Investigating The Association Between Retained Primitive Reflexes and Partial Visual Abilities in Children Aged 4–8 Years

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Abstract

This study is a part of my doctoral research, in which we examined the possibilities to improve development of sensorimotor skills in children. Within the area of sensorimotor development, we researched the persistent primitive reflexes, the vestibular maturity, the gross-motor coordination and multichannel attention.
In this study, we present the impact assessment of our research on the development of sensorimotor development and visual skills, because this is one of the key basic skills for school learning, alongside several other skills.
Visual abilities are necessary for visual perception. Without it, hand-eye coordination, shape background distinction, spatial perception and visual memory cannot be accurate.

It is essential to know which foundational factors, in addition to organic maturity, are necessary for the perfect functioning of visual sub-skills.
One such factor may be the presence of primitive reflexes.
Over a period from 2018 to 2019, we studied the association between the presence of primitive reflexes and partial visual abilities in 422 children aged 5–8 years.
In the research, we found a strong, positive significant correlation between the retained primitive reflexes and partial visual abilities.

Keywords: development; kindergarten; learning skills; elementary school; sensorimotor;

Introduction

In the research, I hypothesized a significant positive relationship between the presence of primitive reflexes and the functioning of visual sub-abilities required for learning. The children included in the research were selected in a two-stage sampling, in which 422 healthy children aged 5–8 years were included. Of these, 63 were in the control group and 359 in the experimental group. The proportion of girls to boys was 53%-47% in the control group and 57%-43% in the experimental group. In the experimental group, children participated in a program of sensorimotor development 3-5 times a week for 6-7 months, one element of which helped to integrate the persistent primitive reflexes. Kindergarten teachers and teachers held the sessions. The control group had regular PE lessons rather than the sensorimotor development program.

The reflex profile was measured by a test from Mary R. Fiorentino: A Basis for Sensorimotor Development-Normal and Abnormal: The Influence of Primitive, Postural Reflexes on the Development and Distribution of Tone. The partial visual abilities examined were: body scheme, shape background distinction, shape perception, differentiation of directions, spatial situation relationship, visual-motor coordination, and visual memory.

Theoretical background of the research

The visual system is a complex perceptual system that helps identify what is seen. It provides information both in space and time, as we perceive visual stimuli in time, see them in sequence, and at the same time perceive the place, extent, and colour of objects in space. Vision should not be confused with sight or gaze. Watching is not a learned process. On the other hand, vision develops during individual development, learning vision through the baby's experience. In this process, the nervous system understands what it sees when it looks (Kranowitz, 2012).

Visual stimuli make up 80-90% of the stimuli among the effects on the nervous system. In children who have problems with visual perception, the information coming into the brain is distorted. Distorted visual information is combined with vestibular, tactile, proprioceptive, and auditory stimuli perceived at the same time, leading to a greater or lesser degree of disorganization. As a result, the expectations associated with visuality for the child will be barely met or unfulfilled (Cheatum and Hammond, 2000).

Problems can arise in many areas. For example, the eye axes do not converge, or the child's eyes cannot focus. Occasionally, shape-background discrimination, part-whole discrimination, or eye-hand coordination is very poor. You may have trouble reading the lines while reading. In such and similar cases, the child's nervous system quickly gets tired and behavioural problems emerge. He drops the pencil, talks to his classmate, pretends not to care. In general, learning lags and negative behaviour patterns can develop (Cheatum and Hammond, 2000).

According to Kranowitz (2012), basic visual skills are essential for flawless visual functioning. These include the ability to see sharply, respond quickly to low or intense light, focus on short and long distances, and allow the eye to make quick changes in terms of near and far. In addition, it includes motion detection, binocular vision, fixation ability, and professional eye movement.

He considers peripheral vision to be necessary, in which one can also perceive events on the periphery of the field of view. For example: depth perception, which is essential for judging relative vision; a stable field of view that allows you to judge which objects are moving and which are stable; and the perception of spatial relationships about each other and the body of the observer. He mentions visual sensitivity as perceiving similarity and difference in size, shape, and location. Shape constancy plays a significant role, among other things, in identifying a sign or shape even if its position, size, colour, or texture changes. Without distinguishing between shape and background (or environment), it would be difficult to decide whether something is in the background or the foreground, or it would be almost impossible to separate a face in the crowd (Kranowitz, 2012). The ability to discriminate shape and background is essential for smooth reading and writing.

