
BRIEF REPORT

Relationship Between Visual-Motor Integration and Handwriting Skills of Children in Kindergarten: A Modified Replication Study

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KEY WORDS

- development
- fine motor skills
- visual-motor integration

OBJECTIVE. The purpose of this study was to examine the relationship of performance on the Developmental Test of Visual-Motor Integration (VMI; Beery, 1997) to handwriting legibility in children attending kindergarten. The relationship of using lined versus unlined paper on letter legibility, based on a modified version of the Scale of Children's Readiness in Printing (Modified SCRIPT; Weil & Cunningham Amundson, 1994) was also investigated.

METHOD. Fifty-four typically developing kindergarten students were administered the VMI; 30 students completed the Modified SCRIPT with unlined paper, 24 students completed the Modified SCRIPT with lined paper. Students were assessed in the first quarter of the kindergarten school year and scores were analyzed using correlational and nonparametric statistical measures.

RESULTS. Strong positive relationships were found between VMI assessment scores and student's ability to legibly copy letterforms. Students who could copy the first nine forms on the VMI performed significantly better than students who could not correctly copy the first nine VMI forms on both versions of the Modified SCRIPT.

CONCLUSION. Visual-motor integration skills were shown to be related to the ability to copy letters legibly. These findings support the research of Weil and Cunningham Amundson. Findings from this study also support the conclusion that there is no significant difference in letter writing legibility between students who use paper with or without lines.

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Handwriting skill development is an increasingly relevant topic in occupational therapy. Handwriting skills and the underlying performance components are particularly germane topics in pediatric and school-based occupational therapy due to the high frequency of referrals for children with handwriting legibility problems (Oliver, 1990; Reisman, 1991). The rise in occupational therapy referrals coupled with the increase in the demands placed on school-aged children has led to an even stronger emphasis on handwriting skill research and effective intervention (Benbow, Hanft, & Marsh, 1992; Lamme, 1979; McHale & Cermak, 1992).

Lamme (1979), Laszlo and Bairstow (1984), and Weil and Cunningham Amundson (1994) recognize the wide range of skills and maturational differences

among children in the first years of elementary school. These differences result in writing readiness that spans the age range from 4 to 6 years, depending on the development of each individual child. Developmentally, a kindergarten age child is sharpening fine motor skills and visual perceptual skills that together enable them to perform activities requiring visual-motor integration, specifically handwriting (Beery, 1997). Weil and Cunningham Amundson place an emphasis on visual-motor integration as an integral component in handwriting skill development, while Benbow et al. (1992) cite visual-motor skills and fine motor coordination as foundational component skills of handwriting.

Further controversy exists regarding the use of lined versus unlined paper for

handwriting instruction (Lamme, 1979; Pasternicki, 1987; Weil & Cunningham Amundson, 1994). A pilot study conducted by Weil and Cunningham Amundson determined that using unlined paper promoted handwriting legibility in kindergarten age children. Lamme likewise supported the use of paper without lines for this age group, proposing that unlined paper enhances letter legibility by decreasing the demands placed upon the child. However, Pasternicki opposed this view concluding that children demonstrated improved letter legibility using lined paper for writing activities.

Weil and Cunningham Amundson (1994) examined the relationship between visual-motor integration skills and the ability to copy letters legibly in kindergarten students. The Weil and Cunningham Amundson study had a sample of 60 typically developing students, ages 64 to 75 months. The study employed the Scale of Children's Readiness in Printing (SCRIPT; Weil & Cunningham Amundson), a handwriting assessment using unlined paper that was developed by the first author, as well as the Developmental Test of Visual Motor Integration (VMI; Beery, 1997). Included in their study were 30 female and 30 male students from six different kindergarten classes from a single school district in Seattle, Washington. Weil and Cunningham Amundson found a moderate correlation ($r = .47, p < .001$) between student's visual-motor skills (score on VMI) and their ability to copy letters legibly (score on SCRIPT). The authors found that as students' scores on the VMI increased, so did scores on the SCRIPT. Students who were able to copy the first nine forms on the VMI were found to perform better on the SCRIPT, using Mann-Whitney U tests (2-tailed, $p = .02$). Results also showed that students who were able to copy the first nine forms on the VMI were better able to copy letter forms legibly, thereby placing them at an optimal level at which to begin formal handwriting instruction (Beery; Benbow et al., 1992). The study further recommended that the appropriate time to initiate formal handwriting instruction was the second half of the kindergarten school year, when the majori-

ty of kindergarten students have the developmental advantage to succeed in learning correct letter formation (Weil & Cunningham Amundson).

