Advancement of Tools in the Diagnosis of Childhood Reading and Writing Disorders in Arabic: Development, Validation, and Normalization

إعداد أدوات لتشخيص صعوبات القراءة والكتابة باللغة العربية: التطوير والتصديق والتقنين

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الملخص

يتناول هذا البحث تطور الأدوات التشخيصية لصعوبات القراءة والكتابة لدى الأطفال، مع التركيز على تطورها ومدى صدقها وعملية تقنينها. وقد أسهمت التطورات الحديثة في فهم الآليات الكامنة وراء هذه الصعوبات في تطوير أدوات أكثر حساسية ودقة. تُعد عملية التحقق من صدق هذه الأدوات أمرًا ضروريًا لضمان دقتها ومصداقيتها. كما أن عملية التقنين التي تعتمد على عينات ممثلة تُوفر معايير مرجعية تُسهم في التفسير السليم للنتائج. ويهدف هذا النهج المتكامل إلى تحسين دقة التشخيص، مما يُسهل تطبيق تدخلات مخصصة لدعم الأطفال الذين يعانون من هذه الصعوبات.

الكلمات المفتاحية: أدوات تشخيصية؛ عسر القراءة والكتابة؛ اللغة العربية؛ الاضطراب الفونولوجي؛ صدق الاختبار، المعايير العادية.

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Abstract

This document explores the evolution of diagnostic tools for reading and writing disorders in children, focusing on their development, validity, and normalization. Recent advances in understanding the underlying mechanisms of these disorders have led to more sensitive instruments. Validation of these tools is crucial to ensure their accuracy and reliability. The normalization process, based on representative samples, establishes reference norms for valid interpretation of results. This integrated approach improves diagnostic accuracy, thereby facilitating the implementation of tailored interventions to support affected children.

Key words: Diagnostic Tools; Reading and writing disorders; Arabic language; phonologic disorder; Validity; Normalization.

1. Introduction

Diagnosing reading and writing disorders among children, particularly within Arabic-speaking populations, presents a formidable challenge due to the lack of standardized and normalized tests in the Arabic language. This absence underscores the critical need for developing reliable and valid diagnostic tools that accommodate socio-cultural and linguistic criteria specific to Arabic-speaking communities, enabling accurate diagnosis and effective intervention. Gad Elbeheri highlights the scarcity of dyslexia identification tests in various languages despite its global recognition. This underscores the predominance of studies conducted in English, potentially limiting understanding of dyslexia in other languages and cultures[1]. Smythe and Everatt (2000) underline the global importance of dyslexia assessment and advocate for systematic research to develop culturally and linguistically appropriate diagnostic strategies[2].

One important study conducted by Salah-Eddine Taghlit (2008) provides a descriptive and analytical look into reading and writing disorders, highlighting the challenges faced by students in Arabic schools, particularly focusing on the difficulties in both reading and writing. This study emphasizes the importance of understanding specific learning disorders within the context of the Arabic language [3]

A more general survey of the literature on dysgraphia and dyslexia in Arabic-speaking regions shows that these disorders are often overlooked in the context of Arabic education, with significant gaps in standardized testing and diagnostic tools for these populations[4]

The objective of this study is to delve into the dynamic landscape of diagnostic methodologies, emphasizing their development, validation, and normalization processes tailored for the Arabic language. One of the primary goals is to introduce a diagnostic tool capable of providing reliable and valid

assessments of reading and writing disorders, thereby facilitating effective intervention strategies.

In recent years, significant strides have been made in elucidating the neurocognitive mechanisms underlying reading and writing disorders, highlighting the intricate interplay between linguistic features unique to Arabic and cognitive processing. As noted in the literature, such as the work of Elbeheri and Everatt (2007), These advancements underscore the critical need for culturally and linguistically sensitive approaches in developing diagnostic instruments capable of accurately assessing reading and writing difficulties among Arabic-speaking children. The complexity of the Arabic script, with its unique orthographic and phonological characteristics, necessitates that researchers consider these elements when designing assessments, as emphasized by Haitham Taha[5].

Central to the effectiveness of diagnostic tools is their validation process, which necessitates meticulous scrutiny to ensure the reliability and validity of assessment measures. According to the literature, including studies by Alhamami and al. (2024), the absence of standardized Arabic tests, the validation process must account for socio-cultural and linguistic factors inherent to Arabic-speaking populations[6]. Through rigorous validation studies, researchers aim to minimize diagnostic errors and enhance the precision of assessments, thereby facilitating targeted interventions and support for affected individuals. These efforts are further supported by the findings of Sutaman , and all (2021), who advocate for the integration of local linguistic contexts into assessment frameworks to better serve the needs of Arabic-speaking children[7].

