

CORRELATION BETWEEN DEVELOPMENTAL TEST OF VISUAL MOTOR INTEGRATION [VMI] AND HANDWRITING IN CEREBRAL PALSY CHILDREN

*Arpita S Desai; Co-Author : **Pratibha V Rege

Deptt. of Occupational Therapy, All India Institute of Physical Medicine & Rehabilitation, Mumbai

Abstract :

AIM:

1. To study the effectivity of Developmental Test Of Visual Motor Integration [VMI] in assessing children with deficits in handwriting skills.
2. To study relationship between VMI and handwriting on Modified SCRIPT
3. To study the effect of Occupational Therapy intervention on cerebral palsy children.

METHODOLOGY: The study was conducted on 40 normal school going subjects and 10 cerebral palsy subjects with normal IQ and having the ability to hold writing tool. VMI test booklets and Modified SCRIPT were administered to both groups. Occupational therapy intervention with emphasis on paper/pencil task was given to all cerebral palsy children over a period of 2 months. Pre and post-intervention scores on VMI and Modified SCRIPT were compared. Also comparison was done on VMI and Modified SCRIPT between normal and cerebral palsy subjects.

RESULTS: Analysis of data was done using statistical "t" tests and Pearson's correlation tests for reliability of parent's questionnaire. There was significant difference between scores of normal children and cerebral palsy on both VMI and Modified SCRIPT at $P < 0.000$. Also there was a high degree of correlation between VMI and Modified SCRIPT at $P < 0.01$. Results stated that two months of Occupational Therapy intervention were helpful to the cerebral palsy subjects.

CONCLUSION: VMI and Modified SCRIPT are sensitive tests to identify children with visual motor integration and handwriting difficulties.

KEY WORDS: Handwriting skills, Visual Motor Integration, Modified SCRIPT, Remedial Occupational Therapy Program.

INTRODUCTION

Hand is a tool to mind that directs and guides in writing. Writing requires precise and rapid manipulation of writing tool, which appears to be accomplished by action of intrinsic muscles. [1] Handwriting is an integral part of every child's school experience. 30 to 60% of the elementary school child's class time is spent in fine motor/writing activities, with writing as the predominant task (McHale & Cermak, 1992). [2] Some children may be ready by age 4 years while others may not be ready by 5 to 6 years. (Lamme 1979, Laszlo & Bainstow 1984).

[1] Factors that contribute to illegible writing are incorrect letter formations or reversals, inconsistent size and height of letters, variable slant and poor alignment, and irregular spacing between words and letters (Alston & Taylor 1987;

Tseng & Cermak, 1991; Ziviani & Elkins, 1984). [2] Lamme (1979) outlined six prerequisites for handwriting: small muscle development, eye-hand coordination, utensil or tool manipulation, basic stroke formation, alphabet letter recognition, and orientation to written language. [5] Benbow, Hanft, and Marsh (1992) listed four prerequisite areas: dominant hand use, midline crossing with the dominant hand, proper posture and pencil grip, and ability to copy the first nine shapes of the Developmental Test of Visual-Motor Integration (Beery & Buktenica, 1989).

[1] Thus early identification of children with the potential for handwriting problems is concern for the school-based therapists. Evaluating visuomotor skills as measured by Berry's VMI may help pinpoint children who need close monitoring or specific interventions to prevent the development of handwriting problems. It was felt necessary to develop a normative data in handwriting skills in normal children and to study the developmental pattern of VMI & handwriting skills in Indian children as a pilot study. Examining this relationship within populations at risk such as cerebral palsy for handwriting problems would be valuable since till date no studies have been done in this area. Further research would be useful whether remedial Occupational Therapy training on writing readiness skills will increase handwriting performance.

*Occupational Therapist

** Chief Occupational Therapist

Place of Study : AIIPM&R, Mumbai

Period of Study : March - June 2004

Correspondence :

Dr. Arpita S. Desai

A/25, Tillibai Apts., Daftari Road, Malad (E), Mumbai - 400 097

Tel. : 9820830593

E-mail: d_arpita20@hotmail.com

Review of Literature

[4]Tseng (1991) examined relationship of set of perceptual motor measures to legibility of hand writing in Chinese children stating that visual motor integration as measured by developmental test of VMI was best predictor of legibility of hand writing and accounted for 30% of variance on legibility scores. [3] Similar findings by Sovik (1975) relationship with both American & Norwegian children.