During visual attention, the eye, brain, and entire body are active at the same time. This allows you to read or follow directions while watching a moving person or object. Visual memory means remembering images you have seen before. This allows images to be recognized, associated, stored, and recalled. Sequential memory, which is nothing more than the recall of words and images written one after the other, is essential in writing and reading. Visualization is a prerequisite for language development. In doing so, the brain shapes the images of objects, people, and landscapes in its imagination (Kranowitz, 2012).

During visual-sensory integration, the nervous system connects and organizes vision with vestibular, auditory, tactile, motor, proprioceptive, and other stimuli (Kranowitz, 2012).

The eye is just a means of vision; for incoming information to be processed with sufficient accuracy, the baby must use a variety of other sensory and motor information. Several neural pathways develop between the central nervous system, the senses, and the body in the first year after birth.

The vestibulo-ocular reflex (VOR)

One of the essential such reflexes from the point of view of vision is the vestibulo-ocular reflex. When we hold our heads while walking and notice the events around us, we owe this to the VOR reflex. This reflex keeps us in balance. Although our head is constantly moving, our eyes are scanning the environment. Because when the head moves, the eye-moving muscles are immediately activated and create movement in the opposite direction to the head movement, but of the same size. This creates the visuals that the retina stabilizes (Somisetty, 2020).

The vestibulo-ocular reflex has three parts; the vestibular organ, central processing, and motor performance, i.e., the functioning of the eye-moving muscles (Fetter, 2007). The central nervous system processes information and sends a motor response to the spinal cord and eye-moving muscles. In addition to the VOR, vestibulospinal reflex (VSR) is present, which provides stability to the head and posture, and prevents falls (Fetter, 2007).

Information is transmitted to other cortical structures where tactile, auditory, and proprioceptive (sensory) integration occurs. The operations of the VOR and VSR create a situation controlled and continuously adjusted by the central nervous system as necessary (Fetter, 2007). Information from the vestibular organ enters the brainstem through the 8th cranial nerve. Here you can also find the cerebral nuclei III, IV, VI, which is responsible for coordinating eye movements related to the change in the position of the head. The relationship with the networked brainstem body plays a role in the development of rotational nausea and seasickness associated with undulation, as well as in the formation of muscle tone. The relationship with the spinal cord also affects the tone of the skeletal muscles (Somisetty, 2020).

The cerebellum also has a significant role in the processing of vestibular information, as it helps regulate vestibular reflexes, maintain posture and coordination (Carleton and Carpenter, 1983). Connections with the cerebral cortex, thalamus, and networked brainstem body are due to the coordination between the central nervous system and the vestibular system, allowing spatial awareness and normal posture (Wallace and Lifshitz, 2016).

Reading can also be difficult due to the reasons just mentioned, as well as due to abnormal nystagmus or its complete absence. Even tiny head movements can cause distortions in recognition of words and letters, and due to the disorder of nystagmus, the eye does not jump back to the beginning of the line, getting lost between the lines. In addition, atypical eye movements can obscure vision. Since such children and adults read slowly, it is often mistakenly diagnosed as dyslexia or even dyscalculia (Takahashi, Okada, Saito, Takei, Tomizawa, Uyama, Takeuti, Kanzaki, and Roles, 1991).

Cheatum and Hammond (2000) highlight the following problems related to vision, which we have extended with our own experience.

1. Disturbance of accommodation, which means insufficiency during changes in eye lens thickness.
    - focusing too far or too close instead of on the target,
    - unable to relax when looking up-close, such as when working at her desk, or trouble looking up at the board from the table or vice-versa,
    - blurred vision,
    - only one eye is used by the child,
    - headaches develop when looking up-close,
    - double vision,
    - dry eyes,
    - sleepiness,
    - weakness and lack of concentration.

