THE PUPILLOMETRIC PREDICTOR OF INTERNET-ADDICTION

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This study aims to investigate the possibilities of using binocular synchronous pupillography as a method of Internet addiction (IA) prediction.

326 undergraduate students (179 females and 147 males, average age = 18,6) took part in this study. They were divided into three groups: "Internet addicted" (34 people), "not-addicted" (136 people), and "moderate-addicted", according to normal distribution of Chen's Addiction Scale results. The pupillography method was used to compare the IA symptoms in IA and Not-IA students.

The total IA in pupillometric parameters was manifested as an increased width of the pupil, emotional instability, exhaustion, slack reactions, combined with the depth of reaction and impetuosity. The severity of Internet addiction was positively correlated with the number of pupillometric parameters.

Our findings suggested that changes in pupil reaction were present in IA students and this finding may provide a new insight into the pathogenesis of IA.

Key words: Internet addiction (IA), pupillometry, pupil reaction, attention disturbances, emotional instability, depression, exhaustion, stress

The modern age is often defined in many ways: Information Age, Connected Age [28] or Internet Age, Information Society [10], Media Society, Network Society [5], Knowledge Society [24] or Meaning Society [4]. Castells said that the impact of Internet technologies is comparable to that of the Industrial Revolution [5]. Now Internet technologies are disseminating across the world with high speed. In 2014 there were 277 million Internet users in the USA, 643 in China and 87 million in Russia. Online access is a vital part of the modern world and an important tool in the education; as well as it is a highly entertaining and informative medium.

Current research suggests that the psychological consequences of informatization are ambiguous and may include both positive and negative aspects.

The last decade has witnessed a large increase in research on the newly emerging mental health problem of Internet addiction. Recently, Internet addiction (IA) has been

considered a serious public health issue [12; 29]. IA is a compulsive-impulsive spectrum disorder that involves online and/or offline computer usage and identifies problematic Internet use associated with significant social, psychological, and occupational impairment [23; 27].

Current research suggests that the consequences of addictive use of computer are ambiguous and may lead to whole range of psychological and psychosocial disturbances [7]:

— ***cognitive disturbances***. The overuse of Internet tools may cause attention disorders (ADHD) and the decrease in the cognitive control efficiency in children and adolescents [20], as well as the problems with reading in the senior preschool children [22]. Turkle [21] argues that animism is a feature of the thinking process of internet-addicted people;

— ***disturbance of social skills:*** social anxiety (*fear of missing out*) [19], social isolation [17], familial discord, divorce, financial debt and job loss [6; 11; 13];

— ***emotional disturbances****:* depression, social phobia, and hostility [9]. Anderson and Bushman [1] discovered the disorder of empathy caused by Internet addiction (the mild violence phenomenon);

— ***academic achievement***. Angrist and Lavi [2] noted a decline in academic performance in mathematics in fourth graders, in many subjects in senior pupils after the introduction of computers in school. Sim et al. [19] showed a strong positive correlation between the duration of play in aggressive "action" or "shooter" computer games with impulsive behavior in schoolchildren and the negative correlation was found between duration of play and academic performance.

In addition, Y.Zhou et al. discovered *special changes in brain structure* (lower gray matter density in the left anterior cingulate cortex, left posterior cingulate cortex, left insula, and left lingual gyrus) in IA adolescents [29].

Addiction components criteria are: 1) excessive use, often associated with a loss of sense of time or a neglect of basic drives, 2) withdrawal, including feelings of anger, tension, and/or depression when the computer is inaccessible, 3) tolerance, including the need for better computer equipment, more software, or more hours of use, and 4) negative repercussions, including arguments, lying, poor achievement, social isolation, and fatigue [3].

Traditionally IA and its symptoms is measured by the self-report questionnaires. Present study was conducted with objectives to determine the pupillometric characteristics of IA. We compared cognitive, psycho-emotional features, and psychophysical condition (measured by pupillometry method) in Internet-addicted and not-addicted students. We also assessed the demographic background and types of Internet use.

