

Analysis of handwriting patterns of Dyslexic Children vis-à-vis the non-dyslexics using Hamming Distance

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Abstract – Learning disabilities can affect a person's ability to speak, listen, read, write, spell, reason, recall, organize information, and do mathematics. Researcher has tried to study what could be the percentage of children having writing difficulties among all types of Learning Disability. In this paper, the researcher has focused particularly on Dysgraphia. The survey conducted with a group of Learning Disabled children and the researcher wanted each of them to identify certain words. This study is to investigate in which pattern of the text Dysgraphia child finds difficulty to understand and by how much error factor a Dysgraphia child is distinctly identifiable from non-Dysgraphia one.

Keywords-Dysgraphia; Learning Disabled; Dyslexia; Handwriting

I. INTRODUCTION

First of all, it is important to exclude a range of other reasons why a child is having great difficulty in learning to read and write. These include poor eyesight, hearing difficulties, absence from school due to ill health, inadequate or much interrupted schooling or emotional stress at home.

Researchers have found that if children suffer from this condition around the age of two (when they are acquiring spoken language very rapidly) or around five (when they are beginning to learn the skills needed for reading), they are more likely to experience difficulties in learning to read. If they are dyslexic, these difficulties will certainly compound the problem.

A. What is Dysgraphia

Deuel (1994) has divided dysgraphia into three subtypes[8]:

1. Dyslexic dysgraphia - spontaneously written text is poorly legible and spelling is severely abnormal. Copying of written text is relatively preserved, however, and finger-tapping speed on a neuropsychological battery is generally normal.
2. Dysgraphia due to motor clumsiness - associated with poorly legible spontaneously written text, preserved spelling, and poorly legible copying of written text. Finger tapping speed in such cases is generally abnormal.
3. Dysgraphia due to a defect in the understanding of space - associated with poorly legible spontaneously written text, preserved spelling, poorly legible copying of written text, and normal finger tapping speed.

Some of the symptoms of Dysgraphia, many of which occur in groups, include [8]:

- Tight awkward pencil grip
- Awkward body position
- Illegible handwriting
- Inconsistencies, e.g. mixtures of print and cursive, upper and lower case, irregular sizes,
- unfinished words, omitted words, position on page, spaces between words
- Avoiding writing or drawing tasks
- Saying words out loud while writing
- Strong verbal but poor written skills
- Unfinished or omitted words in sentences
- Non-existent punctuation
- Difficulty organizing thoughts on paper
- Difficulty with syntax structure and grammar
- Large gaps between written ideas and understanding demonstrated through speech

Dysgraphia is often misunderstood by parents, teachers, and students. While the label is not important, understanding that some students experience problems processing and organizing information in a written format is important [7]

Important factors which 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 (Tseng & Cermak, 1991; Alston & Taylor 1987; Ziviani & Elkins, 1984). Smits-Engelsman and Van Galen (1997) found that dysgraphic children (i.e., children with writing deficits) 7 to 11 years old showed more variability in letter size than nondysgraphic children [16].

B. Why focusing on Dysgraphia

Among all the type what we found is there is not much study has been done in identifying handwriting difficulty in child so we

have attempted to done study to find out percentage of Dysgraphia children among Learning disabled children and which word pattern confuses the child more so that we can simplify those patterns for the child. This study actually helps in recognizing the severity of difficulty in of writing and understanding language.

It's always worth remembering that suitable help from a young age may prevent children from falling behind.

II. SIGNIFICANCE OF THE STUDY

Identifying Learning disability is not only sufficient but to actually detect in which part of the learning child is facing difficulty. So that parents and teachers can put extra effort to improve those areas and channelizes the child's ability.

III. LITERATURE REVIEW

Researcher has shown that handwriting is casually related to writing and that explicit and supplemental instruction of handwriting are important elements in elementary program to prevent writing difficulties (Garaham, Harris and Fink 2000)

Meese (2001) describes Dysgraphia as handwriting problems, specifically, a partial inability to remember how to make certain alphabet

Unfortunately many student struggle in school because of dysgraphia, a problem with expressing thoughts in written form [1] Students concentrating too hard on letter formation may develop problems with gripping the pencil [1].

