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CONTENTS

LEGAL AND POLITICAL SCIENCE

Bondarchuk N. V. THE ROLE OF PUBLIC-PRIVATE PARTNERSHIP IN DEVELOPING OF CIVIL SOCIETY....	4
Мідик Оксана Михайлівна ЕКОНОМІЧНІ ТА СОЦІАЛЬНІ НАСЛІДКИ ЕМІГРАЦІЇ МОЛОДІ З УКРАЇНИ.....	8
Провоторов Олександр Петрович ВПЛИВ «ТЕОРІЇ ФІКЦІЇ» НА ФОРМУВАННЯ СУБ'ЄКТУ ЗЛОЧИНУ В КРИМІНАЛЬНОМУ ПРАВІ УКРАЇНИ.....	13

MEDICINE

Filimonova N. I., Geyderikh O. G., Antusheva T. I., Tischenko I. Yu. ANALYSIS OF BACTERIOLOGICAL PREVALENCE INDICATORS OF CORYNEBACTERIUM DIPHTHERIAE AMONG THE POPULATION OF KHARKIV REGION (UKRAINE).....	16
Hloba N. S., Isaeva I. N., Karmazina I. S., Marakushin D. I. INFLUENCE OF PHYSICAL ACTIVITY ON ORGANISM'S ADAPTATION TO CHANGES OF WEATHER CONDITIONS.....	22
Maslova N. M. EVALUATION OF THE REACTION OF THE VISUAL SYSTEM OF STUDENTS OF DIFFERENT AGE GROUPS TO A PRINTED LOAD WITH DIFFERENT DESIGN PARAMETERS.....	25
Тихон Алёна ФУНКЦИОНАЛЬНЫЕ ИЗМЕНЕНИЯ В ОРГАНИЗМЕ ПРИ ФИЗИЧЕСКИХ НАГРУЗКАХ.....	28
Кармазіна І. С., Маракушин Д. І., Ісаєва І. М., Глоба Н. С. ЦИТОКІНИ ТА С-РЕАКТИВНИЙ БІЛОК – ТРИГЕРИ ДИСБАЛАНСУ СИСТЕМИ ГЕМОСТАЗУ ПРИ ЗАПАЛЕННІ.....	32
Оспанова А. С., Керимкулова А. С., Рымбаева Т. Х., Маркабаева А. М. УРОВНИ ЛИПИДОВ КРОВИ, ГЛЮКОЗЫ У ПОДРОСТКОВ 12-13 ЛЕТ И ИХ СВЯЗЬ С АРТЕРИАЛЬНОЙ ГИПЕРТЕНЗИЕЙ.....	37
Жумакаев А. М. СРАВНИТЕЛЬНЫЙ АНАЛИЗ ЛЕЧЕНИЯ КАМНЯ ВЕРХНЕЙ ТРЕТИ МОЧЕТОЧНИКА.	40
Скак К., Мутайхан Ж. СРАВНИТЕЛЬНАЯ ХАРАКТЕРИСТИКА ЛАБОРАТОРНЫХ МЕТОДОВ ДИАГНОСТИКИ МЛУ ТБ.....	43
Тиленова Л. С., Тажиева А. Е. ФАКТОРЫ ПРОФЕССИОНАЛЬНОГО ВЫГОРАНИЯ МЕДИЦИНСКИХ СЕСТЕР.....	48
Mirzamuhammedov O. M., Akhmedova S. M. STATE OF THE MYOCARDIUM IN EXPERIMENTAL TOXIC MYOCARDITIS.....	53

VETERINARY SCIENCE AND PHARMACY

Козіко Н. О., Негода Т. С., Саханда І. В. SWOT – АНАЛІЗ ЯК ЕТАП МАРКЕТИНГОВОГО ПЛАНУВАННЯ ДІЯЛЬНОСТІ ФІТОВІДДІЛІВ АПТЕК.....	56
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TOURISM AND RECREATION

Ковальська Л. В., Вичівський П. П. ВПЛИВ МІГРАЦІЙНИХ ПРОЦЕСІВ НА РОЗВИТОК ТУРИЗМУ В УКРАЇНІ В ПЕРІОД АГРЕСІЇ РОСІЙСЬКОЇ ФЕДЕРАЦІЇ.....	59
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EVALUATION OF THE REACTION OF THE VISUAL SYSTEM OF STUDENTS OF DIFFERENT AGE GROUPS TO A PRINTED LOAD WITH DIFFERENT DESIGN PARAMETERS

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Abstract. *The results of the evaluation of the visual system of 199 students of three age groups for a printed load with different parameters of registration using the method of pupilligraphy are presented. Comparison of the functional response of children and teenagers to different types of text load allowed to see that decreasing of the print size among teenagers, when the visual system is already formed and sufficiently resistant to unfavorable effects, causes a much weaker reaction than among children. Among teenagers, the number of persons with a pronounced asymmetry of functioning increases insignificantly with a soft load (only 1.5%) and only 6.5% when working with a "hard" load. Obviously, the positive influence of the "soft" load on the children's visual system (significant growth of symmetric and slightly asymmetric functioning in comparison with the initial state) is evident.*

Keywords: *asymmetry, pupilligraphy, visual system, reading, printed load.*

Introduction. The visual analyzer is the main "channel" through which information is received about the surrounding world. It accounts for more than 90% of the total information perceived by the human body. Maximum adaptation of a person to environmental conditions is possible only with the successful operation of both the peripheral and the central parts of the visual analyzer. During the growth and development of the child, the success of the process of forming the visual analyzer depends both on the characteristics of its structural and functional organization, and on the quality and quantity of visual information that needs to be processed. Based on this, the evaluation of the environment of a person (and especially a child) as a kind of "visual habitat" is important [2, 8, 10, 11].

