SPATIAL ORIENTATION PARAMETERS OF FACE IMAGE RECOGNITION AS PREDICTORS OF LIVER FAILURE SYMPTOMS IN ADOLESCENTS

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Functional assessment of higher mental functions in case of intoxication or during treatment will make it possible to identify predictors of the symptoms of hepatic encephalopathy associated with portal hypertension. The study was aimed to determine the diagnostic predictors of the emergence of the earliest symptoms of hepatic encephalopathy in adolescents with portal hypertension. The study involved 60 adolescents aged 13–17 years: 28 males, 32 females. The experimental group included 30 adolescents with the diagnosis K76.6 Portal hypertension, unspecified form. The control group included 30 adolescents with normal somatic status, who had no mental disorders, traumatic brain injuries or severe infectious diseases of the brain (based on the records of the annual check-up). The studied groups were matched by sex, age, and social status. The proprietary method, Tobii EyeX hardware and software system (GazeControl software), and Cambridge Face Memory Test for Children (CFMT-C) were used. It has been found that recognition of single face images, multiple face images, and multiple face images camouflaged with noise by adolescents with portal hypertension is associated with the greater efforts (manifested in the increased number and duration of gaze fixations), than recognition of the above by adolescents with normal somatic status. The accuracy of recognition of single face images, multiple face images, and multiple face images camouflaged with noise shown by adolescents with portal hypertension experiencing the toxic effects associated with manifestations of hepatic encephalopathy is significantly reduced compared to that shown by adolescents with normal somatic status. The results obtained can be considered as the diagnostic predictors allowing one to trace the changes in the hepatic encephalopathy severity at various stages of treatment (including after surgical intervention).

Keywords: face image recognition, portal hypertension, hepatic encephalopathy, oculomotor reactions, gaze fixation

Author contribution: the authors contributed to the study and manuscript writing equally.

Compliance with ethical standards: the study was approved by the Ethics Committee of the Pirogov Russian National Research Medical University (protocol № 229 dated 15 May 2023) and conducted in accordance with the requirements of the Fundamentals of the Legislation on the Protection of Citizens' Health; all participants submitted the informed consent to examination.

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ПРОСТРАНСТВЕННО-ОРИЕНТАЦИОННЫЕ ПАРАМЕТРЫ УЗНАВАНИЯ ИЗОБРАЖЕНИЙ ЛИЦ КАК ПРЕДИКТОРЫ СИМПТОМОВ ПЕЧЕНОЧНОЙ НЕДОСТАТОЧНОСТИ У ПОДРОСТКОВ

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Функциональная оценка изменений высших психических функций при интоксикационном воздействии, а также в процессе лечения позволит выявить предикторы симптомов печеночной энцефалопатии при портальной гипертензии. Цель работы — определить диагностические предикторы выявления наиболее ранних симптомов печеночной энцефалопатии у подростков с портальной гипертензией. В исследовании участвовали 60 подростков 13–17 лет, 28 человек — мужского пола, 32 человека — женского пола. В экспериментальную группу вошли 30 подростков с диагнозом K76.6 «Портальная гипертензия» без уточнения формы. В контрольную группу вошли 30 подростков с нормативным соматическим статусом без психических, церебрально-травматических и тяжелых инфекционных заболеваний головного мозга (по результатам заключений ежегодной диспансеризации). Исследовательские группы уравнивали по полу, возрасту и социальному статусу. Использовали авторскую методику и программно-аппаратный комплекс Tobii EyeX (ПО «GazeControl»), а также Кембриджский тест запоминания лиц для детей (CFMT-C). Установлено, что узнавание единичных, множественных, множественных зашумленных изображений лиц подростками с портальной гипертензией сопровождается большими усилиями (проявляющимися в увеличении как числа фиксаций взгляда, так и их продолжительности), чем подростками с нормативным соматическим статусом. Точность узнавания единичных, множественных и множественных зашумленных изображений лиц при токсическом влиянии при проявлении печеночной энцефалопатии у подростков с портальной гипертензией значимо снижается по сравнению с подростками с нормативным соматическим статусом. Полученные результаты можно рассматривать в качестве диагностических предикторов, позволяющих отслеживать изменение выраженности симптомов печеночной энцефалопатии на разных этапах лечения (в том числе после оперативного вмешательства).

Ключевые слова: узнавание изображений лиц, портальная гипертензия, печеночная энцефалопатия, глазодвигательные реакции, фиксации взгляда

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The search for predictors of the symptoms of hepatic encephalopathy associated with portal hypertension requires functional assessment of the changes of higher mental functions under conditions of intoxication and in various phases of treatment (including after surgical treatment).

Visual perception represents a combination of the processes underlying construction of a visual image of the surrounding environment. It consists of various structural components: randomness, focus, hand-eye coordination, visual evaluation skills, analytical and synthetic activity of the visual analyzer,

perception volume and constance. Formation of the attention, speech, intelligence functions depends on the visual perception development. Furthermore, visual gnosis can be divided into the following subtypes: visual object, simultaneous, color, and facial gnosis. In turn, facial gnosis reflects the process of face identification.

The changes occurring in this system under the influence of morphological and other factors are a significant indicator and, at the same time, the challenge of the functional rehabilitation training. A number of somatic disorders that seem to be nonspecific for brain disorders are associated with the prominent neurotoxic effects affecting the function of brain structures.

