



Psychological Mechanism of Adolescent Internet Addiction and Brain Functional Imaging

Gui Xiao

ABSTRACT

In order to further explore the deep-seated mechanism of adolescent Internet addiction, this study screened out those adolescents with Internet addiction through Young's diagnostic questionnaires revised by Beard and Wolf and conducted multiple personality test questionnaires together with the negative control group, thus analyzing the psychological features of adolescents with Internet addiction. Subsequently, the Barratt Impulsivity Scale (BIS) and GoStop impulse test software are adopted to investigate the relationship between impulsivity and Internet addiction in the experimental group and the control group. It is concluded that the emotional behaviors of adolescents with Internet addiction all present obvious negative features, and Internet addiction is closely related to impulsivity.

Key Words: Adolescents, Internet Addiction, Psychological Mechanism, Impulsivity

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Introduction

With the increasing popularity of the Internet, the number of Internet users in China is gradually increasing. According to the "Statistical Report on the Development of China's Internet Development" issued by the China Internet Network Information Center (CNNIC) on August 4, by the end of June 2017, the population of Internet users in China has increased to 751 million, of which mobile phone users accounted for 96.3% of the total. According to the age distribution, netizens aged 10-19 account for 19.4% of the total; according to the occupation, the dominant proportion should be shared by middle school students in China, accounting for 24.8% of the all. Related research shows that Internet addicts all account for a considerable proportion in different countries, and this is especially true with young people.

Due to the fact that China has large population and adolescents and students occupy the dominant proportion of all Internet users, the

Internet Addiction (IA) has become a common concern of the whole society. In recent years, social problems and social conflicts caused by adolescent Internet addiction have also become common occurrence (Ge *et al.*, 2017). Internet addiction damages young people's physical and mental health to varying degrees, resulting in their vision loss, emotional instability, decline in academic performance, decreased concentration and increase of conflict in family relationship (Ge *et al.*, 2014). Some adolescents are even engaged in thefts, robberies and other illegal and criminal activities for the expense of Internet, eventually leading to a heavy legal burden on themselves and their family (Santos *et al.*, 2015).

Behind the young people is not just one family, they are carrying the hope of the entire country. Whether or not young people can grow up in a healthy environment determines whether this country is capable of sustainable development in the future. Therefore, it is of great practical significance to conduct research on

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Corresponding author: Gui Xiao

Address: Hunan Polytechnic of Environment and Biology, Hengyang, 421000, China

e-mail ✉ guixiaohengyang@126.com

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adolescent Internet addiction.

Some studies have found that young people with Internet addiction are relatively unstable in their emotion and have features such as lack of responsibility, depression, and dependence (Yao *et al.*, 2014). The lack of social skills can easily lead to their vulnerability to negative emotional impact (Kim *et al.*, 2013). Adolescents with Internet addiction also have relatively weak performance in terms of time control, and they are lacking in the ability to plan for their study and life. Once they are on the Internet, they will easily lose the control of time (Turner *et al.*, 2018). Studies have found that individuals who have good performance in time management have a significantly lower level of anxiety than those who have weak performance (Webb *et al.*, 2018). It is also found in clinics that young people with attention deficit hyperactivity disorder are more likely to indulge in Internet and online games (Mallorquí-Bagué *et al.*, 2017). The lack of a long-term perseverance often means that they are more likely to be evasive, irresponsible and impulsive (Zajac *et al.*, 2017). When young people with Internet addiction are addicted to online games, this performance is particularly significant.

Therefore, this study attempts to discuss the psychological mechanism of adolescents with Internet addiction. After referring to relevant documents, a focused survey questionnaire is selected for assessment and these questionnaires can fully analyze and clarify the personality characteristics of adolescents with Internet addiction. In the pathogenesis of substance addiction and pathological gambling, impulsivity plays a major role (Beard *et al.*, 2017). We hope to find the relationship between traits of characteristics and impulsive personality of adolescents with Internet addiction through the measurement of impulsivity.