2. Problems with fixation, i.e., one-way recording of the gaze

- unable to focus permanently,
- eyes tearing-up,
- tiredness,
- stress,
- problems with movement and sports,
- continuous movement of the eye between targets,
- difficulties grasping what is happening in the classroom,
- short duration of concentration,
- often does not know where they are in the text when reading,
- mixing up letters,
- reversing words.

3. The inability to maintain binocular vision, i.e., vision with two eyes,
    - double vision,
    - Strabismus (crossed eyes),
    - strange posture at the desk,
    - squinting,
    - skipping words when reading,
    - writing and sorting numbers and letters in the wrong row or column,
    - fatigue when focusing,
    - looking with one eye,
    - difficulty in completing written and reading tasks,
    - doubling letters,
    - tight posture,
    - unable to pinch/pick-up very small objects,
    - support of the head when reading and writing.

4. Visual tracking issues

    - skipping words and letters when reading or writing,
    - when reading, moves his head to the right and left but does not move his eyes,
    - does not fill the available space when drawing,
    - squinting,
    - slow reaction time,
    - weakness in targeting when playing sports,
    - writing inverted numbers, letters, or words,
    - skipping lines when reading,
    - difficulties in comprehension,
    - switched eye use,
    - difficulties in crossing the midline of the body (especially when looking),
    - more subdued behavior than you'd expect in class.

5. Strabismus

    - headache,
    - blurred vision in one eye,
    - double vision,
    - closing one eye when looking,
    - covering one eye (with the hand),
    - no dominant eye,
    - one or both eyes randomly jumping.

6. Problems with visual memory

There is a significant correlation between visual memory and readability. A task related to a smooth reading, such as learning the alphabet, can be a problem if visual memory is poor. If the child does not remember each letter, there is no chance they will recognize the letter in a word and read it.

7. Problems with shape-background discrimination

- difficulty selecting a graphic, word, number, or letter in a particular image or text,
- problem of perception of the whole and part of the relationship,
- recognition, coupling or breakdown of letters into their elements,
- difficulties copying letters,
- spelling problems,
- difficulties in navigating the text.

8. Visuomotor problems

- difficulties in handling a ball due to dual vision,
- the child is unable to concentrate on the teacher for a sufficient period of time,
- problems with focused attention,
- difficulty in distinguishing the movement of a moving or approaching object (does the ball come closer or move away?),
- clumsiness, movement coordination problems,
- disturbance of eye-hand coordination.

(Cheatum & Hammond, 2000; Sarlós, E.,2021)

If a child has problems learning at the beginning of their school years, it is worth checking if his eyesight is correct. Many children's learning difficulties stem from this problem (Cheatum and Hammond, 2000).

Research Method

Selection of the children participating in the research was made in two steps. First, we contacted every 10th institution from the educational authority's website. Then, from those who responded, we selected the participating institutions using layered random sampling, considering the regional (village, city, capital), the maintenance (state, municipality, foundation, church).

The selection of the control group was difficult because everyone wanted to be in the experimental group. In the end, two kindergartens and one school group were placed in the control group. The sex ratio and the value of the sensorimotor variables studied were approximately the same in the experimental and control groups. The proportion of girls to boys was 53%-47% in the control group and 54%-46% in the experimental group.

At the outset off the study, there was no significant difference between the two groups regarding persistent infant reflexes, vestibular maturity, motor coordination, and multichannel attention. The average age in the experimental group was 5.95, and the average age of the control group was 6.38 years.

The experimental group received sensorimotor development 3-5 times a week. The control group members did not participate in this development program but took part in the educational institution's regular physical education sessions.

For the experimental group, the program of development exercises was incorporated into their psychical education lessons and did not include targeted visual training exercises. In addition to the reflex test, the sensorimotor test tested the level of vestibular maturation with a static and dynamic position balance test, and the post-rotation nystagmus was tested. In addition, we tested motor coordination and multichannel attention.

Mathematical, statistical procedures

Given the ordinal nature of the data, we used order statistical procedures, i.e., the Mann-Whitney test, the Wilcoxon test, the Kruskal-Wallis method, and studies related to the calculation of Spearman's rank correlations (Nahalka, 2000).

