

# ViMoT - Development of Visual-Motor Tests Methodology Including the Adoption of Uniform Rules and Digital Test Development

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**Abstract** The authors have previously researched and analyzed, both manually and with the help of a computer program, preschool and primary school children's performance in the eye-hand coordination test and their depth perception. The study used the standardized DTVP-2 test - a psychophysiological test, and it will report as a golden standard for evaluation of visual - motor and visual perception integration. Computer-aided test processing significantly accelerates the collection and acquisition of test results - as we know, time is now a very high resource that everyone needs to spare. We evaluated the stereo vision of 56 participants by using the TNO test and eye-hand coordination. The participants were children of preschool and primary school age. Twenty of them were from a school for children with cognitive disabilities. The TNO test results showed that 54% of children between the ages of 5.5 and 9.0 years old had 60 arcsec, 18% - 120 arcsec, and 29% - 240 arcsec. The DTVP -2 test execution rate shows a very strong correlation with the stereoacuity ( $r = 0,90$ ;  $p < 0,05$ ). A computerized DTVP -2 test performance coefficient shows a higher correlation with stereo ( $r = 0,99$ ;  $p < 0,05$ ). The DTVP -2 performance coefficient related to stereovision value - the higher the eye-hand coordination performance coefficient, the lower are the stereo threshold value. The conclusions of master thesis research became hypotheses of PhD research and started developing a ViMoT methodology. The development of a new methodology (ViMoT) for assessing visual-motor coordination and visual perception in

electronic format and the subsequent development of a computer program will facilitate many specialists' work. It will make it possible to devote more time to processing, but correction or help of an individual (patient), depending on his problem. By working in an interdisciplinary manner, there is an in-depth knowledge of the topic, researched, and new solutions relevant to e-learning. Ensures the quality of the research and increases competitiveness. The following primary research methods will be applied to achieve the aim of the study: theoretical data research as descriptive analysis, content analysis, and comparative method; mixed type of methods as both qualitative research methods and quantitative research methods – document use, case studies, surveys, focus groups discussions and interviews with target groups, experimental and practical testing of recommendations; analysis methods as descriptive analysis, statistical analysis, and others. Today's users and learners require a user-oriented and personalized approach, not only in applications but also in education. The primary study aims to develop components for improving e-learning and learning process Visual-Motor Test (ViMoT) methodologies based and a new computerized tool on visual science basic principles, psychophysiological, and learners' needs.

**Keywords** E-study, DTVP-2, Visual-Motor Integration, Visual Perception, Computerized Assessment

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## 1. Introduction

Eye-hand coordination, or visual-motor coordination by its very nature, is a coordinated movement of visual information and body muscles, which are generally visual skills related to visual perception. Eye-hand coordination is only one of several visual skills related to visual perception - also an important role plays visual memory, visual concentration, visualization, stereo vision, and visual reaction time [1]. In other words, eye-hand coordination is the response of hand muscles to information perceived through the visual system and processed by the brain. Looking at visual information processing, three sub-systems that interact simultaneously can be distinguished: the sensor, the motor, and the perception system. At the same time, it must remember that the world's visual perception and cognition are active and coordinated. Precisely for the learning process to be successful, visual signals must be effectively perceived, interpreted, and integrated with incoming information from other senses [2]. Visual perception is a generic term used to describe visual information processing techniques such as visual analysis, visual-spatial and visual-motor integration, and auditory-visual integration. Visual-motor integration (VMI) describes the degree of coordination of visual perception and body movement. As already mentioned, this process involves the touch (sensory perception) that activates the muscles for a fluid and productive task. Examples of such activities are catching a ball, overwriting from the board at school. Physical exercise has conducive impact on certain cognitive functions especially the efficiency of decoding-coding through the cognitive processing speed of information [3].

However, such conclusions will reach over many years by conducting various tests and refining their language's application methods and methodologies throughout the text.

## 2. Methods

Creating a new methodology in electronic format, the authors of the article briefly reviewed existing standard psychophysiological tests: One of the first DTVP tests developed by [4]. The DTVP test involves studying five aspects of perception: eye-hand coordination, the constancy of form, shape, and background, spatial position and spatial relationship, or spatial interaction. It is a screening test for children aged 3 to 9 years [4]. However, the test has been incomplete and, despite its widespread use, over time, it has been refined and developed for DTVP-2.

The DVPT-2 test is a test that combines two factors – both visual perception skills and visual-motor integration skills. Accordingly, DTVP-2 has eight aspects of being studied in the subtests, which in turn include the following nuances:

- Eye-Hand Coordination;
- Copying;
- Spatial Relationships;
- Position in Space;
- Figure-Ground;
- Visual Closure;
- Visual-Motor Speed;
- Form Constancy [2].

The DTVP-2 test data characterization, credibility, and validation determines that the DTVP-2 test results are 95-97% credible [5].

It best describes the development of visual perception in children between the ages of 6 and 10 years, and the desired duration of the test is 30 minutes to 1 hour. There is also an age-appropriate table for evaluation, as an example in table 1.