Methods

Research object

This experiment selected 12 junior high schools in X city, including junior high school first grade, junior high school sophomore, senior high school first grade, and senior high school sophomore. One class was selected from each school with simple random sampling, and a questionnaire survey was conducted for all together 2735 students. The questionnaire was Young's diagnostic questionnaire revised by Beard and Wolf and excluded those with severe physical and

mental illness. After re-interviews, the researchers finally identified 72 IA students, including 59 males and 13 females, aged 12 to 18 years, with an average age of (14.6±1.8) years. The control group selected those students whose student number was just before the IA student. If there was continuity, the top two were selected, and so on. Upon verification, the selected control group was evaluated as negative in the Young's diagnostic questionnaire revised by Beard and Wolf. In the control group, there were 59 males and 13 females, aged 12-18 years, with an average age of (14.5±1.7) years.

Research methods

(1) Screening of adolescents with Internet addiction

The Young's diagnostic questionnaire revised by Beard and Wolf was used to make judgments on adolescents with Internet addiction. There were 8 items in the diagnostic questionnaire. The positive indicators are: the first 5 items must be positive and at least 1 of the last 3 items should be positive.

(2) Analysis of psychological features of adolescents with Internet addiction

Eysenck Personality Questionnaire (EPQ, Children's Edition), Adolescence Time Management Disposition Scale (ATM), and Children's Anxiety Disorder Screen (The Screen for The Child Anxiety Related Emotional Disorders (SCARED) survey were used to investigate the experimental group and control group. Strength and Difficulties Questionnaire (SDQ, Parents' Edition) and Parents' Edition of Attention Deficit Hyperactivity Disorder Diagnostic Scale (ADHDDS-P) were used to investigate the strengths and difficulties of the two groups of parents. The above investigation results were input into SPSS 23.0 and statistical analysis was performed. The measurement data between the two groups were compared using the paired t-test of the two-sample mean; the enumeration data were compared using the Chi-square test; and the conditional logistic regression equation was used for multivariate analysis. Figure 1 shows the psychological features of brain responses.

(3) Neuropsychological determination of impulsive behaviors of adolescents with Internet addiction



The Barratt Impulsivity Scale (BIS) and GoStop impulse test software were used to test the experimental group and control group. The above test conditions were input into SPSS 23.0 and statistical analysis was performed. The measurement data between the two groups were compared using the paired t-test of the two-sample mean and the enumeration data were compared using the Chi-square test.

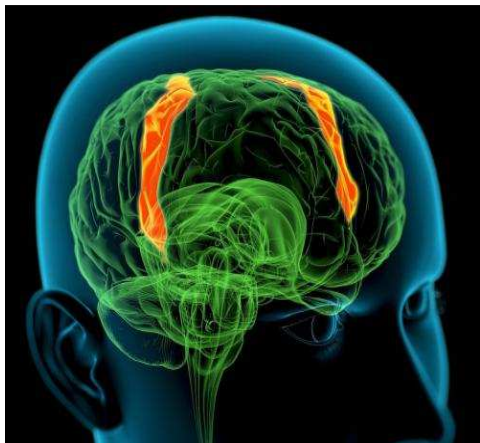


Figure 1. Psychological features of brain responses

Results

(1) General information and screening results

The average age of the experimental group was (14.6±1.8) years, and the average age of the control group was (14.6±1.8) years. There was no statistically significant difference between the two groups in terms of age and the gender and age of the two groups were the same.

