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IS THERE ANY DIFFERENCE IN COMPUTERIZED ANALYSIS OF HANDWRITING SKILLS BETWEEN CHILDREN WITH LOW AND TYPICAL VISION?

ORIGINAL ARTICLE

ABSTRACT

Purpose: It is of great importance to evaluate children's writing skills, as this ability affects their academic achievement. Technological analysis methods can now be used to evaluate the writing skills of school-age children with low vision. The aim of this case- control study is to analyse the writing skills of children with low vision using a computerized program and to compare their results with those of their typically developing peers with normal vision.

Methods: Eighteen school-age children with low vision and 24 children with typical visual development (n=42) participated in the present study. Each of the children wrote a 20-word sample standard sentence; the samples were then analysed using the MovAlyzeR (Neuroscript LLC, USA) computerized analysis system (version 6.1) to describe the spatial and dynamic characteristics of their writing.

Results: The mean age of the children with low vision were 9.72±2.11 years and the control group were 10±2.02 years. Statistically significant differences were found in the handwriting samples in terms of the average width of the letters, horizontal start, vertical start and length (Respectively; p=0.000, p=0.010, p=0.000, p=0.030). It was found that the results obtained in children with low vision were higher in these variables. This result is in favor of typically developing children with normal vision.

Conclusion: The results indicated that the school-age children with low vision wrote letters of larger dimensions than their peers with typical vision. This may be due to the difficulty of discerning the spatial dimensions of handwritten letters or because of the diminished visual acuity in children with low vision.

Keywords: Child, Low vision, Performance and Analysis, Task Handwriting

AZ GÖREN VE TİPİK GELİŞİM GÖSTEREN ÇOCUKLAR ARASINDA BİLGİSAYARLI ANALİZDE EL YAZISI BECERİSİ AÇISINDAN FARK VAR MIDIR?

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Çocukların yazma becerilerinin değerlendirilmesi akademik başarıyı etkilediği için büyük önem taşır. Okul çağı az gören çocukların yazma becerilerini değerlendirmek için teknolojik analiz yöntemleri kullanılabilir. Bu vaka kontrol çalışmasının amacı, az gören çocukların bilgisayar programı kullanarak yazma becerilerini analiz etmek ve sonuçlarını normal görmeye sahip tipik gelişim gösteren yaşıtlarıyla karşılaştırmaktır.

Yöntem: Bu çalışmaya okul çağında az gören 18 çocuk ve tipik görsel gelişimi olan 24 çocuk (n=42) katılmıştır. Çocukların her biri 20 kelimelik örnek bir standart cümle yazdı; örnekler daha sonra yazılarının uzamsal ve dinamik özelliklerini tanımlamak için MovAlyzeR (Neuroscript LLC, ABD) bilgisayarlı analiz sistemi (versiyon 6.1) kullanılarak analiz edildi.

Sonuçlar: Az gören çocukların yaş ortalaması 9,72±2,11, kontrol grubunun yaş ortalaması ise 10±2,02 idi. Harflerin ortalama genişliği, yatay başlangıç, dikey başlangıç ve uzunluk açısından el yazısı örneklerinde istatistiksel olarak anlamlı farklılıklar bulunmuştur (Sırasıyla; p=0.000, p= 0.010, p=0.000, p=0.030). Az gören çocuklarda elde edilen sonuçların bu değişkenlerde daha yüksek olduğu saptanmıştır. Bu sonuç, normal görüşe sahip, tipik gelişim gösteren çocuklar lehinedir.

Tartışma: Sonuçlar, az gören okul çağı çocuklarının tipik görmeye sahip akranlarına göre daha büyük boyutlu harfler yazdıklarını göstermiştir. Bunun nedeni, el yazısı harflerinin uzamsal boyutlarını ayırt etme güçlüğü veya az gören çocuklarda görme keskinliğinin azalması olabilir.