When solving the problem of the gnostic feature specification in adolescents with hepatic encephalopathy, we assessed the prevalence of liver diseases in Russia and found out that 950 individuals per 100,000 population were susceptible to the diseases of this class in 2016 [1], and 60–70% patients with chronic liver diseases developed hepatic encephalopathy of varying severity [2]. It should be also noted that, according to the data obtained in 2007–2016 by comparing children under the age of 14 years with the general population in Russia, the pediatric incidence of some liver diseases exceeded the adult incidence 1.6-fold [3]. Furthermore, the development of liver failure is associated with the generalized intoxication affecting the nervous system [4] that involves the posterior association area [5] responsible for realization of the face recognition function, one of the periods of intense development and differentiation of which is the age between 15–16 years [6].

When assessing the research interest within the framework of the study of face recognition and the spatial orientation factors affecting the process, we performed bibliometric analysis using the eLibrary scientometric database. The depth of analysis was 10 years (2013–2023). The findings suggest insufficient study of the subject: the number of publications reported for the specified period varies between 1–3 scientific papers per year. Thus, it becomes clear that there is a need to study the factor of the spatial orientation characteristics of face images during face image recognition.

Modern domestic concepts of the higher mental function development patterns, specifics of age development and ontogenesis of the psyche [7, 8], perceptual processing patterns, visual perception dynamics and visual phenomena associated with oculomotor activity [9, 10], as well as conceptual provisions and empirical studies of the visual spatial gnosis impairment associated with hepatic encephalopathy [11, 12, 13–16] provided the theoretical and methodological basis for the study.

Visual gnosis represents the process involving reception of the featured visual stimuli that pass through the perceptual filters organized in the existing structures and templates and are later interpreted based on the earlier experience. Human face image is a complex social object. The oculomotor activity associated with face image perception demonstrates a number of specific patterns related to the distribution of gaze fixations depending on the goals of the face photo perception and facial expression. The routes of the gaze associated with face image perception are cyclic and regular [9, 10, 17, 18].

Portal hypertension (K76.6 according to ICD-10) is a syndrome of blood pressure increase in the portal venous system caused by impaired blood flow in the portal vessels, hepatic veins and the inferior vena cava; along with other manifestations (splenomegaly, varicose veins in the esophagus and stomach, ascites), it is associated with the hepatic encephalopathy syndrome. Impaired liver function also results in the toxic effects on the central nervous system (CNS, brain) due to the generalized ammonia and mercaptan intoxication. The effects of intoxication result in the glial edema, which, in turn, affect the neurodynamics (impaired nerve impulse transmission and depression of the CNS function in general) (Fig. 1).

Therefore, the functional impairment resulting from intoxication leads to the difficulty in realization of higher mental functions. Hepatic encephalopathy as a symptom of liver failure (acute or chronic) that belongs to neuropsychiatric syndromes usually represents a potentially reversible brain function impairment manifested in psychomotor, intellectual, emotional and behavioral disorders. Impairment of the visual spatial functions, specifically face image recognition (facial gnosis), is among the earliest manifestations observed during the period, when the other symptoms are subtle. Identification of the above requires using specific psychometric methods.

The study was aimed to assess the spatial orientation parameters of face image recognition in adolescents with portal hypertension.

METHODS

The total size of the research sample was 60 adolescents aged 13–17 years (according to the WHO ICD), the average age was 14.7 ± 1.54 years; among them 28 were males, 32 were females. The experimental group (EG) included 30 adolescents (14 males, 16 females) with the diagnosis of K76.6 Portal hypertension (ICD-10) established by gastroenterologist, among them 16.7% had extrahepatic forms of hepatic encephalopathy, 83.3% had intrahepatic forms of hepatic encephalopathy. In the vast majority of cases (90% of patients), liver failure resulted from the liver disease associated with viral infection. The other subjects (three individuals) had congenital liver failure. The control group (CG) included 30 adolescents (14 males, 16 females) with normal somatic status, who had no mental disorders, traumatic brain injuries or severe infectious diseases of the brain (based on the records of the annual check-up available in May 2023). The studied groups were matched by sex, age, and social status.

Two research method types were used: empirical methods and methods of quantitative and qualitative data processing.

Empirical methods included the following: clinical structured conversation method; archival method involving the analysis of medical history data; method of functional neuropsychological tests represented by the Cambridge Face Memory Test [13]; test for lateralization of higher mental functions.

The visual gnosis characteristics were assessed using the Cambridge Face Memory Test for Children (CFMT-C) [19]. This test represents an adaptation of the initial Cambridge Face Memory Test version designed for adults. The face stimuli were chosen from those used in the CFMT version for adults. The faces represented grayscale images of the children, who posed with the neutral facial expression. Each face was photographed from the same three angles in the same lighting conditions and cropped to remove the hairline and all facial defects. The presentation procedure consisted of five stages.

Stage 1

The adolescents were offered to sequentially memorize six faces in three positions with the limited presentation duration (3 s); then each of three images was displayed together with two faces (distractions), and the adolescents had to choose the face they had just seen. Each correct answer of the subject was assigned one point (the maximum score was 18).

Stage 2

At this stage the adolescents first looked at one screenshot showing six front views of the target faces for 20 s, then they

