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Psychometric Analysis on Neurotransmitter Deficiency of Internet Addicted Urban Left-behind Children

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Abstract

Aim: In the study, a questionnaire survey was proposed-for neurotransmitter deficiency of internet-addicted urban left-behind children, trying to provide psychometric bases for exploration on neurophysiological mechanism of internet addiction.

Method: First, 199 internet-addicted urban left-behind children were selected from 1895 Chinese urban left-behind children by use of *Adolescent Pathological Internet Use Scale* (APIUS), and then a test in *Symptom Scale of Neurotransmitter Deficiency*(SSND) was conducted.

Results: The neurotransmitter deficiency extent of internet-addicted urban left-behind children was higher than moderate grade; that of boys was higher than that of girls; that of parents-leaving group was higher than that of single-parent-leaving group. The neurotransmitter deficiency extent of internet-addicted urban left-behind children was higher than that of non-internet-addicted urban left-behind children.

Keywords: Internet addiction; Urban left-behind children; Neurotransmitter; Psychometrics

Introduction

Internet addiction is a negative result derived from interaction between human and internet nowadays. Adolescents account for 25.6% of 668 million netizens in China [1], and the detected rate of adolescent internet addiction is 6.6%-7% [2,3]. In May 2013, "internet addiction" was included formally in the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-V) (American Psychiatric Association, 2013). Internet addiction is presented as impulsive out-of-control behavior with excessive repeated use of network and without effect of addictive substances; such behavior already results in psychological and physical dependency of individuals as well as damages to physical, psychological and social functions [4,5].

"Left-behind children", being left in native places by their parents who rush from less-advanced western regions to advanced eastern regions for work after the reform and opening-up, is a special adolescent group. Initially, the concept only refers to rural children who are left at home and under care by their grandparents, relatives and neighbors or who live independently, and their psychological health problems are increasingly prominent [6-8]. However, in recent years, the proportion of urban left-behind children starts to increase. "Urban left-behind children" refers to juveniles (under the age of 18) who live in cities or towns for long time and under long-term care by nurse, nurture by grandparents or tutelage by other relatives or non-relatives, and whose parents or parent works or studies outside for over a half year and cannot take care of the juveniles [9,10]. Generally, this group of children has enough economic capacity to afford internet usage and is easy to be addicted to internet in case of improper guidance during internet usage, resulting in various deviations. As shown by the latest studies, their internet addiction rate is 10.8% [11], being in a relatively high level.

The neurotransmitter of brain is a particular chemical substance acting as a messenger in chemical synaptic transmission as well as a channel for transmitting emotive information, and it has excitability and inhibitive ability [12]. It is deemed at present that the addiction behavior is related to 6 different kinds of neurotransmitters: dopamine, acetylcholine, γ-aminobutyric acid, 5-hydroxytryptamine, noradrenaline and ß-endorphin. [13] had found that it is due to imbalance of neurotransmitter on composition, release, uptaking, absorption and metabolism as well as neuroendocrine disorder that the series of physical and psychological symptoms of internet addicts are caused. Some other domestic and overseas studies also show that the level of dopamine, 5-hydroxytryptamine, acetylcholine and noradrenaline of internet addicts is different from that of normal persons [14-20]. The neurotransmitter mechanism of internet addiction is behaved as:

As a substance of brain, dopamine (DA) is related to joy, excitement and other similar emotions, released by nerve cells of reward system and exerting the function of neurotransmitter [21,22]. When an individual surfs the internet for a long time, its dopamine level will increase and generate euphoria. The "award system" of brain will remember such situation. Then, the individual will continuously repeat such behavior and extend time online to gain joviality again. Finally, the dopamine-producing imbalance is caused, which forms psychological dependence on internet, and that is the fundamental mechanism of such addiction behavior [23].

Cholinergic neuron (Acetylcholine, Ach) of brain participates in the "stimulation - award" learning related to addiction, and the cholinergic neuron can improve sensitivity to addictive substances in award effect of addiction and negative reinforcement of withdrawal. Dopamine and acetylcholine mutually act on the brain function. The

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acetylcholine has adjustment effect on award projection tract, and the adaptive change of cholinergic nerve may be a physiological basis of addiction award [24,25].

