



**Received:** 04 January, 2022

**Accepted:** 23 March, 2022

**Published:** 24 March, 2022

**\*Corresponding author:** Dr. Nirvana Gamal El-Din Hafez, MD, Professor, Professor of Phoniatics, ENT Department, Faculty of Medicine, Ain Shams University, 10 Mostafa Mokhtar st. Heliopolis Cairo, Egypt, Tel: 02-01005090020; E-mail: nirvanagh2@gmail.com

**ORCID:** <https://orcid.org/0000-0001-6336-6518>

**Keywords:** Dysgraphia; Writing difficulty; Handwriting problems

**Copyright License:** © 2021 El-Deen Hafez NG, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

<https://www.peertechzpublications.com>



Check for updates

## Short Communication

# Validation of the Dysgraphia Disability Scale (DDS); An assessment tool for writing difficulty

Nirvana Gamal El-Deen Hafez<sup>1\*</sup> and Dina Khaled<sup>2</sup>

<sup>1</sup>Professor of Phoniatics, ENT Department, Faculty of Medicine, Ain Shams University, Egypt

<sup>2</sup>Lecturer of Phoniatics, Faculty of Childhood Studies, Ain Shams University, Egypt

## Abstract

Dysgraphia is defined as the difficulty in the production of written language. This study was carried out on 50 subjects aged 6-12 years who suffered from writing disabilities. This methodological study was designed to measure the possible breakdown mechanisms causing dysgraphia. A scale was created to cover most of the weak points in dysgraphia especially the fine motor and proprioceptive aspects. Reliability and validity of this scale were performed to allow its application. Findings were dealt with statistically and it was found that three types of dysgraphia have been known as Dyslexic, Motoric, and Spatial Dysgraphia. The scale diagnoses dysgraphia in an objective way and the severity of the condition can be determined in addition. This helps better understand the patients' needs when a trainer designs the remediation program.

## Introduction

Handwriting is complex motor and cognitive process that requires linguistic, lexical and motor planning skills [1]. Writing and spelling are conceived as concerted actions comprising cognitive planning, motor action and expressive content. An old belief that was writing is a primary motor process. However, writing is a written language process that requires multiple brain mechanisms starting with eye-hand coordination, visual fine motor integration, Proprio-kinesthetic feedback that needs awareness of the movement, and the location of the finger in space [2]. In addition, motor memory feedback is a mechanism of motor engrams that needs visual-fine motor coordination to produce symbols, essentialization, speed, and accuracy.

As a cultural technique, in literate societies, individuals use the alphabetic system following language acquisition. Eventually, writing is the last and most complex skill to develop, so it is the most vulnerable to insult injury [3].

Many authors tried to put the outlines and to define writing difficulty. Hamstra- Bletz and Blote [4] reported that difficulty in the production of written language that has to do with the mechanics of writing is defined as Dysgraphia. The American Psychiatric Association stated that Writing difficulty can be defined also as a combination of difficulties in an individual's ability to compose a written text that is manifested by illegible handwriting, letter shape distortion, dysfluent writing, spelling errors, and difficulty in written expression of ideas that cannot be attributed to disabilities in reading or oral expression [5]. Margolin [6] suggested that a major part of writing disability appeared in the graphomotor execution of sequential symbols to convey thoughts and information.

All authors agreed that the problem of having poor handwriting doesn't mean that this equals dysgraphia.

Theoretically, three types of dysgraphia have been defined by Deuel [3] as Dyslexic dysgraphia, in which the child suffers illegible writing, poor oral spelling, and reading difficulty.



Motor dysgraphia is characterized by fine motoric deficits which affect their ability to do things that need fine motoric coordination. This type of dysgraphia shows a lack of motoric coordination rather than motoric weakness or involuntary movements. Spatial dysgraphia is another type in which the child is unable to acquire the right directions needed to write letters, words and this is accompanied essentially by poor drawing.

All types of dysgraphia share common features as most of them suffer illegible handwriting, irregular size, and shape of letters, slanting, missing letters, and missing words even during copying. They are unable to respect lines and margins with inconsistent spaces between words and letters with inefficient speed [7].