The ***participants*** were 326 undergraduate students from State University of Humanities and Social Studies (179 females and 147 males). The mean age was 18,6 years old. Questionnaire and pupillometry were administered in class at two separate times to maximize participation in the survey. Respondents were offered extra credit for participating in the study.

The respondents were divided into 2 groups: "Internet-addicted" and "Not addicted" to the Internet. The division was based on the normal distribution of Chen`s test results.

The Internet-addicted group consisted of Examinees who scored more than 57 points by CIAS (22 girls and 12 boys). It was 10.1% of the total number of Examinees: 11.9%

of the total number of female and 8.3% of the total number of male respondents. 136 people (70 girls and 66 boys) were included in the "not addicted" group, they scored less than 43 points by CIAS. The results of students with moderate level of IA (43—57 points by CIAS) were not considered.

Internet addiction was studied by The Russian adaptation of Chen`s Addiction Scale (CIAS) adapted by Feklisova and Malygin [14]. CIAS is a 26-item self-report measurement scored on a 4-point Likert scale.

The CIAS consists of five subscales: Symptom of compulsive use (Sym-C), Symptom of withdrawal (Sym-W), Symptom of tolerance (Sym-T) Symptoms of Internet addiction, Scale of interpersonal and health-related problems (RP-IH) and Time management problems scale (RP-TM). The minimum score of the CIAS is 26 and the maximum is 104, respectively. Higher scores indicate increased severity of addiction to Internet activity.

The ***pupillographic measurements*** were performed with "Sambon Stress and Soul" (SSaS) pupillometer, developed by the South Korean company "Sambon Precision and Electronics Co., LTD". The measurements are based on the automatic pupil detection algorithms [15]. That allows the physiological and psychological characteristics of the subject to be determined by the reaction of the pupil to light flash. It is known that the pupillography method (registration and analysis of a pupillary reflex — pupil reaction for light stimulus) may be used to find dependence of an examinee's physical conditions and characteristics of his or her vegetative nervous system's activity, for example reactivity, speed of reaction, overall stamina, restoration ability of an organism after stimulus [8; 16].

Pupillography testing consists of:

— synchronous video registration of pupil reactions for supraliminal light stimulus (flash more bright than minimal for photoreaction) of both eyes;

— automatic processing of eye images and pupillograms building;

— computing of pupillographic parameters;

— interpretation of results.

Pupillograms are registered three times during the test. First and second registrations are made with a light stimulus of 3 lux intensity and a 10 milliseconds duration (weak flash). Third light stimulus has an intensity of 145 lux and a duration of 30 milliseconds (strong flash). The duration of each registration is 2,5 seconds. The flash is set off simultaneously for both eyes. Pupillogram's registration for both eyes is done synchronously. The overall time of the procedure is about 3 minutes.

The SSaS method is based on the analysis of three basic phases of pupillary reaction (Fig.1):

1. Latent period: the time between the moment of the light stimulation and the start of the pupil constriction. It is marked as 'Tlat' in Fig.1.

2. The phase of pupil constriction, which reflects the condition of the parasympathetic nervous system ('Para' in Fig.1). The parasympathetic phase contains three parts:

— First part: the region, where pupil starts its constriction. At this part the speed of pupil constriction is increased.

— Second part: The speed of pupil constriction is constant.

— Third part: the speed of pupil constriction is reduced. The end of this part is time when a pupil comes to its minimal size.

