Article ▸ # A Comparison of Two Tests of Visual-Motor Integration

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## ABSTRACT

**Background:** Visual-motor integration is the degree to which visual perception and body movement are coordinated. This study investigated the relationship between two tests used to evaluate visual-motor integration, the Developmental Test of Visual Perception (DTVP-2) and the Developmental Test of Visual-Motor Integration (VMI).

**Methods:** Fifty-three children (ages 7 years, 0 months to 11 years, 11 months) were evaluated using the eye-hand coordination subtest of the DTVP-2 and the VMI. They were patients in either the Pediatrics or Vision Therapy departments at The Eye Center at Southern College of Optometry. Thirty-two of the 53 were currently enrolled in, or had completed, a vision therapy program. Further correlations were studied between subsamples of patients who were currently enrolled in, or had completed, a vision therapy program and those who had not.

**Results:** There was no significant correlation between the VMI and age (r=-0.005, p=0.9686) or the DTVP-2 and age (r=-0.2699, p=0.0506) in the main group. A significant positive correlation was found between the two tests (r=0.2744, p=0.0467). In the subsample of those subjects who had never been enrolled in a vision therapy program, there was no significant correlation between the VMI and age (r=0.1108, p=0.5459) or between the DTVP-2 and age (r=-0.3306, p=0.0646). A statistically significant positive correlation between the two tests was found (r=0.4513, p=0.0095). Likewise, in the subsample who were currently either enrolled in or had completed a vision therapy program, there was no significant correlation between the VMI and age (r=-0.0236, p=0.3029) or DTVP-2 and age (r=-0.1654, p=0.4736). However, contrary to the subsample of those not in a vision therapy program, the two tests were not correlated (r=-0.0437, p=0.8510).

**Conclusion:** Performance on the VMI and the eye-hand coordination subtest of the DTVP-2 correlated with one another, but cannot be used interchangeably. The two tests assess different aspects of visual perceptual and visual motor integration abilities. Both tests accurately discriminated between the subsample of patients who had participated in vision therapy and those who had not.

**Keywords:** Developmental Test of Visual-Motor Integration, Developmental Test of Visual Perception-2, visual information processing, visual-motor integration, visual perception, vision therapy

## Introduction

The visual process is the dominant process for the interpretation of our world.[1-3] When considering developmental visual information processing, three subsystems can be thought of as interacting simultaneously: sensory, motor, and perceptual. Perception and cognition of the visual world are active and coordinated.[4] To ensure success in the learning process, the visual signals must be efficiently collected, interpreted, and integrated with the incoming information from the other senses.[3,5]

Visual perception is the global term used to describe methods of visual information processing, such as visual-analysis, visual-spatial, visual-motor integration, and auditory-visual integration. Visual-motor integration is the degree to which visual perception and body movement are coordinated. This process requires proprioception or touch, which requires the muscles to be activated to perform the task smoothly and efficiently. Examples include catching a ball and copying from the board in school.[6] Deficits in these abilities may be associated with disturbances in coordination, posture, and activities of daily living.[7] Studies have shown an association between visual perception abilities and academic achievement[8,9] and also that vision therapy is successful at remediating such deficiencies.[8]

There are numerous tests that evaluate visual perception. This study investigated the relationship between the Developmental Test of Visual Perception (DTVP-2) and the Developmental Test of Visual-Motor Integration (VMI) to evaluate visual-motor performance. Both tests are standardized with established norms, reliability, and validity.

The VMI is a form reproduction task that has been shown to be a good discriminator for visual perceptual and visual fine motor difficulties.[9-12] The test consists of a developmental sequence of 30 geometric figures ranging from a simple line to a star with overlapping sides (Figure 1). The patient is asked to reproduce the figure in a given space; no memorization is required. Grading is very specific and is outlined in detail in

