

Dysgraphia Among Students in the Early Stages of Learning: A Study in light of Neurolinguistics

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Abstract

This study aims to examine dysgraphia among primary school students, with particular emphasis on its cerebral (neural) dimension. Writing is a mental activity before it is a physical (manual) one; consequently, both diagnosis and treatment are challenging. Acquiring writing skills is also highly demanding because writing requires visual, auditory, and motor coordination. Any impairment in these three components will inevitably lead to dysgraphia.

Keywords: writing, dysgraphia, students, skills, difficulties.

Introduction

Language is the fundamental basis of human thought. Through language, individuals formulate their ideas and communicate them to others. Language therefore has a neural substrate that supports its processing, as linguistic processes such as reading, writing, and speech are mediated by the brain. Accordingly, language is closely linked to the brain, and learning in all its forms arises from this relationship (Khalil, 2013, p. 79).

As one of the processes involved in learning, writing is an acquired productive and creative skill that subsequently becomes a means of communication. Students acquire and master it as a cognitive activity grounded in thought, and its development requires auditory, visual, and motor coordination. Writing is therefore fundamentally an individual skill (Al-Sufi, 2009, p. 230). However, students may experience difficulties in written production, a condition known as dysgraphia. What is dysgraphia? What causes it? How is it related to the brain? Which interventions may address this difficulty?

Definition of Dysgraphia

Writing is a sensorimotor activity that requires maturation in two domains. The first is muscular and involves the coordinated action of the fingers, hand, wrist, and arm up to the shoulder. The second is neural and concerns the integrity of the brain region responsible for writing, including the neural pathways that transmit signals from the brain to the fingers.

Myklebust (as cited in Ibrahim, 2010, p. 320) was the first to use the term *dysgraphia* to denote writing difficulties. He defined it as a disturbance or dysfunction between the mental representation of a word and the motor system. In this account, dysgraphia arises from a mild functional brain disorder in which the affected person cannot recall the motor sequence required to write letters and words, despite knowing the intended word and being able to pronounce and recognize it when it is presented visually.

Kirk likewise attributed dysgraphia to brain dysfunction:

The concept of learning disabilities refers to a delay or disorder in one or more processes related to speech (language, reading, writing, or arithmetic) or in any other school subject, owing to the possible presence of brain dysfunction or emotional or behavioral disorders. This academic delay is not attributable to intellectual disability, sensory deprivation, or cultural or educational factors. (as cited in Ali, 2011, p. 27)

This definition demonstrates that Myklebust and Kirk both attributed learning difficulties to functional brain dysfunction rather than to behavioral disturbance or intellectual disability.

Al-Sharif (2011) ranked writing difficulty second only to reading difficulty because dysgraphia requires several complex cognitive processes to occur simultaneously, including retrieving words from memory, coordinating linguistic rules, controlling hand movements during writing, and coordinating eye and hand movements. He attributed writing difficulty to dysfunction in one or more of these skills (p. 116). These skills, in turn, originate in the brain, as discussed below.

Al-Zayyat (2007) defines dysgraphia as follows:

Difficulties in remembering the sequence and order of letters and, consequently, in coordinating the muscles and fine motor movements required to write letters and numbers sequentially, form words and sentences, and produce written expressions that convey meanings, feelings, ideas, and situations. (Al-Zayyat, 2007, p. 271)

According to Al-Zayyat (2007), dysgraphia rarely occurs without accompanying learning problems, learning difficulties, or other learning disorders. It may coexist with disorders such as dyslexia and memory impairment (p. 271). This view is supported by Muflih, who states:

Writing occupies the highest level in the hierarchy of language-skill acquisition, preceded by comprehension, speaking, and reading. If a child experiences difficulty acquiring the first three skills, the child will most likely also experience difficulty learning to write. (as cited in Al-Zayyat, 2007, p. 271)

This relationship is expected because dysgraphia may arise from difficulties in preceding processes, such as speaking and reading.