3. The restoration phase, which reflects the condition of the sympathetic nervous system ('Symp' in Fig.1).

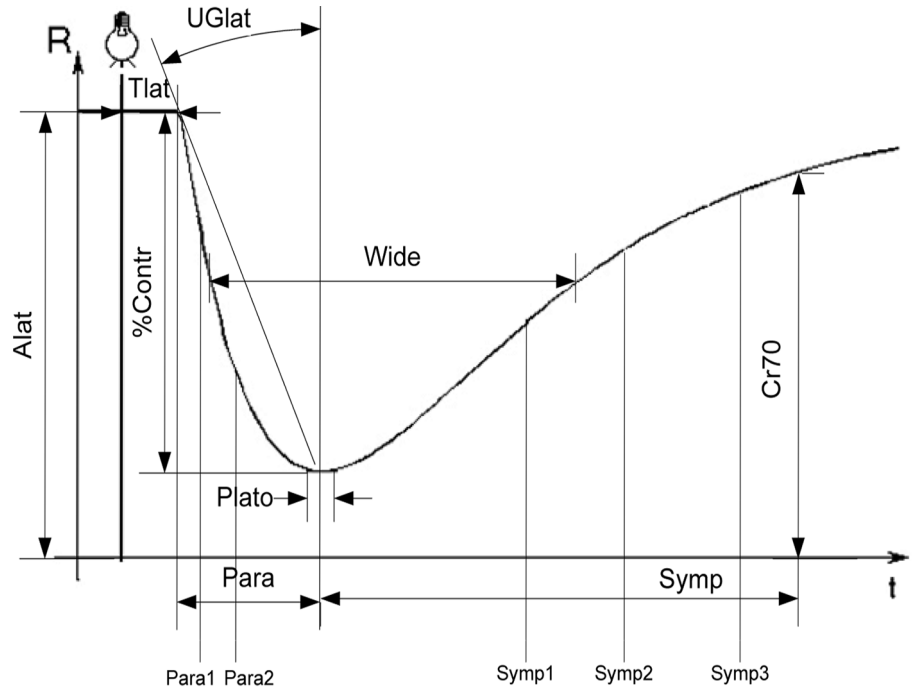

Fig. 1. Pupillogram and its diagnostic criteria

Note. Fig. 1 shows the following coordinates: axis of abscissa (t) — time, axis of ordinates (R) — pupil size.

The figure denotes:

Alat — initial pupil size.

%Contr — amplitude of reaction, measured as a constriction of pupil in percents relative to initial pupil size.

Tlat — duration of latent period of pupil constriction, i.e. time elapsed from light flash till the start of pupil reaction.

Para — duration of parasympathetic phase, phase of pupil constriction.

Plato — duration of latent period of recovery, time from stopping constriction till starting dilation. This is the width of the plateau. This value as well as Tlat phase of pupil reaction characterizes agility of neural processes, i.e. speed of switching between excitation and inhibition.

Symp — duration of control part of sympathetic phase of pupil reaction i.e. time passed from minimal point. Duration is 1,2 seconds. Really pupillary reaction for light stimulus and full pupil size restoration continues more than three seconds in most cases. As soon in current method registration time of pupil reaction takes 2,5 seconds, fixed time after point of minimal pupil radius was selected for restoration criteria. It is situated in 2,5 sec of pupil reaction in any case. At the end point of control part the restoration criteria (Cr70) is calculated.

Cr70 — restoration criteria — pupil size at the fixed time 1,2 sec from point of minimal pupil size.

Wide — time measured from point of half constriction of pupil size to same radius of restoration.

UGlat — criterion of pupil constriction activity, which is an angle between the ordinate axis and direction from minimum to start point of constriction.

Para1 — end of first part of pupil constriction phase (the speed of constriction is increased before this point).

Para2 — end of second part of pupil constriction phase (constriction part with constant speed).

Symp1 — the time point, when pupillogram starts to curve in restoration phase.

Symp2 — the time point of crook center in restoration phase.

Symp3 — the time point, when pupillogram ends to curve in restoration phase.

There are also following derived parameters that are calculated as combination of several above parameters:

CrLPhS — criteria of instability of latent part of pupil reaction. The parameter evaluates the excitement, psycho-emotional instability.

Exhaustion — the derived parameter that computes deviation from norm of parameters characterized pupillomotoric system weakness and correspondingly nervous system tiredness.

Activity — the derived parameter that computes deviation from norm of parameters characterized pupillomotoric system activity and correspondingly nervous system excitation.

Stress — the derived parameter that computes deviation from norm of parameters characterized pupillomotoric system and correspondingly nervous system stability.

Pupillometry results comparisons were performed between the groups using the two-sample t-test and the correlation analysis with SPSS 20. The significance levels were set at $P < 0,05$.

Hypothesis No. 1. It is known, the IA would typically be accompanied by the attention disturbances, emotional imbalance, exhaustion, stress and depression. We assumed that pupillometric parameters reflected these IA symptoms would be different in two groups.