[2]Weil and Amundson (1994) examined the relationship between the kindergartner's ability to copy letterforms and geometric shapes. They analyzed performance on the Developmental Test of Visual-Motor Integration (VMI) and the Scale of Children's Readiness In PrinTing (SCRIPT). They concluded from the results " most children in kindergarten will be ready for beginning handwriting instruction during the latter half of the kindergarten school year".

[6]Study by C.J.Daly (2003) on relationship of performance between VMI to Handwriting legibility in kindergarten children on lined versus unlined paper on letter legibility on Modified version of SCRIPT. Research showed strong positive relationship between VMI assessment scores and student's ability to copy letter forms. Students who could copy the 1st 9 forms on VMI performed significantly better than students who could not copy the 1st 9 forms on both versions of modified SCRIPT. Thus Visual-Motor Integration skills were shown to be related to the ability to copy letters legibility and supporting the study of Weil and Amundson (1994).

AIMS AND OBJECTIVE

1. To study the development of visual motor integration and handwriting skills in normal children and cerebral palsy children.
2. Study relationship between Developmental Test Of Visual Motor Integration (VMI) and handwriting skills on Modified Scale of Children's Readiness in PrinTing (SCRIPT).
3. To study the effectivity of Occupational Therapy intervention for prewriting skills.

METHODOLOGY

The study was conducted on a sample size of 50 children both males and females between the age group of 5.5-6.5 years. Of the 50 subjects, 40 subjects were selected from normal English convent school (normative data) and 10 cerebral palsy students were taken from rehabilitation centers and special schools.

Inclusion Criteria

Subjects with diagnosis of CP Diplegia/ Infantile Hemiplegics

Subjects with normal IQ

Subjects who had the ability to hold writing tool in hand and Attending school (Normal/ Special School)

Instrumentation: [1]Developmental test of Visual Motor Integration (VMI) was used since it identifies difficulties in specific areas of visual motor integration, with emphasis in visual perception and eye hand coordination during pencil reproduction of geometric forms as related to major component of handwriting. The VMI was thus primarily designed for children in their preschool and early elementary school years to screen for children who have potential developmental disabilities.

[7] **The Developmental Test of Visual-Motor Integration (VMI) (Beery, 1997)** is a widely used test of visuomotor skills. The student copies a series of shapes in a test booklet, and the graphic responses are scored using the criterion listed in the manual. Each shape is awarded either a 1 for passing or a 0 for failing. Scoring is discontinued after the student has earned three consecutive 0s. The maximum score possible is 18. Test-retest reliability is reported as .87, and inter-scorer reliability is reported as

.94. Additional detailed information on the reliability and validity is cited in the test manual.

[1,6]The **Modified Scale of Children's Readiness In Printing (SCRIPT)** is a letterform copying research test developed by Weil (modified by C.J.Daly 2003). The test booklet consists of four pages with a maximum of ten letters per page using the Zaner-Bloser manuscript alphabet. All 26 lowercase letters are included, as are the following eight uppercase letters: A, K, M, N, V, W, Y, and Z. In total, the student copies 34 letters. The student sees the stimulus letter printed in the left side and is asked to copy the letter in the blank space located directly adjacent to the stimulus letter. Scoring criteria was the same provided by Weil (1994). Each letter is given a score of 1 for passing and 0 for failing the criteria, thus the total maximum scoring was 34.

PROCEDURE

Oral consent was obtained from the teacher of the school for 40 normal subjects who were given standardized VMI test booklets and Modified SCRIPT to collect the normative initial data. Parents of the experimental group (cerebral palsy) were explained the purpose of the study, importance of therapy protocol and thus gaining active participation and cooperation from them. All the subjects under study were

administered Test Booklets of VMI and Modified SCRIPT at the start to account pre intervention scores. Non-hemiplegic hand for hemiplegics subjects and dominant hand for diplegics subjects was used. Test administration was done on individual and in one session. Also assessment of in-hand manipulation affectation was done to all subjects under study using 2HB Natraj pencil and plastic beads of diameter 0.5cm and 1cm. Finally subjects under study were exposed to therapy protocol for a period of 2 months with two/ three sessions per week lasting about 35-45 min per session.