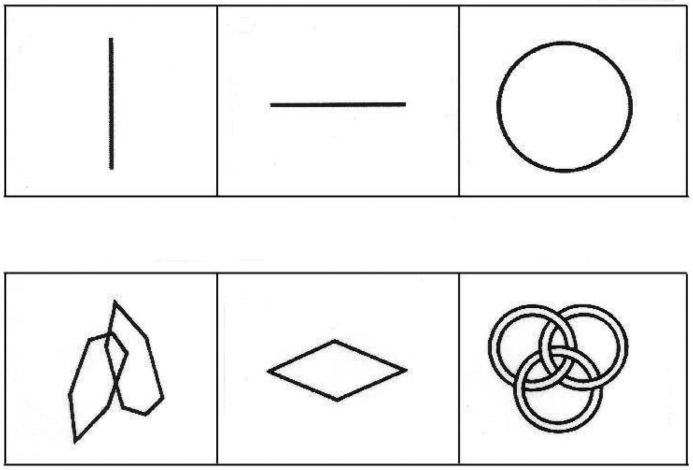

***Figure 1:*** *Developmental Test of Visual-Motor Integration*

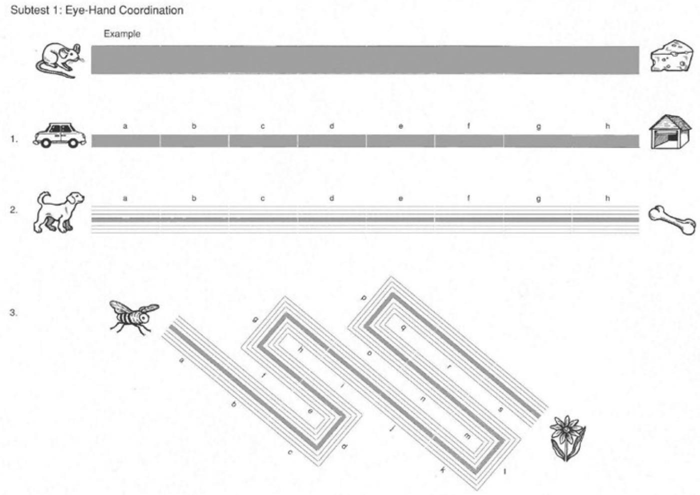


***Figure 2:*** *Eye-hand coordination subtest of the Developmental Test of Visual Perception*

**Table 1: Number of subjects in each six month age interval**

| Age (years-months) | Number of Subjects |
|---|---|
| 7-0 through 7-5 | 5 |
| 7-6 through 7-11 | 6 |
| 8-0 through 8-5 | 3 |
| 8-6 through 8-11 | 4 |
| 9-0 through 9-5 | 8 |
| 9-6 through 9-11 | 10 |
| 10-0 through 10-5 | 4 |
| 10-6 through 10-11 | 6 |
| 11-0 through 11-5 | 4 |
| 11-6 through 11-11 | 3 |

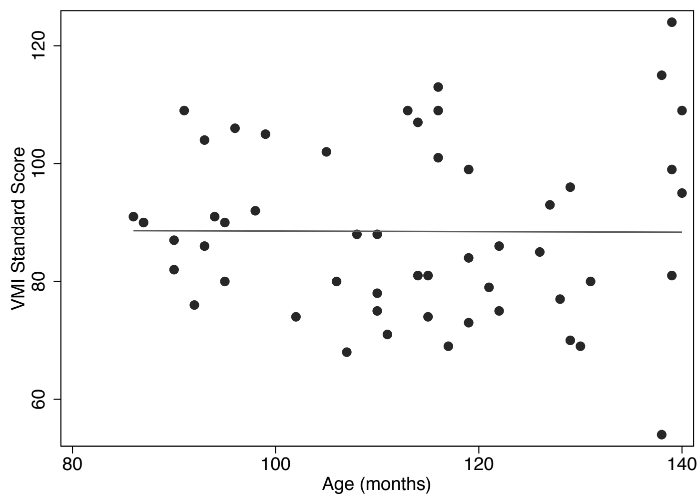


***Figure 3:*** *VMI correlation plot for age.*

the scoring manual. The test can be administered to children as young as three years and is considered to be valid and reliable.[8, 9] It is designed to measure the ability to recognize the features of a design and to reproduce it, as well as to identify through early screening significant difficulties that some children have integrating their visual perceptual and motor abilities.[5,13]