Anahtar Kelimeler: Çocuk, Az Görme, Görev Performansı ve Analizi, El Yazısı

INTRODUCTION

Handwriting is an important activity for school-age children, who spend a considerable amount of time engaged in activities involving handwriting in their classes. Writing-related activities also have a significant impact on academic achievement (1). The act of writing includes fine-motor skills such as visual-motor control, legibility, speed and performance, as well as cognitive and perceptual skills and kinaesthetic perception (2,3). A child's visual acuity plays an important role in developing these skills. The writing skills of children with low vision are weakened because they cannot pick up on as many cues from their environment as their peers with typical visual development, particularly those related to visual-motor control (4). Children with low vision may need optical aids even if their visual acuity is sufficient to enable them to identify letters in writing activities (5).

When considering the decrease in visual stimuli in children with low vision, even those who use optical aids write more slowly than their peers: they have more difficulty seeing the movement of their pen or pencil and writing on a straight line (3,4,6). They must also analyse what they are writing as they write, including the width and height of and gaps between letters. It is therefore vital to assess children's writing skills regularly, as it greatly affects the academic achievement of children with low vision (7).

Despite the fact that approximately 3 million children worldwide have low vision, the number of studies conducted on the problems affecting this population is limited (7). Although some research investigating the writing skills of children with low vision has been done (3,4,8), to the best of our knowledge this is the first study to analyse the writing skills of school-age children with low vision using scan and analysis computer technology. Technological devices such as computers and tablets were used in the assessments conducted for this study and the sample population included children with different diagnoses and typical development.

In the studies, technological devices such as computers and tablets were used in children with different diagnoses (9,10), but in these studies, writing short sentences or following figures on tablets were measured. In this study, unlike their work, it is a technological analysis of their own handwriting that children are familiar with as the student role in the school setting.

In this context, the aim of this study is to compare the writing skills of children with low vision with that of their peers, who typically have a well-developed vision, using a computerized text analysis system.

METHODS

This research was approved by the Non-Interventional Ethics Committee of Hacettepe University (11th December 2018, Decision number: GO 18/880). The study protocol was explained to all children and their parents and those who provided signed informed consent were included. The study was planned as a descriptive study and was conducted between December 2018 and May 2019.

Participants

The study population comprised school age children with low vision who applied to Hacettepe University Faculty of Physical Therapy and Rehabilitation in Ankara. A group of children with typically developed vision comprised the control group. Each child who took part in the study was given information about the research, and both the children and their families read and signed a consent form indicating informed consent to participate. School-age children with low vision consulted in clinic by eye specialists. Their diagnosis and visual acuity information was obtained from the health report. All school- age children had moderate low vision. Any child with a disability other than low vision, which could affect writing, was excluded from the study. School-aged children in the same age group with typical vision and no other disabilities were also included.

Procedure

The participants were evaluated in one-on-one interviews. Each participant's age, gender, height, weight and body mass index were recorded. Each participant's dominant hand was defined as the hand he or she used most frequently. A physiother-

apy specialist performed the evaluations in a quiet environment. Each child's writing speed was measured using the Jebsen Hand Function Test (JHFT) while he or she sat at a table in a chair with hip and knee joints flexed at 90 degrees and ankles in a neutral position (11). The children were given a sentence consisting of 20 words typed in 12 point font size and Verdana type (3,4). It was placed in front of them on the table and they were asked to copy it out on a piece of paper. The time each child took to write out the sentence was recorded.

All of the children successfully completed the copying task. The sample sentences were scanned and recorded at 900 dpi resolution. The kinematic properties of the sentences (trace length, vertical size, horizontal size, vertical start, horizontal start, loop area average width, straightness rel error and slant) were analysed using MovAlyzeR (Neuroscript LLC, USA) computerized text analysis system (version 6.1) (12) (Figure 1).