In the Arabic Language, most of the letters are similar in their shape but can be differentiated from each other only by dots. In children who have dysgraphia, it is common to find them writing the Arabic letters without using dots and as a result, many letters seem to be similar. Another defect that can be noticed in Arabic that the defective ability to discriminate the writing letter at the beginning of a word that may differ from the end of the word like /س/ and /ك/ despite they are the same phoneme.

Proprioception or kinesthesia, Motor programming, and visual-motor coordination are mandatory pre-requisites for normal handwriting performance. Some dysgraphia children hold their writing tools incorrectly with their incorrect wrist position, body position, and paper position [8].

In addition to the apparent features of handwriting difficulties, poor content of language output is noticed. Their expression of vocabulary tends to be simple and superficial. They have syntax difficulties, defective ability to think and write at the same time.

Different assessment procedures were studied before trying to determine the faults of this disorder. However, most of the studies were subjective and depends on the experienced teachers who judge the problem from their point of view not depending on objective assessment tools. Others based their studies on analyzing the handwritten product and speed. Copying tests like (NEPSY II) were tried to assess dysgraphia through observing motor and visual-perceptual skills associated with copying geometric figures [9].

The proper assessment measure will allow for a better chance to document and determine the breakdown mechanism causing the disability and to draw the plan of intervention starting not from zero level but from a definite point trying to tackle the defective skills.

### Aim of the work

To establish a preliminary screening assessment test for Dysgraphia disorder that can help in diagnosis, able to clarify the main criteria of the theoretically three types of dysgraphia, and determine the severity of such disorder.

## Subjects and methods

A total of 50 subjects from October 2010 to April 2012 were brought by their parents to the outpatient clinic in the Special Needs' Center at Childhood Institute Ain Shams University complaining of their child's poor handwriting or inability to spell words at school.

They were 12 females and 38 males of the age range (6 to 12 years) mean age = 9 years. All of them were students in different grades of elementary (primary) governmental schools. Another group was examined as a control group that collected from relatives and patients' sisters and brothers.

**Every case was subjected to the following protocol of assessment:**

- i. Elementary Diagnostic procedures that can be applied to patients in any primitive clinic for evaluation. This step includes personal history, complaint, family history, antenatal, natal, postnatal history. This is achieved by direct questions to the family trying to detect the cause of the disability. The presence and absence of seizures, general illness, and delayed milestones should be excluded. General examination and Neurological examination should be done to exclude any gross motoric deficit of the child. Defective hearing and vision should be excluded.
- ii. Clinical Diagnostic Aids using formal testing battery including: Psychometry using:
  - A. Stanford Bennet Intelligence scale (version IV).
  - B. Wechsler intelligent scale IV for children especially the Processing Speed Index (PSI). It assesses the child's ability to focus attention and quickly scan, discriminate between and sequentially order visual information.
  - C. Bender Gestalt especially the copying task. It is a psychological test used to evaluate visual-motor functioning, visual perceptual skills, neurological impairment, and emotional disturbances in children and adults. It consists of nine figures that are presented to the test subject one at a time and ask the subject to copy it. Results are scored according to accuracy and organization.
  - D. Illinois test of psycholinguistic abilities
  - E. Good enough- Harris Drawing test: The child is asked to draw a man than a woman and then a scale from 1-37 is used to evaluate the child's ability and gives the corresponding mental age.
- iii. Additional Instrumental measures: Computed Tomography and Electroencephalography are infrequently needed

### Inclusion criteria of subjects in the study

- Normal cognitive abilities that were documented using the Stanford Binnet Intelligence scale (version IV).



- No physical handicap.
- All subjects had received at least 6 months of general education prior to testing.
- All children demonstrated skills below their performance range on school assessments.

**Inclusion criteria of the control group**

- Normal cognitive abilities by Stanford Bennet intelligence scale (version IV)
- No physical handicap
- Average literacy
- No history of delayed language or speech disorders.

**The Dysgraphia Disability Scale (DDS)**

**Test characteristics:** In This study, DDS was developed to evaluate a wide range of difficulties in handwriting. It is designed to assess handwriting performance as well as fine motor difficulties causing poor handwriting. The items testing DDS covered five aspects related to writing skills.

*The fine motor function* was tested by asking the child to do four fine motoric purposeful movements by his/her hands.