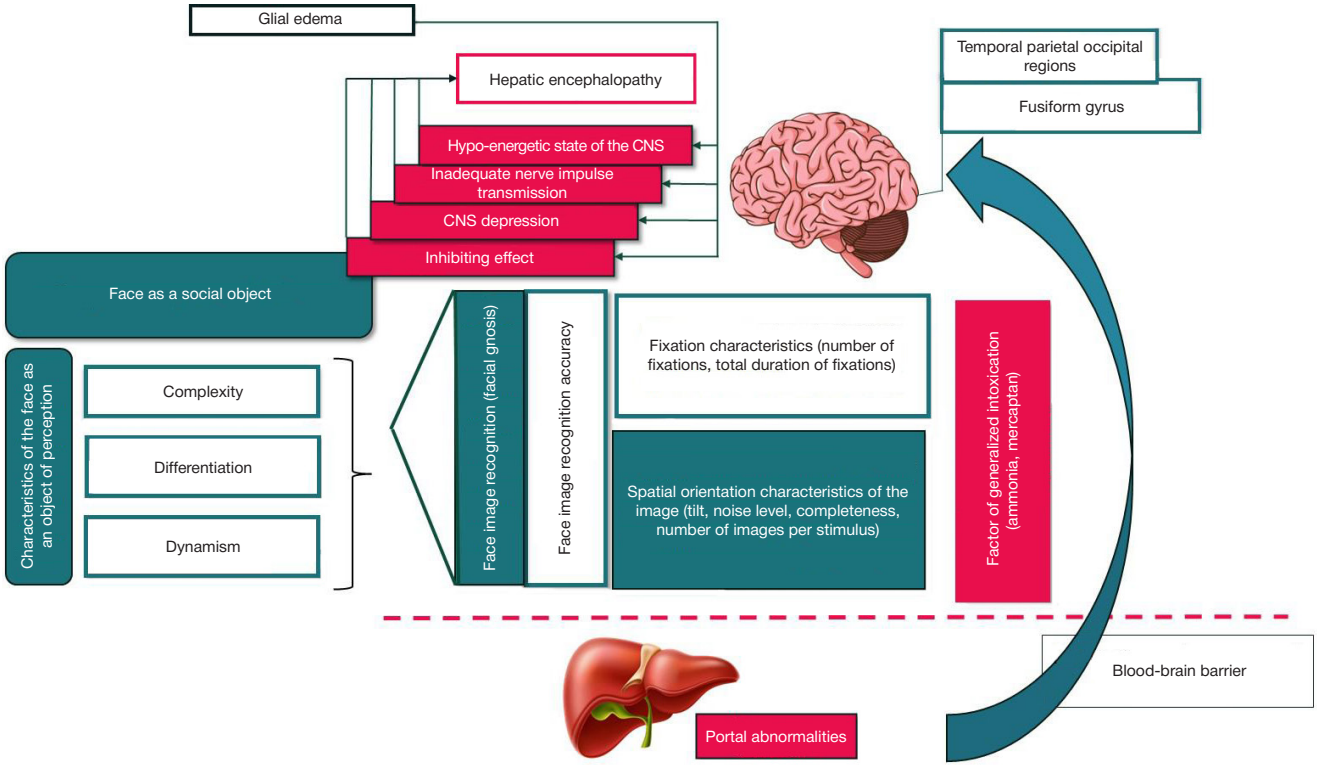

Fig. 1. Scheme of the conceptual model for assessment of the spatial orientation parameters of face image recognition in adolescents with portal hypertension

completed 30 tasks, each of which involved looking at one target face and two distraction faces; the adolescents decided which of the three faces was one of the six target faces they had been offered to memorize. Each correct answer of the subject was assigned one point (the maximum score was 30).

Stage 3

At this stage the adolescents also first looked at one screenshot showing six front views of the target faces for 20 s and then completed 24 tasks, each of which involved looking at one target face and two distraction faces (it should be noted that the images of both target and distraction were camouflaged using the preset Gaussian noise value, which made the process of decision making more difficult than at the 2nd stage). Each correct answer of the subject was assigned one point (the maximum score was 34).

Stage 4

The adolescents had to identify the appropriate entire image, displayed together with two distraction faces during each presentation, by a fragment; the area of the fragment was increased as the adolescents went through the test (from one fragment out of 12 to 12 fragments out of 12).

Stage 5

At the final stage, adolescents were offered to sequentially memorize 10 images of the faces photographed from different angles, each of the faces was later displayed together with two distraction faces, and the adolescents had to choose the face they had just seen. Each correct answer of the subject was assigned one point (the maximum score was 10).

Eventually, assessment was performed based on the following parameters: recognition of single face images; recognition of six face images; recognition of six face images camouflaged with noise; recognition of fragmented face images; recognition of single inverted face images (Fig. 2).

The GP3 HD eye tracker (Tobii Eye; Sweden) was used to assess the characteristics of the subjects' oculomotor responses when they passed the face image recognition test. This model of the device based on the machine vision sensor and image processor is used for eye tracking. The model has the following characteristics: 0.5–1.0 degree of visual angle accuracy; 150 Hz operation frequency; 5–9-point calibration; the range of free head movement relative to the calibrated position within 35 cm (horizontal), 22 cm (vertical), and at least 15 cm on each side. The following parameters were analyzed: total number of fixations on the stimulus image; number of fixations on the upper half of the stimulus image; number of fixations on the lower half of the stimulus image; number of fixations on the left half of the stimulus image; number of fixations on the right half of the stimulus image; number of fixations on the zone between eyes and nose of the stimulus image; number of fixations on the zone between mouth and nose of the stimulus image; number of fixations on the area within the face oval of the stimulus image; number of fixations outside the face oval of the stimulus image; total duration of fixations on the stimulus image.

The lateralization profile of functions was assessed using the following tests for motor and sensory preferences [3; 7]: hand lock test — the finger of the dominant hand is on top; Napoleon pose — the finger of the dominant hand is on top; "handset" test — determining the hand that will reach for the handset and the ear to which the handset will be put; "look-through-the-telescope" test — determining the hand that will reach for the telescope and the eye to which the telescope will be put.

