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# The Ability of Conceptual Monitoring and the Quality of Working Memory at Children With Calculation Difficulties

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Calculia is considered to be the ability of performing arithmetic operations, the preconditions for the development of mathematical skills in the complex functioning of psychological functions represented in neuro-anatomical systems, as well in the interaction with the environment. Problems in acquiring arithmetic skills can be described as difficulties in counting as well as developmental dyscalculia. Reported prevalence rate for this problem in general population is 6%-10%. The most common difficulties in counting are: difficulties in logic, difficulties in planning, perseverance of inappropriate (responses) procedures and poor understanding of arithmetic operations. This paper aims to identify the influence of assessed arithmetic skills and to clarify to what extent the assessed cognitive skills affect each other in children with difficulties in counting. The relations between the level of working memory and acquiring of arithmetic skills, between the attention and the conceptual observation, and also between planning ability and acquiring of arithmetic skills have been assessed within the study goals. The tested sample consists of 84 third-grade pupils of general population divided into an experimental and a control group. The subjects of the experimental group were chosen according to the discrepancy between general intellectual competences, general achievement at school and success in the filed of mathematics expressed by school marks. Following tests of neuropsychological test battery were used: (1) Taylor's word list-Rey test; and (2) Trail-making-TMTa/b test. The results have been analyzed regarding qualitative test results, as well as the aspect of previous knowledge in the studies dealing with dyscalculia. The results of the studies indicate that there is statistically a significant difference in effectiveness of assessed cognitive characteristics of working memory, attention and planning abilities between experimental and control group (sample) ($p < 0.01$). The subjects of experimental group, i.e., those with difficulties in counting and the results given, show that there is poor effectiveness but positive connection of moderate intensity among assessed cognitive characteristics ($p < 0.01$).

*Keywords:* difficulties in counting, developmental dyscalculia, cognitive functions, planning, perseverance, working memory, attention

## Introduction

Each of nerve fields and each quality of psychic functions that take part in the recognition of mathematical signs and their handling in mental processes has its developmental path. It can be determined not only by the

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genetic heritage, but also by direct personal experience.

The skill of calculating is based on the idea of a number, the relations of bigger and smaller and plurality. Arithmetic operations are expressed by the use of lexical and semantic units, so that the calculation has the form of a language behavior. Mathematical operations are also defined by the spatial factor. Thus, the two basic types of human behavior, language and space, are built in the acquired ability to calculate. For this reason, both hemispheres, though the dominant one is the left, participate in the anatomical and functional organization of the calculia. The prerequisite for the development of mathematical skills lies in the complex functioning central nervous system of the three hierarchically organized functional blocks. They take part in the organization of any form of complex psychic activities and behaviors. Psychic functions represent functional systems whose links of afferent and efferent types are placed in the cortical and subcortical parts of the brain. General characteristics of functional systems are a high level of plasticity, so that each psychic function is supported by the mutual work of various brain parts which are component parts of the given functional system.

The difficulties in mastering the mathematical skills include discrepancies which disable a child to adopt them, disregarding the normal intellectual development and normal functioning of senses. It can be easy, moderate and heavy. Terminologically speaking, we recognize dyslexia as a partial difficulty and dyscalculia as a full disability of mastering mathematical skills. At children, these are usually disabilities formed at an early age of development, and that is the reason why they are called “developmental” MLD (mathematical and learning disabilities). Some research studies have dealt with this problem and claim that there are 6.2% children in the overall population with difficulties in mastering mathematical skills; that the numbers of boys and girls are equal and that they usually coexist with the states, such as attention deficit hyperactivity disorder, anxiety and dyslexia (Barbaresi, Katusic, Colligan, Weaver, & Jakobsen, 2005). The most frequent difficulties are those with understanding of concepts and signs, sequencing, complex thinking and flexibility and logic, planning and anticipation.

## Problem and Aim

The quality of mathematical skills depends on the quality of cognitive functioning. Within this research, the distinction has been made among cognitive functions that have an important role in the adoption of mathematical skills.

Working memory is a multi-component system whose function is to temporarily store and manipulate information. Within the quality of attention, directing, focusing, maintenance, flexibility with the adequate transfer from one content to another, as well as an adequate reaction to distracters are of extreme importance.

