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Sensory Integration Disorder in Children with Dyslexia

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Abstract:

The theory of sensory integration is used to explain the relationship between the brain and behavior, and to elucidate why an individual responds to sensory inputs in certain ways. Sensory integration problems lead to various academic difficulties. The current study aimed to identify sensory integration disorder in children with dyslexia. A case study methodology was employed, involving a sample of two cases (one male and one female) aged between 10 and 11 years. The Colored Progressive Matrices Test by Raven, prepared and standardized by Emad Ahmed Hassan Ali (2016), was used to measure IQ. The Holiday Test by SalehaGhaleb (1997) was used to identify dyslexia, and the Sensory Integration Scale for Children by (Elshoky, El-Tantawy, Taima) (2016) was employed to detect sensory integration disorder. The results of the study indicated the presence of a moderate degree of sensory integration disorder in children with dyslexia.

Keywords: Sensory Integration Disorder – Dyslexia – Children with Dyslexia.

Résumé :

La théorie de l'intégration sensorielle est utilisée pour expliquer la relation entre le cerveau et le comportement, et pour élucider pourquoi un individu répond aux entrées sensorielles de certaines manières. Les problèmes d'intégration sensorielle conduisent à diverses difficultés académiques. La présente étude visait à identifier le trouble d'intégration sensorielle chez les enfants dyslexiques. Une méthodologie d'étude de cas a été utilisée, impliquant un échantillon de deux cas (un homme et une femme) âgés de 10 à 11 ans. Le test de matrices progressives colorées de Raven, préparé et normalisé par Emad Ahmed Hassan Ali (2016), a été utilisé pour mesurer le QI. Le test de vacances de SalehaGhaleb (1997) a été utilisé pour

identifier la dyslexie, et l'échelle d'intégration sensorielle pour les enfants par (Elshoky, El-Tantawy, Taima) (2016) Le DST a été utilisé pour détecter les troubles de l'intégration sensorielle. Les résultats de l'étude ont indiqué la présence d'un degré modéré de trouble de l'intégration sensorielle chez les enfants atteints de dyslexie.
Mots-clés : Trouble d'intégration sensorielle - Dyslexie - Enfants atteints de dyslexie.

1- Introduction:

The senses are among the primary sources for receiving stimuli; they serve as a means to understand what is happening around us, and their function lies in detection, transmission, and transformation. Each sense acts as an independent detection element, and this integrated system of sensory functions is called sensory integration, which helps children interact efficiently with their environment. The degree of sensory integration varies among children and is significantly related to their social maturity (Allah, Abdul Rahman, & Ahmed, 2022, p. 43). Sensory integration disorder reflects the inefficiency of our central nervous system in processing information, i.e., incoming stimuli. Our nervous system organizes and processes information—sights, smells, touches, tastes, and noises—so that we can use it in our daily lives. Difficulties in processing this information can lead to many issues, such as motor coordination disorders, sleep, eating, attention, learning, and social and emotional functioning (Ostovar, 2009).Nicholson and Fawcett's (2001) study showed that individuals with dyslexia struggle with motor control and coordination difficulties due to a slight impairment in the development and function of the cerebellum. This cerebellar dysfunction weakens the ability to acquire automatic behaviors, requiring individuals with dyslexia to exert more conscious effort during reading, writing, and performing other tasks to achieve and maintain the desired positional orientation (Barela, Paulo, André, & Milena, 2014, p. 1871).Recent studies confirm the strong relationship between dyslexia and the development of the nervous system, which impedes the process of receiving, understanding, and translating auditory and visual information. Dyslexia and dysgraphia are associated with disorders of written and spoken language without any mental or sensory impairments (Salama&Soltani, 2022, p. 172). Dyslexia is characterized by disturbances during reading, random movement between letters, or dropping some letters, and both oral and silent reading are slow and lack comprehension (Baltaji, 2010, p. 18).According to Salem et al., learning to read requires the ability to visually distinguish between letters and words, the ability to perceive shapes through the background, and the ability to auditorily distinguish between speech sounds and understand and use linguistic vocabulary (Salem, Mehmadi, & Ahmed, 2006).As humans possess five sensory channels to receive and perceive information from their surrounding environment (sight, hearing, taste, smell, and touch), children differ in their reliance on one sense over another for learning. For instance, some rely more on sight, some on hearing, and some on sensory and motor abilities. Children with dyslexia often suffer from deficiencies in one of these sensory perceptions, such as visual or auditory perception, and thus need a method to compensate for these sensory deficits (Sartawi, Sanaa, Emad, &Nadhim, 2009).Since learning involves looking at printed words, pronouncing sounds, and then using linguistic skills to convey meaning, a child needs the ability to form automatic and lasting associations between the printed words in front of their eyes, the sounds the words make, and the meaning connected to them. The reader pays attention to the messages received through their eyes and ears, as well as the reinforcement obtained from body parts that articulate words. The precise differentiation between voiced and unvoiced sounds is felt in the nerves and muscles of the lips, tongue, teeth, and larynx. Writing adds the use of the arm and hand, so to recognize, remember, and write a single word, the entire body is used: eyes, ears, touch, movement, and the coordination of nerve signals among different parts of the brain that control these functions (Al-Shakh, Mahmoud, & Dalia, 2017, p. 497).

