# Change of Manual Movement Duration Depending on Visual Perception of Senior Preschool Children

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**ABSTRACT**
The period of pre-school childhood is characterized by intensive development of all body organs and systems and therefore is more influenced by the new external environment. The changes in this age interval are caused by the influence of biological and social development programs. At present, actual material and knowledge has now been accumulated on many issues related to the changes in pre-school children during their psychophysiological development. The results of the study confirm the plasticity of monocular vision systems in the conditions of 3D viewing, phasing and heterochrony of mono- and binocular vision, functional nature of monocular vision asymmetry.

***Keywords:*** *visual perception, ways of vision, movements, children of pre-school age*

## 1. INTRODUCTION

The most important factor ensuring the efficiency of formation and socialization of a person is the functional asymmetry profile [1, 2, 5, 7, 8]. It seems quite relevant to differentiate between motor, sensory, mental asymmetry of a person, as well as to identify an individual asymmetry profile (IPA), which is understood as a certain combination of functional asymmetries typical for each subject. Motor (motional) asymmetry directly related to sensory and mental asymmetries has a large number of variations and determines the nature of motor action. There are certain scientific results and physiological mechanisms that justify the formation of individual profile of functional asymmetry of child's brain. It can be considered proven that the foundations of functional specialization of brain hemispheres are innate. As the child develops, the mechanisms of interhemispheric interaction and manifestations of functional asymmetries become more complex [7, 8, 10].

Functional asymmetry reflects the state of subordinated readiness of an organism, which leads to coordinating prospective adaptation of lateralized motor actions.

If the proposed hypothesis is correct, the motor asymmetry of the adaptation nature shall be accompanied by other certain lateral preferences ensuring the stability of an individual asymmetry profile. Despite the fact that the leading scientists studying functional asymmetry in medicine [1], in physiology [5], in pedagogy [7] and other sciences pay much attention to this aspect there are no facts that clearly prove the stability of the individual asymmetry profile in ontogenesis.

The manual asymmetry is a property of a man only and therefore its study allows determining the peculiarities of not only the motor system, but also the control of the motor system by the central nervous system. At the same time, functional motor reserves, maturity of their coordination mechanisms determine the formation of the main natural locomotions of a child. Motor processes are gradually woven into all activities. Especially this concerns motor coordination of hands [6, 9, 11].

When stabilizing their temporal and spatial characteristics the motor actions shall be accompanied by the stability of parameters in the activity of other related systems of the organism, including the way of vision. According to this logic, the change of the vision mode should change temporal-spatial characteristics of movement. However, the regulating role of motor asymmetry and the related development of motor skills with lateral preference in the use of bilateral organs, and the stability of the asymmetry profile are not well studied.

The visual analyzer is the most adequate object of the study, since due to its structure it allows quite clearly addressing and differentiating the input of information to a brain hemisphere. The approach used in the study to the analysis of visual perception as to a product of the activity of the paired analyzer revealed the influence of the vision methods on the hidden period of the motor reaction when performing a single manual movement.

Motor asymmetry, and therefore the quality of implementation of motor actions, is directly related to visual asymmetry [6, 7]. Therefore, the lack of knowledge on the impact of the vision method on the quality of the main motor actions reduces the possibility of forming their rational execution.

Especially this problem is exacerbated in children of 5–6 years of age during the period of development of main

 

movements and intensive formation of functional asymmetries [3, 4, 6].

One important aspect of pre-school development in preparation of a child for school is the development of fine motor skills and coordination of finger movements. The problem of increasing the efficiency of complex work on the development of fine motor skills and coordination of finger movements of children at the age of 5–6 years does not lose its relevance.

Children of pre-school age develop all organs and systems intensively, develop motor skills and abilities, lay the foundations for the execution of movements that ensure the efficiency of all motor activities of a child [7, 12]. The movements of children of preschool age are developed during their training in such types of physical activities as tossing, ball throwing and catching, kicks a ball, etc.

One of the features of the motor program is the duration of its formation in the central nervous system, which can be determined by the time of the latent phase of the motor action.

**The purpose of the study** is to identify the functional asymmetry of the visual analyzer and to experimentally justify the influence of vision methods on the hidden period of motor reaction during single manual movement in senior pre-school children.

## 2. METHODS AND MATERIALS

The study was carried out at the Laboratory of Ergonomic Biomechanical Engineering of Adyghe State University and pre-school educational institution No. 6 in Maikop and simultaneously covered children at the age of 5–6. In total, 95 pre-school children took part in the experiment. Children aged 6 were studied traditional educational system in a pre-school group.

