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Assessment of Motor and Sensory Interhemispheric Asymmetry of Brain in Children

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Introduction

Nowadays, two approaches are used in physiology to assess brain interhemispheric differences: the method of determining "handiness" by means of a survey (Edinburgh test) [13] and the method of actively detecting motor and sensory asymmetry by N. N. Bragina and T. A. Dobrokhotova methodology [4]. The Edinburgh test is widely used in the world: it is used in studying behavior [14] and emotions [2, 12]. Trials to determine the leading limbs and the leading eye are recommended to use when assessing the impact of brain lateralization on intelligence and mathematical abilities [6], when studying the adaptive capabilities and physical development of young people, as well as the formation of the body's stress resistance [8]. Both techniques are widely represented in modern scientific literature, but we have not found research that describes the relationship between the results of testing assessment of functional brain asymmetry using the Edinburgh test and tests for determining motor and sensory asymmetry.

Another aspect of the test results, which is important not to ignore, concerns the peculiarities of the development of interhemispheric asymmetry and interhemispheric interaction in children with left-handedness. It is well known that the presence of the left-handedness factor in most cases suggests an atypical, from the point of view of brain organization, the flow of mental ontogenesis [17]. Usually, left-handers have distortions, peculiar delays, and disproportions in the formation of various mental functions: speech (oral and written), reading, counting, constructive processes, spatial representations, emotional sphere, etc. They are a “risk group” in terms of the occurrence of logoneurosis (stuttering) and the pathocharacteristic features of the personality [11, 16].

According to the results of several studies, in the group of ambidextrous children, a balanced right-left laterality in brain processes appeared. In our

opinion, the term "ambicerebrality" is more appropriate for this phenomenon. The following working formulation should be adopted: ambicerebrality is the ability of the right and left human brain alternately, or in parallel, and at the same time to process information. We express the opinion that this is a more accurate fixation of a new trend that differs from "two-handedness" – ambidexterity [10].

The aim of the study was the assessment of motor and sensory interhemispheric brain asymmetry in children.

Testing methodology

Functional testing should be carried out in the first half of the day, in conditions that meet the hygienic requirements for educational institutions [15], and comply with the ethical requirements prescribed by the Helsinki Declaration.

Detection of functional asymmetry of hands

At the first stage of the research, schoolchildren answer the questions of the Edinburgh test [5]. In this case, their parents can answer for children aged 8-9 years. Since the purpose of the study is to perform a comparative analysis of functional motor asymmetry of normally developing schoolchildren and children of the same age with varying degrees of mental retardation, we have developed our original test questionnaire, adapted from well-known tests — the Edinburgh and Bragina and Dobrokhotova method [4]. In our test questionnaire, we retained the first 10 questions of the Edinburgh test, which supplemented with 4 questions that, in our opinion, will help to form a clearer impression about the preference for using the right or left hand when performing certain actions, such as writing, painting, sewing, combing hair, brushing teeth, using a spoon or fork, etc. (table.).

According to the results of the test questionnaire, the coefficient of functional asymmetry (CFA), the coefficient of manual (motor) asymmetry (CMA) and the coefficient of general asymmetry (CGA) are calculated using the following formulas:

CFA = (N (right) - N (left)) / Nm

Where CFA is the coefficient of functional asymmetry, N (right) and N (left) the number of "+" signs in the columns "Right hand" and "Left hand", respectively, Nm is the number of proposed tests.

CMA = (N (right)) / Nm

Where CMA is the coefficient of manual asymmetry, N (right) is the number of actions performed by the right hand, Nm is the number of proposed tests.

Student Application Form

Table

	Action performed	Left hand	Right hand
1.	Which hand do you write with?		
2.	Which hand do you draw with?		
3.	Which hand do you throw the ball with?		
4.	Which hand do you catch the ball with?		
5.	Which hand do you hold scissors with?		
6.	Which hand do you hold a toothbrush with?		
7.	Which hand do you hold a dinner spoon with?		
8.	Which hand do you hold the comb with?		
9.	Which hand do you open the lid of the box (candy box) with?		
10.	Which hand do you hold the hammer with when you hammer a nail?		
11.	The finger of the leading hand rests on top when crossing (lock) fingers		
12.	"Napoleon's Pose" (the leading is considered to be the hand which is directed first to the forearm of the other hand and is placed on top of it)		
13.	Applause test (the leading hand is more active and mobile, makes shock movements on the palm of the non-leading hand)		
14.	Which hand do you pick up the object from the floor with?		

$$CGA = (CFA + CMA) / 2$$

Where CGA is the coefficient of total (General) asymmetry, the arithmetic average of the coefficients of CFA and CMA.