The current study's problem emerges in light of the results of many previous studies and research. Diane and West's (2004) study indicated that sensory integration issues lead to academic, social, and emotional difficulties for children. Exploring appropriate strategies to help overcome these problems could significantly aid in addressing such difficulties (Diane & West, 2004, p. 96).Taima's (2017) study showed

the effectiveness of sensory integration in treating reading and writing difficulties in children. Myhra's (2009) study findings revealed that participation in sensory stimulation activities and training in sensory processing activities had a positive impact: improving writing skills, fine motor skills, arithmetic counting, cognitive matching between objects, enhancing comprehension and understanding, linguistic naming of objects, performing gross motor skills, and achieving motor balance of the body.Many researchers have linked the lack of vestibular stimulation to dozens of educational problems, including dyslexia (Janes, 2001, p. 39). Based on the above, the current study's problem can be identified in the following main question:

Does a child with dyslexia suffer from sensory integration disorder?

Study Hypothesis:

The study hypothesis is as follows:

A child with dyslexia suffers from a moderate degree of sensory integration disorder.

1-1- Importance of the Study:

The importance of the study lies in the following points:

- Guiding Future Research: It directs future research in the field of learning disabilities to determine the extent of the reciprocal impact between sensory integration disorder and learning disabilities, which benefits researchers in building and developing therapeutic programs based on sensory integration.

- Identifying Strengths and Weaknesses: This study helps in identifying the strengths and weaknesses in sensory integration in children with dyslexia, aiding in the development of appropriate training and therapeutic programs.

- Educational Guidance: The results of this study will guide teachers on the best methods to deal with students with dyslexia in educational settings.

- New Research Horizons: It opens new horizons for future research in reading instruction methods and skill development, and the potential use of sensory integration programs for other learning disabilities.

1-2- Study Objectives:

The current study aims to achieve the following objectives:

- Understanding the Relationship: To understand the relationship between dyslexia and sensory integration disorder.

- Determining Sensory Integration Disorder Level: To determine the level of sensory integration disorder in children with dyslexia.

- Identifying Affected Senses: To identify the senses most affected in children with dyslexia.

- Describing and Explaining the Relationship: To describe and explain the relationship between sensory integration and dyslexia.

1-3- Basic Concepts of the Study:

1-3-1- Dyslexia:

- **Linguistically:** The word "Dyslexia" is derived from Greek, consisting of two parts: "Dys" meaning difficulty, and "Lexia" meaning word or language.

- Terminologically: The Child Assessment Center at Indiana University Medical Center defines dyslexia as a deficiency in the ability to read correctly to the degree mastered by the child's normal peers of the same age and educational stage. It occurs due to organic neurological or genetic factors during the developmental stage (Hamza, 2008).

- Operational Definition: Dyslexia is a neurodevelopmental disorder manifested through a delay in acquiring the reading mechanism. A dyslexic student is one who scores an IQ of 90 or above on the Raven's Colored Progressive Matrices test. In the current study, it is diagnosed based on the score obtained in the "Holiday Text" reading test by GhallabQazadri, compared to the normative scores for children of the same age, ensuring the integrity of senses (hearing and vision), that the child has received appropriate education and training in reading, in addition to having a suitable economic and cultural background.

1-3-2- Sensory Integration Disorder:

- Terminologically: It is a deficiency in the brain's ability to interpret sensory signals received through various senses and organize the response to them, i.e., determining whether a response to the sensory message is necessary or not, specifying the type of response, and then executing the response motorically, perceptually, or emotionally. This means that individuals with sensory integration disorder interpret sensory inputs as stronger or weaker than they actually are, and consequently respond to them inappropriately, affecting their ability to learn, interact, and communicate (Aquilla et al., 2017, p. 66).

- Operational Definition: It is the child's ability to receive information through various senses, process it, and respond appropriately to the situation. It is measured by the total score obtained by the child through their responses to the Sensory Integration Scale for Children by (Al-Shakhs, Al-Tantawi, To'eima) (2016).

1-4- Theoretical Framework of the Study:

1-4-1- Dyslexia:Dyslexia is a neurobiological disorder characterized as a specific developmental impairment in reading. It is not a direct result of general intelligence deficits, significant neurological impairments, uncorrected visual or auditory problems, emotional disturbances, or inadequate education. Dyslexia persists throughout an individual's life and interferes with academic achievement or daily activities that require reading skills. It occurs in all known languages and is one of the most common developmental disorders, affecting approximately 5% of school-aged children (Schulte &Jenniter, 2010).