The aim of the research is to determine the relationship between the ability of conceptual monitoring and mastering mathematics, as well as the relationship between the quality of working memory and mastering mathematics of junior schoolchildren.

Within the same aim, the interrelation of examined cognitive functions at children with difficulties in mastering mathematics has been compared.

## Methods

The examined sample consists of 54 pupils of the third-grade of regular population from two town primary schools. Among them, 30 are boys and 24 are girls, age ranging from 9.25 to 10.25 years. The range of intelligence quotient is between 90 and 115. The examined sample has been divided into experimental and control groups. The examined experimental sample has been chosen according to the discrepancy between general intellectual abilities, general achievement at school and the success in mastering mathematical skills shown by a grade (unchanged and in the previous grade).

The examined variables are as follows:

(1) The range of working memory for which Rey-test or Taylor-list of words have been used. The basic structure of the test comprises five presentations of 15 words, five evocations and interference test;

(2) Flexibility of attention for whose evaluation TMTa/b test has been used. The test consists of two parts: (a) A series is connected according to the sequence; and (b) Two different conceptual series are monitored side by side.

The acquired results are shown in tables and graphs in absolute numbers and percentages. The following tests are used for data processing of results: $Y^2$-test, *T*-test, variant analysis and correlation measures. The achievements have been analyzed in relation to the quantitative test parameters, as well as from the point of available knowledge in that scientific field.

## Results and Discussion

The comparison of results acquired by Rey-test between the experimental and control groups are shown in Table 1. The conclusion has been drawn by the application of $x^2$-test that the range of working memory is smaller at the examinees from the experimental group ($p < 0.01$).

The learning curve at the examinees from the experimental group shows lower efficiency and performance smaller than seven words (see Figure 1).

Table 1

*The Comparison of Results Acquired by Rey-Test Between the Experimental and Control Groups*

| | Experimental group | | Control group | | Total |
|---|---|---|---|---|---|
| Above median | 6 | 22.22% | 18 | 66.66% | 24 |
| Below median | 21 | 77.77% | 9 | 33.33% | 30 |
| Total | 27 | | 27 | | 54 |

*Notes.* $x^2 = 19.39$; $df = 1$; $p = 0.01$.

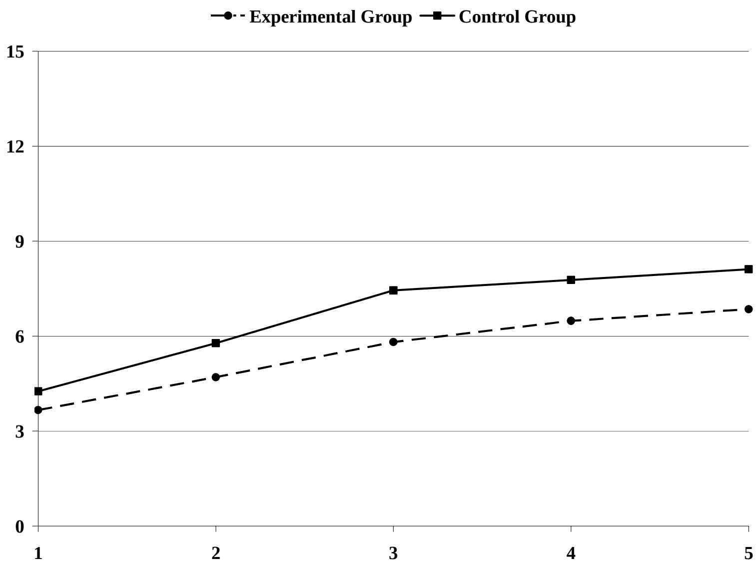


*Figure 1.* Graphic presentation of the learning curve.

The comparison of results acquired by TMTa test between the experimental and control group is shown in Table 2. The conclusion has been drawn by the application of $x^2$-test that the examinees from the experimental group ($p < 0.05$) are less efficient.

The examinees from the experimental group are less efficient since they have spent more time doing the test (see Figure 2).

The comparison of results acquired by TMTb test is shown in Table 3. The results show a statistically important difference in achievement between groups with lower efficiency of examinees from the experimental group.