Table 1. EPQ score comparison between experimental group and control group (score, $\bar{x}\pm s$)

EPQ	EG (n=72)	NC (n=72)	t value	P value
E	17.00±4.62	17.14±4.35	0.17	0.825
P	5.89±3.13	3.52±2.13	5.53	0.000
N	15.13±5.97	9.15±5.46	5.11	0.000
L	8.52±3.12	11.23±4.35	4.13	0.000

Table 2. ATMD score comparison between experimental group and control group (score, $\bar{x}\pm s$)

ATMD	EG (n=72)	NC (n=72)	t value	P value
Sense of time value	34.35±8.01	38.92±7.63	2.35	0.016
Sense of time control	63.96±15.02	77.02±15.35	3.97	0.000
Sense of time efficacy	28.93±6.31	34.95±6.94	4.75	0.000
Individual-oriented time value	16.65±4.17	19.03±4.25	2.63	0.010
Social-oriented time value	18.23±4.73	19.98±4.69	2.15	0.035
Setting goals	12.98±3.50	15.46±3.85	3.90	0.000
Planning	12.35±3.13	14.50±3.83	3.20	0.002
Priorities	15.02±3.34	17.35±3.38	3.32	0.001
Feedback	12.83±4.72	15.92±4.70	3.21	0.002
Time allocation	11.30±3.21	13.84±3.59	3.72	0.000
Efficacy of time management behaviors	14.01±3.77	16.97±4.12	4.36	0.000
Efficacy of time management	15.15±4.73	18.27±4.37	3.81	0.000
Time management disposition	137.13±24.69	149.76±32.16	4.35	0.000

(2) Analysis results of psychological features between experimental group and control group After comparing the scores of the EPQ questionnaire between the experimental group and the control group (as shown in table 1), it was found that the scores of psychoticism (P) and nervousness/emotional stability (N) in the experimental group were higher than those of the control group, and the score of disguise (L) was lower than that of the control group. There was no statistically significant difference in the scores of introversion-extroversion (E) between the two groups.

After the comparison of the ATMD scores between the experimental group and the control group (as shown in table 2), it is revealed that the scores of senses of time value, time monitoring, time efficacy, time value of personal orientation, time value of social orientation, behavior efficacy of goals, plans, priorities, feedback, time allocation and time management, time management efficiency and time management disposition in the experimental group were all lower than those of the control group.

After the comparison of the SCARED scores between the experimental group and the control group (as shown in table 3), it is revealed that the scores of somatization/panics, generalized anxiety, separation anxiety, social phobia, school phobia and anxiety in the experimental group were all lower than those of the control group.

After the comparison of the SDQ scores between the experimental group and the control group (as shown in table 4), it is revealed that the scores of emotional symptoms, conduct problems, attention deficit hyperactivity and difficulty in the experimental group were all lower than those of

Table 3. SCARED score comparison between experimental group and control group (score, $\bar{x}\pm s$)

SCARED	EG (n=72)	NC (n=72)	t value	P value
Somatic/ panic	8.32±6.21	4.83±4.03	3.92	0.000
General anxiety	8.72±4.03	5.21±3.61	4.85	0.000
Separation anxiety	5.65±3.93	3.10±2.21	4.82	0.000
Social phobia	7.13±3.42	5.47±3.13	3.21	0.002
School phobia	3.30±2.14	1.21±1.31	5.52	0.000
Phobia(total)	35.21±15.83	19.05±11.93	5.35	0.000

Table 4. SDQ score comparison between experimental group and control group (score, $\bar{x}\pm s$)

SDQ	EG (n=72)	NC (n=72)	t value	P value
Emotional symptoms	2.63±2.34	1.72±1.73	2.46	0.015
Behavioral problems	2.33±1.75	1.13±1.10	3.52	0.000
Hyperactivity note	5.42±2.23	4.01±2.01	3.71	0.000
Peer relationship	3.01±1.67	2.91±1.75	1.23	0.153
Total difficult	14.03±4.72	9.75±5.10	4.04	0.000
Prosocial	5.21±1.83	6.97±1.65	3.32	0.001

the control group and the score of prosocial behavior was lower than the control group. There

After the comparison of the ADHDDS-P scores between the experimental group and the control group (as shown in table 5), it is revealed that the scores of attention deficit, hyperactivity-impulsive factor and ADHDDS-P score in the experimental group were all higher than those of the control group.