*The proprioceptive function* was tested by examination of pain sensation using a pin brick, while light touch using the cotton piece. Pressure by hand. Stereognosis is one of the cortical sensations and is defined as the ability to recognize and identify objects by feeling them. This ability was examined while putting a familiar object in the patient’s hand and he/she should recognize it when he/she closed his/her eyes.

Graphesthesia is one of the cortical sensations too and defined as the ability to recognize symbols written on the skin. The patient should be asked to close his/her eyes and an alphabetic letter is written inside his/her palm of the hand and the patient should recognize the letter without seeing it.

*The perceptual-motor function* was tested by asking patients to do certain skills or imitate gross motoric movements with their hands.

*The Handwriting skills* were tested by asking subjects to copy a sentence to monitor their line respection, spacing between words, letter directions. Another sentence was dictated to monitor spelling errors and punctuations.

*The drawing* was asked routinely to confirm or exclude any spatial element of dysgraphia as well as finger tapping speed to measure the coordination and rapidity.

**Test administration:** It should be administered in an environment that ensures an undisturbed session. Each child was tested individually in a quiet room. In some cases, the familiar people to the child remain in the same room without interference. Instructions were given and the child is allowed a certain time for every task, with a total application time

between 20 to 40 minutes. Marks are added and compared to a range score. This range score may lie in one of the disability categories that started from normal to Total disability. This test as well can categorize types of dysgraphia according to the features of the disability.

**Scoring:** Possible disabilities in dysgraphia subjects were collected and categorized into 5 groups. Each group is subdivided into items. Each item carries normally a mark. The scale is graded from

0= Unable to do the task even with the help

0.25= Subject is hardly able to do the task with examiner’s help

0.50= Fair in which the subject is able to do the task in a slow manner with many mistakes.

0.75= Subject is able to do the task with minimal mistakes.

1.0= Subject is able to do the task without any mistakes.

A total marks range from {20 to 17} was considered as a normal hand writer with no disability or dysgraphia even if the subject was complaining of bad handwriting.

Marks that range between {16.75 to 13} was considered as good hand writer with minimal disability.

A range of {12.75 to 9} had a fair ability and was considered as having mild to moderate disability.

A range of {8.75 to 5} was considered as disabled and have a severe disability.

A range between {4.75 and 0} was unable with total disability.

This kind of grading classifies the severity of dysgraphia as minimal, mild to moderate, severe and total disability.

Dysgraphia Disability Scale					
	Unable (0)	Help (0.25)	Fair (0.50)	Good (0.75)	Normal (1.0)
<b>I. Fine motor function</b> <ul style="list-style-type: none"> <li>• Grip</li> <li>• Pour a glass of water into other</li> <li>• putting a coin in a safe box</li> <li>• Buttoning</li> </ul>					
<b>II. Proprioceptive function</b> <ul style="list-style-type: none"> <li>• Pain</li> <li>• Light touch</li> <li>• Pressure</li> <li>• Steriognosis</li> <li>• Graphesthesia</li> </ul>					
<b>III. Perceptual motor function</b> <ul style="list-style-type: none"> <li>• Tying a ribbon</li> <li>• Contouring around a figure</li> <li>• Cutting a circle</li> <li>• Imitation of hand posture</li> </ul>					

<b>IV. Handwriting</b>					
<ul style="list-style-type: none"> <li>Respecting lines</li> <li>Spacing between words</li> <li>Letter directions</li> <li>Spelling a sentence</li> <li>Punctuation</li> </ul>					
<b>V. Drawing a man</b>					
<b>VI. VI. Finger tapping speed</b>					

Using the previous new scale helps classify dysgraphia participants into three groups: Dyslexic dysgraphia, Motoric dysgraphia, and spatial dysgraphia.

### Reliability

Reliability is referred to the consistency, stability, and accuracy of a test's score [10]. The patient's group employed to assess the reliability of the Dysgraphia Disability scale is typically comprised of individuals who suffered difficulty in writing.

Test-retest reliability was done twice in identical locations with a delay of approximately 4 weeks between testing sessions.

### Validity

Validity is referred to the demonstration that a test actually measures what it claims to measure and that inferences made about performance on that test are appropriate [11]. Face validity is an estimate of the degree to which a measure is clearly and unambiguously tapping the construct it purports to assess.