Identifying students that have dysgraphia can be a challenge because it affects them to different degrees or is often combined with other types of learning problems [5].

Dysgraphia affects a student's ability to write coherently, regardless of their ability to read [6].

Researcher tried to address handwriting problems have been varied and include visual perception and visual motor and letter formation training (Oliver, 1990; Lockhart & Law, 1994; Peterson, 1999).

IV. RESEARCH METHODOLOGY

In this study, we started with the collection of handwriting patterns of the primary students from one of the well known school. We compare the two set of samples which is handwriting patterns, one set from Learning disabled students and another from normal students. We collected the samples from the students class book only so that we get the more natural pattern, otherwise if we allow the child to work under tension the chances of getting errors will be more. Our attempt was to gather as much real and natural data as possible.

To calculate the error factor we used one of the methods of error detection, Hamming Code technique.

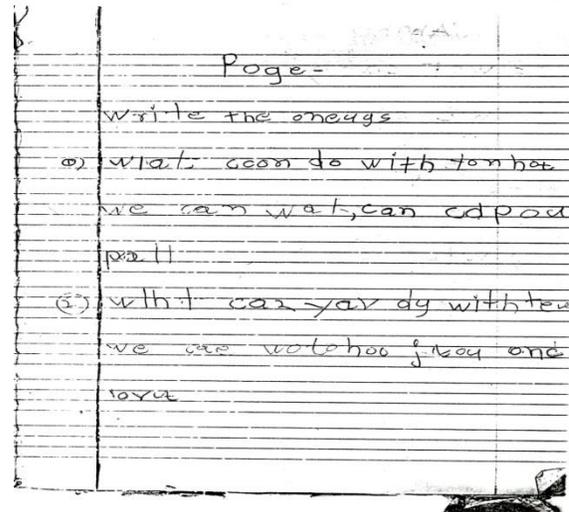


Figure 1. One Sample of text of Learning disabled child

A. Steps to perform:

Procedure Hamming Distance (P1, P2 ... Pn)

1. Using Hamming distance:
The Hamming distance $d(x, y)$ between two vectors $x, y \in F(n)$ is the number of coefficients in which they differ. We divided the given pattern of text of all LD children into different segments.
2. Code the segments into 15-bit size frames.
3. Then we coded those segments from 1 to 11 remaining 4 positions are for parity bit.

e.g.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
P	P		P				P							

4. Pattern matching that is we compare the given word with the correct word and if it is correct put 0 otherwise 1 in the frame likewise we coded all the text.
5. Calculated 4-bit parity by taking XOR of all ones in the frame.
6. We compared those final vectors, from which we came to know the average maximum error factor for learning disabled child is 3-bit and for normal child is 1-bit. So we could conclude that the Learning Disabled child is far away by three bits from the non dyslexic one.
7. Now, to find in which part of the text the child has got confused i. e. nothing but most likely pattern of text, we took the min parity bit template.
8. In some cases we got the more than two templates with the same min value, from which we selected one using survival of fittest technique.
9. We proceed further with 4-dimensional cube, which helped us to find nearest neighbor.

E.g. 4-dimensional cube:

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[1000 0100 1100 0010 1010 0110 1110
0001 1001 0101 1110 1001 1101 1111 1
111]
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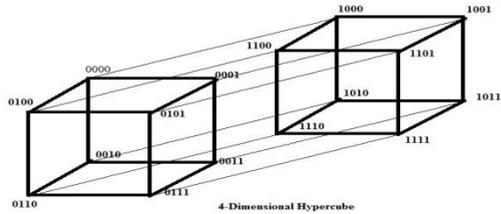


Figure 2. 4-dimensional hypercube

Imagine that the cube is made of wire. Then the Hamming distance between two words is the number of edges in a shortest path connecting the corresponding vertices.

For Example,

$$d(101, 010) = 3.$$

Analogously, the Hamming distance in $F(n)$ can be interpreted as the minimal number of edges in a path connecting two vertices of a n -dimensional cube. This helped us to predict nearest neighbour.

