A Study on the effect of different pencil grips on writing parameters of children suffering from Dysgraphia

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Abstract: Handwriting is one of the most immediate form of communication and is an important component of learning. During school age, failing to reach competence in handwriting can have serious effects on both academic success and self-esteem of a child. Dysgraphia is a specific learning disability that affects written expression that usually results in illegible handwriting. There are various signs and symptoms of dysgraphia. Their pencil holding posture is awkward and unstable, mostly fist-like or tight and they tend to tire down very often when asked to write continuously for long durations. The main aim of the study was to know the effect of various grip shapes on different writing parameters such as writing speed, legibility, and tip-contact force on the paper.

1.0 Introduction

Despite the wide range of tablets available in the market, handwriting is still a parameter significant for expression and communication. The effects of pen shape and size on writing and drawing tasks have been evaluated and 8 mm equivalent diameter pens are the most preferred [1].

Handwriting skills usually develop during kindergarten and grade one (<6 years), stabilizes by grade two (7–8 years) [2, 3]; and are fully attained automatically when they reach grade three (8–9 years) [4]. However, almost 10–30% of children face difficulties in attaining these skills while going through this phase [4].These difficulties are termed dysgraphia by several authors [5].The word 'dysgraphia' means difficulty of expressing thoughts in writing. Dysgraphia is a neurological disorder, which mostly appears when children are first learning to write. Experts are not sure what causes it, but an early treatment can help prevent or mitigate it. Handwriting difficulties in an early age may lead to arrested writing development [6, 7, and 8]. A comparative study of the writing parameters of children with and without dysgraphia has been done via a tablet-based task [9]. But a study on the effect of various grip shapes on writing parameters of children with dysgraphia had not been done which was the primary goal of this research. The study was di-vided into two parts; a preliminary and a final user-study. The dimensions of the grips were taken considering the Chinese hand anthropometric data as the data for Indian children was not available.

2.0 Preliminary User-study

The preliminary user test was carried out in a local training school for learning disorder at Bangalore under the supervision of their principal coordinator. The aim of this study was to check the comfort level and visually check the writing legibility associated with the usage of these grips.

2.1 Participants

As this study was mainly focused on children, 8 participants (all males and right-handed) were selected initially by the teachers themselves based on the severity of their writing impairment. Their age group was between 7-17 years, all having a different degree of severity in writing impairment.

2.2 Grip Designs

Seven grips were made out soft-material (high-density foam) and were put on a conventional pencil. Fig. 1 shows the grips made and Fig. 2 shows the dimensions of these seven grips.

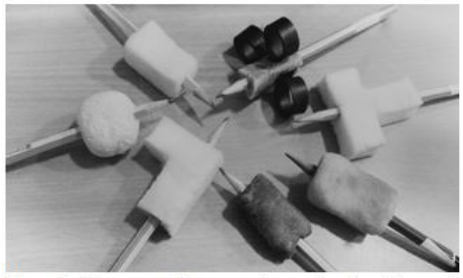

Fig. 1. Seven grips made out of soft material

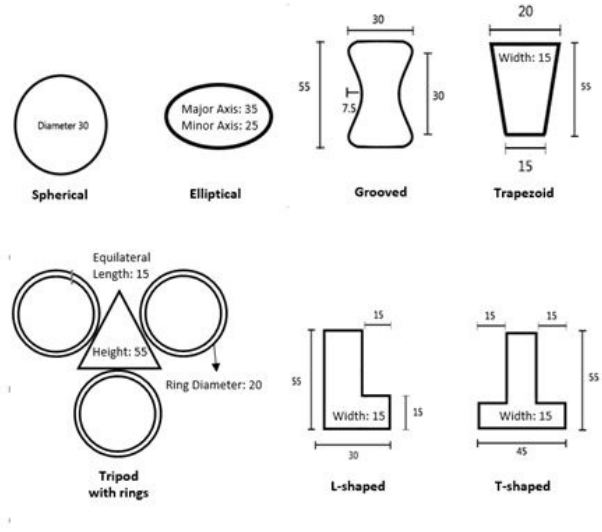

Fig. 2. Dimensions of the grips used (All dimensions are in mm)

2.3 The Task

The task consisted of two A4 pages containing randomly chosen alphabets (in both upper and lower case) and numbers as shown in Fig. 3. The task was presented in the same order to every subject. The subjects were made to perform the task on a study table of height 70cm while being seated on a 40 cm high chair. The subjects were asked to hold the pencil in a position that they felt was the most comfortable. No trial run was given to them.