### Data analysis

The proportion of positivity was done as a descriptive analysis.

Paired "t" test was used to compare the mean values of the control and patients group.

The Spearman Rank ordered correlation matrix was done to correlate between some test items and their pathophysiological correlate.

The control participants were assessed to provide normative data and to assess the validity of the test in its ability to differentiate between those with normal handwriting and those with dysgraphia.

### Results

This study was done using an experimental design work on two groups using a random sample. The first group is the dysgraphia group that comprised of 50 subjects and the second group is the control group which is the matched normative control and they were 20 normal subjects in order to examine the test validity. The mean age of the dysgraphia group was 9 years and the mean age of the control group was 9 years. The following Table 1 summarizes the demographical information of both groups.

The standardization of DDS is based on the results of the test administration to 50 dysgraphic subjects and 20 control subjects. The means, standard deviations of the control group are shown in Table 2.

Using the Dysgraphia Disability Scale (DDS), three patterns of dysgraphia have been known 29/50 was Dyslexic dysgraphia, 5/50 was spatial dysgraphia and 16/50 was Motoric dysgraphia.

Reliability was measured by test-retest reliability on 50 dysgraphia subjects who were tested on 2 occasions approximately 4 weeks apart to quantify the degree of test-retest reliability. This group was considered the most appropriate because they had stable dysgraphia. This time

**Table 1:** Summarizes the demographical information of both groups.

	Control group (20)	Dysgraphia group (50)
Age mean	9 ys	9ys
Age range	6-12	6-12
Gender		
Male:	10	32
Female:	10	18
Elementary School		
Grade 1	0	3
Grade 2	5	10
Grade 3	5	11
Grade 4	5	9
Grade 5	5	10
Grade 6	0	7

**Table 2:** Comparison between mean and Standard deviation of both control (no. 20) and patients' group (no.50).

	Control group	Patients' group	P value	Significance
Grip	18±0.50	13±0.25	>0.05	Non Sig.
Pour glass	17±0.75	12±0.50	>0.05	Non Sig.
Putting coin	18±0.40	10±0.75	< 0.05	Significant
Buttoning	16±0.50	8±0.75	< 0.05	Significant
Pain	20±0.25	18±0.75	>0.05	Non Sig.
Touch	19±0.25	17±1.0	>0.05	Non Sig.
Pressure	19±0.75	17±0.50	>0.05	Non Sig.
Steriognosis	16±0.25	8.0±0.20	< 0.05	Significant
Graphesthesia	16±0.75	5±0.25	<0.01	H. Sig.
Tying ribbon	15±0.30	7±0.6	<0.01	H. Sig.
Contouring	19±0.25	10±0.50	< 0.05	Significant
Cutting circle	16±0.25	7±0.30	< 0.05	Significant
Hand posture	19±0.75	9±0.75	< 0.05	Significant
Line respection	19±0.50	7±0.25	< 0.05	Significant
Spacing	19±70	8±0.50	< 0.05	Significant
Letter direction	18±25	7±0.25	< 0.05	Significant
Spelling	19±0.50	5±0.90	<0.01	H. Sig.
Punctuation	18±0.75	6±0.75	<0.01	H. Sig.
Drawing a man	19±0.50	11±0.5	< 0.05	Significant
Finger speed	17±0.50	10±0.25	< 0.05	Significant

P- value is significant at <0.05

P-value is highly significant (H. Sig.)at <0.01

P- value is non-significant (Non sig) at >0.05



interval was enough to eliminate any changes that can affect their condition even if they started the remediation program.

The validity of the DDS was investigated by face validity using the expert's judgments and in addition the comparison of dysgraphic and normal subjects. The DDS scores of the normal subjects were used to yield normative data and to assess the validity of the test in its ability to discriminate between students with dysgraphia and students with average handwriting (Table 2). The positive correlation between the clinical examination parameters and the outcome of DDS considered another documentation of the scale validity.

The proportion of positivity was done as a descriptive analysis to monitor the degree of disability as the DDS is able to determine the degree or the severity of the disorder.

In Table 3 it was noticed that most dysgraphic children had no abnormality as regards hand grip while most of them showed defective pouring of water from glass to another in the grade of minimal disability. Putting a coin and buttoning were not easy tasks as most of the cases got mild to moderate disability scores.