Training of children with paper/ pencil tasks of writing readiness included following activities as per the ability of each child:

- Mazes (simple & complex)
- Joining dots, completing figures and shapes
- Making basic strokes and curved lines
- Simple geometrical figures construction (using verbal and tactile cues)
- Tracing and Coloring a pattern
- Word mazes
- Identify common objects and matching them

At the end of the 16 sessions, post intervention scores on VMI Test booklets and modified SCRIPT were noted. Parents questionnaire were administered which includes 12 questions to be answered in yes/ no at the end to collect feedback results about the intervention.

Parent's questionnaire

1. Has child become more cooperative with paper/ pencil tasks?
2. Has the concentration of child improved?
3. Has the time span improved for paper/pencil tasks?
4. Does the child use non-dominant hand for stabilization of paper?
5. Is the pressure applied while performing paper/pencil tasks improved?
6. Has the pencil grip improved?
7. Is the formation of letters or strokes better?
8. Is formation of curved lines better?
9. Is the attempt to draw simple geometric shapes like triangle, square circle improved?
10. Is the sizes and proportion of letters /strokes improved as priorly or not.
11. Whether the child has developed concept of copying letter/ stroke in same horizontal line.
12. Whether the parents perception about therapy is

beneficial to child or not.

DATA ANALYSIS AND RESULTS

The data analysis included 40 normal school going children between 5.5 to 6.5 years, 18 boys and 22 girls.

VMI Scores analysis of 40 normal school going subjects were assessed. Their raw VMI scores ranged between 11-16 with mean 13.55 as shown in table 1 below.

Table - 1
VMI scores of normal subjects

Statistical measures	VMI Raw Scores
Range of VMI	11-16
Mean	13.55
Median	13.5
Mode	13, 15
Standard Deviation	1.34

Handwriting assessment on Modified SCRIPT had the score of 34 for all 40 subjects since all subjects had writing readiness skills. This means that normal subjects between 5.5-6.5 years had score maximum on Modified SCRIPT in this study.

Analysis of 10 cerebral palsy children included 6 cerebral palsy diplegics & 4 hemiplegics on both VMI and Modified SCRIPT as shown in table 2 below.

Table - 2
Pre and Post intervention Scores of Cerebral Palsy subjects on VMI & Handwriting on Modified SCRIPT.

Subject	Diagnosis	Pre Intervention		Post Intervention		Affected In-Hand Manipulation
		VMI	Hand-writing	VMI	Hand-writing	
1	Hemi	8	33	11	33	No
2	Hemi	8	27	10	30	No
3	Hemi	3	10	6	17	No
4	Hemi	2	3	4	8	No
5	Diplegia	6	13	7	17	No
6	Diplegia	3	10	5	13	Yes
7	Diplegia	3	3	4	7	Yes
8	Diplegia	3	4	4	6	Yes
9	Diplegia	3	5	5	7	No
10	Diplegia	3	12	5	15	Yes

As per table 2, clinical sample consisted of 6 diplegics and 4 hemiplegics children. In this study sample, in-hand manipulation was not affected in hemiplegics. Out of the 6 diplegics, 4 were having deficits in in-hand manipulation. 2 hemiplegic children had a score of 8 in their preintervention testing on VMI and even good handwriting score Modified SCRIPT. Rest of the 8 subjects had poor scores both pre and

post intervention when compared on VMI and Modified SCRIPT.

Table - 3
Significance of VMI & Handwriting between normal and Cerebral palsy children

	Mean	Std. Dev.	t	P	Significance
VMI Pre CP	4.2	2.25	-10.643	.000	Highly Significant
VMI Normal	13.55	1.34			
HW Pre CP	12	10.27	-9.000	.000	Highly Significant
HW Normal	34	.00			

As per table 3, when t test analysis was done on VMI pre-intervention on cerebral palsy subjects and those of normal subjects score, the results were highly significant with t -10.643 and P<0.000. When t test analysis was done on handwriting with Modified SCRIPT pre-intervention on cerebral palsy subjects and those of normal subjects score, the results were highly significant with t -9.000 and P<0.000 stating Cerebral Palsy subjects lack academic skills as compared to normal subjects.

Table - 4
Pre and Post intervention - Mean and standard deviation of VMI & handwriting scores

Paired Samples Test

	Mean	N	Std. Deviation	Std. Error Mean
Pair 1 VMI Pre	4.20	10	2.25	.71
VMI Post	6.10	10	3.03	.96
Pair 2 HW Pre	12.00	10	10.27	3.25
HW Post	15.30	10	9.53	3.01

Table - 5
Correlation -VMI & Handwriting Pre intervention

Correlations

	HW Pre
VMI Pre	Pearson Correlation .922 **
	Sig. (1-tailed) .000
	N 10

** Correlation is significant at the 0.01 level (1-tailed)

As per table 5, it can be said that there is high degree of correlation between the scores on VMI and that of handwriting on Modified SCRIPT as accounted on pre intervention.