The descriptive, comparative and multivariate statistical methods were used for quantitative and qualitative data processing. Mathematical analysis and data interpretation were performed using the descriptive statistics. The nonparametric Mann–Whitney U test ($p < 0.05$) for independent samples was used for comparative analysis of the ability to recognize static face images based on the fixation characteristics of oculomotor responses and the characteristics of face image recognition depending on the spatial orientation characteristics (image tilt, completeness) in the group of patients with portal hypertension and the group of individuals with normal somatic status (since the distributions of studied traits were non-normal). To determine

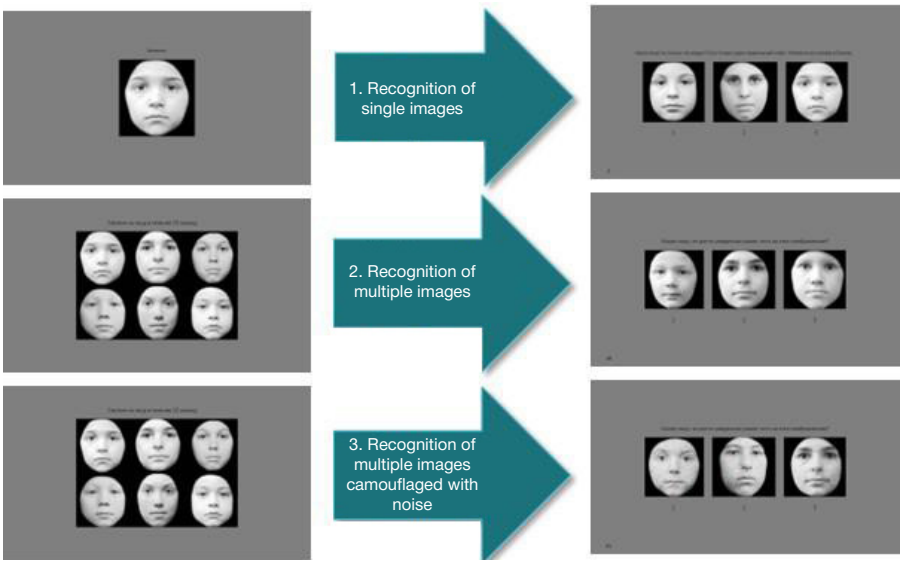

Fig. 2. Examples of the stimulus images used at the stages of the face recognition ability assessment

the factor structure of the static face image recognition based on the fixation characteristics of oculomotor responses and the face image recognition accuracy depending on the spatial orientation characteristics, we performed factor analysis with varimax rotation in order to determine the factor structure of the parameters of oculomotor responses associated with face image recognition considering their spatial orientation characteristics. Statistical processing was performed using the Statistica 13.0 software package (StatSoft; USA).

The study design is provided in Fig. 3.

RESULTS

Assessment of the facial gnosis characteristics using CFMT-C in the group of adolescents with portal hypertension and the group of adolescents with normal somatic status showed that the recognition accuracy observed when presenting single images, multiple images, and multiple images camouflaged with noise demonstrated a significant downward trend in adolescents with portal hypertension relative to appropriate scores of adolescents with normal somatic status (Table).

We revealed significant differences in the facial gnosis scores obtained when performing the test for recognition of single face images between the group of adolescent patients with portal hypertension and the group of adolescents with normal somatic status (*p = 0.001),

We also revealed differences in the facial gnosis scores obtained when performing the test for recognition of multiple face images (*p = 0.012) and the test for recognition of multiple face images camouflaged with noise (*p = 0.003) between the group of adolescent patients with portal hypertension and the group of adolescents with normal somatic status.

The facial gnosis scores obtained upon presentation of a single image (recognition accuracy), multiple face images (recognition accuracy) and multiple face images camouflaged with noise (recognition accuracy) show a significant downward trend in patients with portal hypertension relative to appropriate scores of adolescents with normal somatic status.

The next stage was assessment of the gaze fixation characteristics (total number of fixations; total duration of fixations; number of fixations on the upper and lower halves of face image; number of fixations on the right and left halves of face image; number of fixations on the zones between eyes and nose, mouth and nose; number of fixations on the areas within and outside the face oval of the image) on the presented stimulus images in the group of adolescents with

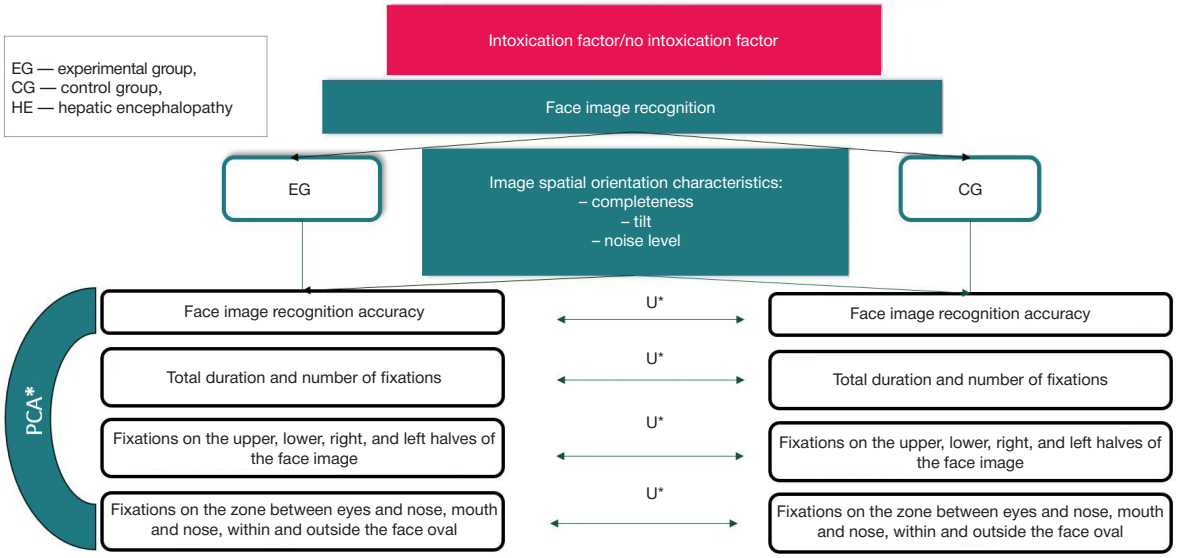

Fig. 3. Design of the study of the spatial orientational parameters of face image recognition in adolescents with portal hypertension