This group of skills showed controversy in their results as nearly no patient suffered a problem as regards pain, touch or pressure.

However, they all shared the disability in stereognosis and graphesthesia (Table 4).

In Table 5, In the perceptual-motor function, the ability to contour around a figure was not a problem for most of the participants but tying a ribbon and cutting a circle using a scissor could not be even done with a few normal subjects.

In Table 6, all patients suffered variable defects ranging from minimal to total disability covering all areas of the scale. Most cases lie between mild to severe with a fewer numbers is minimal and total disability

In the Table 7, only 5 patients showed drawing difficulty and finger tapping speed showed variable results in all participants.

The comparison between the control and the patient group found that all parameters in the Table 2 showed significant or highly significant results except for the superficial sensations.

**Correlation study:** A correlation was done to find the relationship between the breakdown in the Visual-motor coordination using the Bender Gestalt copy test and the fine motor skills. Another correlation was done between phoneme-grapheme correspondence and the findings of the handwriting task. Results revealed a positive correlation ( $r$ -value 0.528–0.644) between the mean value of the disability and the mean value of the copy the task of Bender Gestalt test.

A positive monotonic significant correlation was seen in the correlation between the mean normal value of phoneme-grapheme correspondence and the degree of disability.

## Discussion

In order to diagnose dysgraphia, a series of signs should affect a child's way of writing starting with his or her disability to hold a pencil or pencil grip followed by different neurological insults that affect the fine motoric performance of the child. Spelling is more affected rather than handwriting. Bad Handwriting itself is not considered dysgraphia [12].

Dyslexic dysgraphia concerns the reading background of the child. Some children are unable to write because of their inability to read. This inability to read may be due to a lack of phonological awareness [13] or may be due to a higher deficit in language acquisition or sometimes due to memory deficit. Directional or spatial type of writing disability is a less common type in comparison to the other two types.

It was found that the majority of cases lied were between 2<sup>nd</sup> grade and 5<sup>th</sup> grade of the elementary or primary Egyptian schools and this may be due to the governmental allowance of obligatory transfer from first to second grade without exam

**Table 3:** Proportion of positivity in Fine motor function (no.50).

Fine motor	Grip	Pour glass	Putting coin	Buttoning
Normal	43/50	5/50	0/50	0/50
Minimal	7/50	38/50	16/50	7/50
Mild- Mod	0/50	7/50	19/50	30/50
Severe	0/50	0/50	10/50	7/50
Total	0/50	0/50	5/50	6/50

**Table 4:** Proportion of positivity in Proprioceptive function (no.50).

Proprioceptive	Pain	Touch	Pressure	Stereognosis	Graphesthesia
Normal	50/50	50/50	50/50	0/50	0/50
Minimal	0/50	0/50	0/50	9/50	0/50
Mild- Mod	0/50	0/50	0/50	15/50	4/50
Severe	0/50	0/50	0/50	14/50	14/50
Total	0/50	0/50	0/50	12/50	32/50

**Table 5:** Proportion of positivity in Perceptual motor function (no.50).

Perceptual	Tying ribbon	Contouring	Cutting circle	Hand posture
Normal	1/50	33/50	2/50	2/50
Minimal	3/50	9/50	11/50	24/50
Mild- Mod	17/50	5/50	33/50	23/50
Severe	22/50	3/50	4/50	1/50
Total	7/50	0/50	1/50	0/50

**Table 6:** Proportion of positivity in Handwriting function (no. 50).

Handwriting	Line inspection	Spacing	Letter direction	Spelling	Punctuation
Normal	0/50	0/50	0/50	0/50	0/50
Minimal	2/50	2/50	9/50	0/50	0/50
Mild- Mod	40/50	35/50	31/50	32/50	12/50
Severe	7/50	10/50	8/50	16/50	30/50
Total	1/50	3/50	2/50	2/50	8/50

**Table 7:** Proportion of positivity in Drawing a man and finger tapping speed (no.50).

	Drawing a man	Finger speed
Normal	45/50	1/50
Minimal	0/50	20/50
Mild- Mod	2/50	17/50
Severe	3/50	8/50
Total	0/50	4/50

results. The first primary grade is allowed to pass the exam by governmental regulations of the ministry of education. For that reason, the family usually didn't seek any medical advice as regards the weakness of their child's ability to read or write since their child passed the exam and transferred to the next year. A number of cases lied in the 6<sup>th</sup> grade were less in comparison to the other grades because this year is the last year at the primary or elementary stage of education. Most Egyptian children who are still suffering writing problems are engaged to support programs and don't have enough time for a long battery of investigation and they usually postpone their assessment procedures till the end of the academic year.