Table - 6
Correlation -VMI & Handwriting Post intervention

Correlations

	HW Post
VMI Post	Pearson Correlation .963 **
	Sig. (1-tailed) .000
	N 10

** Correlation is significant at the 0.01 level (1-tailed)

As per table 6, it can be said that there is high degree of correlation between the scores on VMI and that of handwriting on Modified SCRIPT as accounted on post intervention.

Thus it can be said that greater the scores on VMI greater are the number of letters copied on Modified SCRIPT and vice versa. Thus scores on VMI can be used to assess the ability of the child to writing in elementary school years.

Table - 7
Paired sample t test for VMI & Handwriting

Paired Samples Test

	t	df	Sig. (2-tailed)
Pair 1 VMI Pre - VMI Post	-5.460	9	.000
Pair 2 HW Pre - HW Post	-5.526	9	.000

As per table 7, it is found that scores on VMI and handwriting Pre & Post intervention are highly significant at p<000. Thus the analysis of the data reveals that there is definite improvement in the Childs performance in handwriting skills after remedial Occupational Therapy intervention for a period of two months.

Analysis of parent's questionnaire

The reliability of the questionnaire, which was administered by two individual therapists, was calculated using Pearson's Correlation and found to be 0.88 and highly significant as shown in table 8 below.

Table - 8
Inter-rater reliability

Correlations

	Parent Ques Rater 2
Parent Ques Rater 1	Pearson Correlation .882 **
	Sig. (1-tailed) .000
	N 12

** Correlation is significant at the 0.01 level (1-tailed)

DISCUSSION

VMI Scores of 40 normal children [table 1] between the age of 5.5-6.5 years ranges from 11-16 with mean of 13.55 and standard deviation of 1.24. Thus if the child in this age group has a score of less than 11 on VMI, he may have poor visual motor integration and may even reflect in academic performance.

Handwriting assessment on Modified SCRIPT had the score of 34 for all 40 normal subjects, which means that normal subjects between 5.5-6.5 years had score maximum on Modified SCRIPT in this study.

As shown in Table 2 Post intervention Scores on VMI & Handwriting on Modified SCRIPT have shown improvement

in all Cerebral Palsy subjects. In this study, 2 subjects out of 10 had a VMI score of 8 and even their handwriting performance on Modified SCRIPT was much better than other cerebral palsy subjects. The mean SCRIPT score of 28.5 pre-intervention shows greater than 75% of responses correct. [1] Thus it can be concluded that if the child can complete first 8 forms on VMI, then his writing readiness skills would be appropriate and fit for handwriting instructions. Various authors supported this study [Benbow, Hanft, and Marsh (1992), Lindsay & Beck (1984), Taylor (1985), Berry (1989)]. The remaining 8 subjects in this clinical study had both pre and post intervention scores less than 8 on VMI and even their handwriting performance on Modified SCRIPT were much less. Average Modified SCRIPT scores was around 8 and could finish only about 25% of responses. Thus it can be concluded from the study that if the child has low VMI scores (< 8), his handwriting skills will be affected and occupational therapy intervention may be helpful. Thus based on both the test instrumentation, evaluation of child's performance can be predicted for his handwriting abilities in the typically as well as developmentally delayed children between the ages of 5.5-6.5 years i.e. in the kindergarten and early elementary years.

In this study, all 4 hemiplegic children were writing with non-hemiplegic hand. It was observed that hemiplegic hand was less used by the subjects even for stabilization of paper to aid in assistance for writing as compared to diplegics. Further it was observed that hemiplegic subjects functioning was slightly better with occupational therapy intervention as compared to diplegics as observed in the ability to write with firm and steady hand with better clarity of letters and shapes. It was found that 4 diplegic subjects had in-hand manipulation affected while none of the hemiplegics under study had in-hand manipulation affectation. This can be attributed to the functioning of diplegics, which was lesser than that of hemiplegics since in-hand manipulation was affected in them. However, it has not been statistically proved in this study.