The purpose of this study was to partially replicate the Weil and Cunningham Amundson (1994) research, regarding the relationship between visual-motor and handwriting skills in kindergarten-age students. This study also sought to contribute to the body of literature that recognizes the VMI as a useful screening tool, as well as acknowledge visual-motor integration as an important prewriting skill. Opposing views regarding the type of paper media that best promote letter legibility also warranted investigation in this study. The study explored three research questions:

1. Is there a relationship between kindergarten student scores on the VMI and their ability to copy letters legibly?
2. Will students who correctly copy the first nine forms on the VMI (score of 12) demonstrate more legible handwriting as indicated by higher scores on the Modified SCRIPT?
3. Will students using Modified SCRIPT assessments with unlined paper produce more legible letters versus those using assessments with lined paper?

Method

Study Design

Fifty-four typically developing kindergarten students were administered the VMI; 30 students completed the Modified SCRIPT with unlined paper, 24 students completed the Modified SCRIPT with lined paper. A two-member research team evaluated and scored the participant assessments. The evaluators were occupational therapy graduate students trained in evaluation scoring and analysis as a part of degree requirements. This experiment was conducted during the 1999–2000 school year.

Participants

The participants in this study were selected from four kindergarten classrooms from an elementary school in Suffolk County, New York. The school principal recruited classroom teachers to recruit kindergarten students for this study. A convenience sample

of typically developing children from the first four classrooms to volunteer was used.

Fifty-four participants were used in the study, 29 were male and 25 were female. At the time of the assessments (October to November 1999), the participants' ages ranged from 59 months (4.91 years) to 71 months (5.91 years), with a mean age of 65 months (5.41 years), $SD = 3.40$. Fifty participants were right-handed and four participants were left-handed.

Instrumentation and Data Collection

The Modified SCRIPT and the VMI Short Form (ages 3 to 8 years) were used for this study. Thirty students completed the Modified SCRIPT without lines and 24 students completed the Modified SCRIPT with lines. The classrooms were randomly assigned assessments with and without lines. The Modified SCRIPT handwriting assessment differed from the original SCRIPT (Weil & Cunningham Amundson, 1994) with regard to page layout and use of lined paper. The original SCRIPT has a horizontal page layout with two rows containing three boxes of equal size. The boxes in the first row contain one letterform each whereas the box below is blank for letter reproduction. Weil and Cunningham Amundson included all lowercase letters of the alphabet, followed by eight uppercase letters (A, K, M, N, V, W, Y, Z).

The original SCRIPT (Weil & Cunningham Amundson, 1994) was modified for comparison of handwriting legibility using lined versus unlined paper. The Modified SCRIPT also used a horizontal page layout but with two vertical rows. Letter forms were positioned in columns with space to the right for copying. On the unlined version of the Modified SCRIPT the model letters were presented without lines and the reproduction space was also void of lines. The lined version of the Modified SCRIPT contained model letters presented within lines and lined reproduction spaces to the right. The Modified SCRIPT used the same order and number of lowercase and uppercase letterforms as the original SCRIPT. The Modified SCRIPT scoring procedure was the same as on the SCRIPT (Weil & Cunningham Amundson), where subjects received one

point for each correct letter following specified criteria (available upon request). A possible high score of 34 and low score of 0 may have been achieved.

The VMI Short Form (ages 3 to 8 years) contains 15 geometric shapes that become progressively more complex and challenging to copy. The student is asked to copy the shape in the space provided below, with three shapes presented on each page. The VMI is used primarily as a screening tool to identify proficiency in visual-motor integration (Beery, 1997). The VMI and the Modified SCRIPT were administered to participating classrooms in group format as instructed by the VMI manual (Beery). The VMI was administered to students 1 week prior to the Modified SCRIPT by the same examiner; all participants used standard #2 pencils. The VMI was scored by specific criteria in accordance with instruction manual (Beery). Students received one point for each correctly copied shape until three errors in a row were recorded. A possible high score of 18 and low score of 0 may have been achieved.

Data Analysis

The first two authors administered and scored all assessment measures using the standardized procedures. Examiners did not score the tests personally administered. Prior to scoring, raters reviewed and agreed upon scoring criteria and jointly rated assessments when the criteria for correct answers was in question. Descriptive statistics were used to calculate the means and standard deviations for all assessment scores. Because the data on the Modified SCRIPT and VMI total scores had approximately normal distribution, a Pearson product-moment correlation coefficient was used to test the first research question. The Kruskal-Wallis test was used to analyze research questions two and three because scores were not normally distributed in each group and due to the small group size. The data were analyzed using SPSS statistical package (Norusis, 1991).

Results

The first research question, which asked if there is a relationship between kindergarten

children's performance on the VMI and the ability to copy 34 letterforms (Weil & Cunningham Amundson, 1994), was supported with a Pearson product-moment correlation coefficient (Pearson r) of $r = .64$, $p < .01$. For data analysis the authors established that an r value of at least $r = .30$ would signify an acceptable effect size as well as a moderate relationship between variables and $r = .50$ and above represented a strong relationship (Cohen, 1988). Thus, a strong relationship was demonstrated between visual-motor skills and the ability to copy letters legibly.