Furthermore, the normalization of diagnostic instruments within Arabic-speaking populations is paramount for establishing a standardized benchmark against which individual performance can be evaluated, and enabling clinicians and educators to interpret assessment results accurately. This

process not only enhances the diagnostic utility of assessment tools but also promotes equity and fairness in evaluating reading and writing skills across diverse Arabic-speaking communities.

The development of a reliable and valid diagnostic tool for reading and writing disorders in Arabic is crucial for facilitating effective intervention and support. By embracing culturally sensitive and linguistically informed approaches, researchers and practitioners can refine diagnostic practices, ultimately empowering educators, clinicians, and families to provide tailored interventions to Arabic-speaking learners grappling with reading and writing difficulties.

The diagnosis of reading and writing disorders in Arabic-speaking children is confronted with distinctive hurdles, primarily stemming from the absence of standardized and normalized assessment tools specifically designed for the Arabic language. This deficiency underscores the pressing need to develop diagnostic instruments that are culturally sensitive and linguistically appropriate, aligning with the linguistic intricacies and socio-cultural contexts prevalent in Arabic-speaking communities. Addressing this gap is essential to ensure accurate identification and effective intervention for children grappling with reading and writing difficulties in Arabic. Therefore, this study endeavors to explore the development, validation, and normalization processes of diagnostic tools tailored for Arabic-speaking populations, aiming to provide insights into enhancing the diagnostic accuracy and intervention efficacy for children with reading and writing disorders in Arabic-speaking contexts.

Given this gap, how can reliable and valid diagnostic tools be developed that account for the linguistic, cultural, and socio-economic specificities of Arabic-speaking populations, enabling effective management of children with these disorders? to address this issue, an overview of reading and writing disorders is provided.

Operational concepts

Dyslexia is a specific learning disability that primarily affects an individual's ability to read, write, and spell, despite having normal intelligence and receiving appropriate educational opportunities. According to the literature, it is often characterized by difficulties with decoding, word recognition, and spelling, which can lead to challenges in academic achievement.

Several researchers define dyslexia as a neurodevelopmental disorder with a hereditary component. Shaywitz et al. (2008) describe it as difficulty in recognizing and decoding words due to differences in the brain's processing of written language. They note that individuals with dyslexia often have normal or above-average intelligence but face persistent challenges in reading fluency and comprehension[8].

The International Dyslexia Association (IDA) emphasizes that dyslexia is not a reflection of a person's intellectual abilities but rather a difference in the brain's ability to process linguistic information. This difficulty is typically related to deficits in phonological processing, which is the ability to manipulate sounds in language, a critical skill for reading and spelling.

Dysorthographia is a specific learning disability that affects an individual's ability to spell words correctly, despite having adequate intelligence and educational opportunities. It is often considered a subtype of dyslexia or a related condition, as it involves difficulties with spelling and written expression, even though the person may have normal cognitive and language skills. While dyslexia primarily impact reading, dysorthographia focuses on difficulties with writing, particularly spelling.

In Miller and Larkin's (2009) study, dysorthographia is described as a condition in which individuals exhibit difficulties with phonemic awareness (the ability to recognize and manipulate sounds in words) and with orthographic knowledge (the rules and conventions for spelling words

correctly)[9] This leads to consistent spelling errors that are not easily corrected through conventional methods.

Research suggests that dysorthographia can result from a combination of cognitive, neurological, and language-processing issues. It is often linked to dysfunction in the brain regions responsible for language processing and memory, specifically affecting areas involved in the mental encoding and retrieval of orthographic information.

According to Snowling (2000), dysorthographia often co-occurs with other specific learning disabilities, such as dyslexia or ADHD, and it can exacerbate difficulties in both academic and social contexts[10]

Phonological awareness refers to the ability to recognize and manipulate the sound structure of spoken language. It is a broad skill set that is crucial for learning to read and write, as it involves understanding the sound units (phonemes) in words and how they combine to form syllables, onsets, and rhymes.

Phonological disorders are related to the system of speech sounds and how sounds are used and organized in the brain

DysTeflexia is the tool developed by the Language Pathology: Diagnosis and Rehabilitation team at the Scientific and Technical Research Center for Arabic Language Development (Algeria)

1.1. Theoretical aspect of the assessment of reading and writing disorders

In the dyslexia assessment process, various metrics are employed to gauge reading proficiency, encompassing accuracy, fluency, as well as phonological and morphological awareness. Syntactic abilities and spelling skills are also scrutinized to comprehensively evaluate language competence. Furthermore, cognitive assessments are utilized to delve into fundamental cognitive

functions such as memory, attention, and processing speed, which significantly influence reading and language aptitude.