Hypothesis No. 2. At the different stages of Internet addiction formation, its pupillometric predictors may be different.

The differences in computer usage between two groups are presented in the Table 1.

Table 1

Differences in computer usage between "Internet-addicted" and "Not-addicted" students

	Internet-addicted group	Not-addicted group
Beginning age of computer usage	11,04	12,03
Beginning age of Internet usage	13,01	14,23
The daily time of computer usage:		
1–3 hours per day	15,15%	51,47%
4–7 hours per day	63,64%	35,29%
More than 7 hours per day	21,21%	13,24%
Types of computer usage:		
Playing computer games	29,9%	19,1%
Surfing on the Internet	76,74%	53,1%
Communicating in social networks	69,77%	36,17%
Listening to music	51,1%	48,9%
Watching movies	27,66%	32,56%
Reading	40,3%	61,7%

The results of t-test are given in the Table 2.

The significant differences between two groups were found at 11 from 14 pupillometric parameters for a weak flash (the pupil reaction to the weak flash gives an indication of the sensitivity of the nervous system) and at 8 from 14 pupillometric parameters for a strong flash.

Table 2

Differences in pupil reaction to weak and strong flashes between "Internet-addicted" and "Not-addicted" students

Parameters		Weak flash				Strong flash		
	Not-addicted	Addicted	t	p	Not-addicted	Addicted	t	p
Alat	55,15	56,75	–2,14	0,03	54,43	54,65	–0,3	0,76
%Contr	10,82	9,52	2,13	0,03	23,84	21,83	3,19	0
Tlat	285,26	290,25	–1,08	0,28	244,92	250,63	–2,25	0,03
Para	390,49	414,53	–2,72	0,01	529,91	502,3	3,42	0
Plato	239,02	286,91	–4,42	0	200,77	201,86	–0,37	0,75
Cr70	91,56	68,08	3,49	0	66,82	67,9	–0,74	0,46
Wide	739,2	695	1,76	0,08	1051,21	980,43	2,1	0,04
UGlat	76	77,78	–2,64	0,01	67,92	68,57	–1,36	0,17
Para1	378,07	385,88	–1,6	0,11	342,72	347,57	–1,5	0,13
Para2	479,24	497,5	–3,12	0	522,83	505,57	2,26	0,02
Symp1	969,02	901,62	2,9	0	1077,32	1048,43	2,75	0,01
Symp2	1110,19	1028,68	3	0	1289,52	1245,86	2,62	0,01
Symp3	1331,67	1231,03	2,95	0	1637,02	1577,86	2,9	0
CrLPhS	0,33	–0,02	2,21	0,03	30	10	1,33	0,18

For both strong and weak stimulus the features of both parasympathetic and sympathetic phase of the pupil reaction between following parameters are most significant: *%Contr*, *Para*, *Para2*, *Symp1*, *Symp2*, *Symp3*.

Data analysis has shown that the following features characterize the pupil reaction to the weak flash in the Internet addicted group: a longer time and faster speed of the pupil constriction (parameters *Para* and *Wide*). The pupil reaction in this group is shallow and the time of transition from constriction into restoration is higher in comparison with the not-addicted students (parameters *%Contr* and *Plato*). The depletion of resources and exhaustion in the Internet-addicted group were shown by differences of parameters at sympathetic phase (*Symp1*, *Symp2*, *Symp3*). The percentage of pupil recovery after light flash (parameter *Cr70*) in the Internet-addicted group is less than in the not-addicted group that shows the high level of exhaustion and stress in Internet-addicted people.

The parameter *CrLPhS* indicates the level of excitement and emotional anxiety. In the not-addicted group, this parameter for the weak flash reaction is higher than in Internet-addicted students. They perceive the insignificant stimulus as a full-fledged stimulus, whereas the dependent students do not give any emotional response to external stimulation.