Trials of kinesthetic praxis

It is recommended to use experimental methods developed by A. R. Luria [15] to study brain interhemispheric interaction in the field of voluntary movements. The complex of trials includes the study of kinesthetic praxis (mono-manual reproduction of hand position using visual and kinesthetic patterns, transferring poses from one hand to another without visual control), kinetic (dynamic) praxis (performing reciprocal coordination), test “fist-edge-palm” etc., spatial praxis, as well as writing and drawing. These tests make it possible to more accurately assess the interhemispheric interaction in the motor area (this applies, particularly, to bimanual tests), to understand the formation of interhemispheric connections and their influence on the successful performance of spatial motor tasks, and also to make a conclusion about the degree of

maturity and flexibility of interhemispheric relationships in the motor sphere.

When interpreting the results of the study, the percentage of children who successfully completed the proposed tests is calculated, the qualitative features of the errors made are analyzed. The features of interhemispheric relations in normal and with varying degrees of mental retardation, and age differences are evaluated.

Assessment of auditory and oral speech asymmetry

To determine the lateralization of the hearing-speech functions, the dichotic listening method with the definition of the "right ear coefficient" (CPA) is used. Dichotic stimulation can be performed through headphones in both ears at the same time. For separate channels, two sets of verbal stimuli (words) are presented. This technique requires special equipment, while one of our tasks is to propose the use of available methods that we could recommend to school psychologists for diagnostic purposes.

To study the asymmetry of hearing, you can use simple, available techniques and techniques that do not require use of special tools. So, we selected the following methods: test "Whisper" [4], test "Ticking of watch" [7]. In this case, if the test reveals the dominance of the right ear, then give (+1) score, if the left ear is dominant give (-1) score. Zero score is assigned with no identified dominance of the right or left ear.

Test "whisper". The experimenter says something in a whisper. In case of equal hearing acuity in both ears, the subject puts his leading ear to the speaker, which means that this ear hears more easily and realizes faster.

Test "ticking hours". The subject is asked to evaluate the volume of the ticking of the clock or the sound of the stopwatch with one and the other ear. It is noted at the same time, to which ear he puts the clock for the first time and whether the different ears evaluate the volume of the tick to be the same. It should be noted, which ear the subject pushes forward to listen something [7].

Test "tuning fork". The time of perception of the sound of the tuning fork, which is brought alternately to the right and left ear, is determined.

Assessment of visual asymmetry

The following tests are used to determine the leading eye:

Test "blink with one eye". The subject is asked to blink with one eye. Usually non-leading eye closes.

*Rosenbach's test***.** The subject holds a pencil vertically in an outstretched hand and fixes it with a gaze at a certain point (preferably with respect to any vertical line), 3-4 m apart, with both eyes open. Then the subject alternately closes one and the other eye. The eye is considered to be the leading when it is closed, the pencil shifts in its direction [3, 9].

Test "card with a hole". A 1x1 cm hole is cut out in a sheet of thick paper. Holding this card at a short distance from the eyes, the subject examines objects. Viewing is usually carried out by the leading eye [1, 4].

Self-esteem of the subject. The answer to the question of which eye he aims with.

Thus, methods aimed at analyzing motor and sensory preferences when performing certain behavioral acts, which allow us to determine not only the degree of interhemispheric asymmetry, but with their help it becomes possible to evaluate the degree of interhemispheric interaction.

The total assessment of the profile of the lateral organization

All possible types of profile of the lateral organization were divided into 5 main groups.

Group 1: the test group with a full right-sided domination of the arm, ear and eye is included in the “pure right-handers” group.

Group 2: all subjects with dominance of the right hand, but with different combinations of asymmetries of hearing and vision, belong to the “right-handed” group.

Group 3: the left-right equality (ambidextrous) group is characterized by equality in manual lateralization and a different combination of asymmetries in the hearing and visual functions.

Group 4: the group of "left-handed" includes subjects with a predominance of the left hand with various combinations of asymmetries of hearing and vision.