Table 5. ADHDDS-P score comparison between experimental group and control group (score, $\bar{x}\pm s$)

ADHDDS-P	EG (n=72)	NC (n=72)	t value	P value
Inattention factor	9.73±5.13	5.92±3.75	4.15	0.000
Hyperactivity/impulsivity	6.53±5.14	3.68±3.72	3.33	0.001
Total	15.95±11.13	9.24±8.35	4.65	0.000

At the level of $\alpha=0.05$, psychoticism and nervousness/emotional stability, disguise, sense of time value, time monitoring, time efficacy, somatization/panics, generalized anxiety, separation anxiety, social phobia, school phobia, emotional symptoms, conduct problems, attention deficit hyperactivity, attention deficit and hyperactivity-impulsive factors are taken as independent variables and the logistic regression analysis is used to examine the influence of psychological behavioral factors on the experimental group (as shown in table 6). It is revealed that: generalized anxiety and attention deficit hyperactivity are the dangerous factors in the experimental group. Attention should not be a risk factor in the experimental group while the prosocial behavior is a protective factor.

was no statistically significant difference between the two groups in terms of peer interaction.

Table 6. Logistic regression analysis of influencing factors in experimental group

Variables	Partial regression coefficient	Standard error	Wald X2 value	P value	OR value
General anxiety	0.46	0.15	6.72	0.01	1.53
Hyperactivity note	0.71	0.27	5.83	0.02	1.95
Prosocial	-0.87	0.31	6.83	0.01	0.39

(3) Results of neuropsychological measurement of impulsive behavior between experimental group and control group

After the comparison of the BIS-11 scores between the experimental group and the control group (as shown in table 7), it is revealed that the scores of attention factor, exercise factor, and BIS score in the experimental group were higher than those in the control group. There was no statistical difference in terms of scores between the two groups in the absence of the plan factor.

Table 7. BIS-11 score comparison between experimental group and control group (score, $\bar{x}\pm s$)

BIS-11	EG (n=72)	NC (n=72)	t value	P value
Attentional key	30.93±4.75	29.13±4.04	3.33	0.001
Motor key	23.92±4.05	23.10±4.13	2.36	0.016
Lack of planning factor	20.32±2.83	19.89±3.16	1.73	0.075
Total	77.13±8.03	73.12±10.01	3.32	0.001

After the GoStop software test between the experimental group and the control group, it is found that the number of four kinds of Stop task



error reaction in the experimental group was higher than that of the control group (as shown in table 8). It should be pointed out that in the table, the loss of inhibition rate is the error rate, and the inhibition rate is the correct rate. The higher the loss of inhibition rate, the stronger the impulsiveness; the higher the inhibition rate, the lower the impulsivity.

Table 8. Comparison of the number of various task error reaction in GoStop software test in experimental group and control group (score, $\bar{x}\pm s$)

Type of experiment	Number of trials	EG (n=72)	NC (n=72)	t value	P value
50 msec Stop	20	7.03±3.25	3.21±2.03	7.93	0.00
150 msec Stop	20	12.38±2.34	8.10±3.23	7.56	0.00
250 msec Stop	20	14.98±2.15	11.32±3.02	7.73	0.00
350 msec Stop	20	18.21±1.13	14.48±2.16	9.32	0.00

Table 9. The number of error reaction between experimental group and control group being converted into loss of inhibition rate and inhibition rate

Type of experiment	EG		NC	
	Loss of inhibition rate	Inhibition rate	Loss of inhibition rate	Inhibition rate
50 msec Stop	31.27%	68.73%	11.03%	88.97%
150 msec Stop	57.26%	42.74%	29.38%	70.62%
250 msec Stop	79.35%	20.65%	48.79%	51.21%
350 msec Stop	91.38%	8.62%	65.76%	34.24%

After the analysis of scores of Young's diagnostic questionnaires revised by Beard and Wolf, BIS-11 impulsive scale and the number of various task error reaction in GoStop software (as shown in table 9), it is found that attention factor and exercise factor in Young's diagnostic questionnaires revised by Beard and Wolf and BIS-11 impulsive scale are positively correlated with the score of the absence of plan factor and the score of Young's diagnostic questionnaires revised by Beard and Wolf is positively correlated with the 50 msec Stop, 150 msec Stop, 250 msec Stop, 350 msec Stop task error reaction in the GoStop Software (as shown in table 10).