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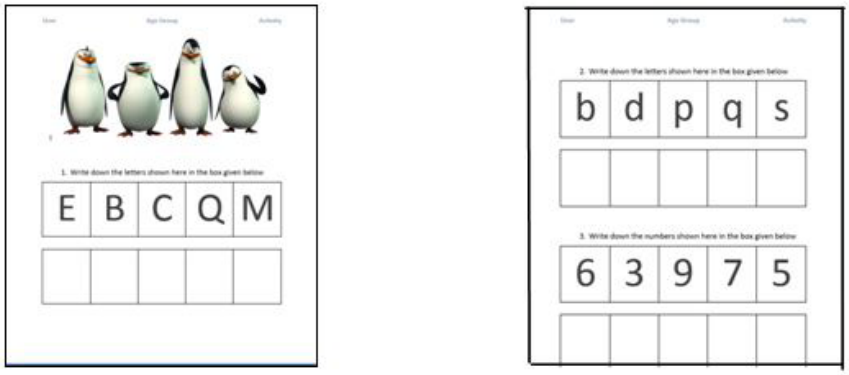

Fig. 3. The writing task assigned to the subjects

3.0 Final User-study

After the preliminary test, 3 grips were finalized based on level of improvement seen in their writing and the user preference. These grips were made out of silicone rubber.

3.1 Participants

Out of the 8 participants in the first user-study, only five participated in this.

3.2 Grip Designs

Out of the seven grips three (Tripod, Trapezoid and L-Shaped) were selected.

3.3 The Task

The task & the place remained the same. Each person had to complete the task four times; one with a conventional pencil without any grip and the rest with each individual grips. A user feedback was taken at the end of the task. The following parameters were measured.

3.3.1 Tip-contact Force

The contact force on the writing surface was measured using a Force Sensing Resistor. An acrylic platform of half the dimensions of a standard A4 sheet was cut. Three FSRs were affixed at the bottom of the platform as shown in Fig 4.

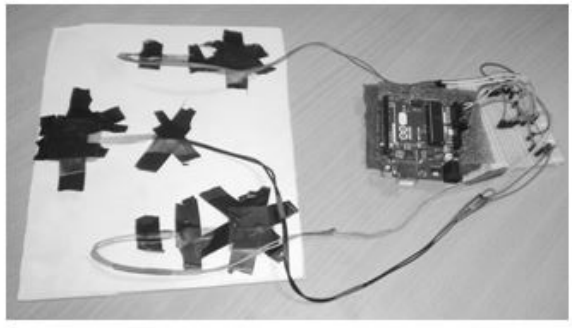

Fig. 4. Three FSR's with their positons on an acrylic A4 size board

To keep the task simple this test was done separately at the end with the task being only the first page (containing four alphabets in capital case). The platform was kept under the page and instructions were given to the subjects that while writing their hand shouldn't rest on the acrylic board and instead they should use the table to support their elbow and then write. The output was stored using an RS data logger software for further processing. Since the aim of the study was only to make a comparative evaluation of the tip-contact forces, the sensors were not calibrated. The average reading on the three sensors was taken as the final output.

3.3.2 Writing Legibility

It was checked online using optical-character-recognition technique. The legibility of the letters was then checked on the basis of whether the scanned individual letter output could be identified as a correct letter or not. There were a total of 15 letters in each task.

3.3.3 Writing Time

The writing time (in sec) to complete the task was measured using a stopwatch.