The first weak flash in a pupillometry method is considered a kind of pre-stimulation of the pupillomotoric system, preparation for a strong stimulation. Seeing as that the Internet-addicted students have extensive experience of interaction with Internet devices (flashing computer screen), their pupillomotoric system is more trained and prepared, that is why the Internet-addicted students don't perceive a weak flash as a significant signal. We can conclude that the threshold of sensitivity in the addicted students is higher than the threshold in the not-addicted students. It means that it is more difficult for them to concentrate and keep their attention on the slight stimulus and uninteresting information. Moreover, their attention, due to the general exhaustion of the nervous system is unstable.

Whereas the not-addicted students, react fully, deeply and emotionally to a weak stimulation.

Interesting results have been shown for the reaction to the strong flash. As well as for weak flash, the Internet-addicted students spent more time at the start of the pupil reaction (parameter *Tlat*), the phase of constriction was completed faster than in not-addicted group (parameter *Para*). As previously noted with weak flash, the trend of superficial reaction and higher speed of pupil reaction for the strong flash remained the same (parameters *%Contr* and *Wide*). As for a weak flash, lower rates of parameters at sympathetic phase in Internet-addicted students indicated that they had a higher degree of tiredness (parameters *Symp1*, *Symp2*, *Symp3*). Thus in the habitual stimulus environment the nervous system of the addicted students began to react more sharply and more quickly but not deeply. Signs of tiredness and exhaustion are stored for a strong flash. Higher rates in the parameter *CrLPhS* indicate higher level of excitement in the not-addicted students, whereas for the addicted the situation of hyper stimulation is habitual.

Thus, on a psychological level the combination of insensitivity to weak stimulation, little depth of reaction and signs of exhaustion in the Internet- addicted students means that they find it difficult to attract and retain their attention, they need more time to be included in the work, and the process of their attention and concentration could be short-term, volatile and shallow. It is particularly difficult to attract and retain the attention of the stimulation of low power. The Internet-addicted students showed the greater emotional stability, lack of excitement during the reaction to an unexpected stimulation. At the same time, the signs of depression were found in this group with the strong flash. *Exhaustion*, *Stress* and tiredness (parameter *Activity* reflects it) are integral features of the Internet-addicted students. It is clearly seen in Table 3. The Hypothesis No.1 was confirmed.

Table 3

Levels of "*Exhaustion*", "*Activity*" and "*Stress*" variables in "Internet-addicted" and "not-addicted" groups

Parameters	Level	"Not-addicted" group	"Addicted" group
Exhaustion	norm	86%	68,60%
	intensive	7%	20%
	pathology	7%	11,40%
Activity	norm	52%	3%
	intensive	38%	60%
	pathology	10%	37%
Stress	norm	86%	3%
	intensive	13%	88%
	pathology	6%	10%

The correlation analysis showed that the pupillometry parameters for the weak flash of Internet-addicted students were more closely associated with the addiction scales (37 relationships — for the Internet-addicted group and 21 relationships — for the not-addicted students) (Table 4).

Table 4

Correlation between IA scales and pupillometric parameters in two groups for the weak flash