The DTVP-2 consists of a battery of eight subtests, including eye-hand coordination (Figure 2), position in space, copying, figure-ground, spatial relations, visual closure, visual-motor speed, and form constancy. It is designed to measure various aspects of visual perceptual and visual motor abilities.[3] The eye-hand coordination subtest requires the patient to draw either a straight or curved line between two points while remaining within specified boundaries. The principle of this subtest is that the child must use the boundaries to direct their hand movements accurately. Each item is segmented, and points are awarded for how accurately the line was drawn within the boundaries in each segment. A scoring key for determining the patient's total score is available in the examiner's manual. The test is designed for use in children aged four to 11 years and has been found to be reliable and valid.[6] It was designed to document the presence of visual perceptual or visual-motor difficulties, to identify the need for referral, to verify intervention program effectiveness, and to serve as a research tool.[14] It has been documented to discriminate between children with and without learning disabilities on the variables of visual perception.[12]

This study investigated the relationship between two tests used to evaluate visual-motor integration, the Developmental Test of Visual Perception (DTVP-2) and the Developmental Test of Visual-Motor Integration (VMI).

## Methods

Fifty-three children (ages 7 years, 0 months to 11 years, 11 months) were evaluated using the eye-hand coordination subtest of the DTVP-2 and the VMI. Table 1 details the number of subjects in six-month age intervals. Thirty-two subjects were female and twenty-one were male. All subjects had a comprehensive visual examination, 20/20 visual acuity at distance and near, and no physical limitation that would prevent participation. The subjects were patients in either the Pediatrics or Vision Therapy departments at The Eye Center at Southern College of Optometry. Thirty-two subjects were currently enrolled in, or had completed, a vision therapy

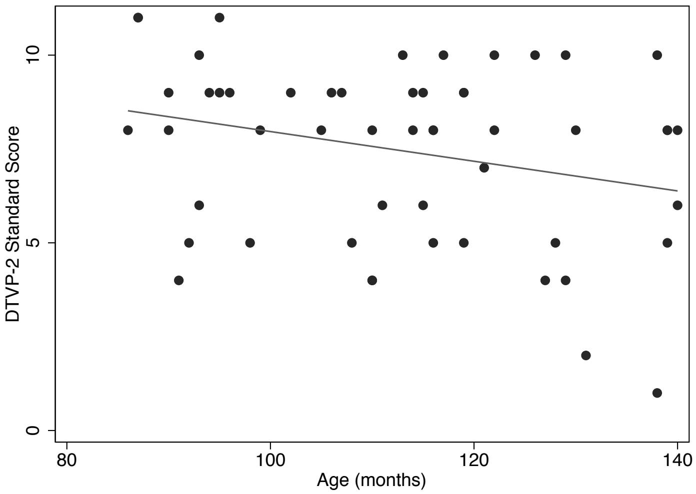


***Figure 4:*** *DTVP-2 correlation plot for age.*

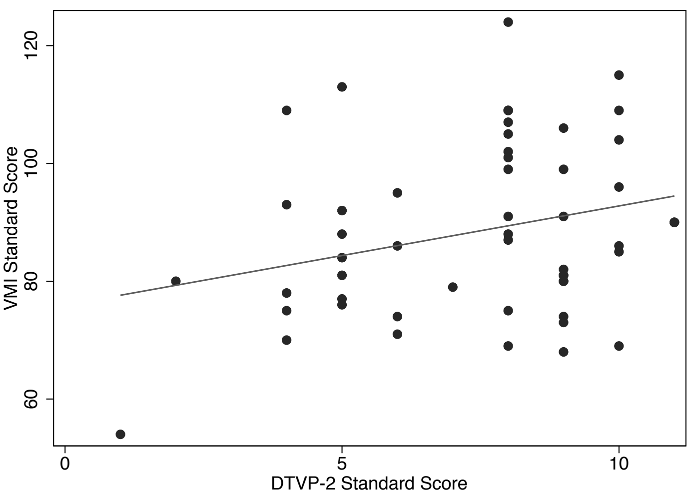


***Figure 5:*** *VMI and DTVP-2 standard score correlation plot.*

program for either a visual efficiency or visual processing dysfunction. Test order was alternated to eliminate fatigue as a bias. Test administration and scoring followed the examiner's manual for each test. Testing was performed by two testers, a high school senior under the supervision of one of the authors (MT) and another one of the authors (JI). Scoring was performed by the testers on their subjects. The study protocol was approved by the Institutional Review Board at Southern College of Optometry. A p-value of 0.05 was considered statistically significant for the purpose of this study.