Al-Zayyat (2007) notes that learning basic handwriting skills can support a child's progress and provide strong, immediate reinforcement across various aspects of learning. Conversely, writing difficulties may adversely affect students by causing distress and frustration stemming from misunderstanding and unfavorable perceptions among teachers and parents (p. 272). Reprimands from teachers and parents may lead students to develop psychological difficulties, further complicating the problem rather than reducing or resolving it. Teachers and parents should therefore support students who exhibit dysgraphia and remain patient to facilitate diagnosis and treatment.

Types of Dysgraphia

Ali (2011) divides learning difficulties into two categories: developmental and academic.

Developmental Learning Difficulties

These difficulties concern the development of mental abilities and the processes responsible for students' academic, personal, and social adjustment. They include attention, perception, thinking, memory, and problem-solving. A disturbance in any of these processes may reduce students' performance in subjects involving reading, writing, and related skills (Ali, 2011, p. 57). Ibrahim (2010) classified developmental learning difficulties into two categories (p. 46):

- Primary difficulties: attention, memory, and perception.
- Secondary difficulties: language and thinking.

Academic Learning Difficulties

Academic learning difficulties include difficulties in reading, writing, and arithmetic. They are outcomes of developmental learning difficulties or are directly related to them (Ali, 2011, p. 57), as follows:

1. Learning to read requires comprehension and proficiency in language use. It also requires auditory perceptual skills to recognize the sounds represented by letters in words and visual skills to discriminate and identify letters and words.
2. Learning to write requires proficiency in motor skills, beginning with visual observation when writing involves copying (i.e., observing and reproducing text) and extending to the use of the hand and flexible finger movements.
3. Learning arithmetic requires adequate visual-spatial imagery skills, quantitative concepts, and knowledge of the meanings and values of numbers, among other skills (Ghani, 2010, pp. 155–156).

Ali (2011) notes that new evidence suggests that most learning disabilities do not arise from dysfunction in a single, specific brain region but from difficulties integrating and connecting information across different brain regions. Contemporary theories of learning difficulties suggest that disorders such as dysgraphia result from dysfunction in the brain's structural and functional organization (p. 58).

Al-Zayyat (2007) proposes another classification of dysgraphia comprising three types:

1. Writing legibility difficulties: These involve an inability to communicate meaning effectively through writing. Although individual letter forms may be clear and legible, their arrangement within words may appear illegible, nonstandard, or irregular.
2. Difficulties with the rhythm or formation of letters and words: This type involves a reduced ability to form letters and words despite intact spelling. The problem lies in letter formation, and the rate or rhythm of writing is abnormally slow.
3. Difficulties with spatial use in writing: This pattern involves difficulty organizing and aligning letters and words and using the space designated for handwriting. These spatial difficulties are based on inaccurate spatial perception (Al-Zayyat, 2007, pp. 282–283).

Causes of Dysgraphia

Johnson (as cited in Kamel, 2005, p. 51) stated that learning to write requires children to distinguish among shapes, letters, words, and numbers. Children who have difficulty visually discriminating letters and words also have difficulty reproducing or copying them accurately. Harrison (as cited in Kamel, 2005, p. 51) further attributed dysgraphia resulting from functional brain damage to the following factors:

- Problems in visual perception, including the recognition of objects and shapes, and in visual discrimination.
- Problems in perceiving visual-spatial relationships.
- Impairment of visual-motor ability, or the ability to process spatial relationships.
- Impairment of visual-motor coordination, including difficulty reproducing copied material.
- Impairment of visual memory, including an inability to remember letter forms and the resulting difficulty writing words.

These problems and disorders correspond to those identified by Al-Zayyat (2008):

Writing represents the third form of the linguistic system through the integration of oral language, written language, and reading. Written language is a highly complex form of communication. It is an important educational skill and an even more important means of self-expression. It is also integrated with visual, motor, and perceptual abilities, and writing and reading skills are positively related. (Al-Zayyat, 2008, p. 46)

Ibrahim (2010) attributed dysgraphia to four groups of factors (p. 320):

Cognitive Factors

Students with dysgraphia may lack specific abilities associated with writing, such as visual memory, the ability to perceive spatial relationships, and the ability to retrieve information from memory. They may also exhibit deficiencies in central information-processing systems and in specific brain functions related to perception and movement.

