



Original Article

The effect of fine motor skills on handwriting legibility in preschool age children

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Abstract. [Purpose] The purpose of this study was to examine the effect that fine motor skills have on handwriting legibility in children of preschool age. [Subjects and Methods] The subjects of this study were 52 children of normal growth and development. In order to ascertain handwriting legibility, a Korean alphabet writing assessment was used; to measure fine motor skills, fine motor precision and manual dexterity, sub-items of BOT-2 were measured. Furthermore, in order to measure in-hand manipulation skills, a Functional Dexterity Test was conducted. [Result] The results of the study showed a high level of correlation between fine motor skills and handwriting legibility. The study revealed that the accuracy of hand and in-hand manipulation skills is factors that have an effect on handwriting legibility. [Conclusion] Through the current research, occupational therapists can provide activities that aid the development of fine motor precision and in-hand manipulation skills for children during the instruction and treatment of handwriting to preschool age children, which helps to conduct better legibility in their handwriting.

Key words: Handwriting, Handwriting legibility, Fine motor skill

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INTRODUCTION

Handwriting is an important functional task that needs to be performed by children in lower grades of elementary school, and it is an essential ability for academic achievements¹⁾. However, because the time period in which children attempt handwriting varies according to the maturity of the nervous system, environmental experience, and the level of interest in letters²⁾, it is important to verify in the early stages of development whether children have problems in performing the task of handwriting³⁾. In order to evaluate the ability of handwriting performance in children, various dimensions must be considered including the domain of handwriting, legibility, speed, and ergonomic factors⁴⁾. Among these dimensions, legibility signifies the legibility of their handwriting. The factors that influence handwriting legibility include the shape of the letters, the size of the letters, the arrangement of the letters, and the amount of space between the letters^{5, 6)}. Before beginning the act of handwriting, children need to develop readiness skills for forming letters, such as the comprehensive abilities of various sensorimotor systems, the development of large and small muscles, visual perception, fine motor skills, and in-hand manipulation skills^{7, 8)}. If children without sufficient development of such readiness skills learn handwriting, they are at risk of developing bad handwriting habits, which may lead to difficulties in developing handwriting legibility⁹⁾. According to previous studies^{9, 10)}, which emphasize the importance of acquiring readiness skills before starting handwriting, there are various factors connected to the issues involved in this study^{10–12)}. Among these factors, fine motor skills allow for the demonstration of good handwriting legibility through the ability to control a handwriting tool with speed and accuracy over the course of activities such as fine motor precision, manual dexterity, and in-hand manipulation^{9, 10)}. As such, fine motor skills are essential for children before developing the repeated behavior of holding appropriate writing utensils¹³⁾.

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However, previous studies^{9, 14)} have focused on the factors of and correlation between visual perception and visual motor integration. As such, existing research on this topic lacks study on the effect of fine motor skills aside from visual perception on handwriting legibility. Therefore, the present study attempts to examine the correlation between fine motor skills and handwriting legibility in preschool age children. Ultimately, this study seeks to examine the effect that fine motor skills have on handwriting legibility.

SUBJECTS AND METHODS

The subjects of the present study are 52 children between the ages of 61 and 75 months who attend the daycare center H located in Gyeonggi Province in South Korea. The study began after receiving consent from the children and their parents. In order to analyze the effect that fine motor skills aside from visual perception and visual motor integration has on handwriting legibility, the Korean Denver Development Screening Test and Korean visual perception screening tests were conducted in order to discern normal development of the participants. According to the screening results, the normally developed children in terms of growth, development, and visual perception were given the Korean alphabet writing assessment¹⁵⁾ to examine their handwriting legibility. The Korean alphabet letters on this assessment used New Ming-style font typeface, size 32, of the Korean alphabet, and the size of the square was two centimeters by two centimeters. The method was short range copy, in which participants had to look at the alphabet letter provided in the top box and reproduce it in the box below. The score ranged from 0 to 24 points, 24 being the highest. The inter-rater reliability was $r=0.95$, and the test-retest reliability was $r=0.65$ for the test results in which the same child participated at intervals of one week. Furthermore, in order to ascertain the ability of the participants' fine motor skills, 1) fine motor precision and 2) manual dexterity, two of the sub-items of Bruninks Oseretsky Test of Motor Proficiency-2: BOT-2¹⁶⁾ were used. A Functional Dexterity Test¹⁷⁾ was also used to examine the Complex Rotation of in-hand manipulation skills. The test-retest reliability of the sub-items was $r=0.81-0.82$, and the internal consistency of the items was $r=0.92$. The site of evaluation was a small classroom inside the daycare center. In each space, two or three participants were evaluated at the same time, but the desks and chairs were spread out and placed in the corners of the room by the wall so that they did not disturb others' evaluations. The children sat at desks and chairs appropriate for their height, and the evaluator sat next to them to conduct the assessments. The total time it took for all of the assessments was 30 minutes, and the assessments were conducted without any breaks. All statistical analysis used SPSS version 21.0 for Windows operating system. In the present study, descriptive statistics were conducted in order to examine the general characteristics of the participating children. Through Pearson product-moment correlation coefficients, the correlation between handwriting legibility and factors of fine motor skills were confirmed. Ultimately, stepwise multiple regression analysis was used to confirm the effect of variables on handwriting legibility. The statistical significance was set at $p<0.05$.