Validity was reached in this study by many procedures in which face validity was used as experts judged the test items and recommends their application. In addition to the comparative study between the normative and patients group who found significant and highly significant differences. Validity was determined by correlating some of the test items with the examination procedures.

The proportion of positivity explains the main features or criteria of the assumption of the theoretical 3 types of dysgraphia. 29 patients (58%) included in the study were dyslexic dysgraphia, 16 patients (32%) were fine motoric dysgraphia and 5 patients (10%) were spatial dysgraphia. Most of the cases were minimal and mild to moderate disability and this may reflect the degree of family alertness toward their children in addition to a group of them who were enrolled in the rehabilitation program at the special needs center.

Most of the dysgraphic children in this study had no abnormality as regards hand grip (Table 3) because most of them are 6 years and above and were seen by their parents trying to correct their handgrip earlier before seeking advice. In addition, it is considered a little bit gross motoric movement needs larger muscles of the wrist that may be easier to control however the small muscles are responsible for finer movements like tying a ribbon or holding a fork. Most of the participants showed mild to moderate disability in putting a coin and buttoning as these fine motoric movements need attention and highly coordinated skills.

Ayres [14] and Levine [15] attributed the lack of fine motoric control to developmental dyspraxia as patients assign too many muscles to stabilize the writing utensil and few muscles to mobilize it.

Although superficial sensation or the primary sensory modality was intact in all patients Table 4, the prominent

feature that, they all had a common defect in cortical sensations (Stereognosis and Graphesthesia). Astereognosis and Graphanesthesia were expected to be present in cases of dysgraphia as it was found that 5 % of subjects in the control group had defects in such sensation. This highlights the importance of neural encoding of mechanoreceptors of the hand, perception of the muscle motion as a kinesthetic function, and cortical sensation as well that requires analysis of individual sensory modalities by the parietal lobes to provide discrimination as part of the motor programming [16].

The breakdown in the neural encoding which is a crucial corner in dysgraphia was reflected from the defects that appeared with the perceptual-motor skills especially tying the ribbon and cutting with a scissor a figure of a circle (Table 5). This is subsequently will be reflected in the patients' allographic errors as well as the motor patterns of the graphemes outcome.

Writing is hard to hide. Therefore, the handwriting part of the test was considered as the corner of the test scale (Table 6). The need to add more items was raised in order to fulfill all the defects that could be detected in such patients. There are no special items were considered to examine the linguistic or the lexical element of dysgraphic because all of them followed a long battery of assessments before their engagement in this scale. The writing defects could be classified to a group of patients who were unable to retrieve the orthographic representations due to memory defects or due to impaired orthographic decoding. Spelling errors, lack of spacing, punctuation, misalignment were attributed to the sum of defects in the orthographic coding, impaired motor planning, and execution as well as deficits in the visual perceptual skills. Several studies reported the strong relation of dysgraphia to dyslexia as part of the defective phoneme-grapheme correspondence [17,18]. They estimated that 80% of children with reading difficulties have trouble with phonological awareness. Those children are unable to use higher-order linguistic skills to access the meaning until the word has first been decoded and identified.

The defective drawing in some patients may reflect poor visual-motor coordination as well as a directional problem (Table 7).

The comparative study using a paired t-test to compare between variables (Table 2), found significant changes between the control and the pathologic group nearly in all parameters this reflects the validity of the scale and in addition, it explains the deviation in the outcome of dysgraphia children.

