and NoGo-P3 are always related to the process, i.e., N2 and P3 can reflect the response inhibition process of human brain nerve against target stimulus. However, the origins of NoGo-N2 and NoGo-P3 in the cranial nerve are different, that is, the former originates from the prefrontal cortex on the right eyelid of the individual and the latter from the prefrontal cortex on the left eyelid of the individual. In addition, there are also some factors such as different mode (w/o and with clues), disparate stimulus materials, inconsistent stimulus organs (visual, auditory senses) in NoGo / Go paradigm that may trigger differential amplitudes and latency periods (Schendan & Kutas, 2014).

NEURAL MECHANISM OF TEENAGE’ ADVENTURES

Purpose and assumptions

In NoGo / Go paradigm, brain neuroscience is involved to explore the cranial neurofeedback mechanism of teenage’ adventures. Testees should be scored according to the impulse scale Barratt: high-impulsive teenage (high impulse group) and control group (low impulse group), and it is assumed that the high impulse group will consume higher brain energy when completing brain inhibition behavior than the other group.

Test procedure and method

Testees

Testees are randomly chosen from some freshmen at a university, half male and half female. They need to meet the following conditions: (1) they are all right-handed; (2) no mental disease, brain organ disease and severe physical history; (3) (rectified) cases are normal; (4) the numbers of testees in high and low impulse groups are equal, namely 20 cases each; (5) they are fully informed of the test and willing to cooperate.

Procedure and tasks

Testees are stimulated by 26 English words displayed on the computer screen, each appears for 200ms, and at a time interval of 1500ms.

Testees are required to quickly and accurately press the button when the letter X appears immediately after the letter O, while other letters appear after the letter O, no action is required. Therefore, the letter O in the task is taken as a clue, the letter X is Go stimuli that requires testees to make a response. When other letters appear after the letter O, testees’ brain needs to make a inhibition response. This task has a total of 500 stimuli, as shown in Fig. 1. Among them, 100 are letters O, 50 letters are followed by letters X. The test lasts for about 12 min.

Figure 1. Test stimulus modes

ERPs record and data process

Test instrument uses a 64-pole ERP workstation from the US Neuroscan, which requires the testees to remain blinking in a relatively quiet environment, and sitting in front of the computer screen at equal viewing angles and ranges of sight. Before the test, the testees have been trained for the operation of the buttons and the like.

The electrode cap of the instrument used in the test records EEG data at 30 points, i.e. FPI → FP2, FZ, F3, F4, FCZ, FC3, FC4, F7, F8, FT7, FT8, T7, T8, TP7, TP8, C3, C4, CPZ, CP3, CP4, PZ, P3, P4, P7, P8, OZ, O1, O2 etc. Reference electrode point uses a bilateral mastoid, and an electrode is grounded at 5 mm below the forehead hairline, and an electrode recorder VEOG (vertical eye electricity) is placed under the left eyelid and above the left eyebrow;
the other electrode recorder HEOG (horizontal eye electricity) is placed on the surface of the binoculus cortex face. The impedance between the electrode and the scalp is set to <5KΩ, the filter bandpass to 0.1–40 Hz and the analysis time to 1200ms. Record continuous EEG data at a frequency set to 500 Hz and perform offline data processing. By classifying and superimposing EEG data, two types of ERPs, as well as the amplitude and peak latency periods, can be available for NoGo / Go tasks. This paper compares the results of FZ, FCZ, CZ, PZ, FC3, FC4 and analyzes the BEAMs of the component of the testees.

RESULTS

NoGo and Go tasks all induce obvious P3 components, while P3 component evoked by one testee in Go task at FZ, FCZ, CZ, PZ, FC3, appears earlier than in NoGo task, as shown in Fig. 2 and Fig. 3.

Comparison of ERP component amplitudes

The average amplitudes of P3 evoked by the two groups of testees under the NoGo and Go tasks at FZ, FCZ, CZ, PZ, F3, F4, FC3, FC4 are listed in Table 1.