The World Health Organization defines dyslexia as a persistent qualitative difficulty in learning written language, found in a child with average intelligence, without sensory disabilities, social or emotional problems, and not suffering from cultural or educational deprivation (Cheminal&Brun, 2002).

According to the International Federation of Neurology, "dyslexia is a disorder characterized by an individual's inability to learn to read despite having normal intellectual abilities and receiving appropriate education and training in reading, along with a suitable cultural and social background. Dyslexia is based on perceptual difficulties of a developmental nature" (Al-Sartawi, Sania, Imad, &Nazim, 2009, p. 51).

1-4-2- Types of Dyslexia:

Scientists classify dyslexia into two main types:
- Acquired Dyslexia (Dyslexieacquise): This is a reading disorder resulting from brain injury, meaning the individual could read before experiencing an accident or brain injury.

- Developmental Dyslexia (Dyslexiedéveloppementale): This refers to reading difficulties encountered by a child from the beginning of learning to read, despite having average intelligence and no neurological or emotional disorders. Numerous studies suggest different patterns of developmental dyslexia, including phonological dyslexia, surface dyslexia, and mixed dyslexia. Valdoise (1995) added another type—visual attention dyslexia (Luzai, 2017, p. 114).

1-4-3- Associated Disorders with Dyslexia:

Several disorders can accompany or be syndromic with dyslexia, which may include specific learning difficulties or other disorders such as dysgraphia, dyscalculia, speech disorders, dyspraxia, and attention-deficit/hyperactivity disorder (Salma &Saltani, 2022, p. 173). Other noticeable disorders may include language delays, temporal and spatial disorders, lateralization issues, and executive function weaknesses (Luzai, same reference, p. 118).

1-4-4- Sensory Integration: Sensory integration is defined as an internal neurological process that involves the ability of the nervous system to organize sensory inputs from the surrounding environment and process them correctly to develop functional responses essential for participation in daily activities (Atiana, Mona, &Sumaya, 2019, p. 740). J. Ayres defined sensory integration as the process by which individuals register, modify, and distinguish sensations received through the sensory system, leading to adaptive behaviors in response to the environment (Al-Shakarchi, Mahmoud, & Dalia, 2017, p. 500).

1-4-5-Sensory Integration Theory:

The Sensory Integration Theory was developed by Anna Jean Ayres (1979), an American occupational therapist. Her interest in neurological function and learning processes contributed to understanding "intelligence" as a result of sensory perception, integration, and processing. Her work led to extensive research aimed at improving learning abilities through sensory integration therapy, assisting children in maximizing their cognitive potential (Inji, 2022, p. 90).Ayres focused on explaining how difficulties in receiving and processing sensory information from the body and environment relate to challenges in school or using the body for daily life. Various body parts relay sensory information from our environment (like skin, eyes, and ears) to the brain, which interprets this information by comparing it with other incoming data and stored memories, allowing for proper responses to our surroundings. Therefore, sensory integration is crucial for all activities, such as dressing, eating, social interactions, and work (Abdullah, 2021, p. 19).

1-4-6- Neurophysiological Principles of Sensory Integration:

The neurophysiological principles underlying sensory integration theory include:

- Multi-sensory information is more impactful than information from any single sense.

- Feedback is essential for motor performance.

- The brainstem is vital in sensory integration (organizing and processing sensory information) as it develops before other brain parts.

- The brain self-organizes in response to functional demands of the environment.

- Sensory integration develops gradually and sequentially.

- Motor activity plays a critical therapeutic role in sensory integration due to the information it provides about body position, balance, and changes occurring in it (Al-Samadi&Adhiyat, 2024, p. 89).

1-4-7- How Sensory Integration Occurs:

Anzalone (1996) & Williamson identified five interconnected elements that help understand how sensory integration occurs:

- **Sensory Registration**: Sensory registration begins when we become aware of a sensory event. We may not be conscious of certain sensory inputs until they reach a specific sensory threshold or intensity level.

- **Orientation**: Sensory orientation allows individuals to focus on new sensory information. It involves determining which sensory inputs require attention and which can be ignored through inhibitory and facilitatory functions.

- **Interpretation**: Our brains interpret sensory information and describe its qualities—for example, feeling the softness of silk on our arm or hearing a loud sound. The ability to interpret sensory information allows us to determine how to respond and whether the information poses a threat.

- **Response Organization**: Our brains decide if a response to a specific sensory message is necessary, leading to a choice of response type. Sensory messages can be physical, emotional, or cognitive.

- **Response Execution**: The execution of a response, whether motor, cognitive, or emotional, constitutes the final stage of sensory integration. The ability to execute an appropriate sensory response relies on primary elements such as motor planning for a specific motor response (Ali, Sarah, &Nailah, 2021, p. 77).