Internet-addicted group														
	Alat	%Contr	Tlat	Para	Plato	Cr70	Wide	UgLat	Para1	Para2	Symp1	Symp2	Symp3	CrLPhS
Sym-C	,273*	0,098	0,013	0,135	0,057	–,342**	0,127	–0,098	0,051	0,169	0,032	0,028	0,027	–,307*
Sym-W	,242*	0,216	–,310*	0,118	–0,061	–0,228	,263*	–0,194	–0,156	–0,089	0,017	0,068	0,097	–,384**
Sym-T	0,193	0,156	–0,119	0,005	–0,061	–,267*	0,086	–0,189	–0,125	0,000	–0,065	–0,057	–0,031	–,252*
RP-IH	0,146	0,104	0,079	0,036	–0,069	–,323**	,241*	–0,083	0,148	,314**	,246*	0,222	0,235	–,385**
RP-TM	0,152	,327**	–,369**	,263*	0,003	–,35**	0,181	–,310*	–,337**	–0,046	–0,015	0,075	0,166	–,435**
IA	,285*	,266*	–0,204	0,171	–0,040	–,442**	,277*	–,252*	–0,113	0,118	0,087	0,123	0,171	–,528**
Not-addicted group														
Sym-C	Alat	%Contr	Tlat	Para	Plato	Cr70	Wide	UgLat	Para1	Para2	Symp1	Symp2	Symp3	CrLPhS
Sym-W	0,081	–0,010	–0,025	0,060	0,035	–0,036	0,085	0,008	–0,030	–0,005	–0,016	0,037	0,067	–0,090
Sym-T	0,017	0,007	0,023	,160**	0,038	–0,017	0,075	0,050	0,072	,173**	0,047	0,071	0,090	–,121*
RP-IH	–0,049	0,042	–0,009	0,021	–0,017	–0,009	–0,014	–0,0147	0,020	–0,007	0,009	–0,010	0,024	–0,117
RP-TM	–0,049	0,098	–,203**	–0,066	–,146*	0,040	–0,057	–,157*	–,229**	–,168**	–,171**	–,165**	–,142*	0,042
IA	0,041	0,073	–0,059	0,040	0,012	–,139*	–0,016	–0,061	–0,039	0,080	0,022	0,022	0,042	–0,095
Sym-C	0,010	0,080	–0,100	0,084	–0,030	–0,059	0,026	–0,077	–0,072	0,034	–0,038	–0,016	0,031	–,146*

* — the significance level is at $P \leq 0,05$; ** — the significance level is at $P \leq 0,01$.

The results of pupillometry to the weak flash were more informative, because they describe the psychophysical status and shallow neurological diseases of a person that are less discernible during a strong flash. Thus, at the different stages of addiction formation the physiological predictors are different. The Hypothesis No.2 was confirmed.

Two pupillometric parameters: *Cr70* and *CrLPhS* were the most closely connected with the IA scales. The *Cr70* parameter (its low level shows the high degree of the nervous system exhaustion) — had negative correlation with scales of all tendency. The overuse of computer and other Internet devices may lead to a decrease in resources and an exhaustion of the nervous system, which was fixed during pupillography. The parameter *CrLPhS* gives an indication of the excitement and emotional instability of a person. For Internet-addicted students high rates on *CrLPhS* were combined with high scores on the compulsive use scale (*Sym-C*), tolerance (*Sym-T*), the scale of interpersonal and health-related problems (*RP-IH*) and time management scale (*RP-TM*).

Compulsiveness (*Sym-C*) as an indicator of IA on the level of pupillometry appears as a wider pupil size at the start of reaction, general exhaustion and excitement.

A withdrawal symptom (*Sym-W*) (anxiety, agitation, obsessive thoughts about what is happening on the Internet) is seen as a wider pupil size at the start, a shortened latent period before the pupil constriction, slackness of reaction and emotional instability.

High scores on a tolerance symptom (*Sym-T*) scale in the Internet-addicted group are connected with exhaustion, emotional instability and anxiety.

The interpersonal and health-related problems (*RP-IH*) scale correlates with a high level of exhaustion, fatigue, slack reaction and emotional instability.

Students who have problems with time management (*RP-TM*) are characterized by a shorter latent period before the response to the weak flash, durability of reaction connected to high amplitude of the pupil constriction, impulsiveness, exhaustion, emotional instability and shorter period of acceleration speed of constriction.

The total IA in pupillometry parameters is manifested as an increased width of the pupil, emotional instability, exhaustion, slack reactions, combined with the depth of reaction and impetuosity (activity of reaction).

At the strong flash, the number of correlations between the scales of IA and pupillometric parameters in the Internet-addicted group reduced to 23 correlations, as opposed to the not-addicted group where the number of correlations increased to 41correlations (Table 5).

The reduced specificity of the relationships between the Internet-addiction scales and pupillometric parameters in both groups can be explained by the fact that a strong flash erases irrelevant, weak symptoms and allows for detection of more serious diseases.

At the strong flash, the scales of the interpersonal and health-related problems and compulsiveness are more closely connected with pupillometric parameters in Internet-addicted students.

The scale of the interpersonal and health-related problems in the Internet-addicted group appears as a weak pupil reaction, accompanied by a rapid depletion.

Compulsiveness at a psycho-physiological level is revealed as a slackness and slowness of pupillary reaction during the phase of constriction.