γ-aminobutyric acid (GABA) is a main inhibitory neurotransmitter of nervous system and is significant in mesolimbic dopamine circulation. Once the GABA defects, the human organism will lose rhythm sensation and become nervous and irritable; in case of severe defect, malignant behaviors such as smoking marijuana and alcoholism will appear. GABA deficiency is the main pathological mechanism that causes anxiety and depression [26].

5-hydroxytryptamine (5-HT) is an important central neurotransmitter. The possible occurrence mechanism of 5-HT in internet addiction is: the serotoniergic neuron and its tracts in central nervous system of internet addicts are damaged, and the 5-HT content in central nervous system is reduced correspondingly; thus, blood platelets are activated to release 5-HT stored internally, which will cause reduction of 5-HT content in the blood platelets [27].

In short, after internet addicts go through short-term "peak experience", their normal level of neurotransmitter, both excitatory and inhibitory, is lower, at a deficient status [28].

Data shows that almost all addictive substances have certain effects on the award system, or affect the function of dopamine in the system directly or work through other neurotransmitters such as 5-hydroxytryptamine, γ-aminobutyric acid and acetylcholine [29,30] pointed out that when the four key neurotransmitters of brain (dopamine, acetylcholine, γ-aminobutyric acid and 5-hydroxytryptamine) are at a balanced status, the words and deeds of an individual will meet normal social norm. Defect or imbalance of neurotransmitter will cause different extents of social aversion, bringing negative effects on personality development and emotional life. Each kind of neurotransmitter has its specific current mode and is transmitted in the form of brain wave. The natural order of brain wave activity is frontal lobe (dopamine), temporal lobe (γ-aminobutyric acid), parietal lobe (acetylcholine) and occipital lobe (5-hydroxytryptamine), and the dominance sequence of the four neurotransmitters also comply with such schema [31,32].

The biometric measurement of neurotransmitter requires extraction of cerebrospinal fluid or application of encephalofluctuograph technology, and that is limited for detection on large crowds and special crowds (such as juveniles). For this reason, [30] prepared *Symptom Scale of Neurotransmitter Deficiency* (SSND) according to his years of brain science research and clinical research results and in reference to various detection means and testing results of chemical components of human brain and their deficiency situation in the past half century. The SSND is used for screening neurotransmitter deficiency extent of human and is proven in clinical practices. Although it is not as accurate as biometric and electrophysiological measurement, SSND is simple, convenient, rapid and economic, and it can yet be regarded as a tool for preliminary screening of neurotransmitter deficiency extent, especially for measurement on juveniles. SSND is already used in Chinese adolescents at present, and its corresponding reliability and validity indexes are already checked [33].

Therefore, a questionnaire survey is proposed to be conducted in the study for neurotransmitter deficiency of internet-addicted urban left-behind children, in order to obtain preliminary psychometrics indexes on neurotransmitter deficiency of internet-addicted urban left-behind children and try to provide psychometric bases for exploration on neurophysiological mechanism of internet addiction. It is assumed in the study that there has difference in neurotransmitter deficiency between internet-addicted urban left-behind children and non-internet-addicted urban left-behind children.

Methods

Participants

The survey involved1,895 urban left-behind children from Chongqing, Hu'nan, Hubei and other regions of China and used *Adolescent Pathological Internet Use Scale* (APIUS) to screen and select internet-addicted urban left-behind children. There were199 internet-addicted urban left-behind children and 1,696 normal urban left-behind children (no person for marginal group), and the detected rate of addiction was10.50% (Table 1).

Tools

Adolescent pathological internet use scale (APIUS): *Adolescent Pathological Internet Use Scale* (APIUS) was prepared by [34], and it is a suitable measurement tool for internet addiction of Chinese adolescents. The APIUS has 38 questions in 6 dimensions: salience—the use of internet as a decisive role in the customer's thinking and behavior, mood alternation—the use of internet to change the customer's negative mental state, social comfort—regarding online communication as a more comfortable, secure means of social contact, tolerance—the customer's increased input of time and energy into the internet to obtain a sense of satisfaction, compulsive surfing of the internet—failure to achieve purposeful lessening of the time spent online and exhibiting an obsessive fascination with the internet, and negative consequence—the negative influence of internet use on normal life, with a focus on the internet-access related issues on interpersonal relationship, health and academic achievements. The scale adopts 5-point self-rating scale, ranging from "absolute inconformity" to "absolute conformity". With KMO index of 0.940 and Cronbach's Alpha coefficient of 0.948, the scale possesses relatively high reliability and validity. In APIUS, participants with average score no less than 3.15 points are defined as "internet-addicted group"; those with average score of 3.00-3.15 points are defined as "marginal group"; those with average score less than 3.00 points are defined as "normal group".