1-4-8- Forms of Sensory Integration Disorder:

Sensory integration disorders can occur in some or all sensory systems, leading to maladaptive responses to sensory stimuli. These disorders manifest in three forms:

- **Movement-Dependent Sensory Disorders:** Sensory integration is essential for motor planning skills in structured play activities during preschool, where children's games are expressive and constructive.

- **Sensory Discrimination Disorders:** This type is characterized by an individual's inability to interpret spatial or temporal sensory characteristics, affecting touch, movement, or body texture interactions.

- **Sensory Modulation Disorders:** Sensory modulation refers to the central nervous system's ability to organize and manage mental and motor capabilities in a gradual and adaptive manner. When this process is disrupted regarding behavior intensity and duration, children exhibit inconsistent reactions to sensory stimuli (Atiana, Mona, &Sumaya, 2019, p. 741).

2- Methodology and Tools:

2.1. Study Areas: The field study was conducted on two (male and female) students in the third and fourth year of primary education at Mihubi El-Tomi Primary School in the municipality of SidiImbarck, BordjBouArreridj province. The study was carried out in the second academic term, in February of the 2023/2024 academic year.

2.2. Study Methodology: The current study aimed to identify the sensory integration disorder in the child with reading difficulties. Therefore, the appropriate methodology for this research is the case study method, as it is the fundamental approach for a comprehensive and in-depth understanding of individual cases and obtaining a large amount of data about the examined subjects.

2.3. Study Population and Sample: The study population consisted of repeating students in the third and fourth years, whose ages ranged between 10 and 11 years, from Mihubi El-Tomi Primary School in BordjBouArreridj province. Based on the nature of the topic and its objective, as well as the specifics of the study sample, we relied on the non-random sampling method, specifically the purposive sampling technique, from the aforementioned study domain. The sample consisted of two students (one male and one female).

2-4 Study Tools:

2-4-1 John Raven's Colored Progressive Matrices Test, developed and standardized by Imad Ahmed Hassan Ali (2016):

The test consists of 3 sections: (A), (AB), and (B), each with 12 items. Each item presents a basic shape or pattern from which a specific part has been removed, and below it are 6 options from which the examinee must select the part that completes the basic shape. Colors were used to make the test more engaging, clear, and attention-grabbing for children.

The test should be administered in the order presented in the test booklet, with the examinee starting from the first item in section (A) and continuing until the last item in section (B). The time allotted for the test administration varies by age group, and for the age group of our study (10.5 - 15.5 years), the allotted time is 22 minutes.

Scoring and Correction:

The examinee must select the missing part of the design from among the 6 alternatives provided. There is only one correct alternative, which is awarded one point, while the incorrect answer is awarded zero points. The scores of the three sections are summed, with a maximum total score of 36 points. The percentile rank is then determined using the corresponding norms table.

Psychometric Properties of the Test:

Validity: Imad Ahmed Hassan Ali standardized the test on a sample of Egyptian individuals from different age groups (5.5-68.4 years). The correlation coefficients between the test and some subtests of the Wechsler, Boris Maze, and Seguin Board tests ranged from 0.28 to 0.52. The correlation coefficients between the subtests of the scale and the total score ranged from 0.87 to 0.93, all statistically significant at the 0.01 level. The correlation coefficients ranged from 0.32 to 0.86, all significant at the 0.01 level.

Reliability: The reliability of the test was calculated on the Egyptian samples using the Kuder-Richardson formula, with a value of 0.85, which is an acceptable reliability value (Ali, 2016, pp. 31-32).

2-4-2- The Holiday Reading Test:

The test was designed by the researcher Le Favrais in 1965 and was titled: L'alouette (The Lark). It was translated into Arabic and adapted to the Algerian environment by the researcher SalihaGhaleb, as part of a study she conducted for her doctoral degree in Orthophony, titled: Dyslexia in the School Clinical Environment. The test includes a short text in Arabic entitled: The Holiday. The text consists of four paragraphs, with each paragraph written in a progressively smaller font size, with the purpose of assessing the student's visual acuity. The text also contains a series of illustrative drawings distributed throughout the various sections, designed to help the student reader visualize the context of the text and comprehend the meaning of the content.

The Holiday Reading Test focuses on the diagnosis of dyslexia by monitoring the number of correctly read linguistic units and comparing them to the time taken during the reading. The text contains 267 words, with a reading time of 3 minutes.

Scoring and Correction of the Test: The total reading time, the number of words read during the 3 minutes, the number of correct words, and the number of errors during the first 3 minutes are calculated. Students with dyslexia are characterized by numerous errors, a significant slowness in reading, and the inability to complete the text within 3 minutes. There is no predetermined time limit for the administration of the test, but the entire time taken to read the full text is recorded, as this time value is used to diagnose the disorder by comparing it to the standard reading duration.