In order to determine the functional asymmetry of visual analyzer the "asymmetry coefficient" ($C_{as}$) was calculated by the formula, which allowed detecting the differences of indicators and distributing children of 5–6 years old into groups according to the level of asymmetry [2].

$$C_{as} = \frac{E_r - E_l}{E_r + E_l + E_o} * 100\ \%,$$

where $C_{as}$ – asymmetry coefficient; $E_r$ – number of tests with the prevalence of the right side; $E_l$ – number of tests with the prevalence of left side; $E_o$ – no prevalence.

The results obtained as a percentage were compared via angular transformation method of φ* – Fisher's ratio test.

Time characteristics were recorded using the optical system of three-dimensional video analysis "Video analysis of Statokin movements". The video recordings were processed using the Video Motion_ 3D Software Complex. The software part of the system performed the following operations:

- recorded movements at a rate of 50 shots per second;
- automatically processed coordinates of markers on a human body;
- graphically presented all recorded motor information.

The motor activity of pre-school children shall correspond to the functional abilities of the body, which forms the basis of an individual approach to each child. The most effective natural age-based movement to detect time characteristics was catching an object. The catching considered the duration of the latent period (LP) of the motor reaction, which makes it possible to determine the duration of the motor action of a child within the central nervous system where the movement program is created.

During the study the children were asked to catch a ball thrown by an experimenter. The time of visual-motor reaction to a falling object from the moment of throwing to the moment of catching was estimated. The latent period of the motor reaction and the execution time of the holistic motor act were measured. The children visually fixed the object, at the same time the cameras recorded the time of ball falling, the time of catching and the time of movement of the wrist joint. The participants of the experiment performed movements with open eyes, with closed right eye and closed left eyes in turn. The subject was in the standing position with arms down.

## 3. RESULTS

In the course of determining the asymmetry of visual perception it was revealed that 58 % of pre-school children of 5–6 years of age have the right leading eye, 27.3 % – left and 45.7 % – mixed type. Despite the fact that the vision is binocular, the visual impressions of each of the eyes have different abilities, i.e. one eye takes the leading importance (more often the prevalence of the right eye) and the other – subordinate. In most children, there is a prevalence of right eye functions, probably because the left hemisphere processes verbal information.

The obtained results show the validity of diagnostics of the leading eye on the basis of visual samples (aiming, winking, telescope) and at the same time they provide additional information on the general laterality of the visual analyzer of the subjects.

At the age of 5–6 years the formation of the foundations of the technique of performing this motor action is completed, the sensational period has passed.

It is assumed that the consideration of the speed of motor action under different methods of vision does not produce objective results without taking into account the dominance or subdominance of the vision organ. In order to determine the validity of this assumption, the subjects were divided into three groups, which included 60 children of senior pre-school age:

1) children with dominant right eye;
2) children with dominant left eye;
3) children whose dominant eye is not detected (ambidexters).

**Table 1** Distribution of visual asymmetry by φ* – Fisher's ratio test (n = 95)

| Feature | Leading right eye | | Leading left eye | | Ambidexters | |
|---|---|---|---|---|---|---|
| **Subject** | **Effect** | **No effect** | **Effect** | **No effect** | **Effect** | **No effect** |
| Boys (n=45) | 58 % | 40 % | 27.3 % | 32.1 % | 35.7 % | 24.1 % |
| Girls (n=50) | 42 % | 50 % | 22 % | 54 % | 22 % | 41 % |
| φ*, P | φ* = 1.96 P<0.05 | | φ* = 2.55 P<0.05 | | φ* = 1.72 P<0.05 | |

Note: P – validity of differences between the indicators in children with right and left eyes, φ* – Fisher's ratio test, percentage share for calculation between girls and boys.

The groups are identified during visual asymmetry evaluation by testing after data processing by conventional methods of calculation of basic characteristics of sample distributions.

The time of the latent period of the motor reaction in 5-year-old children depends on the quality of the vision method in two groups, namely the ambidexters group and the leading left eye group (Table 2).

In the ambidexters group, the duration of the latent period of the motor reaction depends on the method of vision. This conclusion follows from the fact that the differences between the studied parameters in the implementation of the task with open eyes (0.18±0.03 sec.), with closed right eye (0.14±0.04 sec.) and with closed left eye (0.10±0.02 sec.) differ significantly (Fig. 1).

It is interesting that children of this group perform motor tasks with the most time required when seeing actions with both eyes, i.e. for children of 5 years of age, the interaction of visual analyzers in binocular vision conditions is more difficult than the accurate determination and analysis of the motor task by the dominant organ.

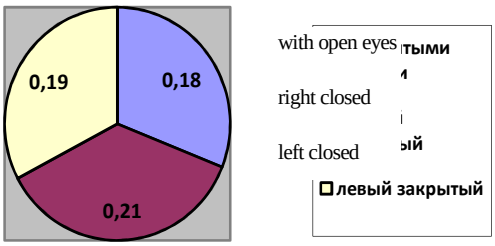


**Figure 1** Average latent time (sec.) in catching a ball depending on the leading eye in 5-year-old children; X ± σ (n=27)

Due to the fact that the ambidexters do not have a dominant organ (i.e. both eyes are dominant) the children of this group analyze the motor task better by each eye than by both eyes.