When t test analysis was done on VMI pre-intervention scores of cerebral palsy subjects and those of normal subjects [table 3], the results were highly significant with $t = -10.643$ and $P < 0.000$ and on handwriting with Modified SCRIPT with $t = -9.000$ and $P < 0.000$. Thus it was found in the study that there is significant difference between the scores of the normal children in the age group of 5.5-6.5 years and that of cerebral palsy subjects. This statistically proves that cerebral palsy subjects lack academic skills as compared to normal subjects.

The analysis of parent's questionnaire was established by 2 raters and found to be 0.88 thus stating the questionnaire to

be effective in determining the output perceived by parents after the occupational therapy intervention. Almost all the parents have reported that the child's behavior had improved towards handwriting skills. Their Children have shown improvement in concentration, attention, and willingness to perform handwriting tasks. Majority of parents said that the child's duration of time for sitting for handwriting tasks had improved along with attention, willingness and concentration. Few parents reported that their child started to draw curved strokes and lines much better. Previously most of the subjects were reluctant with these tasks itself. Few subjects reported to have concept of geometric shapes and sizes where they would discriminate and do matching correctly, which they did not have prior to therapy. Although imitation of geometric shapes was found to be difficult by most of the subjects, attempt to do the tasks was present. They were able to write with firm and steady hand with better clarity of letters and shapes. Since these were perceptible improvements to the parents, they had better acceptance of remedial occupational therapy intervention for handwriting skills. However the parents were not really happy with this small time duration of two months and have emphasized to continue this remedial occupational therapy for long duration to the researcher.

CONCLUSION

Following conclusions can be drawn from present study

There is a difference in Visual Motor Integration abilities of normal children and cerebral palsy children. Cerebral palsy children have significant lesser abilities in the area of Visual Motor Integration, which also reflects in their handwriting skills.

There is a significant difference in the scores of normal children and that of cerebral palsy children on Modified SCRIPT.

Strong positive correlation between VMI and Modified SCRIPT scores among pre-intervention and post intervention phases which means that after remedial Occupational Therapy Intervention there was increase in VMI Scores as well as in Modified SCRIPT.

As intervention progressed, it was observed by both therapist and parents that Occupational Therapy Remedial Intervention has shown improvement in child's behaviors required for handwriting such as attention, concentration, pencil grasp and willingness to sit for academic tasks.

ACKNOWLEDGEMENTS

We are thankful to the director Dr. B.D. Athani, Director of All India Institute of Physical Medicine and Rehabilitation.

We are grateful to Mr. Christopher J. Daly, Senior

Occupational Therapist, New York-Presbyterian Hospital for providing me with Modified SCRIPT without whose help this study would not have been possible.

We sincerely thank Ms. Sumita Rege, Mrs. Smita Jaywant, Mrs. Anita Gupta and all the staff of AIIPMR [OT] Department, for their support and help rendered.

We are thankful to Mrs. Anjali Joshi, Associate Professor, OT Department at KEM Hospital for her support.

Our sincere thanks to Children's Academy school [Malad] and SEC Day school [Agrimada] for their frank co-operation and permission to conduct this study.

REFERENCES

1. *Handwriting Readiness: Locatives and Visuomotor Skills in the Kindergarten Year. Early Childhood Research & Practice, Spring 2001, Volume 3, Number 1.*
2. *Weil, Marsha, & Amundson, Susan, Relationship between visuomotor and handwriting skills of children in kindergarten. American Journal of Occupational Therapy (1994), 48(11), 982-983.*
3. *Mei Hui Tseng, Sharon Cermak; The influence of ergonomic factors and perceptual motor abilities on handwriting performance. American Journal of Occupational Therapy (1993), 47(10), 919-923.*
4. *Schneck, Colleen; Comparison of pencil-grip patterns in first graders with good and poor writing skills. American Journal of Occupational Therapy (1991), 45(8), 701-709.*
5. *Beery, Keith, & Buktenica, Norman; The Beery-Buktenica developmental test of visual-motor integration (3rd ed, 1989) Cleveland, OH: Modern Curriculum Press.*
6. *Daly C.J, Kelly Y. Dail, Andrea Krauss; Relationship between Visual Motor Integration and Handwriting skills of children in Kindergarten. American Journal of Occupational Therapy (2003), 57,459-462.*
7. *Beery, Keith, The Beery-Buktenica developmental test of visual-motor integration (4th ed, 1997), Parsippany, NJ: Modern Curriculum Press.*