Table 2. Go task

![Figure 2. Go task](image.png)

Table 1. Comparison between amplitudes (\(\bar{x} \pm SD\))μv of P3 evoked by two groups under different tasks

| Electrode point | High impulse group Go | Low impulse group Go | t | High impulse group NoGo | Low impulse group NoGo | t |
|-----------------|-----------------------|----------------------|---|------------------------|-----------------------|---|
| FZ              | 10.1±0.7              | 12.4±0.8             | -1.279 | 17.2±6.8               | 21.2±5.8              | -2.167 |
| FCZ             | 12.1±7.7              | 15.2±5.8             | -0.245 | 19.2±7.8               | 24.2±7.4              | -1.699 |
| CZ              | 14.5±5.8              | 17.5±5.8             | -0.213 | 17.2±7.5               | 21.2±7.4              | 12.589 |
| PZ              | 17.5±5.4              | 17.7±6.8             | 0.089  | 12.2±5.8               | 14.2±7.8              | -1.214 |
| F3              | 8.8±6.1               | 10.9±5.4             | -1.202 | 13.2±5.1               | 17.2±5.1              | -2.402 |
| F4              | 9.5±6.8               | 12.4±4.8             | -1.598 | 12.2±6.0               | 18.2±3.8              | -3.698 |
| FC3             | 11.5±6.6              | 13.6±5.1             | -1.113 | 15.7±6.1               | 20.2±6.1              | -2.399 |
| FC4             | 12.6±6.8              | 15.4±4.5             | -1.579 | 15.9±6.9               | 20.1±5.8              | -2.275 |
As shown in Table 1, the P3 component evoked by the visual Go task has the highest amplitude at PZ, while the highest amplitude of P3 evoked by NoGo task appears at FCZ. Comparing amplitudes of the P3 components of the two groups under NoGo and Go tasks, it is found that: (1) NoGo task: for amplitude of P3 component evoked when finishing this task, the high impulse group has a decreasing trend compared with the low impulse group, and at FZ, F3, F4, FC3, FC4 the high impulse group is significantly lower than the low impulse group (p<0.05); (2) Go task: the amplitude of P3 component evoked by the high impulse group when the task is finished has a decreasing trend that than that by the low impulse group, but the difference between the two has no statistical meaning (p>0.05).

Comparison of ERP component latencies
The peak latencies of the P3 evoked by the two groups under the NoGo and Go tasks at FZ, FCZ, CZ, PZ, F3, F4, FC3, FC4 are shown in Table 2.

As shown in Table 2, there is no statistical meaning in the latencies of the P3 components evoked by the two groups at FZ, FCZ, CZ, PZ, F3, F4, FC3, FC4, when the Go / NoGo tasks are fulfilled (p>0.05).

Comparison between ERP component BEAMs
BEAMs of P3 component evoked by two
groups when fulfilling the Go / NoGo tasks are shown in Fig. 4.

**Figure 4. BEAMs of P3 component evoked by two groups under different tasks**

As shown in Fig. 4, the P3 components evoked by the two groups in Go task have obvious changes at P2, CZ, while in NoGo task, they have a significant change at FZ, FC2, FC3 and FC4. The high and low impulse groups have similar BEAMs when the impulse response occurs, but the high impulse group have a wider distribution. The enhancement of EEG activity in the testees is most evident in the frontal area in the NoGo task.

**Discussion of results**

**Relationship between ERP component and response inhibition of frontal lobe**

The clue-guided vision Go / NoGo task is used in this paper. The results show that the P3 component evoked in the two groups by the Go task has the highest amplitude at PZ, while the P3 component evoked by the NoGo task has the highest amplitude at FCZ. In the BEAM, the P3 components evoked in the high and low impulse groups by the Go and NoGo tasks have significant change, which suggests that the components evoked by the two tasks had different brain origins.

Simultaneously, when the high and low impulse groups fulfill the NoGo task, the amplitude of P3 component in the high impulse group is significantly lower than that in the low impulse group (p<0.05). This phenomenon may be attributed to higher energy consumed by the high impulse group than the low impulse group and further associated with the change of the frontal lobe inhibition function in the high impulse group.