Table 10. Correlation analysis between the score of young's diagnostic questionnaire revised by beard and wolf and impulsivity

	Attentional key	Motor key	Lack of planning factor	50 msec Stop	150 msec Stop	250 msec Stop	350 msec Stop
YDQ	0.403	0.415	0.230	0.457	0.463	0.482	0.503
P value	P<0.01	P<0.01	P<0.05	P<0.01	P<0.01	P<0.01	P<0.01

Discussion

The scores of psychoticism and nervousness/emotional stability of Eisenck personality questionnaire in the experimental group are higher than those in the control group, indicating that adolescents in the experimental group are relatively unstable in characteristics, depressed, dependent and lacking responsibility. For adolescents, the scores of disguised indicate whether the individual's personality is mature, while the score of disguise in the experimental group is lower than that of the control group, indicating that immature individuals account for a large proportion in adolescents with Internet addiction. These individuals are introvert, lonely and pessimistic and a series of behaviors such as top-up and victory in online games can help these adolescents to establish short-term self-confidence and vanity within a short period, so they will rely on the Internet to achieve self-worth.

The adolescents in the experimental group obviously lack the sense of time management and are not good at monitoring their own time. The ability to control their own time is an important manifestation of self-control, and it is also an indispensable skill for planning complex tasks. In the experiment group, we can easily infer the following situation: adolescents with Internet addiction are prone to indulge in the Internet - increasing anxiety - escaping anxiety - in a vicious circle of further indulging, finally unable to extricate themselves.

In the SCARED, strengths and difficulties questionnaires for children, the scores of emotional symptoms, total scores of anxiety, and scores of various anxiety factors in the experimental group were significantly higher than those in the control group, and the general anxiety also is also in the regression equation, which further reveals that there are more negative emotions, especially anxiety in the experimental group, adding the severity of previously-mentioned vicious circle.



Conditional Logistic regression analysis indicates that attention deficit hyperactivity is a risk factor in the experimental group and prosocial behavior is a protective factor. We know that adolescents with attention deficit hyperactivity disorder will resort to short-term, fast-paced, less rewarding achievements compared with long-term, difficult, and highly rewarding achievements. After a short period of success, they often gain strong sense of psychological gratification. The illusion of victory over opponents, personal worship and power in hand in online games is more likely to stimulate their sense of rewards, and thus they will continue to strengthen their behavior patterns, resulting in the phenomenon of increased addiction.

After the comparison of the BIS-11 scores between the experimental group and the control group, it is revealed that the scores of attention factor, exercise factor, and total score of BIS in the experimental group were higher than the control group. In the GoStop neuropsychological test, the performance of the experimental group was far worse than that of the control group. There was a significant positive correlation between the score of YDQ and scores of attention factors, exercise factors and lack of plan factor and the number of four kinds of Stop task error reaction. This indicates that the control group has a higher level of impulsivity, an abnormality in the reward system, and poor behavioral inhibition.

Conclusion and prospects

This study used a variety of research methods to systematically discuss the psychological mechanisms of adolescents with Internet addiction. Their personality traits and emotional behaviors were different from those of the control group: they had more negative emotions, lack of time control, anxiety and emotional disorder and attention deficit hyperactivity, and these may have an important relationship with the formation of Internet addiction. At the same time, with the help of evaluation method of impulsivity, it was found that adolescents with Internet addiction were more impulsive than those in the control group, and their level of inhibition of

reaction was low and Internet addiction was related to impulsivity. It is the wish of this study that this research can play an inspiring role in the phenomenon of Internet addiction, may benefit the relevant psychological intervention and treatment of Internet addiction in the future.

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