Since the formation of the visual system occurs in the process of adapting it to the visual load, and the obtained result largely depends on both the initial condition of its elements and the character of the visual tasks that must be solved, so why it is necessary to monitor constantly their quality and quantity [2, 5, 6, 8, 13].

The research of the diameter of the pupils of the eyes in the visual system before and after the visual load allows us to judge the mechanisms of adaptation and symmetry of its functioning [3, 12, 14]. In addition, the diameter of the pupil allows to judge indirectly the degree of tension of accommodation, which is also important for evaluating the response of the visual system to the visual load.

With the action of light on one eye, the pupil of this eye narrows (direct reaction), as well as the pupil of the other eye (friendly reaction). Normally, these reactions are similar. After the flash, the recovery time (i.e., the latent period of the pupillary-dilatation reaction) to the original pupil size is 0.2 to 0.6 seconds [7], and in some cases up to 1-3 minutes.

While taking a photo-registration of pupils, it is necessary to take into account the presence of both the friendly reaction of the pupil of the unlighted eye and the latent period of the pupillary dilatation reaction. Therefore, the time of photographing one eye should be less than 0.15 seconds, and the time between shooting the right and left eyes is more than 1-3 minutes. Then the results obtained will correspond to the objective picture of the pupils' state, and not be the result of a reflex friendly reaction to the effect of light on the other eye. This approach to research of pupillary reactions is due to our goal, which is to evaluate the response of the visual system of students of different age groups to a printed load with different parameters of registration using the method of pupilligraphy.

Materials and methods of research. Photo-registration of pupils of the eyes in the dynamics of visual work was carried out with the help of a photophthalmoscope FOSP-1. The pupil diameter was measured from photo-prints, and the diameter of the pupil of each eye was determined by calculating the mean value between its vertical and horizontal dimensions. Obtained values were normalized, which was accomplished by dividing the mean diameter of the pupil by the average diameter of the cornea of the corresponding eye [4, 7, 9].

119 children (60 boys and 59 girls) from 7 to 15 years old took part in the research of the effect of the text load on the functional state of the visual system of students of different ages.

The visual load was carried out by students doing dosed work in the form of reading and recognizing letters. According to age, each subject was given a fixed visual load in the form of Anfimov's tables. The print size was 10 (soft reading) and 7 (hard reading) typographic items. The researches were conducted in two stages during two days. Each of the subjects performed searching and selecting of a certain letter in the text of the table.

Results of the research. To quantify the degree of functional asymmetry in the visual system of children and teenagers in the dynamics of reading texts, the moduli of the difference in the relative diameter of the pupils of the right and left eyes of each subject were calculated. Depending on the magnitude of these differences, we proposed three gradations: 1-st symmetry (0-0.02); the 2-nd is a small asymmetry (0.03-0.04); 3rd - marked asymmetry (0.05 and more). The results of dividing the subjects into groups before and after reading the two kinds of texts are presented in the table. Based on the preliminary analysis of facts, the subjects were divided into two groups (excluding sex, as there were no significant differences in this indicator between boys and girls). The first group included the subjects of the younger group (children), the second group - the middle and the senior (teenagers).

Table 1. Results of evaluation of the pupilographic facts of subjects during the reading process

groups	loading	amount of subjects (%)		
		1 gradation	2 gradation	3 gradation
children	before reading	37	23	40
	soft reading	46	25	29
	hard reading	38	20	42
teenagers	before reading	63	18,5	18,5
	soft reading	67	13	20
	hard reading	33	42	25

From the table, it is obvious that the majority of junior schoolchildren before work have an asymmetry in the diameter of the pupils, which may indicate an initial asymmetry of the visual system, due to its functional immaturity. As a result of working with a "soft" visual load (optimally corresponding to a given age group in terms of design parameters), the number of children with symmetry and a slight asymmetry in the functioning of the visual system increases.

When working with "hard" (not optimal by design parameters, with an obviously understated print size) load, the number of persons with the asymmetry of functioning returns to the original level. This result shows that a non-age-appropriate text load, which is constantly being presented, will cause the formation of a functionally asymmetric visual system, which under certain conditions can serve as a foundation for the emergence of pathology (strabismus, amblyopia).

In the group of teenagers, the majority of the subjects had the initial functional symmetry of the visual system. Working with a "soft" load led to an increase in the number of persons with symmetry of functioning and a small increase in the number of persons with a pronounced asymmetry of functioning. The "hard" load led to a twice decrease in the group with symmetry of functioning and an increase in asymmetry, although, mainly, due to moderate asymmetry.

Comparison of the functional response of children and teenagers to different types of text load allows us to see that underestimation of the print size in teenagers, when the visual system is already formed and sufficiently resistant to unfavorable effects, causes a much weaker reaction than in children. In teenagers, the number of persons with a pronounced asymmetry of functioning increases insignificantly with a soft load (only 1.5 %) and only 6.5 % when working with a "hard" load. Obviously, the positive influence of the "soft" load on the children's visual system is evident (significant growth of symmetric and slightly asymmetric functioning in comparison with the initial condition).

Conclusions. Thus, the obtained facts as a result of the research shows that the quality of the design of printed text is an important factor that has both a negative and positive effect on the visual system of children and teenagers. The publication for children and teenagers of textbooks and teaching aids with a large print size will allow not only to avoid the development of pathological and pre-pathological conditions, but also to improve the quality of the functioning of the visual system.

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