Table. Average face recognition accuracy values in adolescents with portal hypertension and normal somatic status

Tests	Mode (Mo)		Median (Me)		Mean ± standard deviation (M ± σ)	
	EG	CG	EG	CG	EG	CG
1	0.83 0.89 0.94	0.94	0.89	0.94	0.87 ± 0.09	0.93 ± 0.09
2	0.53 0.57 0.73	0.67	0.73	0.83	0.71 ± 0.07	0.79 ± 0.07
3	0.79	0.92	0.75	0.83	0.72 ± 0.06	0.76 ± 0.07
4	0.42	0.33	0.33	0.33	0.28 ± 0.02	0.26 ± 0.02
5	0.8	0.80 0.90 1.0	0.8	0.8	0.75 ± 0.08	0.78 ± 0.07

portal hypertension and the group of individuals with normal somatic status of the same age.

We revealed significant differences in the total number of fixations on the stimulus images obtained when performing tests for recognition of single face images (*p = 0.001), multiple face images (*p = 0.015), multiple face images camouflaged with noise (*p = 0.009) between the group of patients with portal hypertension and the group of adolescents with normal somatic status. We also revealed significant differences in the total duration of fixations obtained when performing tests for recognition of single face images (*p = 0.035), multiple face images camouflaged with noise (*p = 0.005), and single inverted face images (*p = 0.049) between the group of patients with portal hypertension and the group of adolescents with normal somatic status (Fig. 4).

The total number of fixations on the stimulus images obtained when presenting single face images, multiple face images, multiple face images camouflaged with noise shows a significant upward trend in the adolescent patients with portal hypertension relative to appropriate scores of adolescents with normal somatic status. The total duration of fixations on the stimulus images obtained when presenting single face images and multiple face images camouflaged with noise shows a significant upward trend in the adolescent patients with hepatic encephalopathy relative to appropriate scores of adolescents with normal somatic status. Upon presentation of single inverted images, these, on the contrary, show a significant downward trend in adolescents with hepatic encephalopathy along with the increase in adolescents with normal somatic status.

The next stage was assessment of the gaze fixation characteristics considering location in the presented stimulus images according to the criterion of the characteristics' distribution along the vertical axis (right/left half of the image) and distribution along the horizontal axis (upper/lower half of the image).

The study revealed significant differences in the number of fixations on the upper half of the stimulus image obtained when performing tests for recognition of single face images (*p = 0.034), multiple face images (*p = 0.001), multiple face images camouflaged with noise (*p = 0.011) between the group of adolescents with hepatic encephalopathy and the group of adolescents with normal somatic status. We also revealed significant differences in the number of fixations on the lower half of the stimulus image obtained when performing the test for recognition of multiple face images camouflaged with noise (*p = 0.006) between the group of patients with hepatic encephalopathy and the group of adolescents with normal somatic status. There were significant differences in the number of fixations on the right half of the stimulus image obtained when performing the test for recognition of single inverted face images (*p = 0.004) between the group of patients with hepatic encephalopathy and the group of adolescents with normal somatic status (Fig. 5).

The number of fixations on the upper half of the stimulus image obtained when presenting single face images, multiple face images, multiple face images camouflaged with noise shows a significant upward trend in the adolescent patients with hepatic encephalopathy relative to appropriate scores

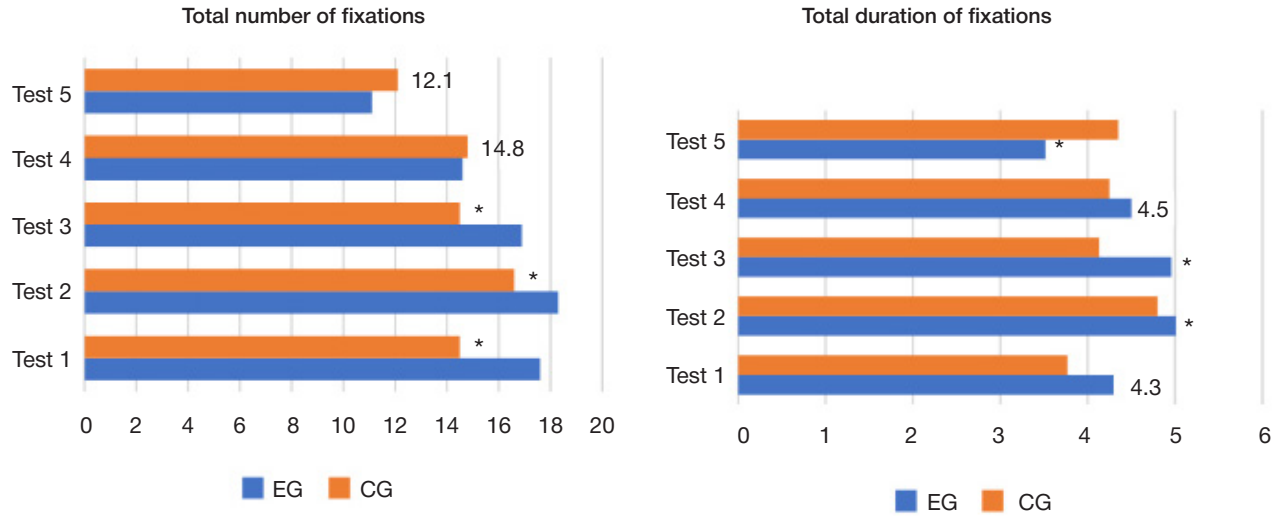

Fig. 4. Average total number and duration of gaze fixations associated with face image recognition