The Psychometric Properties of the "Holiday" Test in its Original Study:

Reliability of the test: The researcher relied on the test-retest method to measure the reliability of the test, which is of two types: a normal sample and a pathological sample. The normal sample consisted of 39

individuals, and the pathological cases were 15. The test was first administered during the last week before the semester break, in order to avoid the effect of learning, assuming that reading activity during the holiday period would be almost non-existent. The second administration was immediately after the school return from the semester break, within the first two days of resuming studies.

Validity of the test: The validity was calculated based on intrinsic validity, which is defined as the experimental scores of the test in relation to the true scores that are free from measurement errors. Thus, the true scores of the test become the standard against which the validity of the test is attributed. The researcher found that the reliability coefficients for each of the scale dimensions ranged between 0.682 and 0.931. By calculating the square root of each coefficient, the validity coefficients were obtained, ranging between 0.82 and 0.96, which confirms that the holiday scale has both validity and reliability (Qazadri, 2012, pp. 164-165).

2-4-3- Sensory Integration Scale for Children: Developed by the researchers Abdel Aziz El-Sayed El-Shakhes, Mahmoud Mohamed El-Tantawy, and Dalia Mahmoud Sayed Taaima (2017), the Sensory Integration Scale in its final form consisted of 90 tasks distributed across 9 domains, with each domain containing 10 tasks as follows:

Domain 1:Visual-Motor Integration: Consists of 10 tasks, including coloring shapes within a defined area without going outside, connecting with and without guide lines, and tracing lines.

Domain 2:Figure-Ground Perception: (10 tasks) Includes distinguishing between shapes that intersect and overlap with other shapes, or are hidden within the picture, and identifying differences between images.

Domain 3:Spatial Orientation: (10 tasks) Includes distinguishing shapes and body parts that are on the right and left sides, and identifying matching positions among shapes that are in reverse or rotated positions.

Domain 4:Form Copying: (10 tasks) Includes copying shapes composed of lines and angles using the hand and pencil without the use of assistive tools.

Domain 5:Tactile Localization: (10 tasks) Includes touching different areas of the child's hand and arm while the eyes are closed.

Domain 6:Finger Identification: (10 tasks) Includes the child identifying their fingers in random order with eyes closed.

Domain 7:Hand Writing (Tactile Spelling): (10 tasks) Includes writing letters, shapes, and numbers drawn on the child's skin with eyes closed.

Domain 8: Motor Balance: (10 tasks) Includes various positions the child takes to maintain balance and the body's center of gravity without disturbance.

Domain 9: Body Imitation: (10 tasks) Includes the child imitating body positions exactly as shown in several pictures, moving their joints and muscles according to the image they see.

Scale Scoring Procedure:

The scale items are scored, and the scores are determined as follows:

The ratings assigned by the rater for each task are summed, keeping in mind that the score for each task ranges between 0 and 1, where the child is given one (1) point for correctly performing the required task, and zero (0) for not performing the required task (incorrect performance).

The total scores for each dimension are calculated across all tasks, and then the overall total score for each child is calculated by summing the total scores for each dimension.

A single overall score for the child, ranging from 0 to 90 points, is recorded.

A low score indicates weak sensory integration, while a high score indicates strong sensory integration. The child is considered in need of intervention programs if their score falls below half of the total score, which is 45 points.

Psychometric Properties of the Sensory Integration Measure in its Original Study:

The standardization sample for the Sensory Integration Measure consisted of 100 children, with ages ranging from 9.3 to 10.9 years, with a mean age of 10.6 years and a standard deviation of 1.66 years. All the children were typically developing and enrolled in the fourth grade of regular schools.

Validity of the Measure:

The internal consistency validity of the measure's tasks was calculated by computing the correlation coefficient between the children's scores on each task and the total score of the dimension to which it belongs. All the correlation coefficients between each of the nine tasks of the measure were positively and statistically significantly correlated at the 0.01 level, indicating that the measure has a high degree of validity. The correlation coefficients between the sum of the scores of the sample individuals on the subdimensions and the total score of the measure ranged between 0.82 and 0.94, and these values were statistically significant at the 0.01 level.

Reliability of the Measure:

The reliability of the measure was calculated using two methods: Cronbach's alpha and split-half. All the reliability coefficient values were high using Cronbach's alpha method, ranging between 0.82 and 0.92 for the different subdimensions, and the value of the overall measure's reliability coefficient was 0.95, indicating a high degree of reliability for the Sensory Integration Measure. As for the split-half method, each subdimension was divided into two halves (odd and even items), and the correlation coefficient between the halves was calculated, as well as the correlation coefficient between the standardization sample's scores on each subdimension half. The entire measure was also divided into two halves (odd and even items), and the coefficient was corrected for the split-half effect using the Spearman-Brown formula. The values ranged between 0.81 and 0.94, and the overall reliability of the measure was 0.97, indicating a high degree of reliability for the Sensory Integration Measure (Elshaheen, Mahmoud, & Dalia, 2017, pp. 512-517).