RESULTS

The subjects of this research were in total 52 participants, and their average age was 69.19 ± 3.71 months. Among them, 23 participants were male (44.2%) and 29 were female (55.8%) (Table 1). The general characteristic of the research subjects showed that their handwriting legibility was 17.85 ± 3.64 points, and fine motor precision among the fine motor skills measured was 34.25 ± 4.42 points. Manual dexterity among fine motor skills was measured at 22.37 ± 3.24 points, and the result of the Functional Dexterity Test was 32.98 ± 5.19 sec (Table 2). According to the results of the correlation between fine motor skills and handwriting legibility, handwriting legibility had a statistically significant correlation with fine motor precision ($r=0.78$) and a high correlation with manual dexterity ($r=0.49$). It also showed a statistically significant inverse correlation with the performance time of the Functional Dexterity Test ($r=-0.68$) (Table 3). Furthermore, stepwise multiple regression analysis revealed that fine motor precision has a sixty percent effect on handwriting legibility and that the performance time of Functional Dexterity Test has a four percent effect (Table 4).

DISCUSSION

The present study examined the correlation between fine motor skills and handwriting legibility in 52 preschool age children as the study subjects. It also attempted to analyze the factors that affect handwriting legibility. The results of the study revealed that fine motor precision and in-hand manipulation skills are factors that influence handwriting legibility. The results of the present study thus support the outcomes of previous research such as Cornhill and Case-Smith¹⁸⁾ which concluded that games and fun activities that use fine motor skills have a positive effect on handwriting performance as well as Ziviani and Watson-Will¹⁹⁾ which reported that children who demonstrate poor patterns in holding writing tools have low handwriting legibility and concluded the correlation between fine motor skills that control writing tools and handwriting legibility. Such results indicate the possibility of a high level of performing handwriting legibility by repeatedly conducting activities that allow children to develop their fine motor skills. Through such activities, children are able to acquire more mature fine motor precision as well as in-hand manipulation skills, which will in turn have a positive effect on proficient control of writing tools when commencing handwriting down the road. The limit of this study is that it was unable to take into consideration numerous variables that affect handwriting legibility, as it only evaluated fine motor skills in assessing handwriting legibility.

Table 1. Gender characteristics of study participants

| Characteristic | N | Month (Mean ± SD) |
|----------------|--------|-------------------|
| Gender | Male | 23 |
| | Female | 29 |
| Total | 52 | 69.12 ± 3.71 |

Table 2. Measurement results of fine motor skills and handwriting legibility

| | Mean ± SD |
|------------------------------------|--------------------|
| Korean Alphabet Writing Assessment | 17.85 ± 3.63 |
| Fine motor precision | 34.25 ± 4.42 |
| Manual dexterity | 22.37 ± 3.24 |
| Functional Dexterity Test | 32.98 ± 5.19 (sec) |

Table 3. Relationship between fine motor skills and handwriting legibility

| | KAWA | FMP | MD | FDT |
|--------------------|---------|---------|---------|---------|
| KAWA ¹⁾ | - | 0.78** | 0.49** | -0.68** |
| FMP ²⁾ | 0.78** | - | 0.63** | -0.66** |
| MD ³⁾ | 0.49** | 0.63** | - | -0.58** |
| FDT ⁴⁾ | -0.68** | -0.66** | -0.58** | - |

**Significant difference $p < 0.01$.

^{a)} Korean Alphabet Writing Assessment ^{b)} Fine motor precision ^{c)} Manual dexterity ^{d)} Functional dexterity test.

Table 4. Stepwise multiple regression analysis of factors which affect handwriting legibility

| | Adjusted R2 | β | t | p |
|-------------------|-------------|---------|-------|--------|
| FMP ¹⁾ | 0.60 | 0.59 | 5.33 | 0.00** |
| FDT ²⁾ | 0.04 | -0.29 | -2.62 | 0.01** |

**Significant difference $p < 0.01$.

^{a)} Fine motor precision ^{b)} Functional dexterity test.

Furthermore, the subjects of the research were only partially sampled from one region; as such, there are difficulties in generalizing the results of this research. In conclusion, future studies must take into consideration other variables that can influence handwriting legibility and also sample from a wider and more various population of research subjects. As a result of current research, occupational therapists can provide activities related to the development of fine motor precision and in-hand manipulation skills to children during the instruction and treatment of handwriting to and for preschool age children, which helps to conduct better articulation in their handwriting. In addition, in the rehabilitation field, children with cerebral palsy who are not able to perform legible handwriting can be provide appropriate sitting postures by applying physical therapy interventions that improve the stability and control ability of the trunk. These therapeutic interventions can provide stability to children with cerebral palsy in coordinated movements of the upper limb and fine motor skills of the hand. Therefore, children with cerebral palsy may make legible handwriting. This may increase the self-esteem of children with cerebral palsy and increase the level of participation in classroom activities and academic achievement.

Conflict of interest

None.

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