Symptom scale of neurotransmitter deficiency (SSND): *Symptom Scale of Neurotransmitter Deficiency* (SSND) comes from the second part of Braverman's biological characteristics assessment [30] and is used to test whether the content of the 4 main neurotransmitters (DA, Ach, GABA and 5-HT) is deficient. The Scale has 115 items in total. Because the participants are urban left-behind children who are juveniles, the 4 items that involve sexual behavior are deleted. Thus, the SSND used in the study includes 111 items in total, covering symptoms on physiology, personality, character and memory caused by deficiency of the 4 neurotransmitters. There are 24 items for dopamine deficiency, 24 items for acetylcholine deficiency, 38 items for γ-aminobutyric acid and 25 items for 5-hydroxytryptamine deficiency. The participants are

	Group	Number	Proportion (%)
Gender	Male	141	70.9
	Female	58	29.1
Grade	Primary school group	151	75.9
	Middle school group	48	24.1
Type of left-behind	Parents-leaving	127	63.8
	Single-parent-leaving	72	36.2

Table 1: Statistical list for basic information of participants (N=199).

required to select options that meet their own situation based on their current feedings. The constant value for conformity is 1, and that for inconformity is 0. The total points of each item group shall be recorded. The neurotransmitter deficiency extent will be judged as per such points, with higher points indicating severer deficiency extent.

Procedures

The test was carried out in twice respectively based on Adolescent Pathological Internet Use Scale and Symptom Scale of Neurotransmitter Deficiency.

Data processing

Software Epidata3.1 and SPSS19.0 were used for statistical analysis on data. First, valid questionnaires were screened out, and Epidata3.1 was used to establish a database; then, SPSS 19.0 was employed for descriptive analysis,correlation analysis and *t*-test on grouped data; finally, G-power3.1.6 was adopted for effect size and statistical test power analysis.

Results

Reliability and validity analysis on SSND

Because *Symptom Scale of Neurotransmitter Deficiency* (SSND) was employed in Chinese urban left-behind children for the first, and the 4 sex-related questions in it were deleted in the study, Cronbach's Alpha coefficient was adopted in the study for checking the reliability and validity of the scale and each factor in it. The results showed that the Cronbach's Alpha coefficient of the scale was 0.95 and that for each factor was0.79 (DA), 0.81 (Ach), 0.88(GABA) and 0.85(5-HT) respectively, indicating relatively good reliability and validity of SSND.

The construct validity of SSND is checked through calculation of correlation coefficient between each factor and SSND. The correlation coefficient between each factor was 0.67-0.73 which indicated that the direction of each factor was consistent but they were independent from each other. The correlation coefficient between SSND and each factor was 0.86-0.94 which indicated relatively good consistency between each factor and SSND (Table 2).

Status quo of neurotransmitter deficiency of internet-addicted urban left-behind children

General situation of neurotransmitter deficiency of internet-addicted urban left-behind children: According to the assessment standard of the SSND maker [30] on neurotransmitter deficiency extent, 4 grades are divided as per total score in the four groups of items – DA, Ach, GABA and 5-HT. The total score of 0 indicates no neurotransmitter deficiency; the score of 1-5 points indicates mild neurotransmitter deficiency; the score of 6-15 points indicates moderate neurotransmitter deficiency; and the sore more than 16 points indicates severe neurotransmitter deficiency.

The general situation of neurotransmitter deficiency extent of internet-addicted urban left-behind children is as shown in Table 3 below. In aspect of dopamine (DA) deficiency: 1.50% of no deficiency, 23.10% of mild deficiency, 73.40% of moderate deficiency and 2.00% of severe deficiency; in aspect of acetylcholine (Ach) deficiency: 1.50% of no deficiency, 36.70% of mild deficiency, 61.30% of moderate deficiency and 0.50% of severe deficiency; in aspect of γ-aminobutyric acid (GABA): 1.50% of no deficiency, 12.10% of mild deficiency, 38.70% of moderate deficiency and 47.70% of severe deficiency; in aspect of 5-hydroxytryptamine (5-HT): 1.50% of no deficiency, 30.70% of mild deficiency, 60.30% of moderate deficiency and 7.50% of severe deficiency. As for internet-addicted urban left-behind children, the deficiency extent of γ-aminobutyric acid (GABA) was at moderate and severe grades, while that of other factors were at mild and moderate grades (Table 3).