## Results

Standard scores were used for statistical comparisons between the VMI and DTVP-2. There was no correlation (Pearson's R) between VMI and age (r= -0.005; p=0.9686) (Figure 3). Similarly, there was no correlation between the DTVP-2 and age (r=-0.2699; p=0.0506), but there was a suggestive trend (Figure 4). There was a statistically significant correlation between the two tests (r= 0.2744; p=0.0467) (Figure 5).

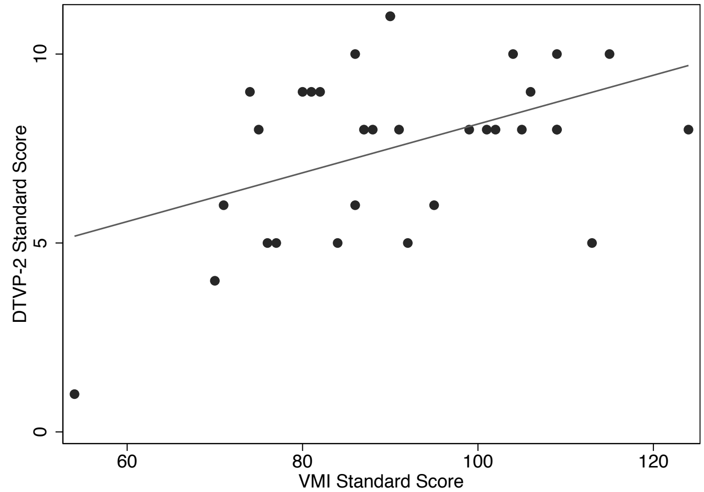


***Figure 6:*** *VMI and DTVP-2 standard score correlation plot for the subsample that had never been enrolled in vision therapy.*

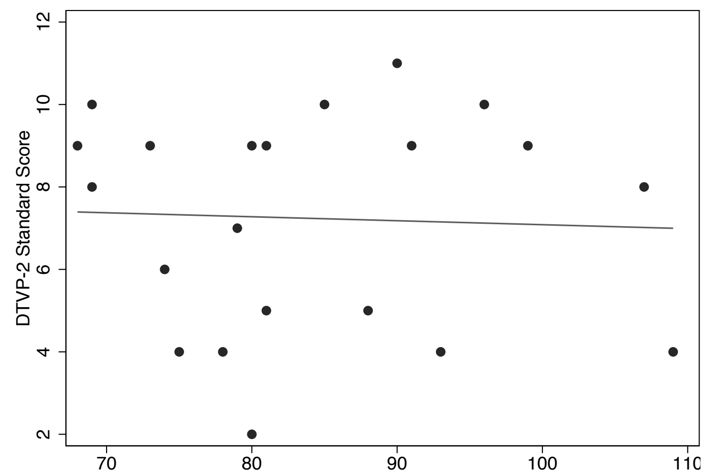


***Figure 7:*** *VMI and DTVP-2 standard score correlation plot for the subsample that was currently enrolled in or had completed a vision therapy program.*

For further statistical analysis, the sample was divided between those subjects who were either currently enrolled in or had completed a vision therapy program (n=21) and those who had not (n=32). In the subsample of those who had never been enrolled in vision therapy, there was no correlation between VMI and age (r=0.1108; p=0.5459). Likewise, there was no correlation between DTVP-2 and age (r=-0.3306; p=0.0646), but there was a suggestive trend. There was a significant positive correlation between the two tests (r=0.4513; p=0.0095) (Figure 6).

In the subsample who were currently enrolled in or had completed a vision therapy program, there was no correlation between VMI and age (r=-0.0236; p=0.3029). Similarly, there was no correlation between the DTVP-2 and age (r= -0.1654; p=0.4736). However, in contrast to the subsample of those who had never been enrolled in vision therapy, there was no correlation between VMI and DTVP-2 (r=-0.0437; p-value 0.8510) in the sample that had experience in a vision therapy program (Figure 7).