The following aspects of the participants' handwriting samples were measured. The vertical and horizontal sizes were defined as the height and width of the letters. The vertical and horizontal starts were defined as the starting position on the vertical plane (Y axis) and horizontal plane (X axis). The loop area was described as the area of roundness and width of letters such as g, h, o, y, b and d. The straightness rel error was called deviations from smoothness during writing. The slant variable indicated negative values (-) to the left and positive (+) values to the right (13). The assesment of the children and the analyzing of the data took 30 minutes.

Statistical Analysis

The statistical analysis was conducted using the Statistical Package for Social Sciences (SPSS) for Windows version 22 (IBM, Armonk, NY, United States). Whether the variables were distributed normally was determined using a statistical analysis method (skewness and kurtosis, the Shapiro-Wilk test or the coefficient of variation) and a visual analysis method (detrended Q-Q plot, histogram or a normal Q-Q plot). Descriptive statistics were derived using the mean and standard deviation for parametric variables (age, height, weight and body mass index) and the median interquartile range for non-parametric variables (trace length, vertical size, horizontal size, vertical start, horizontal start, average width of loop area, straightness rel error and slant). The Mann-Whitney U test was used to determine the differences between the two groups for non-parametric variables. According to the power analysis, the number of children has been determined as at least 22 participants in the each group (Type I error<0.05, Type II error=0.80) (3).

RESULTS

The mean age, the school- age children with low vision (n=18) were 9.72±2.11 years, the control group (n=24) were 10±2.02 years, and the dominant hand for all of the participants was the right hand. In this study, it would have been sufficient to include 22 children in each group as a result of the power analysis. We aimed to include 24 people in each group. The writing analysis of 6 children with low vision could not be performed by the program then the study group was completed with 18 people. A total of 42 children participated in the study: 18 (nine boys and nine girls) in the study group and 24 (12 boys and 12 girls) in the control group. The participants' demographic data is presented in Table 1.

When the writing analyses of the groups were compared, statistically significant differences were found between the groups' writing samples

Table 1. Demographic Characteristics of Participants

	Study Group Mean±SD	Control Group Mean±SD
Age (year)	9.72±2.11	9.88±2.04
Height (cm)	140±13	142±13
Weight (kg)	32.86±9.28	35.33±9.3
BMI (kg/m^2)	16.62±3.24	17.36±2.97

SD: Standard Deviation, cm: centimeter, kg: kilogram, m: meter, BMI: Body Mass Index.

Table 2. Comparisons of Data Related to Writing According to Participants' Computerized Writing Analysis

	Study Group		Control Group		p
	Median	IQR	Median	IQR	
Vertical Size	0.17	0.09	0.15	0.04	0.030*
Average Thickness	0.09	0.04	0.07	0.02	0.000**
Vertical Start	223.24	121.61	92.83	47.66	0.000**
Horizontal Start	525.78	620.62	483.04	57.27	0.010*
Loop Area	0.01	0.009	0.02	0.007	0.010*
Straightness Rel Error	0.02	0.02	0.02	0.01	0.620
Slant	-1.53	2.73	-2.61	5.92	0.370
Horizontal Size	0.28	0.16	0.23	0.05	0.240
JHFT (Writing time) (sec)	200	571.25	81.5	63.25	0.000*

IQR: Interquartile range, JHFT: Jebsen Hand Function Test, sec: second *p<0.05, **p<0.001.

in terms of vertical size, average width, vertical start, horizontal start, loop area and writing speed (p<0.05). The high results was obtained in children with low vision in these variables. There were no other statistically significant differences between the groups in terms of the other variables evaluated by computerized text analysis. The data obtained from the computerized text analysis of the participants' samples are presented in Table 2.

DISCUSSION

The evaluation of the handwriting scanned by the MovAlyzeR (Neuroscript LLC, USA) computerized writing program revealed that on average, school-age children with low vision wrote their letters longer (vertical size), wider (average width) and with starting points which were higher (vertical start) and further to the right (horizontal start). These participants also produced letters with a narrower circular area (loop area) and had a slower writing speed (measured using the JHFT) than the control group.