The duration of latent period of motor action in children with the leading left eye does not depend on method of lateralization of vision. This fact requires further study, but it may be a consequence of the proven influence of the right-hand culture in numerous studies, leading to the need for a reduction of left-hand dominance and a restructuring towards right-hand dominance within the limits allowed by the genetic development program.

In the group with the leading right eye, closing the dominant eye gives the same result (P>0.05) as in case of binocular vision.

However, the closure of the subdominant eye, i.e. the fixation of the object by the dominant eye (0.12±0.02), results in a significant reduction in the duration of the latent reaction period (P<0.01) compared to the binocular method of vision (0.18±0.02). Consequently, in a somewhat hidden form, but in this group, the pattern manifested in the group of children with an unselectable dominant organ of vision is repeated.

The calculation of the average holistic motor act shows that in the group with equal possibilities of using both eyes, there is no convenience or inconvenience of vision and therefore the task is performed with about equal span time.

In the groups with identified dominants of one of the vision organs, the picture is modified. Closing the dominant eye in the other two groups reliably increases the duration of motor action compared to binocular control. In the group with the leading left eye, closing the left eye (0.34±0.03) provides a reliable (t=4.13; P<0.001) increase of time (in case of binocular vision – 0.25±0.05) (Fig. 2).

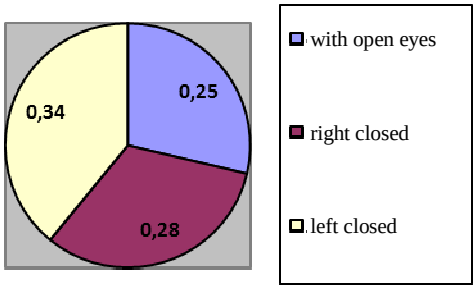


**Figure 2** Average motion depending on the leading eye in 5-year-old children; X ± σ (n=27), sec.

The pattern is also repeated when closing the dominant eye in the group with a leading right eye (t=2.52; P<0.05), where the duration in this case makes 0.32±0.08, and in binocular vision the span time is only 0.22±0.04.

However, this group has a valid (t=2.36; P<0.05) improved result with binocular vision than with a dominant organ alone. It is believed that this phenomenon is cause not only by visual asymmetry, but also by its overlap with other lateral preferences and functional asymmetries.

In six years of age, there are no significant increases in the rate of performance of the test motor action and the latent period of the motor reaction relative to the group of five-year-olds. However, the quality of binocular vision increases resulting in a reliable, relative vision by the subdominant eye, improvement of results.

In the group of children with the leading right eye, for unclear reasons, the duration of the hidden period of reaction with the right and left eyes closed relative to the children of 5 years of age increases (Fig. 3).

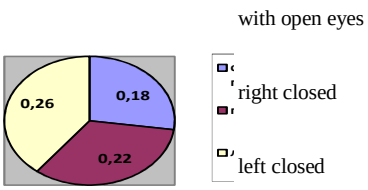


**Figure 3** Mean time (sec.) of latent period of motor reaction in ball catching depending on leading eye in 6-year-old children; X ± σ (n=33)

At the age of six, the speed of the test task is not different from that shown by 5-year-old children. However, the quality of its implementation is higher, which reduces the impact of convenience – inconvenience of vision to the result. This result is confirmed by the calculation of reliability of indicator differences (Fig. 4).

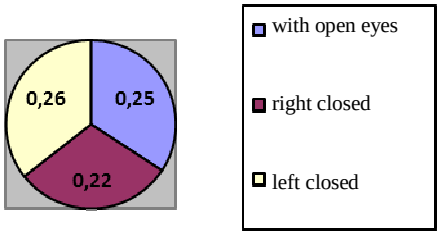


**Figure 4** Average time (sec.) of motion depending on the leading eye in 6-year-old children; X ± σ (n=33)

The obtained results of the study confirm the plasticity of monocular vision systems under conditions of spatial vision, phasing and heterochrony of mono- and binocular vision, functional nature of monocular vision asymmetry.

## 4. CONCLUSION

1. Most children have a prevalence of right eye functions, probably because the left hemisphere is involved in the processing of verbal information.

2. The obtained results show the validity of diagnostics of the leading eye on the basis of visual samples (aiming, winking, telescope) and at the same time they provide additional information on the general laterality of visual perception.

3. The results of the study confirm the plasticity of monocular vision systems under conditions of spatial vision, phasing and heterochrony of mono- and binocular vision, functional nature of monocular vision asymmetry.

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