Neuropsychological Factors

Neuropsychological factors are those associated with dysfunction in the central nervous system, particularly the brain, and play a substantial role in behavioral disturbances, including writing difficulties. Numerous studies indicate that dysfunction in the brain's auditory system affects auditory perception, resulting in distorted sound perception. This, in turn, impairs

auditory discrimination between similar letter sounds and may cause them to be represented incorrectly in writing. Damage to the left temporal lobe can also disrupt the analysis and synthesis of sounds, writing processes, and the sequential storage and retrieval of words.

Environmental Factors

These factors are associated with the school environment and include the following:

- Coercive, nonmotivating instruction and failure to select appropriate instructional methods.
- Failure to accommodate individual differences in group instruction.
- Restricting writing instruction to penmanship lessons alone.

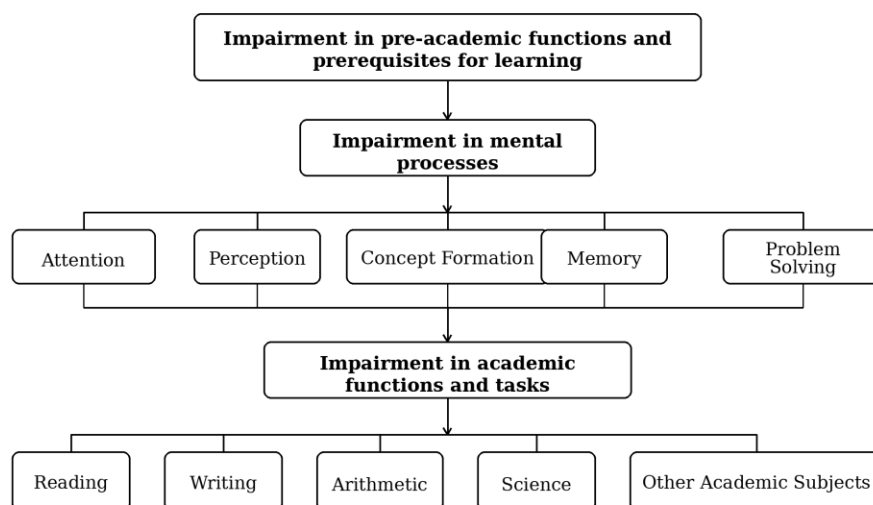
Parental Monitoring of Students' Writing

Writing requires continuous training and sustained practice beyond classroom instruction, which alone is insufficient for mastery. Parents are therefore advised to monitor and support their children's writing practice to help prevent dysgraphia.

According to Ibrahim (2010), the consequences and manifestations of functional impairment in a learner's brain can be summarized as follows:

Figure 1

Levels of Functional Impairment Among Individuals With Learning Difficulties



Note. Adapted from *The Reference in Developmental, Academic, Social, and Emotional Learning Difficulties* (p. 56), by S. A. W. Y. Ibrahim, 2010, Anglo-Egyptian Bookshop.

Theories Explaining Learning Difficulties

Definitions of learning difficulties vary according to the perspectives used to explain the factors underlying these difficulties. Scholars and specialists in the field have not reached consensus on their actual causes. Explanations are therefore commonly divided into external (indirect) and internal (direct) causes. External causes include factors in the student's

surroundings, such as family and school, whereas internal causes include organic, biological, hereditary, and environmental factors (Bani Hani, 2008, p. 19).

The nervous system is the biological system that enables language production, planning, thought, reception, and acquisition. Language cannot exist without the nervous system, whereas the nervous system can exist without language (Ahmed, 2019, p. 141). Language is therefore a product of the nervous system, which governs its production. Ahmed (2019) reports that neuroscientific research demonstrates the role of learning in brain growth and increased brain volume, language acquisition, production, and reception, the brain's capacity to process and store language, the encoding of experience and information in neural synapses, and the contribution of those synapses to learning (p. 243). This perspective rests on two central components: the brain and education. The brain is a primary concern of neuroscientists, whereas education is the focus of educational specialists. The following discussion examines the factors associated with these two components that contribute to learning difficulties generally and dysgraphia specifically. To clarify this relationship, the principal theories of learning difficulties, particularly those related to the brain, are reviewed.