Lower efficiency of the examinees from the experimental group who have had considerably longer time and a greater number of mistakes is noticed in the graph (see Figure 3).

Table 2

*The Comparison of Results Acquired by TMTa Test Between the Experimental and Control Groups*

| | Experimental group | | Control group | | Total |
|---|---|---|---|---|---|
| Above median | 18 | 66.66% | 9 | 33.33% | 27 |
| Below median | 9 | 33.33% | 18 | 66.66% | 27 |
| Total | 27 | | 27 | | 54 |

*Notes.* $x^2 = 1.86$; $df = 1$; $p < 0.05$.

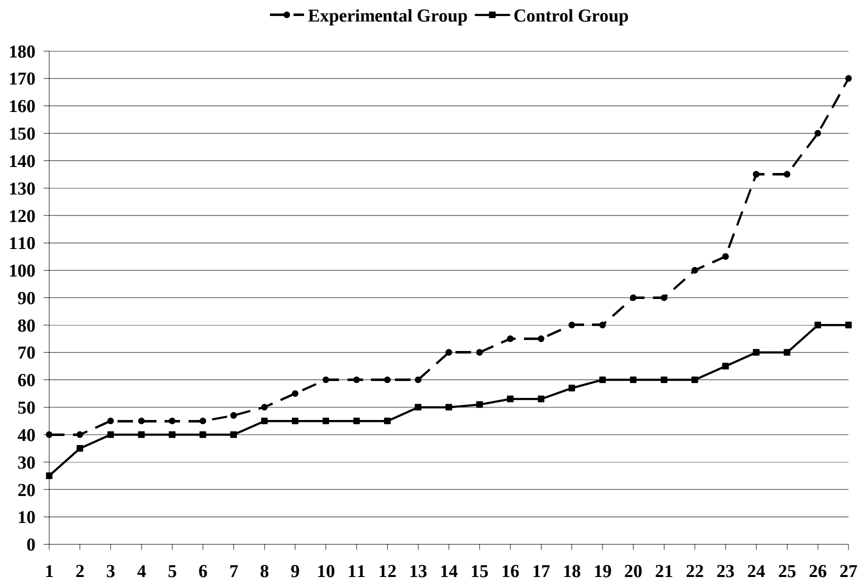


*Figure 2.* Total time at TMTa test.

Table 3

*The Comparison of Results Acquired by TMTb Test*

| | Experimental group | | Control group | | Total |
|---|---|---|---|---|---|
| Above median | 20 | 74.07% | 7 | 25.92% | 27 |
| Below median | 7 | 25.92% | 20 | 74.07% | 27 |
| Total | 27 | | 27 | | 54 |

*Notes.* $x^2 = 10.67$; $df = 1$; $p < 0.01$.

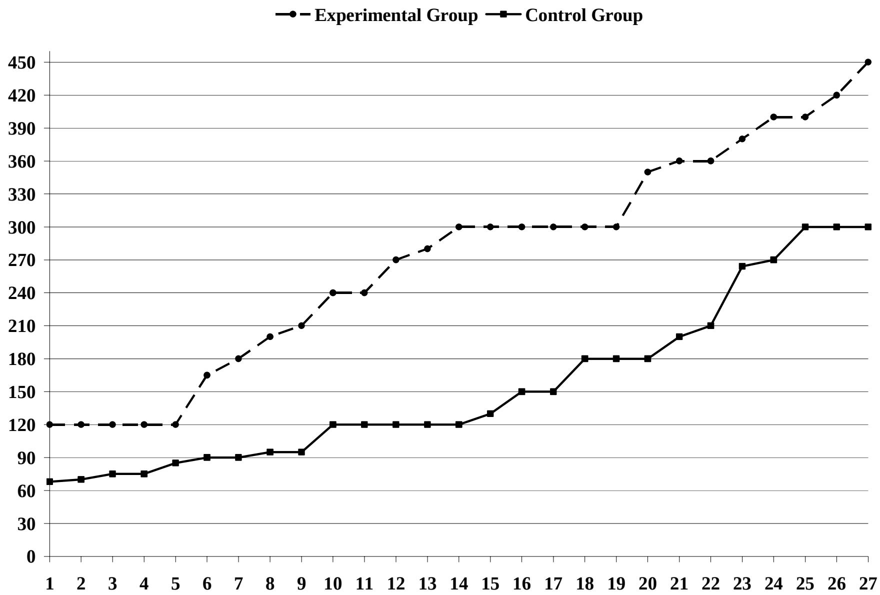


*Figure 3.* Total time at TMTb test.