Test results support a hypothesis that NoGo-P3 is the ERP component associated with the response inhibition function of the individual frontal lobe.

**Changes in components evoked in high/low impulse groups in Go / NoGo tasks**

In this paper, the components evoked in the two groups by Go task appear earlier than that by the NoGo task, and the amplitude of P3 component evoked in the high impulse group at FZ, F3, F4, FC3, FC4 is significantly lower than that in the low impulse group (p<0.05), which suggests that the EEG activity of the high impulse group is different from that of the low impulse group; in the BEAM, the high and low impulse groups have similar distributions, but the distribution range in the high impulse group has a tendency to expand outward, especially in the frontal area, indicating the brain neurons in the area are more active. For the amplitude and latency of the P3 components, there is no significant difference between the two groups when the Go task is fulfilled, showing that the high and low impulse groups had similar EEG responses in this process; while for the latency period of the P3 component, the high impulse group has a great mutation, which suggests that there is a difference in the EEG response between the two groups.

Simultaneously, the P3 component evoked in the high impulse group when fulfilling the NoGo task appears abnormal, which indicates that the high and low impulse groups have similar treatment processes for information and stimulus in the inhibition response.

**CONCLUSION**

This paper explores the brain neurofeedback mechanism of teenage group against adventures by the NoGo / Go paradigm to map the wave amplitudes, latencies, BEAMs and other information evoked in the high/low impulse group. Here are several conclusions:

For wave amplitudes of the P3 component evoked when two groups fulfill the NoGo task, the high impulse group at FZ, F3, F4, FC3 and FC4 are significantly lower than the low impulse group; when fulfilling the Go task, the above value of the high impulse group is slightly lower than that of low impulse group, but there are no statistical difference; so do the latencies of the P3 components evoked in the two groups at FZ,
FCZ, CZ, PZ, F3, F4, FC3 and FC4 when fulfilling the Go / NoGo task.

In the BEAMS, the P3 components evoked in the high and low impulse groups by the Go, NoGo tasks have obvious changes at PZ / CZ, FZ /FCZ/FC3/FC4; the two groups have similar distributions of BEAs, but the distribution range of BEAs in the high impulse group has a tendency to expand outward, especially in the frontal area, which suggests that the brain neurons in this area are more active.

Impulsive teenage may have dysfunction of frontal lobe.

REFERENCES

Airan, R. D., Meltzer, L. A., Roy, M., Gong, Y., Chen, H., & Deissereoth, K. (2007). High-speed imaging reveals neurophysiological links to behavior in an animal model of depression. Science, 317(S839), 819-823.

Alain, C., Mcneely, H. E., He, Y., Christensen, B. K., & West, R. (2002). Neurophysiological evidence of error-monitoring deficits in patients with schizophrenia. Cerebral Cortex, 12(8), 840-846. DOI: 10.1093/cercor/12.8.840

Bortoloni, C., Capdevielle, D., & Raffard, S. (2015). Face recognition in schizophrenia disorder: a comprehensive review of behavioral, neuroimaging and neurophysiological studies. Neuroscience & Biobehavioral Reviews, 53, 79-107.

Chorlian, D. B., Rangaswamy, M., Manz, N., Wang, J. C., Dick, D., & Almasy, L., Bauer, L., Bucholz, K., Foroud, T., Hesselbrock, V., Kang, S. J., Kramer, J., Kuperman, S., Jr. J. N., Rice, J., Schuckit, M., Tischfield, J., Edenberg, H. J., Goate, A., Bierut, L., Porjesz, B. (2013). Genetic and neurophysiological correlates of the age of onset of alcohol use disorders in teenage and young adults. Behavior Genetics, 43(5), 386-401.

Hobson, N. M., Saunders, B., Al-Khindi, T., & Inzlicht, M. (2014). Emotion down-regulation diminishes cognitive control: a neurophysiological investigation. Emotion, 14(6), 1014-1026.