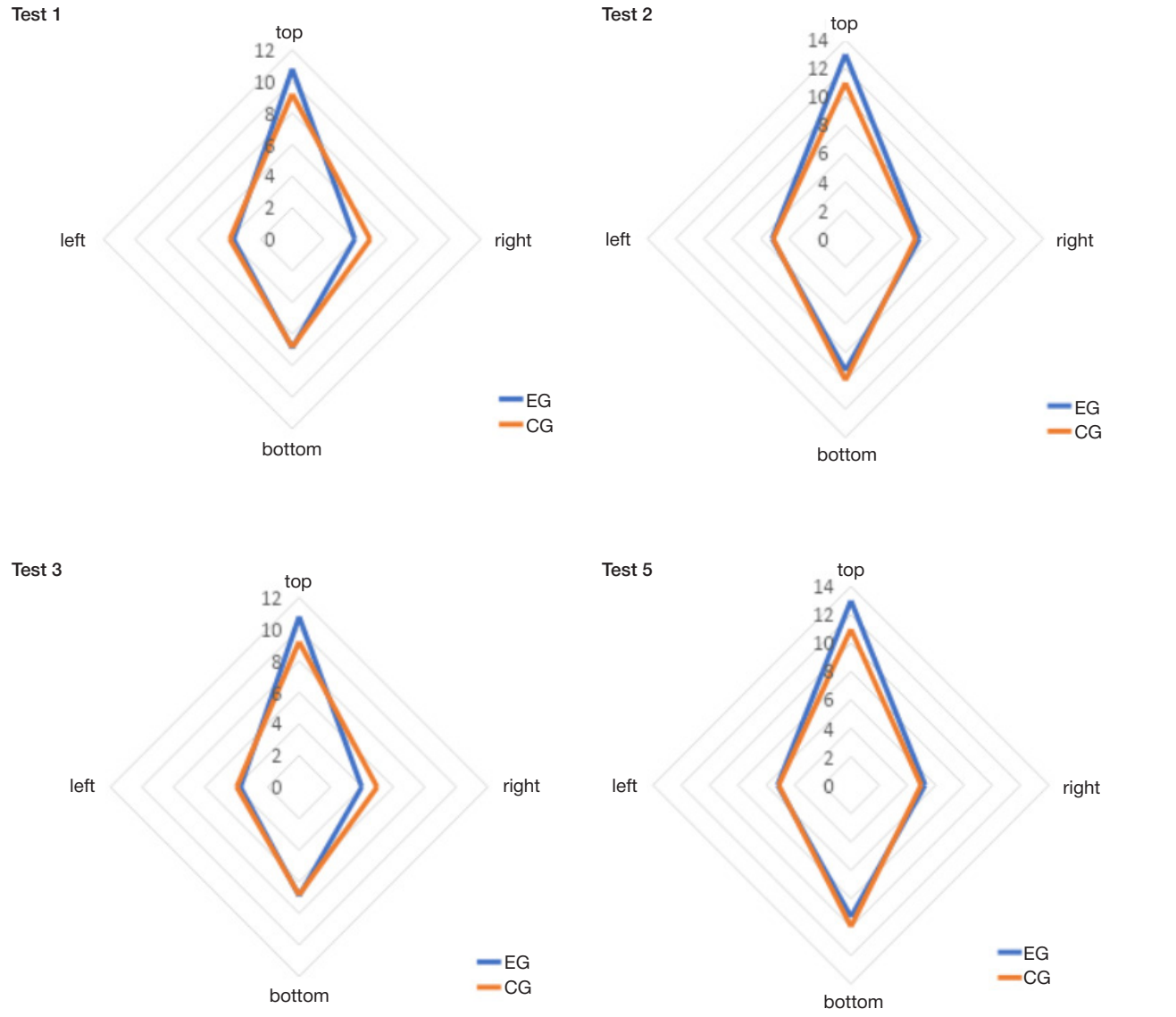

Fig. 5. Average gaze fixation distribution along the vertical (right/left half of the image) and horizontal (upper/lower half of the image) axes in the groups of adolescents

of adolescents with normal somatic status. The number of fixations on the lower half of the image obtained when recognizing multiple face images camouflaged with noise and the number of fixations on the upper half of the image obtained when recognizing single face images, multiple face images, multiple face images camouflaged with noise shows a significant upward trend in the adolescent patients with portal hypertension relative to appropriate scores of adolescents with normal somatic status. The number of fixations on the right half of the image obtained when recognizing single inverted face images shows a significant downward trend in the adolescent patients with hepatic encephalopathy relative to appropriate scores of adolescents with normal somatic status (Fig. 6).

The analysis of the number of fixations on the zones between eyes and nose, mouth and nose of the stimulus image revealed significant differences in the number of fixations on the zone between mouth and nose obtained when recognizing single inverted face images (*p = 0.006) between the group of patients with hepatic encephalopathy and the group of adolescents with normal somatic status. Thus, the number of fixations on the zone between mouth and nose obtained when presenting single inverted face images shows a significant downward trend in adolescent patients with hepatic encephalopathy relative to appropriate scores of adolescents with normal somatic status.

When performing factor analysis of the structure of the parameters of oculomotor responses observed during recognition of face images considering their spatial orientation characteristics in adolescents with portal hypertension, the fully explained variance showed that there were 12 factors explaining 87.3% of variance. However, after the analysis of the graph of normalized simple stress we decided to include 1–5.7 factors explaining 73.6% of variance in the analysis as the most significant (Fig. 7).