Differential analysis on each category of neurotransmitter deficiency of internet-addictive urban left-behind children: A multi-factor analysis of variance was conducted by taking the gender, grade and type of left-behind of internet-addicted left-behind children as independent variables and each neurotransmitter as dependent variable, and the analysis results showed inexistence of interaction. Now, an analysis was carried out for each main effect.

In the aspect of gender, the SSND scores of most internet-addicted urban left-behind children ranged from 6 to 15 points, at a moderate deficiency level, and the scores of γ-aminobutyric acid (GABA) were near to 16 points, at the lower limit of severe deficiency level. The scores of male children were higher than those of female children (except for DA), and there was a significant difference ($p<0.001$) in γ-aminobutyric acid (GABA) between the two genders. Details are shown in Table 4.

In the aspect of grade, as shown in Table 5, the score for each neurotransmitter ranged from 6 to 14, at a moderate deficiency level, and the score for γ-aminobutyric acid (GABA) was still at a higher level of 14 points, near to severe deficiency level. The score for each neurotransmitter of the primary school group was higher than that of the middle school group; however, the difference in score of each item had no statistical significance ($p>0.05$).

In the aspect of type of left-behind, as shown in Table 6, the score for γ-aminobutyric acid (GABA) was still the highest, over 12 points, at the lower limit of severe deficiency level, and the scores for the other three categories ranged from 6 to 10, at moderate deficiency level. The scores for the four neurotransmitters of parents-leaving group were higher than those of single-parent-leaving group, and significant difference ($p<0.05$) existed.

Comparison on status quo of neurotransmitter deficiency between non-internet-addicted and internet-addicted urban left-behind children

According to study demand, 199 urban left-behind children were selected at random from normal "non-addicted group", and comparison was conducted between such children and urban left-behind children of "addicted group". Table 7 shows the mean value and standard deviation of the score of both groups for each SSND factor. The score (both total score of SSND and score of each factor) of internet-addicted urban left-behind children was higher than that of non-internet-addicted urban left-behind children, and there was a very obvious difference in the score of neurotransmitter deficiency symptoms, which was of statistical significance ($P<0.001$). The score of the addicted group ranged from moderate deficiency level to lower limit of severe deficiency level, while that of the non-addicted group ranged from mild deficiency level to moderate deficiency level. The γ-aminobutyric acid (GABA) deficiency extent of the addicted group still stayed at a high level.

Discussion

Reliability and validity SSND

Symptom Scale of Neurotransmitter Deficiency (SSND) was prepared by American experts with years of verification and is proven in clinical

	Dopamine (DA)	Acetylcholine (ACh)	γ-aminobutyric acid (GABA)	5-hydroxytryptamine (5-HT)	Total score
Dopamine (DA)	1				
Acetylcholine (ACh)	0.72***	1			
γ-aminobutyric acid (GABA)	0.73***	0.73***	1		
5-hydroxytryptamine (5-HT)	0.67***	0.71***	0.70***	1	
Total score	0.86***	0.87***	0.94***	0.92***	1

Note: *: p<0.05; **: p<0.01; ***: p<0.001

Table 2: Correlation coefficient between each factor of SSND and between each factor and SSND.

Deficiency extent	Dopamine (DA)		Acetylcholine (ACh)		γ-aminobutyric acid (GABA)		5-hydroxytryptamine (5-HT)	
	Number	Proportion (%)	Number	Proportion (%)	Number	Proportion (%)	Number	Proportion (%)
No	3	1.50%	3	1.50%	3	1.50%	3	1.50%
Mild	46	23.10%	73	36.70%	24	12.10%	61	30.70%
Moderate	146	73.40%	122	61.30%	77	38.70%	120	60.30%
Severe	4	2.00%	1	0.50%	95	47.70%	15	7.50%

Table 3: General situation of neurotransmitter deficiency of internet-addicted urban left-behind children.