Nearest neighbour:

Given a code $C \in F(m)$ and a vector $y \in F(n)$

Then $x \in C$ is a nearest neighbour to y

$$\text{If } d(x, y) = \min(d(z, y) \mid z \in C)$$

10. We calculated min for all (x, y) pairs, we got the frames where the Learning disabled child is more confused where learning disabled child is getting difficulty that means he is not able to write the accurate spelling for those words.
11. If we get more than two templates with the same min value.

E.g. Nearest neighborhood as follows:

$$\begin{aligned} [1011-1000] &= 0011 = 2 \\ [1110-1000] &= 0110 = 2 \\ [1101-1000] &= 0101 = 2 \\ [0111-1000] &= 1111 = 5 \\ [1011-1000] &= 0011 = 2 \end{aligned}$$

Then that would be the optimum solution as it is the nearest neighbour and when we drawn the hypercube the co-ordinates were the nearest instead of the other two i.e.

$$\begin{aligned} [1110-1000] &= 0110 = 2 \\ [1101-1000] &= 0101 = 2. \end{aligned}$$

So, we can state that the learning Child is more confused in these two frames.

V. CONCLUSION

Here, we state some final measures after comparing overall results.

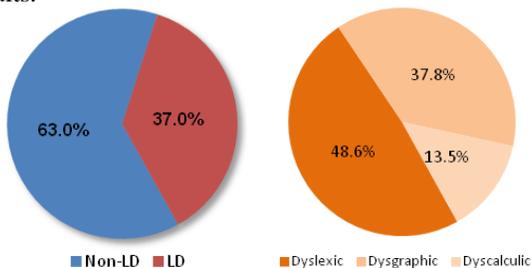


Figure 3. Population averages

Assumption: On an average, 37.8% of LD children are cases of Dysgraphia.

$$\text{i.e. } \bar{P} = 37.8\% = 0.378$$

H_0 : Use of Humming distance method has same chances of identifying Dysgraphic child as any other method

$$\text{i.e. } P_{\text{Calculated}} \leq 0.378$$

H_1 : Use of Humming distance method has better chances of identifying Dysgraphic child than any other method

$$\text{i.e. } P_{\text{Calculated}} > 0.378$$

Where,

$P_{\text{Calculated}}$ = Percentage of children from the test identified as Dysgraphic

And,

Test identifies the child as Dysgraphic if no. of words correctly identified by the child is lesser than the group's average

Hence,

Test statistics is –

$$t = \frac{P_{\text{Calculated}} - \bar{P}}{\sigma}$$

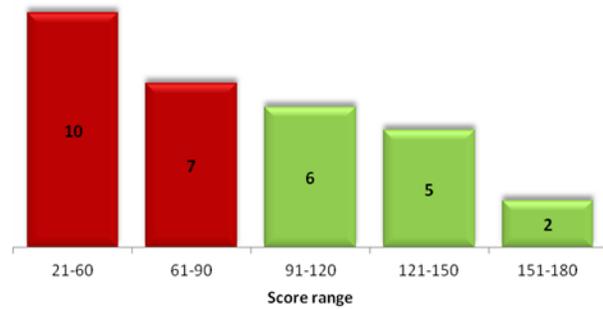


Figure 4. Distribution of scores

In the study,

Average no. of correctly identified words = 90

No. of children who identified lesser than 90 words = 17

Hence,

$$\begin{aligned} P_{\text{Calculated}} &= 17/30 = 0.5667 \\ q_{\text{Calculated}} &= 1 - P_{\text{Calculated}} = 0.4333 \end{aligned}$$

$$\begin{aligned} \sigma &= \sqrt{P_{\text{Calculated}} * q_{\text{Calculated}} / N} \\ &= \sqrt{0.5667 * 0.4333 / 30} \\ &= 0.090472 \end{aligned}$$

Hence,

$$t = \frac{P_{\text{Calculated}} - \bar{P}}{\sigma}$$

$$= \frac{0.5667 - 0.3780}{0.090472}$$

$$= 2.081177$$

Decision is to reject the null hypothesis if -

Calculated value of t-statistics > Table value of t-statistics,

Where -

Table value of t-statistics = 2.045 at 95% level of significance

Since -

2.081177 > 2.045

Hence -

We reject the null hypothesis and we conclude that use of Humming distance method has better chances of identifying Dysgraphic child than any other method.

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