**Table 2: Ethnicity characteristics of the normative samples of the VMI and DTVP-2 along with the study sample.**

| Ethnicity | VMI | DTVP-2 | Study Sample |
|---|---|---|---|
| African-American | 14% | 12% | 55% |
| Hispanic | 12% | 11% | 15% |
| Native American | 1% | 1% | 0% |
| Asian/Pacific Island | 3% | 3% | 17% |
| Other | 70% | 72% | 13% |

## Discussion

Both the VMI and DTVP-2 assess the ability to use vision to perform motor tasks. Looking at the two procedures more closely, it becomes apparent that the VMI evaluates many more aspects of visual perception than does the eye-hand coordination subtest of the DTVP-2. Possible areas of visual information processing used when performing the VMI include visual discrimination, visual closure, and visual spatial relations. Accurate saccadic tracking skills are also required, as the subject has the chance to saccade to visually scan the form they are copying without having to rely on visual memory. The VMI tests the individual's ability to integrate the visual perception and motor development. If an individual performs poorly, he or she may have appropriate visual perceptual and motor abilities but may exhibit deficiencies in the higher level integrative process.

The convergent validity, or degree to which the two tests are related, was shown to be low. It can be argued that a high correlation between the two tests would not be desirable, as this would indicate that the two tests measure the same elements, in which case there would be no need for separate tests. The notable differences between the VMI and DTVP-2 allow for a range of visual perceptual and visual motor integration abilities to be assessed.

Traditional scoring would dictate that as the child matures, the score should improve on the VMI and DTVP-2. However, a strong correlation with age was not seen in the results of this study. The data obtained in this study showed a restrictive range of scores. For example, on the DTVP-2, the expected average standard score ranges from eight to 12, yet it was 7.45 in this sample. The highest standard score attainable is 20, but the highest achieved in this sample was 11.3. These results can be viewed as reflecting the sub-population of children from which the data were sampled, rather than a bias in the sampling. The norms of this sub-population may not fit the norms on which the original scoring was based.

Both the VMI and DTVP-2 were designed in the United States and have American norms that were based on a nationally representative sample.[5,6] The patients in this study were locally representative, thus contributing to a geographical bias. The percentages of the nationally representative sample, as classified by ethnicity, used for normative data in the VMI and DTVP-2 were compared to the ethnicities of those tested in this study; these comparisons are displayed in Table 2. Significant differences in the percentages can be seen, most notably in the African-American, Asian/Pacific Island, and "Other" categories. Ideally, each test would be locally normed on the population for which it will be used. Performance on tests can differ between populations; consequently, it is important that the test norms are appropriate for the population for which they are being applied.[6]

When the sample was divided into those who were either enrolled in or had completed a vision therapy program and those who did not, the subpopulations showed differences in performance. A positive, significant correlation was seen between the two tests in those who had never participated in vision therapy, whereas no correlation was seen in those who had. This shows that both tests demonstrated discriminative validity in this sample, meaning they accurately discriminated between the two groups with known differences.[7] Although the local sample overall did not perform as would be expected by the nationally representative norms, the tests were still able to distinguish between those children with known problems, as demonstrated with their enrollment in a vision therapy program, and those with no documented deficiencies.

One weakness in this study is the lack of matched groups. As participation in, or completion of, a vision therapy program was not an exclusion criterion, those patients were not differentiated in the original study design. It became apparent in the analysis, though, that there was a difference in this population, so it has been reported. Further investigation is warranted with closer attention paid to the type of visual dysfunction and the amount of therapy performed compared to children not in a therapy program.

## Conclusions

This study demonstrated that performance on the VMI and the eye-hand coordination subtest of the DTVP-2 do in fact correlate with one another, but cannot be used interchangeably, as the results found are significantly different. Future studies will expand the number of subtests of the DTVP-2 evaluated in comparison to the VMI, which will allow further investigation of the relationship between the two tests. In addition, results from future studies performed in different populations will be related to the normative sample and may reveal further conclusions that can be drawn regarding the relationship between these two tests.

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