	Male (n=141)		Female (n=58)		*t*	*p*	*d*	Statistical test power
	Mean	SD	Mean	SD				
Dopamine (DA)	8.293	3.612	8.431	4.035	-0.141	0.881	0.031	0.071
Acetylcholine (ACh)	7.542	3.653	6.911	4.054	1.162	0.243	0.162	0.201
γ-aminobutyric acid (GABA)	15.182	7.132	8.511	7.153	**2.713****	0.000	0.930	0.993
5-hydroxytryptamine (5-HT)	9.301	4.901	8.082	5.372	1.614	0.101	0.236	0.321
Total score	40.338	16.197	35.665	18.295	1.862	0.065	0.277	0.382

Note: *: p<0.05; **: p<0.01; ***: p<0.001

Table 4: Comparison on SSND scores between different gender of internet-addicted urban left-behind children.

	Primary school group (n=151)		Middle school group (n=48)		*t*	*p*	*d*	Statistical test power
	Mean	SD	Mean	SD				
Dopamine (DA)	8.355	3.897	8.201	3.175	0.241	0.812	0.047	0.070
Acetylcholine (ACh)	7.574	3.745	6.621	3.794	1.522	0.123	0.255	0.341
γ-aminobutyric acid (GABA)	14.471	8.704	14.253	6.734	0.161	0.862	0.041	0.072
5-hydroxytryptamine (5-HT)	10.124	5.436	8.553	4.896	1.881	0.065	0.300	0.443
Total score	39.433	18.809	38.744	16.323	0.243	0.803	0.030	0.070

Note: *: p<0.05; **: p<0.01; ***: p<0.001

Table 5: Comparison on SSND scores between different grades of internet-addicted urban left-behind children.

practices. The scale was applied in Chinese urban left-behind children for the first time and met statistical requirements through reliability and validity assessment. Although the questionnaire survey was not as accurate as biometric and electrophysiological measurement, the scale was very advisable for preliminary screening of neurotransmitter deficiency extent for its simpleness and economy. The practical value will be further verified along with promotion of more researches (especially combination with biometric and electrophysiological measurement).

Status quo of neurotransmitter deficiency of internet-addicted urban left-behind children

The participants screened out in the study by use of *Adolescent Pathological Internet Use Scale* was of polarization, either internet-addicted or normal, with no person in marginal group, showing the particularity of such addicted group. Reasons remain to be further researched.

In the study, the deficiency rates of internet-addicted urban left-behind children for the four neurotransmitters was as high as 98.50%, and the moderate or above deficiency rates of the neurotransmitters all exceeded 60.00%. The γ-aminobutyric acid (GABA) deficiency rate waspromінent, and its severe deficiency rate was up to 47.70%. Neurotransmitters are tracts for transmitting emotional message. In the four neurotransmitters, γ-aminobutyric acid (GABA) is the only inhibitory neurotransmitter, exerting inhibition effect, while the other three are excitatory neurotransmitters, exerting excitation effect. γ-aminobutyric acid (GABA) is a kind of amino acid composed in vivo by glutamic acid, and it can quiet down nervous excitation, tension and anxiety; therefore, in case of GABA deficiency, anxiety, insomnia and depression will be caused. Dopamine (DA) will bring pleasure and happiness and form gratification award system; in case of deficiency, movement disorders, facial expression deficiency and single speech mode will be caused; while in case of excess, hallucination and delusion will be generated; sensory threshold will be increased; dependency will be formed; and original nervous award system will be broken. 5-hydroxytryptamine (5-HT) has sedative effects such as adjustment of dopamine activity, elimination of restlessness and stabilization of spirit; in case of deficiency, restlessness and impulsion will occur. Acetylcholine (ACh) transmits signals via parasympathetic nerve and motor nerve and is related to learning, memory and sleep, having the effect of soberness [12].

A previous study result [11] indicated that internet-addicted urban

	Parents-leaving group (127)		Single-parent-leaving group (72)		*t*	*p*	*d*	Statistical test power
	Mean	SD	Mean	SD				
Dopamine (DA)	9.141	3.322	6.862	3.971	**4.340*****	0.000	0.621	0.920
Acetylcholine (ACh)	7.795	3.582	6.550	3.982	**2.250***	0.020	0.321	0.491
γ-aminobutyric acid (GABA)	15.053	7.051	12.984	7.412	**1.951***	0.050	0.281	0.411
5-hydroxytryptamine (5-HT)	9.734	4.913	7.520	5.031	**3.012****	0.003	0.442	0.712
Total score	41.731	16.045	33.93	17.359	**3.203****	0.005	0.465	0.744

Note: *: p<0.05; **: p<0.01; ***: p<0.001

Table 6: Comparison on SSND scores between different left-behind types of internet-addicted urban left-behind children.