3- Results and Discussion:

3-1- Presentation, analysis, and discussion of the results and their interpretation:

Case 1: M. Mohamed

M. Mohamed is 11 years and 3 months old, and he is studying in the fourth year of primary education, (repeated the third and fourth years) and he does not suffer from any sensory problems or mental impairment according to the medical record of the case. He comes from a middle-income family and is the second of 3 siblings. According to the teacher, he has problems with reading and reading comprehension, and low academic performance in all subjects, and he is a very active and talkative student in the classroom.

3-1-1: Presentation, analysis, and discussion of the results of Raven's Colored Progressive Matrices:

Status	Surface level	Mid-level	Deep Level	Total Levels	Hierarchical Arrangement
M. Mohammad	09	04	**07**	20	**50**

The case obtained 20 points by answering the Raven's Progressive Matrices test, and her percentile rank was 50, with an average IQ range (90-109). The case obtained high results at the surface level, but the answers at the second level were slow, and the results of this level were weak. The case obtained good results at the third (deep) level.

3-1-2- Presentation, analysis, and discussion of the results of the holiday test:

The table shows the results of the first case's reading of the holiday text analysis.

Dimensions	results	Criterion	Difference from Standard
Age in Months	135	145-120	
Total Reading Time	322 s	153 s	+ 169 s
Number of units of language read in the first 3 minutes	84	267	183 -
Number of Correct Reading Units	53	262	209 -
Total number of phonemes	30	5	25 +
Number of language units read in the first 60 seconds	35	149	114 -
Number of sound appearances in the first 60 seconds	12		
Number of language units read in 60 seconds	23	110	87 -
Number of sound appearances in 60 seconds	11		
1st V1	0,58	1.81	1,23 -
Second Speed V2	0,38	1.9	1,52 -
Acceleration V2-V1	- 0,2	+0.9	
reading indicator	0,27	0,98	0,71 -
Score	27	98	71 -

(M. Mohammed) read 84 linguistic units in a period of three minutes out of 267 linguistic units, with 3 attempts at self-correction, i.e., a difference from the standard of -183. His reading was slow, as the case took a long time to read the text, with a time of +169 seconds, i.e., a difference from the standard of +213 seconds. The case's reading was initially faster, as it was recorded at 0.58 units/second in the first 60 seconds, then the speed began to decrease in the second 60 seconds (0.38 units/second). This is evident from the decrease in the number of linguistic units read in the second minute (23) compared to the number of linguistic units read in the first minute (35). The case also recorded 30 sound manifestations (errors) out of 84 linguistic units read during the first 3 minutes, and the reading index based on time was 0.27, which is far from the reading index for children of the same age. The reading score was 27, with a difference of -71 from the standard of 98 degrees, and according to the standard table for dyslexia (a score less than 34), the reading is considered very weak. These results are consistent with the study by GhilabQazadri (2012), which found that children with dyslexia have slow reading due to a disorder in a certain level of the verbal and non-verbal information processing system.

The table represents the distribution of the number of repetitions for each sound manifestation in the reading of the case (M. Mohammed) of the holiday text during the first 3 minutes.

Acoustic Appearance	Deleting	Substitution	Plugin:	heart	Total
Frequency	15	6	5	4	30

Percentage	50%	20%	16,66%	%13,33	35.71%

(M, Muhammad) recorded 30 phonological manifestations during the first 3 minutes, which is a large number of errors compared to the standard. The deletion manifestation had the highest percentage at 50%, meaning half of the phonological manifestations, and deletion was the dominant manifestation in the reading, affecting multiple levels of the word, whether at the beginning of the word, as represented by the deletion of the definite article (al-) in 7 words such as (al-janoob - janoob), (al-wasi'a - wasi'a)...as well as the deletion of consonants in several places without considering the gemination due to its constant deletion, and the deletion of the three long vowels, alif, waw, and ya, in several places such as (tatayyarat - tatayyarat), (suqoof - saqf), (an-nakheel - an-nakhl)...

Then the substitution manifestation followed with a rate of 20%, which was especially at the level of similar consonants in shape, such as (yaghdhab - ya'dhab). The case also recorded a rate of 16.66% for the addition manifestation, affecting different parts of the word by adding consonants or vowels, such as ('utla - 'utlatu), (khaffat - khafat). The inversion manifestation recorded the lowest rate at 13.33% and mainly affected the end of the word, such as (ar-rimal - ar-rumman), (yasbah - yashabh).

3-1-3- Presentation, analysis and discussion of the results of the sensory integration scale:

The table number shows the case's (M. Muhammad) grades on the sensory integration scale and his total grade on the scale.