The conceptual factor parameters are of particular diagnostic value for analysis of neurointoxication effects: the recognition accuracy is determined by the distribution of fixations within the face oval. The spatial orientation factor suggests that recognition of inverted images is ensured by evaluation of comparable spatial relationships outside the face oval. The decrease in the total duration of fixations is correlated to the recognition accuracy increase, which is indicated by the temporal factor content.

DISCUSSION

The study has shown that the recognition accuracy observed when presenting single face images, multiple face images, multiple face images camouflaged with noise demonstrates

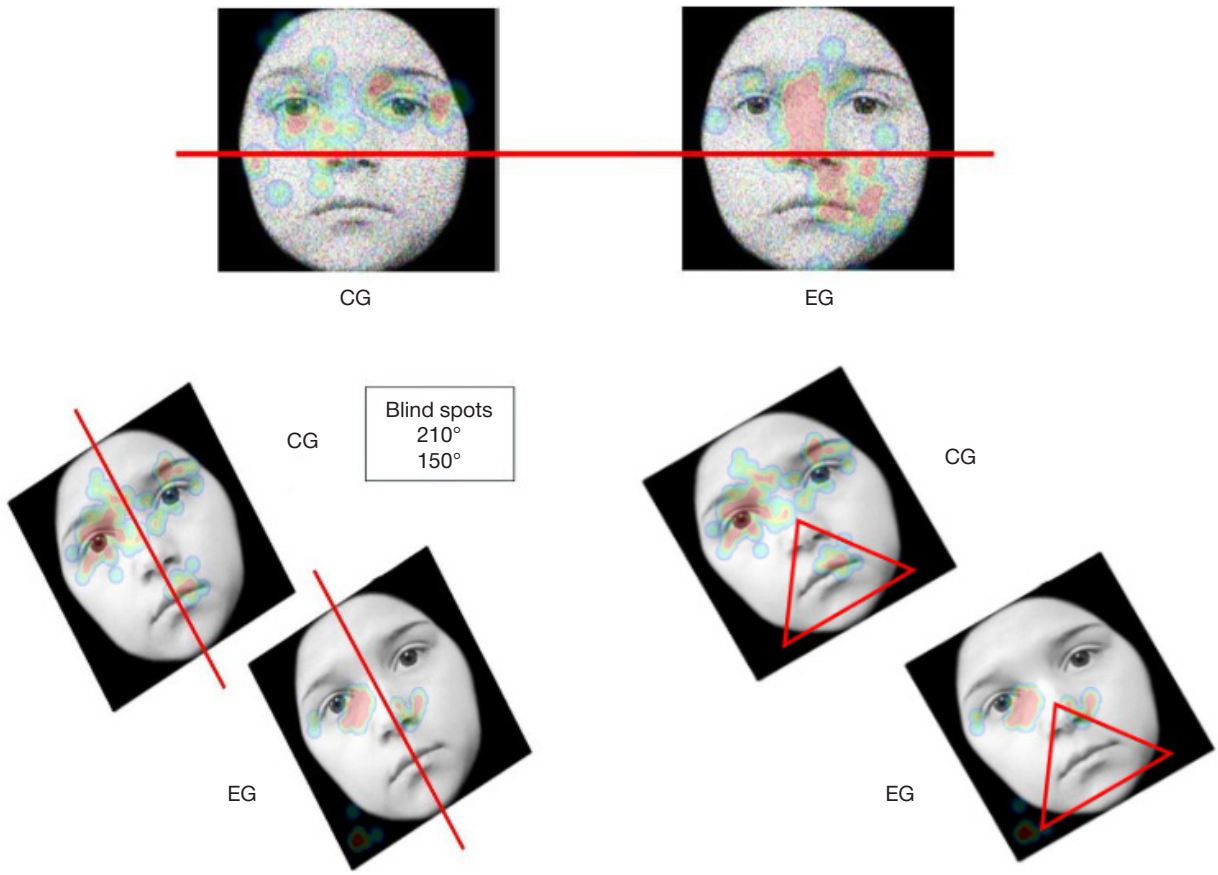

Fig. 6. Examples of the heatmaps of gaze fixation distribution along the vertical (right/left half of the image) and horizontal (upper/lower half of the image) axes in the groups of adolescents

a significant downward trend in patients with symptoms of hepatic encephalopathy relative to appropriate scores of adolescents with normal somatic status.

Taking into account the results of the empirical study of the total number of fixations on the stimulus images, we can say that the parameter demonstrates an upward trend in adolescents with hepatic encephalopathy relative to appropriate scores of adolescents with normal somatic status observed upon presentation of single face images, multiple face images, multiple face images camouflaged with noise.

Taking into account the results of the analysis of the total duration of fixations, we can report an upward trend in adolescent patients with hepatic encephalopathy when comparing with the scores of adolescents with normal somatic status observed upon presentation of single face images and multiple face images camouflaged with noise. The opposite pattern is observed when presenting single inverted images.

The empirical study and comparative analysis of the number of fixations on the upper halves of the stimulus images allow us to conclude that the parameter demonstrates an upward trend upon presentation of single face images, multiple face images, multiple face images camouflaged with noise in adolescent patients with hepatic encephalopathy relative to appropriate scores of adolescents with normal somatic status.