	Addicted group (n=199)		Non-addicted group (n=199)		*t*	*p*	*d*	Statistical test power
	Mean	SD	Mean	SD				
Dopamine (DA)	8.323	3.732	6.002	3.643	**6.343*****	0.000	0.621	0.931
Acetylcholine (ACh)	7.341	3.772	4.441	3.420	**8.103*****	0.001	0.801	0.990
γ-aminobutyric acid (GABA)	14.307	7.235	8.723	6.712	**8.075*****	0.000	0.801	0.993
5-hydroxytryptamine (5-HT)	8.937	5.057	5.668	4.949	**6.596*****	0.000	0.651	0.943
Total score	38.901	16.90	24.834	16.274	**8.563*****	0.000	0.865	0.993

Note: *: p<0.05; **: p<0.01; ***: p<0.001

Table 7: Difference comparison between internet-addicted and non-internet-addicted urban left-behind children.

left-behind children had characteristics such as anxiety, restlessness, introversion and difficulty in daily communication and that internet addiction had a certain prediction effect on personality trait, which conformed to symptoms expressed under deficiency of the four neurotransmitters. Recent studies indicate that internet-addicted adolescents have insufficient sleep quality and irregular living clock [35-37]. Under dependence on alcohol, nicotine and other substances, repeated in taking of relevant substances would increase the sensory threshold of an individual and change the award and balance system of neurotransmitter [38] Compared with the situation above, internet-addicted individuals were addicted to virtual world and would release a large amount of neurotransmitter; once leaving the internet, they would suffer withdrawal symptom which decreases the neurotransmitter level [28]. Thus, internet addiction affected the neurotransmitter system of urban left-behind children.

In aspect of gender, the deficiency extent on the four main neurotransmitters of left-behind male children was higher than that of left-behind female children (except that on DA), and there was a significant difference in γ-aminobutyric acid (GABA) deficiency extent between the both genders, which indicated that the neurotransmitter deficiency extent of the male children was severer than that of the female children. Generally, the internet addiction rate of male is higher than that of female [2,3,39] and such rule is still applicable in urban left-behind children [11]. High-addiction-level individuals seem to suffer severe neurotransmitter deficiency, but the internal relation is to be further explored.

In aspect of grade, the deficiency extent of each neurotransmitter was at moderate level or above. Although such deficiency extent is of no statistical significance, the neurotransmitter deficiency extent situation of internet-addicted urban left-behind children was not optimistic, especially the situation of primary school group, and special attentions shall be paid in subsequent studies.

In aspect of left-behind type, the score of parents-leaving group was higher than the score of single-parent-leaving group with respect to the deficiency extent of the four neurotransmitters. In the family structure, both of the parents played a different role which could not be replaced by each other; the care by one of the parents had a better effect on the growth of left-behind children than no care by the parents [40]. Some studies had verified that the deficiency of upbringing and education from parent would cause strong negative emotions, imbalanced brain neurotransmitter and various defect symptoms to their children [41].

Comparison on status quo of neurotransmitter deficiency between non-internet-addicted and internet-addicted urban left-behind children

The neurotransmitter deficiency extent of the addicted group of the urban left-behind children was higher than that of the non-addicted group, which was consistent with the study results above, indicating again the correlation between internet addiction and neurotransmitter deficiency. Although the neuro-mechanism of internet addiction lacked sufficient conclusions at present, there was a certain corresponding relation between the internet addiction symptoms and the physiological function and nervous function of an individual [42]. The neurotransmitter imbalance and deficiency of internet addicts would cause some problem behaviors and lead to a series of physical and psychological symptoms [43,44]. The study result was an exploration on the internet addiction neuro-mechanism from the view of psychometrics.

Conclusion

- *Symptom Scale of Neurotransmitter Deficiency* (SSND) was applied in Chinese urban left-behind children, with reliability and validity assessment meeting statistics and psychometrics.

- The neurotransmitter deficiency extent of internet-addicted urban left-behind children was over moderate level; that of male children was higher than that of female children, and that of parents-leaving group was higher than that of single-parent-leaving group.

- The deficiency extent on each neurotransmitter of internet-addicted urban left-behind children was higher than that of non-internet-addicted urban left-behind children.

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