Group 5: the group with complete left-sided dominance of the arm, ear, and eye define a group of "clean left-handers."

Therefore, the examined schoolchildren may encounter an almost fully formed primary level of interhemispheric connections, while the second and third levels are still in their formation. At the same time, a comparison between the results of healthy children of 8–11 years of age shows that the functional organization of interhemispheric asymmetry and interhemispheric interaction in this age range is in a state of constant ongoing development.

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Оценка асимметрии моторного и сенсорного межполушарного мозга у детей

Т.Ю. Азатян

Нейропсихологическое изучение некоторых особенностей межполушарных взаимоотношений в двигательной сфере у детей с различными видами психических расстройств представляет несомненный интерес. Оно может показать ряд новых аспектов проблемы формирования межполушарной асимметрии и межполушарного взаимодействия в онтогенезе.

В настоящее время в физиологии используются два подхода для оценки межполушарных различий мозга: метод определения «рукастости» посредством опроса (Эдинбургский тест) и метод активного выявления двигательной и сенсорной асимметрии, методика Н.Н. Брагина и Т.А. Доброхотова.

Обе методики широко представлены в современной научной литературе, однако нам не удалось найти исследования, описывающего взаимосвязь результатов тестовой оценки функциональной асимметрии мозга с помощью Эдинбургского теста и тестов на определение моторной и сенсорной асимметрии. В норме формирование межполушарной асимметрии мозга и межполушарного взаимодействия носит, конечно, гетерохронный характер.

Таким образом, у обследуемых школьников может наблюдаться практически полностью сформированный первичный уровень межполушарных связей, тогда как второй и третий уровни еще находятся в стадии формирования. В то же время сравнение результатов здоровых детей 8–11 лет показывает, что функциональная организация межполушарной асимметрии и межполушарного взаимодействия в этом возрастном диапазоне находится в состоянии постоянного непрерывного развития.

Երեխաների մոտ ուղեղի շարժիչ և սենսոր միջկիսագնդային անհամաչափության գնահատումը

Թ.Յու. Ազատյան

Տարբեր տեսակի հոգեկան խանգարումներ ունեցող երեխաների նյարդահոգեբանական ուսումնասիրությունը շարժիչ ոլորտում միջկիսագնդային անհամաչափության որոշ առանձնահատկությունների վերաբերյալ անկասկած հետաքրքրություն է ներկայացնում: Այն կարող է ցույց տալ մի շարք նոր ասպեկտներ օնտոգենեզում միջկիսագնդային անհամաչափության և միջկիսագնդային փոխազդեցության ձևավորման խնդրի վերաբերյալ:

Ներկայումս ֆիզիոլոգիայում օգտագործվում է երկու մոտեցում՝ ուղեղի միջկիսագնդային տարբերությունները գնահատելու համար՝ հարցման միջոցով (Էդինբուրգյան թեստ) և շարժիչ ուժ և սենսոր անհամաչափության ակտիվ բացահայտման մեթոդ՝ Ն.Ն. Բրագինի և Թ.Ա. Դոբրոխոտովի մեթոդաբանություն:

Երկու մեթոդներն էլ լայնորեն ներկայացված են ժամանակակից գիտական գրականության մեջ, բայց մենք չկարողացանք գտնել ուսումնասիրություններ, որոնք նկարագրում են ուղեղի ֆունկցիոնալ ասիմետրիայի թեստային գնահատման արդյունքների կապը Էդինբուրգյան թեստի և շարժիչ ու սենսոր ասիմետրիայի որոշման թեստերի միջև: Սովորաբար ուղեղի միջկիսագնդային ասիմետրիայի և միջկիսագնդային փոխազդեցության ձևավորումը, անշուշտ, ունի հետերոքրոն բնույթ:

Այսպիսով, հետազոտված դպրոցականները կարող են նկատվել միջկիսագնդային կապերի գրեթե ամբողջությամբ ձևավորված առաջնային մակարդակ, մինչդեռ երկրորդ և երրորդ մակարդակները դեռ ձևավորման փուլում են: Միևնույն ժամանակ 8-11 տարեկան առողջ երեխաների արդյունքների համեմատությունը ցույց է տալիս, որ այս տարիքային միջակայքում միջկիսագնդային ասիմետրիայի և միջկիսագնդային փոխազդեցությունը գտնվում է մշտական շարունակական զարգացման վիճակում:

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