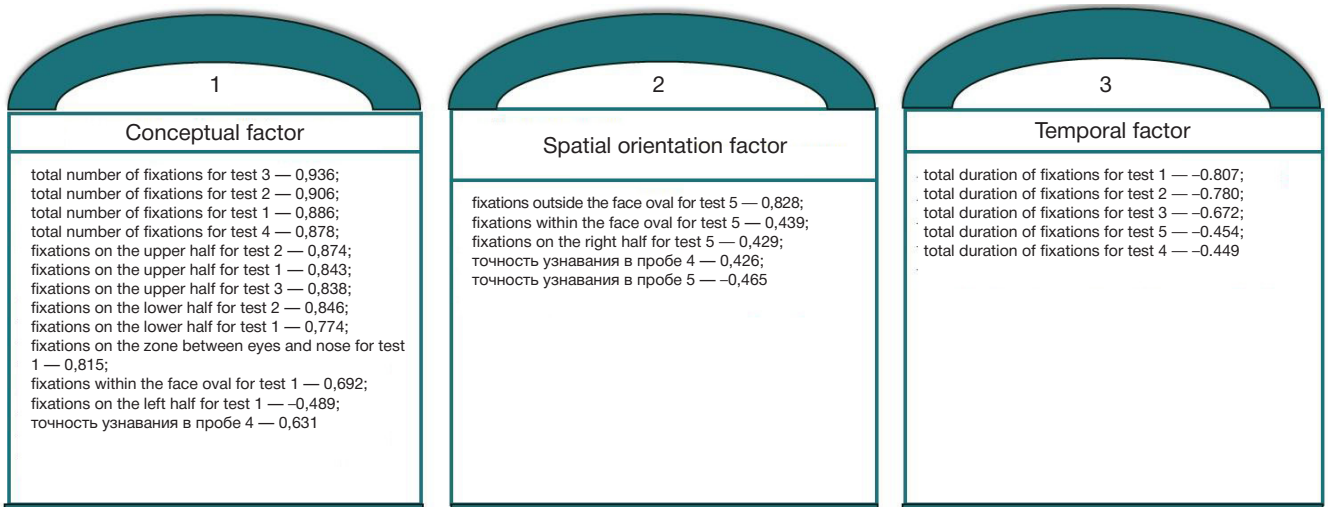

Fig. 7. Factor structure of the parameters of oculomotor responses observed during recognition of face images considering their spatial orientation characteristics in adolescents with portal hypertension

Comparative analysis of the number of fixations on the lower halves of the stimulus images suggests that that the parameter demonstrates an upward trend in adolescents with hepatic encephalopathy relative to appropriate scores of adolescents with normal somatic status obtained upon presentation of multiple face images camouflaged with noise.

Based on the empirical study of the number of fixations on the upper halves of the stimulus images, we managed to reveal a declining trend when performing the test for recognition of single inverted face images in adolescent patients with hepatic encephalopathy relative to appropriate scores of adolescents with normal somatic status.

The empirical study of the number of fixations on the zone between mouth and nose allows us to say that the parameter demonstrates an upward trend in adolescent patients with hepatic encephalopathy relative to appropriate scores of adolescents with normal somatic status obtained when performing the test for recognition of single inverted face images.

Thus, the findings are compliant with the oculomotor activity cyclic and regular nature reported earlier within the framework of studying the parameters of the oculomotor responses associated with face image perception [9, 10]. The processes of face image identification and recognition are characterized by the fact that fixations are distributed mainly within the face oval, in the zone between eyes and nose.

After conducting factor analysis in the group of patients with hepatic encephalopathy, six factors were distinguished. The first factor included the total number of fixations on the stimulus images reported for the tests 1–4, number of fixations on the upper half of the stimulus image reported for the tests 1–3, number of fixations on the lower half of the stimulus image reported for the tests 1–2, number of fixations on the zone between eyes and nose, within and outside the face oval, on the left half of the stimulus image reported for the test 1, as well as the recognition accuracy reported for the test 4. This factor was given the name “factor of fixation characteristics”. The second factor included fixations outside and within the face oval, on the right half of the stimulus image reported for the test 5, and the recognition accuracy reported for the tests 5 and 4; this factor was given the name “image tilt and completeness factor”. The third factor included the total number of fixations reported for the tests 1–5 and fixations on the stimulus images outside the face oval reported for the test 1; this factor was given the name “factor of the total number of fixations”. The fourth factor included fixations on the zone between mouth and nose, within the face oval, on the left half of the stimulus image reported for the test 1, and the recognition accuracy reported for the test 3; this factor was given the name “factor of fixation characteristics associated with recognition of single face images”. The fifth factor included fixations on the left, lower, and right halves, on the zone between mouth and nose, within the face oval, as well as the total number of fixations on the stimulus image reported for the test 5; this factor was given the name “factor of fixation characteristics associated with recognition of inverted images”. The sixth factor included fixations on the upper half and the zone between eyes and nose of the stimulus image reported for the test 5, as well as the recognition accuracy reported for the test 5; this factor was given the name “face image tilt factor”.

CONCLUSIONS

The following conclusions were drawn based on the findings: recognition of single face images, multiple face images, multiple face images camouflaged with noise in adolescents with portal hypertension is associated with the greater efforts (reflected in the increased number and duration of gaze fixations) than that in adolescents with normal somatic status. The accuracy of recognizing single face images, multiple face images, multiple face images camouflaged with noise when experiencing the influence of toxic effects associated with manifestation of hepatic encephalopathy in adolescents with portal hypertension is significantly decreased relative to adolescents with normal somatic status. Based on the factor analysis we distinguished three factors with the greatest uniqueness (conceptual factor, spatial orientation factor, and temporal factor) allowing us to draw the main conclusion that the face image recognition accuracy is determined by the distribution of fixations within the face oval when there is a need to evaluate spatial relationships outside the face oval in case of alteration of its spatial orientation characteristics (tilt). The recognition accuracy is correlated to the total number of fixations. Practical significance of the study is related to identification of the diagnostic predictors that contribute to detection of the hepatic encephalopathy symptoms in adolescents with portal hypertension at its earliest stages on the one hand, and allow one to trace the changes in the severity of the hepatic encephalopathy symptoms during various phases of treatment (including after surgery) on the other hand.

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