Conclusion. To our knowledge, this was the first study that reported the pupillometric parameters in Internet addicted students. The experimental hypotheses were confirmed that allowed proving that the binocular synchronous pupillograghy method could be a predictor of Internet addiction and its symptoms.

Table 5

Correlation between IA scales and pupillometric parameters in two groups for the strong flash

Internet-addicted group														
	Alat	%Contr	Tlat	Para	Plato	Cr70	Wide	UgLat	Para1	Para2	Symp1	Symp2	Symp3	CrLPhS
Sym-C	,062	–,207	,200	,009	,185	–,004	,326**	,242*	,277*	,066	,219	,187	,167	,137*
Sym-W	,007	–,036	,052	,270*	–,130	,133	–,007	–,053	,054	–,080	–,080	–,119	–,151	,115
Sym-T	–,065	,071	,044	–,066	–,042	–,048	,235	–,054	–,003	–,008	,054	,085	,095	,021
RP-IH	,207	–,230	,194	,193	,303*	–,331**	,327**	,236*	,190	,206	,336**	,274*	,126	–,020
RP-TM	–,069	,066	–,120	,046	,029	–,291*	,043	,018	–,128	–,099	,120	,179	,023	–,061
IA	,060	–,116	,110	–,007	,123	–,186	,265*	,119	,118	,035	,207	,189	,071	,049
Not-addicted group														
Sym-C	Alat	%Contr	Tlat	Para	Plato	Cr70	Wide	UgLat	Para1	Para2	Symp1	Symp2	Symp3	CrLPhS
Sym-W	,123*	–,021	–,035	,135*	,048	–,091	,172**	,052	–,047	,109	,164**	,152*	,185**	–,094
Sym-T	,059	–,143*	,079	–,006	,089	,060	,070	,139*	,031	,043	,070	,028	,058	–,074
RP-IH	–,027	–,042	,084	,020	,059	,094	,117	,086	,068	–,060	,081	,076	,083	,014
RP-TM	–,078	,230**	–,068	,219**	–,014	–,112	,197**	–,093	–,023	,143*	,165**	,154*	,160**	,067
IA	,190**	–,048	–,001	,100	,029	–,114	–,029	,006	,015	,074	,045	,007	,024	–,013
Sym-C	,103	–,006	,027	,190**	,085	–,062	,213**	,075	,022	,123*	,212**	,167**	,204**	–,035

* — the significance level is at $P \leq 0,05$; ** — the significance level is at $P \leq 0,01$.

Our findings suggested that changes in pupil reaction were present in IA students and this finding may provide a new insight into the pathogenesis of IA. It should be noted that further research enable to deepen and make more reliable our conclusions.

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ПУПИЛЛОМЕТРИЧЕСКИЕ ПРЕДИКТОРЫ ИНТЕРНЕТ-ЗАВИСИМОСТИ

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Целью данного исследования является изучение возможности использования бинокулярной синхронной пупиллометрии как метода измерения интернет-зависимости.

В исследовании участвовало 326 студентов (179 женщин и 147 мужчин, средний возраст респондентов — 18,6 лет). Участники были разделены на три группы: «интернет-зависимые»,

«независимые от Интернета» и «умеренно зависимые» на основе данных нормального распределения результатов по тесту интернет-зависимости (Chen's Internet Addiction Scale). Пупиллометрия была использована для сравнения выраженности показателей интернет-зависимости в двух группах.

Интернет-зависимость в пупиллометрических параметрах проявляется как увеличенная ширина зрачка, эмоциональная нестабильность, истощение, вялость зрачковой реакции в сочетании с глубиной и стремительностью реакции. Уровень интернет-зависимости положительно связан с количеством пупиллометрических параметров. Результаты свидетельствуют о том, что у интернет-зависимых студентов присутствуют изменения в реакции зрачка, результаты могут обеспечить новый взгляд на патогенез интернет-зависимости.

Ключевые слова: интернет-зависимость, пупиллометрия, зрачковая реакция, расстройство внимания, эмоциональная нестабильность, депрессия, истощение, стресс