Neurological Theory

This theory attributes learning difficulties to brain dysfunction or injury. Dysfunction may alter specific brain functions during learning, leading to conditions such as dyslexia and impaired language functions. Brain injury may result from oxygen deprivation caused by coma or asphyxia or from malnutrition before or after birth. The theory adopts a developmental approach concerned with the pattern and rate of brain growth (Ghanayem, 2016, pp. 92–93). Brain growth is closely related to learning, and impaired growth may therefore lead to learning difficulties, such as dyslexia. Medicine, particularly neurology, has played an important role in diagnosing and treating learning difficulties among individuals who experience reading difficulties or have intellectual disabilities or brain damage (Al-Qabali, 2004, p. 43). Dysfunction in any brain region may therefore contribute to learning difficulties.

Advocates of the organic medical perspective identify several causes of learning difficulties (Ghanayem, 2016, p. 63), including the following:

- Brain damage.
- Minimal cerebral dysfunction.
- Central nervous system dysfunction.
- Chronic brain syndrome.
- Damage to the angular gyrus.
- Damage to the second frontal gyrus.

Neuropsychological Theory

Advocates of this theory maintain that dysfunction, deficiency, or disorder in a child's central nervous system is manifested in the child's behavior. Such dysfunction can also affect cognitive and perceptual functions, language, academic performance, and behavioral skills (Ghanayem, 2016, p. 94). This view indicates that the relationship between the brain and human

behavior influences learning. When brain functioning is intact, although not invariably, behavior is correspondingly typical, and learning difficulties arising from this relationship are less likely. However, behavior may still be influenced by external factors, such as the environment and school. Accordingly, when difficulties occur despite intact brain functioning, they may arise from the student's surroundings rather than from the brain.

Perceptual-Motor Theory

This theory focuses on sensorimotor and perceptual-motor development because it holds that sensorimotor skills and perceptual-motor functioning reflect the state of a child's nervous system. It therefore links children's perceptual-motor development to learning (Ghanayem, 2016, p. 96). Its advocates maintain that most students with learning difficulties experience a neurologically based disorder in the perceptual-motor domain that directly limits their ability to learn (Ali, 2011, p. 71).

Visual Theory

This theory examines visual-motor development and its relationship to learning. Children acquire perceptual-motor skills through progressive stages, including the following (Al-Qabali, 2004, pp. 39–40):

- Development of the primary response system: This system is responsible, for example, for the hand reflex, light reflex, neck reflex, bodily relaxation, and readiness.
- Development of the general motor system: Crawling, rising, standing without assistance, walking, running, and jumping are attributed to this system.
- Development of the specific motor system: This system is responsible for movements based on the two preceding stages, including eye-hand coordination, hand-foot coordination, and the coordinated movement of both hands.
- Development of the visual-motor system: This system is represented by eye movements, including shifting the gaze from one area to another, tracking moving objects, and moving the eyes in all directions.

These stages describe visual-motor integration, reflected in effective eye-hand coordination and the integration of eye and body movements during activities such as drawing and writing (Ghanayem, 2016, p. 82). This relationship is expected because writing depends on both visual processing and hand movement. Impairment in either may therefore lead to dysgraphia.

Conclusion

In light of the preceding discussion, this study has identified several factors associated with learning difficulties, particularly dysgraphia. The principal conclusions are as follows:

1. Difficulties in learning to write, or dysgraphia, constitute a form of academic learning difficulty.
2. Developmental learning difficulties can lead to academic learning difficulties.
3. The causes of dysgraphia vary according to the brain region involved and may be related to visual perception, motor perception, or both.

4. A student may have no sensorimotor or intellectual disability yet still experience dysgraphia because of deficits in the specific abilities required for writing.
5. Dysgraphia may result from brain dysfunction, including damage to or injury of a brain region.
6. Dysgraphia may occur in students who lack effective eye-hand coordination and integration.

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