Axis	Dimension Name	Score
1	Optomotor Synergy	10
2	Recognize the relationship between shape and floor	05
3	Position in space	09
4	Copy Shape	08
5	Location of tactile stimulus	05
6	Fingerprint Recognition	02
7	Handwriting	02
8	Motor Balance	01
9	Posture Simulation	07
Total score		49

The individual obtained a total score of 49 out of 90 on the Sensory Integration measure, which is distributed across nine dimensions. This means that the individual suffers from a moderate level of sensory integration disorder according to the standardized scale. (M. Mohammed) obtained the highest score in the visual-motor coordination dimension, followed by the spatial positioning dimension with 9 points, and the shape copying dimension with 8 points.

These results differ from the findings of the study by Herbert Petry and Mortimer Mishkin (1994), which indicated impaired coordination of eye and head movements in children with learning difficulties. Mishkin highlighted the fact that these differences may be associated with abnormal vestibular system function, which plays an important role in coordinating eye and head movements, particularly in the reading process.

The individual also scored low in 4 dimensions: tactile stimulus localization (5 points), finger recognition (2 points), palm writing (2 points), and motor balance (1 point). These dimensions are related to the proprioceptive system and the vestibular system, indicating that the individual suffers from a reduced ability to sensorily distinguish spatial and temporal characteristics of touch, movement, and body

positioning in space. These findings are consistent with the research of John Ayres, which emphasized that children with learning difficulties often experience muscle tension, balance responses, movement planning, and body schema issues, particularly related to the processing of deep vestibular input.

Case 2 (B. Wasam):

The case is 10 years and 10 months old and is a student in the third year of primary school, having repeated this year twice. She is the middle child in a family of 5 members with a middle-class economic level. According to her medical record, she does not suffer from any sensory or mental problems. The teacher confirmed that the case suffers from problems in reading and understanding the questions and instructions given to her, which was negatively reflected in her school results. On the other hand, the case does not suffer from problems in spoken language. The teacher also mentions that (B. Wasam) is a quiet student with a strong desire to study, which is evident from her participation in class, despite her incorrect answers. According to the teacher, she tries to simplify the questions for her so as not to lose her desire and enthusiasm for studying.

3-2-1: Presentation, analysis, and discussion of the results of Raven's Coloured Progressive Matrices:

Status	Surface level	Mid-level	Deep Level	Total Levels	Hierarchical Arrangement
B. Wissam	10	07	**07**	24	**50**

The case achieved a score of 24 points on the Raven's Progressive Matrices test, with a percentile rank of 50 and an average intelligence quotient (IQ) in the range of 90-109. The case achieved high results at the surface level, while the results for the second and third levels were average.

3-2-2- Presentation, analysis, and discussion of the results of the vacation text analysis:

The table shows the results of the analysis of the second case's vacation text.

Dimensions	results	Criterion	Difference from Standard
Age in Months	130	120-145	
Total Reading Time	543 s	153 s	+390 s
Number of units of language read in the first 3 minutes	57	267	210
Number of Correct Reading Units	24	262	238
Total number of phonemes	21	5	- 16
Number of language units read in the first 60 seconds	25	149	124
Number of sound appearances in the first 60 seconds	8		
Number of language units read in 60 seconds	10	110	- 100
Number of sound appearances in 60 seconds	5		
1st V1	0,41	1.81	1-4.
Second Speed V2	0.16	1.9	1- 74.
Acceleration V2-V1	- 0.25	+0.9	0.65
reading indicator	0.10	0,98	- 0.88
Reading Score	10	98	- 88

The case recorded a very long reading time of 543 seconds compared to the standard time (153 seconds), with a difference from the standard of +390 seconds. The number of units read during the first 3 minutes was 57 linguistic units, during which 21 phonetic manifestations occurred with 4 attempts at self-correction. Her reading was very slow and fragmented, pausing at each word, with hesitation and intermittent fluency, and disregard for punctuation marks. Her speed in the first minute was (0.41 words/second), then the reading slowed down further in the second minute (0.16 words/second) with a negative reading acceleration (-0.25). We notice a decrease in the number of linguistic units read during the second minute, followed by a decrease in the number of recorded phonetic manifestations. The reading index in terms of time reached 0.10, which is very far from the reading index for children of the same age. The reading score reached 10, with a difference of -88 from the standard of 98 points. According to the standard table for dyslexia (score less than 34), the reading is considered very weak.

The studies by Rocher and Chanquoy (2004) and Guphard and Atezeni (2007) have shown that slow reading is related to storage difficulties at the level of working memory, especially if the word is not available in the child's mental lexicon or vocabulary. This is why they resort to deconstruction and reconstruction, which means exerting additional effort, explaining the longer duration that dyslexics take in reading (Gzadri, 2012).