The correlative study that used spearman's rank-order correlation was run to determine the relationship between some test items and their pathophysiological correlate (Table 8). There is a monotonic relationship between both variables with a strong positive correlation. This explains the direct effect of soft neurological insult on fine motoric performance and in addition, the breakdown of the central nervous system is responsible for the difficulty in the implementation of the motoric action of the small muscles of hands and fingers. A kind of poor motor planning and execution that was defined by Deuel and Doar [19] explained this inability to the proficiency expected



for the patient's age and verbal intelligence. However, Cornhill and Case-Smith [8], suggested that visual-motor integration is an important variable in handwriting performance. Several studies have found that visual-motor integration is one of the most significant predictors of handwriting performance with a strong correlation between visual-motor integration and writing legibility. This study proved that visual closure is an area of visual perception in which the child identifies which letters have been formed completely, whereas position in space influences a child's spacing between letters and words and within writing lines [20].

Usually, cases with dyslexia may also suffer dysgraphia and this was documented in this study (Table 9) as there is a positive correlation between phoneme-grapheme correspondence task at the phonological awareness test that determine this deficit during the reading process and the handwriting task in the DDS. This correlation could be attributed to the visual perceptual problems that make the child unable to reproduce these letters upon demand. In addition, visual closure task failure may cause misperceived and poor letter retrieval. Even failure of visual recall may be behind dysgraphia as students are unable to remember what a letter looks like. Spelling errors may be phonetic in nature with a big deficit in the orthographic coding.

It was found that the DDS is a screening test suitable to start within the evaluation protocol for every case of dysgraphia. It can discriminate between the three types of dysgraphia and it can determine the severity of dysgraphia starting from minimal disability to total disability. It can be used to diagnose any case of writing difficulty, and it allows for more complicated procedures to follow after the preliminary diagnosis has been reached using DDS.

## Acknowledgment

We are indebted to Prof. Dr. Ghada El Dorry, Professor of pediatrics at the childhood institute and the manager of the special needs center for her continuous support, encouragement, and for showing her genuine interest and belief in the importance of this subject.

## References

- Berninger VW, Vaughan KB, Abbott RD, Woodruff Rogan L, Brooks A, et al. (1997) Treatment of Handwriting Problems in beginning writers: Transfer from handwriting to composition. *Journal of Educational Psychology* 89: 652-666. [Link: https://bit.ly/3qtYolc](https://bit.ly/3qtYolc)
- Maeland AF (1992) Handwriting and perceptual motor skills in clumsy, dysgraphic and normal children. *Percept Mot Skills* 75: 1207-1217. [Link: https://bit.ly/3txx87b](https://bit.ly/3txx87b)
- Deuel RK (1995) Developmental dysgraphia and motor skill disorders. *J Child Neurol* 10: 6-8. [Link: https://bit.ly/3ivmDuQ](https://bit.ly/3ivmDuQ)
- Hamstra-Bletz L, Blote AW (1993) A longitudinal study on dysgraphic handwriting in primary school. *J Learn Disabil* 26: 689-699. [Link: https://bit.ly/3qufU8N](https://bit.ly/3qufU8N)
- American Psychiatric Association (1994) Diagnostic and Statistical Manual

**Table 8:** Spearman's Rank order Correlation between the Bender Gestalt test results and Severity of fine motoric function in DDS.

	Mean of disability	Mean of Gestalt results	Spearman "r" value	P- value
Minimal	14.25	Copy 104.6±11	0.634	0.050*
Mild-mod	10.75	Copy 101.4±12	0.528	0.047*
Severe	6.25	Copy 97.6±15	0.531	0.042*
Total	3.75	Copy 90.5±11	0.644	0.041*

\* = significant

**Table 9:** Spearman's Rank order Correlation between Phoneme grapheme correspondence in Dyslexia and Severity of Handwriting task in DDS.

	Mean of disability	Mean value of Phoneme grapheme	Spearman "r" value	P value
Minimal	15.25	17.5±5.36	0.867	0.054*
Mild-mod	11.50	17.5±5.36	0.764	0.043*
Severe	4.25	17.5±5.36	0.620	0.024*
Total	1.25	17.5±5.36	0.502	0.010**

\* = significant

\*\* = highly significant

R value  $r = 1 - (6\sum d^2)/n(n^2 - 1)$

of Mental Health Disorders. 4<sup>th</sup> edition, revised. Washington DC: American Psychiatric Association.