**Table 1.** Development of visual perception in children aged six and ten years

Age equivalent	Average value raw score
6	144-145
10	>174

In 1996, M. Bezrukih [6] in her methodological guide, compiled information on how to perform the DTVP-2 test and how to evaluate it properly. These methodological guidelines state that the test does intend for children aged 5 to 7.5 years. At the same time, methodological guidance is useful, for example, in determining a child's readiness to learn school materials; anticipate expected difficulties in mastering the substance promptly; define specific and individual measures of correction in the school curriculum; diagnose the causes of problems that occur in schools; develop individual correction training programs. This author offers six tests as part of DVTP-2, which generally helps assess the state of visual perception development [6].

These tests are as follows:

- 1) Visual-motor coordination involves drawing straight lines, curves, and curves under various angles from a defined starting point to a specific endpoint or according to a specific pattern.
- 2) Shape-background distinguishing involves finding a given shape/figure when the number of background shapes increases. The tasks use shape intersection and "hidden" geometric shapes.
- 3) The permanence of shapes involves identifying a central geometric shape, which can have different sizes, shades, textures, and spatial positions. Usually, use a circle or a square for identification.
- 4) Spatial placement includes recognizing rotated and inverted geometric shapes, groups of shapes, or a series of letters.

- 5) Spatial relationships include analysis and copying of uncomplicated shapes consisting of lines of varying lengths and angles.
- 6) The tricky test involves analyzing figures with the subsequent marking of their parts according to the particular sample.

Each of these tests provides a definite result that can be obtained. These results are also presented by the author clearly and understandably, with a certain number of points corresponding to a certain age, as shown in table 2 and table 3 . .

**Table 2.** The Results of subtest at the maximum number of points 30

Age equivalent	30	20	15	8	8	20
5	10	12	7	5	4	11
6	13	14	9	7	6	14
7	18	17	11	8	8	17

**Table 3.** The Revaluation Scale to Percentage U%

	Perceptual UK scale to percentage U%					
UK	5	10	15	20	25	30
U%	3	5	10	15	20	30

There are various aspects to consider when turning to perform the test itself and to the essential factors that influence the test results, and they are:

- 1) Prepare test material and cards for demonstration and the "registration" / enrolment forms for the children being studied.
- 2) Prepare well-sharpened plain and collared pencils. Younger children may also use markers. These materials (both test material and pencils) must be backed up by the researcher!
- 3) A desk or school bench with height appropriate for the child's age and a sufficiently large and level surface. If the table surface is not level, the child will cover the unevenness on the table surface. Equally important is proper, adequate lighting and ventilation of the room and sound insulation and the absence of other distractions.
- 4) If a group of children is being tested, a school or portable board must explain and demonstrate examples of how to perform the tasks.

### 3. Discussion

Also, the researcher using the DVTP-2 test and the above methodology should carefully read the test manual. Moreover, he must know the evaluation criteria and the processing options for the test results. Particular attention should be paid when examining criteria for the various variations of error that can occur in children's work to

avoid defects in test results processing. The test's essence is that it would be more appropriate to start testing with an individual approach to older children, as group testing requires a sufficient amount of experience with children of all ages. The researcher also needs to think through what and how he says; each instruction should be explicit, with the right words. Before giving the child a command to start the work, it is necessary to make sure that the subject has correctly understood the task. If this is not the case, the briefing must be repeated. Conversely, if the child is very receptive to the briefing, the explanation process can be shortened. Remember to explain to children that drawn lines should not be edited or erased and continuously reminded that most tasks must be done without removing the pencil from the paper. If the child is tired, he should be allowed to rest and take a breath. It should not be forgotten that the test results are no less dependent on maintaining interest and attention in children throughout the exercise. In 2010 the Beery-Buktenica Visual-Motor Integration Test Version 6, VMI Beery were developed were commonly used to determine a person's ability in a particular area, especially school skills and knowledge acquisition [7,8]. This test is designed to measure a person's ability to integrate visual and motor abilities to achieve a specific goal. However, at the same time, it is also used to measure an improvement in visual-motor abilities after performing various handwriting development exercises, as many other researchers have noted a correlation between visual-motor abilities and handwriting. At the same time, it is noted that the VMI test should not be used to detect typing errors. This test stands out, especially for people under the age of 2 and above. Test processing time is relatively short - up to 15 minutes per subtest. In general, the test includes subtests related to visual-motor integration, visual perception, and motor coordination subtests. The reliability of Beery's VMI-6 test is highly dependent on the age of the subjects - the degree of credibility varies from the age of the study group, but overall, this test has a very high degree of credibility as it based on an extensive study group (over 14,000 subjects). The advanced DTVP-3 test, which is often compared to the above-mentioned VMI-6 test, was developed later. Occupational physicians often use this test. Simultaneously, the test works best applicable to children aged 6 to 8 years when used combined with the VMI-6 test. While the VMI-6 test, as already mentioned, is suitable for people between 2 and 100 years, the DTVP-3 test is for people between 4 and 12 years old. The DTVP-3 test requires approximately twice as long time. When it comes to the main features, the VMI-6 test is based on "copying" and fixing the various geometric shapes at the required location, choosing the appropriate geometric shape for each task. The DTVP-3 test, other hands, is based on two sub-grades for how the forms are copied to the relevant endpoint, and three sub-grades for the correct answer are chosen. At the same time, it should