The following table represents the distribution of the number of repetitions for each phonetic manifestation in the case's (B. Wissam) reading of the holiday text during the first 3 minutes:

Acoustic Appearance	Deleting	Substitution	Plugin:	heart	Total
Frequency	07	05	04	05	21
Percentage	%33,33	23,80%	19,04%	23,80%	36.84%

The phenomenon of omission is more prominent in the reading of (B. Wissam) at a rate of 33.33%, affecting multiple levels of the word, represented in the omission of (Al-) at the beginning of the word such as (Al-madinah - madinah), the omission of the phoneme (T) at the end of the word such as (fartajafat - fartajaf), and the omission of long vowels alif and waw such as (suquf - saqf) and (al-manazil - al-manzil). The percentage of substitution and inversion phenomena was equal at (23.80%), with the substitution phenomenon affecting multiple levels of the word (consonants or vowels) such as (al-kuthban - al-kathir) (riyah - rih), and inversion such as (maghib - maghrib). The addition phenomenon had the lowest percentage at (19.04%), by adding (Al-) or consonants or vowels such as (utlah - utlatuh), (ta'arraf - ta'rif). The percentage of phonetic phenomena produced by the case during the first 3 minutes is 36.84%, which is a high error rate compared to the number of correctly read words.

3-2-3- Presentation, analysis, and discussion of the results of the sensory integration scale:

Table number [missing number] shows the scores of the case (B. Wissam) on the sensory integration scale and her total score on the scale:

Axis	Dimension Name	Score
1	Optomotor Synergy	10
2	Recognize the relationship between shape and floor	02
3	Position in space	04
4	Copy Shape	09
5	Location of tactile stimulus	06
6	Fingerprint Recognition	01

7	Handwriting	02
8	Motor Balance	02
9	Posture Simulation	9
Total score		41

The case (B. Wissam) obtained a total score of 41 on the Sensory Integration scale, which means that the case suffers from a moderate sensory integration disorder according to the normative table. The case obtained the highest score in the motor coordination dimension, followed by the shape copying dimension and body posture imitation. These dimensions require the integration of visual and motor skills for a single goal, meaning the child's ability to coordinate eye movements with hand movements. This indicates that the case does not suffer from visual sensory disorders. This result differs from the study of Valerie et al. (1988), which assumed that the severity of sensory dysfunction in children with learning difficulties is related to the severity of dysfunction in the field of visual perception and visual-motor coordination (Szmalec, 2019).

The case also obtained a very low score in the finger recognition dimension (1) with eyes closed and in the palm writing dimension (2), which are part of the proprioceptive system that Ayres focused on studying in her sensory integration theory. This system helps in knowing the locations of body parts and their relationship to each other. The case also obtained a very low score in the motor balance dimension (2) and the spatial position dimension (4). This result is interpreted as the case suffering from problems in the balance system associated with the vestibular system. This is consistent with the study of Nicolson, Fawcett, and Dean (2001), which sees that dyslexics suffer from difficulties in motor control and orientation due to a slight weakness in the development and function of the cerebellum. This cerebellar dysfunction weakens the ability to acquire behavioral automaticity, and dyslexics have to exert more effort to reach and maintain the desired and stable spatial orientation.

The case also suffers from a laterality disorder, as she confused the position of objects and their location in space (right-left). This is consistent with the study of Borel-Maisonny, which sees dyslexia as orientation disorders, meaning difficulty in recognizing how things are ordered or arranged, especially written linguistic signs. Dyslexics also find it difficult to perceive right and left in relation to their body. Research by Hildreth, Grangran, Galviry, and Barnsley also confirmed a positive relationship between proper laterality and the child's performance in acquiring reading and writing. On the contrary, studies by Witty and Kopel, and Anne and Turner found no relationship between the two variables (Debraso, 2012, pages 332-333).

3-2- Study Conclusion and Recommendations:

Sensory integration is an unconscious cerebral process for organizing and processing information provided by the body's senses, enabling meaningful expression and response to situations. Sensory integration is considered the fundamental basis for academic learning and social behavior. It is not sufficient for sensory organs to be intact for sensory processing to occur correctly. Consequently, we find that children with dyslexia suffer from sensory integration disorder, as confirmed by our current study's findings, which align with the results of numerous previously presented studies.In our study of both cases, the most affected sensory systems were:The proprioceptive system, associated with muscles and joints, responsible for connecting different body parts, movement planning, and deep sensation of movement.The vestibular system, responsible for balance, spatial awareness, movement, and processing temporal and spatial characteristics.Jean Ayres' research has confirmed that children with learning disabilities suffer from muscle tension, balance responses, movement planning, body schema issues, and particularly problems related to processing deep vestibular input.

In light of the above, we can present several recommendations that may support and enhance the results of the current study:

- Utilize the current research findings to develop a therapeutic program based on sensory integration, contributing to the reduction of sensory problems in children with dyslexia.

- Curriculum developers must not overlook the inclusion of diverse and integrated sensory activities for children with learning disabilities within educational curricula.

- Conduct awareness campaigns for teachers about learning disabilities, especially dyslexia, as it is the most prevalent, and educate them about its indicators for early detection of children with this difficulty and the provision of early intervention programs.

- Focus on raising societal awareness about appropriate and correct methods for dealing with this category of learning disabilities.

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