As the children participating in the study were all in school, the two groups formed were homogeneous in terms of age; they were also homogenous in terms of their visual diagnosis and visual acuity, and the performance of the children with low vision was similar to that of children of similar age and condition reported in previous studies.

There have also been various studies analysing the writing skills of different age groups (14-18). The kinematic properties of children's handwriting have been studied in many different ways in the literature. In such study, changes in writing characteristics, pressure, direction, velocities and acceleration were examined in order to determine the quality and smoothness of handwriting (10,13). The methods used to detect differences in these variables usually involved digital tablets. In their kinematic writing analysis of school-age children, Guilbert et al. found that sensory input, particularly visual and proprioceptive cues, is more important for children than adults (19). Atasavun and Akı emphasized that their study, visual-motor control are also effective in writing skills of students with low vision (3). Güven and Atasavun Uysal have also found that similar results of their study with kinematic analysis in children. They stated that children with low vision performed greater stroke size except for the vertical size, more dysfluent movements, and slower writing speed, than children with typical development. They made the analysis by writing the short sentence allowed by the program (10). In the present study, unlike them, traditionally, children were asked to write 20 words with paper and pencil in a way they were familiar with. The wrote- sentences were scanned and assigned to the computer, and analysed and compared by the program.

Studies analysing the writing of children with low vision often use paper and pencil writing for evaluations, as this is the most frequently used writing method in school settings (3,4). For this reason, in the present study the participants were asked to write out their sample sentences using the paper-and-pencil method they were accustomed to. The sample sentences were then scanned onto a computer and analysed using MovAlyzeR version 6.1 (Neuroscript LLC, USA) an objective assessment method. The results of this study indicate that the vertical size and average width of letters

differed significantly between the two groups. It is thought that children with low vision tend to write longer and wider letters because of insufficient sensory input. These children also tend to locate the vertical and horizontal starts of their letters very differently, a discrepancy that is statistically significant. Children with low vision write letters that are higher and start further to the right than their peers because they tend to drop the letters into the visual field. The loop area of their letters was found to be significant as well. The circular features of some letters tended to be narrower when written by these students, suggesting that when they write they are attempting to ensure the integrity of the words. Future research is being planned which analysis will be more objective and suitable in the handwriting of children with low vision using a digital tablet and non-inking pen or using their pen and paper with computerized analyses systems.

In the previous studies conducted on the writing speed of children with low vision, the children's writing speed was evaluated with JHFT, and the results of all these studies indicated that children with low vision write more slowly than their peers (3,4,8). In the present study, it was found that school- age children with low vision wrote more slowly than the control group, which confirmed the trend reported in the literature. As they mentioned, we agreed that these difficulties may be due to a lack of visual cues (3,4,8). In a study on how writing is taught to children with low vision and typical development, it was found that children in both groups had difficulty writing a sentence in a straight line and their letters were oblique (3,4). The results of the present study confirm these findings in terms of straight rel error and slant: This may be because school-age children are taught the same the education program for their age group in Turkey, regardless of the school they attend. There was also no difference between the groups in terms of the average length of their sentences. The reason for this may be that children with low vision write most of their letters wider and their round letters narrower.

School-age children with low vision are used in line with the needs of writing training, with their optical devices, using contrast equipment, and in large font paper in proper posture should be included in the rehabilitation program.

The inability to analyze the writing of some children can be considered as a limitation of this study. However, the results among the data are significant.

This research is important because it is the first study to examine the handwriting written on paper by school- age children with low vision using a scan and computerized writing analysis system. The aim of the study was to use a computer program to analyse the writing characteristics of the participants' sentences written with paper and pencil. It was found that school- age children with low vision wrote thicker pencil lines, higher writing points, higher letters and narrower letters with a circular character; they also had a slower writing speed than their peers with typically developed vision.