- Margolin DI (1984) The neuropsychology of writing and spelling: Semantic, phonological, motor and perceptual processes. *Q J Exp Psychol A* 36A: 459-489. [Link: https://bit.ly/3JBBv70](https://bit.ly/3JBBv70)
- Richards R (1998) The writing dilemma: Understanding dysgraphia. Riverside, CA: Richards Educational Therapy Center. [Link: https://bit.ly/3lzkusT](https://bit.ly/3lzkusT)
- Cornhill H, Case-Smith J (1996) Factors that relate to good and poor handwriting. *Am J Occup Ther* 50: 732-739. [Link: https://bit.ly/36CAtsH](https://bit.ly/36CAtsH)
- Korkman M, Kemp S, Kirk U (2007) NEPSY—Second Edition (NEPSY-II). San Antonio, TX: Harcourt Assessment. [Link: https://bit.ly/3ivn0FK](https://bit.ly/3ivn0FK)
- Anastasi A, Urbina F (1996) Psychological testing, 7<sup>th</sup> ed. New York: Prentice-Hall. [Link: https://bit.ly/3Jy3IAN](https://bit.ly/3Jy3IAN)
- Gregory RJ (2000) Psychological testing: History, principles and applications (3<sup>rd</sup> ed.). Boston: Allyn and Bacon. [Link: https://bit.ly/3NirtKm](https://bit.ly/3NirtKm)
- Berninger VW, Abbott RD, Thomson JB, Raskind WH (2001) Language phenotype for reading and writing disability: a family approach. *Scientific Studies of Reading* 5: 59-106. [Link: https://bit.ly/36D9pJS](https://bit.ly/36D9pJS)
- Mitchell G (1956) The process of reading. A cognitive analysis of fluent reading. Individual differences in reading. Mevill Publishing. Columbus. Ohio.
- Ayres AJ (1985) Developmental Dyspraxia and adult onset apraxia. Torrance, CA: Sensory integration International 85. [Link: https://bit.ly/36hdDaq](https://bit.ly/36hdDaq)
- Levine MD (1994) Educational care: A system for understanding and helping children with learning problems at home and school. Cambridge, MA: Educators Publishing service, Inc. [Link: https://bit.ly/3ivsPmG](https://bit.ly/3ivsPmG)
- Roland PE (1976) Astereognosis. Tactile discrimination after localized hemispheric lesions in man. *Arch Neurol* 33: 543-550. [Link: https://bit.ly/3tzFY4E](https://bit.ly/3tzFY4E)
- Shaywitz SE, Shaywitz BA (2001) The Neurobiology of Reading and Dyslexia. Focus on Basics 5. [Link: https://bit.ly/36D9rkY](https://bit.ly/36D9rkY)
- Thomas-Tate S, Washington J, Edwards J (2004) Standardized Assessment of



phonological awareness skills in low-income African-American first graders. Am J Speech Lang Pathol 13: 182-190. [Link: https://bit.ly/3D7pTX2](https://bit.ly/3D7pTX2)

19. Deuel RK, Doar BP (1992) Developmental manual dyspraxia: A lesson in mind and brain. J Child Neurol 7: 99-103. [Link: https://bit.ly/3wrMtlj](https://bit.ly/3wrMtlj)

20. Bender L (1938) A visual motor gestalt test and its clinical use. American Orthopsychiatric Association, Research Monographs. NewYork: American Orthopsychiatric Association. [Link: https://bit.ly/3lydb4o](https://bit.ly/3lydb4o)

### Discover a bigger Impact and Visibility of your article publication with Peertechz Publications

#### Highlights

- ❖ Signatory publisher of ORCID
- ❖ Signatory Publisher of DORA (San Francisco Declaration on Research Assessment)
- ❖ Articles archived in worlds' renowned service providers such as Portico, CNKI, AGRIS, TDNet, Base (Bielefeld University Library), CrossRef, Scilit, J-Gate etc.
- ❖ Journals indexed in ICMJE, SHERPA/ROMEO, Google Scholar etc.
- ❖ OAI-PMH (Open Archives Initiative Protocol for Metadata Harvesting)
- ❖ Dedicated Editorial Board for every journal
- ❖ Accurate and rapid peer-review process
- ❖ Increased citations of published articles through promotions
- ❖ Reduced timeline for article publication

**Submit your articles and experience a new surge in publication services**  
(<https://www.peertechz.com/submission>).

*Peertechz journals wishes everlasting success in your every endeavours.*