Results

There was no significant difference between persistent infant reflexes in the experimental and control groups in the input measurement, with a p >0.001 difference. The reflexes examined were: Moro reflex, grabbing and sucking reflex, asymmetrical neck tonic reflex, Galant reflex, forward tonic labyrinth reaction, tonic labyrinth reaction directed backwards, symmetrical cervical tonic reaction.

Variable	Input measurement average (%)	Output measurement average (%)	The level of significance of Wilcoxon test
Maturity of Primitive Reflexes	53,4	75,9	$p < 0,001$
Vestibular Development	40,1	56,7	$p < 0,001$
Motor-coordination Development	37,9	59,4	$p < 0,001$
Development of multichannel attention	40,2	63,9	$p < 0,001$
Sensorimotor Development	43,3	62,7	$p < 0,001$

Table 1: Average percentages of children in experimental groups showing their sensorimotor development and its components in input and post-development output measurements, Wilcoxon test determined significance level of change

From the data in Table 1, it can be seen that the results of post-development measurements related to the components of sensorimotor development and the sensorimotor development indicator itself are significantly higher than the input values. Each comparison shows a significant difference of $p < 0.001$. Already, these data show that the development program was successful, because the increase in sensorimotor development is significant.

In order to ensure the result is reliable, the possibility must be excluded that the development was caused solely by natural maturation. To address this, we can compare the results of the children in the experimental and control groups by doing the same calculation on the children in the control groups for which we have shown a significant degree of development of children in the experimental groups. The result is shown in Table 2.

Variable	Input measurement average (%)	Output measurement average (%)	The level of significance of Wilcoxon test
Maturity of Primitive Reflexes	48,3	49,4	n.sz.
Vestibular Development	40,4	43,4	n.sz.
Motor-coordination Development	40,1	43,7	n.sz.
Development of multichannel attention	37,4	40,9	n.sz.
Sensorimotor Development	42,0	45,1	n.sz.

Table 2: Average percentages of children in control groups expressing their sensorimotor development and its components in input and post-development output measurements, the significance level of the change determined by the Wilcoxon test

For the children in the control groups, the sensorimotor development did not change in the 6-8 months between the two measurements. None of the differences are significant. This result shows that any change due to the natural maturation of children over this half-year period was not significant compared with development observed in the experimental groups. In comparison, the significantly higher significance of changes in the experimental groups is quite convincing. However, it should be noted that we found that maturation occurs from one year to the next without developmental intervention. We have to assume that the children in the control group also developed during the semester, only this level did not reach the level of being statistically significant, and the impact sizes are also tiny. Therefore, there is a high probability of improvement (this is also indicated by the fact that the change is positive for all variables) and can be large enough in 4-5 years to be statistically "appreciable."

Components of Sensorimotor Development	Visual abilities	
	Spearman correlation coefficient	Significance level
Maturity of Primitive Reflexes	0,314	*p* < 0,001
Vestibular Development	0,509	*p* < 0,001
Motor-coordination Development	0,484	*p* < 0,001
Development of multichannel attention	0,361	*p* < 0,001
Sensorimotor Development	0,542	*p* < 0,001

Table 3: Using a combined sample of children in the experimental and control groups, the Spearman correlation coefficients and significance levels between the sensorimotor development variables of the output measurement and the variables of visual abilities.

It should be emphasized that we did not separately develop the partial visual abilities of the children during the performance of the sensorimotor training (a 6-7 month period).

The values in the table above show that reflex profile strongly correlates with the level of visual abilities. The correlation is significant, $p<0,001$, $r=0,314$

Conclusion

Based on the obtained results, it can be said that there is a positive, significant correlation between the level of primitive reflexes and the level of partial visual abilities in the examined children aged 5-8. The magnitude of the effect of the change due to the sensorimotor exercises performed by the experimental group is significant. It is essential to ensure that children do not have infant reflexes at the beginning of their school years. It should be natural that these reflexes are integrated in the 2-3 years after birth. If they persist, they impede the development of partial visual abilities.

As the examined visual abilities are the basis of successful learning processes, it is worthwhile to address this in children before they begin school, since it will have a beneficial effect on the maturation processes.

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