Writing is an important factor for the academic achievement of low vision students. It is important that technological writing and evaluation training programs become more widespread in order to be more present in the society without lagging behind their peers. However, there are some criteria determined by the program for the analysis of the text. It should be kept in mind that the requirements with these encodings are important in the analysis of the text.

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REFERENCES

1. Kushki A, Chau T, Anagnostou E. Handwriting difficulties in children with autism spectrum disorders: A scoping review. J Autism Dev Disord. 2011;41(12):1706-1716.
2. Graham S, Berninger V, Weintraub N, Schafer W. Development of handwriting speed and legibility in grades 1–9. J Educ Res. 1998;92(1):42-52.
3. Atasavun Uysal S, Aki E. Relationship between writing skills and visual-motor control in low-vision students. Percept Mot Skills. 2012;115(1):111-119.
4. Atasavun Uysal S, Düger T. Writing and reading training effects on font type and size preferences by students with low vision. Percept Mot Skills. 2012;114(3):837-846.
5. Russel E, Nagaishi PS. Services for children with visual or auditory impairments. 5 ed. St. Louis: Elsevier; 2005.
6. Warren M, Lampert J. Assessing daily living needs. Opthalmol Monographs. 1999;12:89-106.
7. Negiloni K, Krishna Kumar Ramani RJ, Kalva J, Sudhir RR. Are children with low vision adapted to the visual environment in classrooms of mainstream schools? Indian J Opthalmol. 2018;66(2):285-289.
8. Aki E, Atasavun Uysal S, Kayihan H. Relationship between upper extremity kinesthetic sense and writing performance by students with low vision. Percept Mot Skills. 2008;106(3):963-966.
9. Giammarco E, Di Sano S, Aureli T, Cerratti P, Fanò-Illic G, Pietrangelo T. Psychological and Physiological Processes in Figure-Tracing Abilities Measured Using a Tablet Computer: A Study with 7 and 9 Years Old Children. Front Psychol. 2016;7:1528.
10. Güven Z. Atasavun Uysal S. Kinematic analysis of handwriting movements and pencil grip patterns in children with low vision. Hum Mov Sci. 2022; 81: 102907.
11. Jebsen RH, Taylor NEAL, Trieschmann RB, Trotter MJ, Howard LA. An objective and standardized test of hand function. Arch Phys Med Rehabil. 1969;50(6):311-319.
12. Dean DJ, Teulings HL, Caligiuri M, Mittal VA. Handwriting analysis indicates spontaneous dyskinesias in neuroleptic naive adolescents at high risk for psychosis. JoVE 2013;81:e50852.
13. Amend, KK, Ruiz MS. Handwriting analysis. The complete basic book: Red Wheel/Weiser; 2000
14. Rosenblum S, Weiss PL, Parush S. Product and process evaluation of handwriting difficulties. Educ Psychol Rev. 2003;15(1):41-81.
15. Alamargot D, Morin MF. Does handwriting on a tablet screen affect students' graphomotor execution? A comparison between grades two and nine. Hum Mov Sci. 2015;44:32-41.
16. Falk TH, Tam C, Schellnus H, Chau T. On the development of a computer-based handwriting assessment tool to objectively quantify handwriting proficiency in children. Comput Methods Programs Biomed. 2011;104(3):e102-e111.
17. Summers J, Catarro F. Assessment of handwriting speed and factors influencing written output of university students in examinations. Aust Occup Ther J. 2003;50(3):148-157.
18. Van Drempt N, McCluskey A, Lannin NA. Handwriting in healthy people aged 65 years and over. Aust Occup Ther J. 2011;58(4):276-286.
19. Guilbert J, Alamargot D, Morin, MF. Handwriting on a tablet screen: Role of visual and proprioceptive feedback in the control of movement by children and adults. Hum Mov Sci. 2019;65:30-41.