Jardri, R., Bartelsvthuis, A. A., Debbane, M., Jenner, J. A., Kelleher, I., & Daavdilliers, Y., Plazzi, G., Demeulemeester, M., David, C. N., Rapoport, J., Dobbelare, D., Escher, S., & Fernyhough, C. (2014). From phenomenology to neurophysiological understanding of hallucinations in children and teenager. Schizophrenia Bulletin, 40(Suppl 4), S221-32.

Konno, A., Togawa, K., & Itasaka, Y. (1982). Neurophysiological mechanism of shrinkage of nasal mucosa evoked by exercise. Auris Nasus Larynx, 9(2), 81-90.

Kouijzer, M. E. J., Schie, H. T. V., Moor, J. M. H. D., Gerrits, B. J. L., & Buitelaar, J. K. (2010). Neurofeedback treatment in autism. preliminary findings in behavioral, cognitive, and neurophysiological functioning. Research in Autism Spectrum Disorders, 4(3), 386-399.

Kujawa, A., Kessel, E. M., Carroll, A., Arfer, K. B., & Klein, D. N. (2017). Social processing in early adolescence: associations between neurophysiological, self-report, and behavioral measures. Biological Psychology, 128, 55-62.

Lewis, M. D., Lamc, C., Stieben, J., Stieben, J., & Zelazo, P. D. (2006). Neurophysiological correlates of emotion regulation in children and teenage. Journal of Cognitive Neuroscience, 18(3), 430-443.

Liu, T., Xiao, T., Li, X., & Shi, J. (2015). Neural mechanism of facial expression perception in intellectually gifted teenage. Neuroscience Letters, 592, 22-26.

Manjaly, Z. M., Bruning, N., Neufang, S., Stephan, K. E., Brieber, S., Marshall, J. C., & Fink, G. R. (2007). Neurophysiological correlates of relatively enhanced local visual search in autistic adolescents. Neuroimage, 35(1), 283-291.

Mayston, M. J., Harrison, L. M., & Stephens, J. A. (2010). A neurophysiological study of mirror movements in adults and children. Annals of Neurology, 45(5), 583-594.

Parvaz, M. A., Aliaklein, N., Woicik, P. A., Volkow, N. D., & Goldstein, R. Z. (2011). Neuroimaging for drug addiction and related behaviors. Reviews in the Neurosciences, 22(6), 609-624.

Roeske, D., Ludwig, K. U., Neuhoff, N., Becker, J., Bartling, J., & Bruder, J. (2011). First genome-wide association scan on neurophysiological endophenotypes points to trans-regulation effects on slc2a3 in dyslexic children. Molecular Psychiatry, 16(1), 97-107.

Rowe, D. L., Robinson, P. A., & Gordon, E. (2005). Stimulant drug action in attention deficit hyperactivity disorder (adhd): inference of neurophysiological mechanisms via quantitative modelling. Clinical Neurophysiology, 116(2), 324-335.

Rubboli, G., Ronchi, F., Cecchi, P., Rizzi, R., Gardella, E., & Meletti, S., Zaniboni, A., Volpi, L., Tassinari, C. A. (1997). A neurophysiological study in children and Adolescents with crigler-najjar syndrome type I. Neuropediatrics, 28(05), 281-286.
Schendan HE, & Kutas, M. (2014). Neurophysiological evidence for the time course of activation of global shape, part, and local contour representations during visual object categorization and memory. *Journal of Cognitive Neuroscience, 19*(5), 734-749.

Young, K. D., Bellgowan, P. S., Bodurka, J., & Drevets, W. C. (2013). Behavioral and neurophysiological correlates of autobiographical memory deficits in patients with depression and individuals at high risk for depression. *Jama Psychiatry, 70*(7), 698-708.

Zonnevylle-Bender, M. J., Van Goozen, S. H., Cohen-Kettenis, P. T., Jansen, L. M., Van Elburg, A., & Van Engeland, H. (2005). Adolescent anorexia nervosa patients have a discrepancy between neurophysiological responses and self-reported emotional arousal to psychosocial stress. *Psychiatry Research, 135*(1), 45-52.