The connection of the results acquired by the application of Rey-test and TMTb test within the experimental group is shown in Table 4. The acquired result shows a statistically important connection of the results of listed tests within the experimental group ($p < 0.01$).

Figure 4 shows the range connection of the working memory and flexibility of attention within the experimental group.

## Conclusions

In accordance with the set research aiming to determine the relationship between the ability of conceptual monitoring and the quality of working memory and mastering the mathematical skills, we have found as follows.

An important relationship between the quality of working memory and mathematical skills at children with calculation difficulties ($p < 0.01$) has been determined.

The results show that children with calculation difficulties have lower range of information duration in the working memory, as well as slow progression of the learning curve with a falling tendency.

An important relationship between the flexibility of attention and the conceptual monitoring and mathematical skills at children with calculation difficulties ($p < 0.01$) has been determined.

Table 4

*The Connection of the Results Acquired by the Application of Rey-Test and TMTb Test Within the Experimental Group*

| TMT \ Rey | | Rey I | | II | | III | | ∑ | |
|---|---|---|---|---|---|---|---|---|---|
| TMT/b | I | 6 | 22.22% | 2 | 7.41% | 1 | 3.70% | 9 | 33.33% |
| | II | 2 | 7.41% | 4 | 14.81% | 4 | 14.81% | 10 | 37.04% |
| | III | 1 | 3.70% | 4 | 14.81% | 3 | 11.11% | 8 | 29.63% |
| | ∑ | 9 | 33.33% | 10 | 37.04% | 8 | 29.63% | 27 | |

*Notes.* $x^2 = 7.06$; $df = 4$; $p < 0.01$.

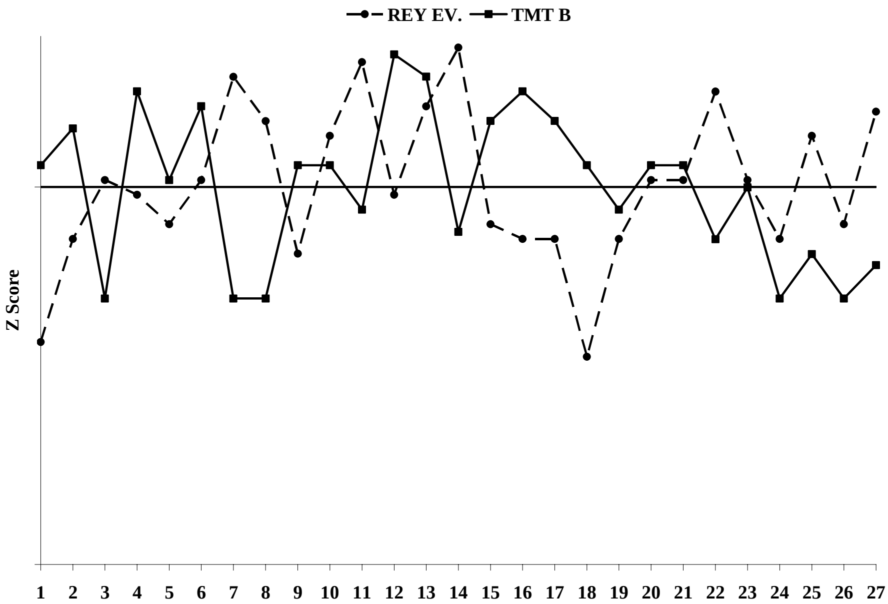


*Figure 4.* The range connection of the working memory and flexibility of attention within the experimental group.

The results show that children with calculation difficulties can hardly follow two different conceptual series, that they spend much more time for that task and that they are prone to the influence of distracters.

An important relationship between the quality of working memory and the flexibility of attention on children with calculation difficulties ($p < 0.04$) has been determined.

According to the acquired results on children with calculation difficulties, the examined cognitive characteristics are manifested as lower-efficient and highly connected with the important influence to one another.

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