The second research question, which asked if students who could correctly copy the first nine forms on the VMI (score of 12) would demonstrate superior handwriting legibility as indicated by higher scores on the Modified SCRIPT, was supported by Kruskal-Wallis Test (2-tailed, $p < 0.001$). On VMI assessments, 24 students were unable to copy the first nine forms correctly while 30 students were able to correctly copy the forms. The 30 students who could correctly copy the first nine forms on the VMI demonstrated higher scores on Modified SCRIPT assessments (see Table 1).

The third research question asked if there was a difference in kindergarten children's writing legibility for Modified SCRIPT assessments on unlined paper ($n = 30$) versus lined paper ($n = 24$). The analysis revealed no relationship between student groups using Kruskal-Wallis Test (2-tailed, $p = .60$). The total mean score for students using lined assessments ($n = 24$) was 20.7, $SD = 9.3$. The total mean score for students using unlined assessments ($n = 30$) was 19.5, $SD = 7.8$. Thus, no significant difference was found in the writing performance of kindergarten students using unlined or lined assessments.

Discussion

A strong positive relationship was found between kindergarten student's performance on the VMI and their ability to copy letter forms legibly ($r = .64$, $p = .001$). This finding is consistent with the research of a number of other authors in this area regarding the relationship between visual-motor and handwriting skills (Maeland, 1992; Tseng & Cermak, 1993; Tseng & Murray, 1994; Weil & Cunningham Amundson, 1994). Our findings support the conclusion that the VMI was a useful screening tool for handwriting abilities, thereby noting visual-motor integration as a requisite skill for handwriting legibility.

Students who were able to correctly copy ($n = 30$) the first nine forms on the VMI (score of 12) performed better on the Modified SCRIPT in comparison to those students who could not correctly copy ($n = 24$) the first nine forms. This finding lends support to the body of research that suggests that students are ready to engage in formal handwriting instruction once they have mastered the ability to copy the first nine forms on the VMI (Beery, 1997; Benbow et al., 1992; Weil & Cunningham Amundson, 1994). The large standard deviation for Modified SCRIPT assessments supported statements regarding the wide variation of letter copying abilities in this age group of children (Benbow et al.; Lamme, 1979; Weil & Cunningham Amundson). Recognition of the maturational variations among kindergartners should be considered when implementing a handwriting curriculum.

In the current study, students were assessed in the first quarter of the kindergarten school year; 24 of 54 typically developing students were unable to correctly copy the first nine forms on the VMI. Weil

Table 1. Modified SCRIPT Total Mean Scores for Groups of Children Scoring Below 12 or 12 and Above on the VMI (Kruskal-Wallis Test)

Group	<i>n</i>	<i>M</i>	<i>SD</i>	M. SCRIPT Low/High Scores	2-tailed <i>p</i> value
VMI Scores < 12	24	14.2	7.4	4/31	< 0.001
VMI Scores ≥ 12	30	24.9	5.9	11/32	< 0.001

Note. Modified SCRIPT = Modified Scale of Children's Readiness in Printing, VMI = Developmental Test of Visual-Motor Integration.

and Cunningham Amundson (1994) demonstrated that only 7 of 59 typically developing kindergarten students were unable to correctly copy the first nine forms on the VMI when tested in the second half of the kindergarten school year. The limited data from this study may lend support to Weil and Cunningham Amundson, who concluded that the latter half of the kindergarten school year was a developmentally appropriate time to initiate formal handwriting instruction for most students.

No relationship was found between the use of lined or unlined writing paper and the handwriting legibility of kindergarten students. Weil and Cunningham Amundson (1994) found that using paper without writing guidelines appeared to enhance the writing legibility of kindergarten students. Although data from Weil and Cunningham Amundson and Lamme (1979) supported the use of unlined paper to enhance letter legibility, findings were not supported by this replication study. Thus, the results of the current study suggest that kindergarten age children be allowed to experiment with various types of writing paper media when initially learning proper letter formation, and to explore options that may enhance the quality of written output.

Limitations

Limitations to the current study regard sample and scoring procedures. Since a convenience sample from only one school district was used, the participants did not effectively represent a heterogeneous population of kindergarten students, as a random sample would have. Additionally, only typically developing students were assessed; thus, the research has no implications for learning disabled students. Finally, interrater reliability and test-retest reliability were not statistically established for the Modified SCRIPT.

Implications for Practice

Results of this pilot study suggest that visual-motor integration, as measured by the VMI, is strongly related to kindergarten students' ability to copy letterforms. These data support the use of the VMI as a screening tool for examining the visual-motor integration skills of typically developing kindergarten students. Based on Modified SCRIPT assessment scores, a wide range of letter copying abilities was demonstrated by this age group of typically developing children in the first quarter of the kindergarten school year. Replication of this study including administration of the VMI and the Modified SCRIPT to kindergarten students at different intervals during the school year would allow for better examination of visual-motor integration as a predictor of handwriting readiness and legibility.▲

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