3.3.4 Writing Posture

The writing posture shown in Fig.5 was checked by video-graphing the users.

Fig.5. Writing postures with the three grips

4.0 Results

Trapezoid and L-shaped Grips had the lowest and almost equal contact forces followed by Tripod and No-grip case as shown in Fig. 6.

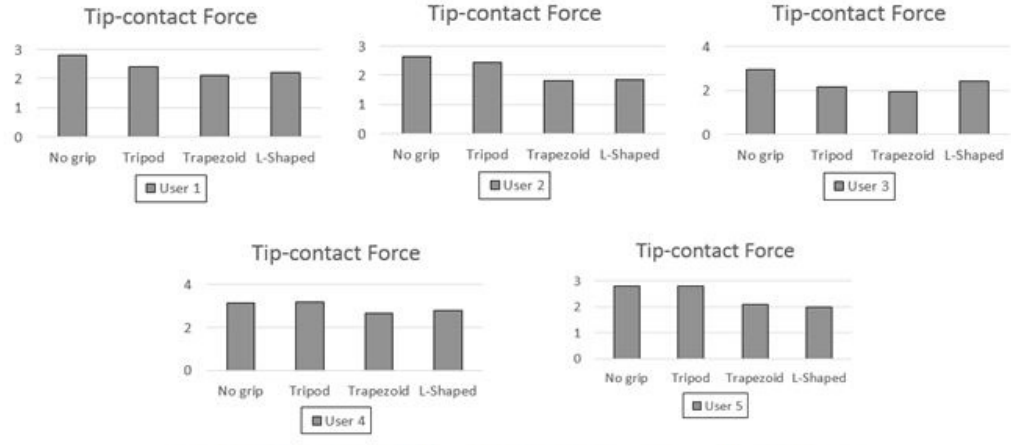

Fig.6. Final output (averaged) of the tip-contact force

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Table. 1 & Table. 2 shows the number of errors and the time taken to complete the task respectively. L-shaped and Trapezoidal grips had the max number of errors followed by Tripod and No-grip which had almost the same number of errors. For writing time, Tripod and No-grip cases took the least (almost same) amount of time while Trapezoid and L-shaped grips took a significantly higher time.

	Number of Errors			
	No grip	Tripod	Trapezoid	L-shaped
User 1	4	2	5	8
User 2	2	2	3	6
User 3	7	6	11	11
User 4	9	9	12	14
User 5	4	2	4	6

Table. 1. Number of errors

	Age	Time taken(seconds)			
		No grip	Tripod	Trapezoid	L-shaped
User 1	17	12.6	11.8	13.5	21.0
User 2	14	11.9	10.8	12.1	13.9
User 3	9	17.8	17.7	18.4	19
User 4	9	27.7	24.4	25.9	36.0
User 5	10	15.4	15.0	16.5	17.2

Table. 2. Writing Time

The writing posture of the users didn't change in the first three cases (No-grip, Tripod and Trapezoid) while performing the task, but in case of L-shaped grips the writing posture of users changed and it was rated the least comfortable. For No-grip and Tripod case, their gripping style was tripod-grasp or quadrupod-grasp while in case of Trapezoid it was a Digital-grasp type style. As far as the user-preference, Tripod and Trapezoidal grips were the most preferred.

5.0 Conclusion and discussion of results

As tripod-grip was smaller in equivalent diameter than the other two grips, it had the highest writing speed & lowest number of errors which was comparable to the conventional lead pencil without any grip. The trapezoid and tripod grips had the least tip-contact forces owing to the extra contact surface area between the grip and the hand. The rationale behind the L-shape design was to provide an extra contact point while writing, but since the users were not able to maintain their writing postures while using L-grip, it took the highest amount of time to complete the task and also had the highest number of errors. By providing an extra contact area or support point in a normal pencil grip, a quality change in the handwriting of the students were observed. The smaller sized grips fared better in terms of speed while as the bigger ones (L-shaped and Trapezoid) had lesser contact forces.

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