be remembered, as test developers also point out, that the limitations of the DTVP-3 test are related to the time of the test - each person has his or her specific biorhythm, especially the children, so performing the test late at night is inappropriate because children are tired. Studies have found that although the DTVP-3 test and the VMI-6 test be used together to arrive at more accurate conclusions, they do not correlate significantly with each other on the scale of overall test scores. Individual subtests correlate, but not the whole test. The application program can help with measurements

ViMoT - Development of Visual-Motor Tests methodology, including the adoption of uniform rules and digital test development:

- a). The existing ViMoT standardized methodology research
- b). Development of ViMoT in electronic format.
- c). Development and publishing ViMoT methodology in the form of electronic format.
- d). Analyze data with standardized ViMoT methodology and newly developed ViMoT methodology in electronic format.
- e). Publish the results in scientific articles and presentations at international scientific conferences
- f). Distribution of the final results.

## 4. Conclusions

Previous theoretical studies by the authors provide an excellent theoretical basis, which, together with research on user habits and analysis of patient complaints and objective findings, provides a factual basis for developing a theoretical methodology.

During master's studies, tested the visual-motor coordination performance of children in standardized DTVP-2 tests and evaluated the correlation between the quality of stereo vision and performance in the eye-hand coordination subtest [9]. Analysed the DTVP-2 test scores using computer program Image, the application program can help with measurements [10]. The obtained results evaluate the curvature of the line and its deviation from the optimal direction. The higher the number, the less accurate is the line drawn by the child. The higher dispersion of lines, scope, and curvature, the higher the average's fair value.

We evaluated the stereo vision of 56 participants by using the TNO test and eye-hand coordination. The participants were children of preschool and primary school age. Twenty of them were from a school for children with cognitive disabilities.

The TNO test results showed that 54% of children between the ages of 5.5 and 9.0 years old had 60 arcsec, 18% - 120 arcsec, and 29% - 240 arcsec.

The DTVP -2 test execution rate shows a very strong correlation with the stereoacuity ( $r = 0, 90$ ;  $p < 0, 05$ ).

A computerized DTVP -2 test performance coefficient shows a higher correlation with stereo ( $r = 0, 99$ ;  $p < 0, 05$ ).

The DTVP -2 performance coefficient related to stereovision value - the higher the eye-hand coordination performance coefficient, the lower are the stereo threshold value.

The conclusions of master thesis research became hypotheses of Ph.D. research.

Allowing the study to focus on practical tasks and results, an interdisciplinary study combines fields such as visual science, optometry, public health, technology, and education, including the e-learning sector, to achieve one goal - to improve the comfort of students/learners and improve the e-learning process. Online education is gaining in popularity and needs for use in the modern world.

The author hypothesized that using and developing a new computer program and methodology in an online format could be useful not only for users but also for specialists in education, medicine, and psychology, facilitating and speeding up their work.

The program developed earlier by the authors and the updated version of the program with the introduction of computer vision (CV) will allow not only determining the results of psychophysiological tests but also, as an example, it will allow determining the correctness of spelling in electronic prescriptions for children of preschool age and elementary school, which will facilitate and speed up the work of spelling teachers. By working in an interdisciplinary manner, there is an in-depth knowledge of the topic, researched, and new solutions relevant to e-learning. Ensures the quality of the research and increases competitiveness. The following primary research methods will be applied to achieve the aim of the study: theoretical data research as descriptive analysis, content analysis, and comparative method; mixed type of methods as both qualitative research methods and quantitative research methods – document use, case studies, surveys, focus groups discussions and interviews with target groups, experimental and practical testing of recommendations; analysis methods as descriptive analysis, statistical analysis, and others. Some of the data that will be studied are already at the disposal of researchers from previous studies. The generation of new data will ensure through surveys and analysis of patient data records (subject to a personal protection curve) and experimental conditions that participants will be aware of and volunteer (subject to the study's ethical aspects). Summarizing all of the above and knowing that eye-hand coordination, or visual-motor integration, is just one of several visual skills related to visual perception, the authors wish to point out that all of the above tests designed for children of a certain age with different limitations. In the author's opinion, the subject's age rating is very individual, and the results largely depend on the

particular person (child), not on his - her specific age, although undoubtedly parallels between age-specific performance exist. Thus, the authors wish to offer an improvement for the tests mentioned above without creating age restrictions. Besides, it was recommended that the results are processed by computer rather than manually and visually, as this is the way to minimize the evaluator's subjective view (as his visual perception may be incomplete) and to minimize the likelihood of misjudgement as such. Computer processing gives the most accurate interpretation of the result's research needs.

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