To build a valid tool from a cognitive perspective, it is necessary to rely on a specific theoretical model of reading and writing development. This model will guide the evaluator in analyzing the results in order to pinpoint deficient processing procedures. Currently, the majority of tools available within the scope of doctoral theses in Algeria adhere to a cognitive perspective based on the dual-route model developed by Max Coltheart (1983).

In the case of this research, a more recent model sharing certain postulates with the former has been selected: Rym Azzem's model[11], which takes into consideration the Arabic language.

Rima Azzam's research proposes that Arabic-speaking children undergo developmental stages in reading and spelling akin to their English counterparts as proposed by Frith (logographic, alphabetic, and orthographic stages). However, the proficiency levels required for each stage may differ. While basic literacy in Arabic relies on the alphabetic strategy, proficient spelling necessitates mastery of the orthographic strategy or even the grammatical/semantic phase due to the unique grapheme-to-phoneme correspondence in Arabic. Azzam delineates the skills and transitions between strategies and phases for reading and spelling, discussing the dissociation between reading and spelling in Arabic and emphasizing the importance of attending to graphic features. Additionally, it highlights that in Arabic, as children progress to level 2 in spelling, their reading advances to level 3, reflecting the incorporation of context-sensitive rules. Unlike English, Arabic spelling rules rely on semantic and syntactic understanding, with one letter consistently representing the same sound but varying in its written form across contexts. During the orthographic phase of literacy development, children

must acquire a deep understanding of morphological units, the root-pattern system of Arabic, and develop grammatical and semantic knowledge.

This acquisition and utilization of information could be perceived as an advanced level of orthographic skill or could signify a distinct phase, termed the grammatical/semantic phase[12].

This study aims to develop and validate tests for assessing specific reading and writing processes among 3rd, 4th, and 5th-grade students, enabling the identification of deficiencies in reading and writing acquisition among pathological populations. To accomplish this, the subject sample will be required. It will consist of a population of Arabic-speaking, typically developing readers from the first cycle of elementary school (3rd, 4th, and 5th-grade students). This will establish the expected norms for this level of schooling, and, enable the observation of performance distribution disparities between the learners and also, between children with the difficulty of reading and writing.

2. Methods and Materials

The assessment tool, named "Dysteflexia," was developed by the Language Pathology: Diagnosis and Rehabilitation team and is based on the theoretical model of Rima Azzam.

After designing the data for the Dysteflexia assessment tool, an analysis was conducted to verify its validity, stability, and reliability.

To assess the effectiveness of the test, the instruments were tested with 90 students from third, fourth, and fifth grades who spoke Arabic, across various schools in Algeria. The main objective of this trial was to examine and extract psychometric data using the difficulty and ease index, as well as the test item discrimination index, followed by an initial evaluation of the reliability and validity of the scales. The agreement rate among the assessors was calculated

when evaluating the various items of the test. The percentage of responses across the board was as follows:

Table 1: Test Evaluation Criteria Percentage of Responses

93.75%	**Alignment of items with academic level**
100%	**Alignment of content with relevant subject area**
56.25%	**Clarity**
12.5%	**Consistency and length**
68.75%	**Linguistic and scientific integrity**
68.75%	**Acceptance of multiple responses**
75%	**Alignment of test with curriculum**

After analyzing the surveys, the percentages for each element subject to evaluation were calculated. It became apparent that the length of the test was one of the points that received unanimous agreement from the reviewers, necessitating a reduction in the number of items to align with the students' ability to complete the test. The overall percentage for the assessment questions across various test items was estimated at 67.85%. Based on the reviewers' feedback, the necessary adjustments were made to the test.

In the second stage, the final version of the tool was applied to a group of 165 students from each class (3rd, 4th, and 5th grade).

The validity of internal consistency of tests

The internal consistency validity of language tests is assessed by examining the correlation of each test item with the total score of the test itself. The internal consistency of individual items is linked to the overall homogeneity of the test, as higher internal consistency indicates greater test homogeneity. The validity of the test score and subtests is determined by the clarity of score interpretation in relation to the scores on the test battery, from an analytical standpoint. Thus, an item with very low correlation to the total score is

considered unreliable and often measures a function completely different from that measured by the other test items. Internal consistency is measured by calculating the correlation coefficient of each item with the total test score. The study notice positive correlations among all the tests, indicating internal consistency in the content of the diagnostic battery, its construction method, and the objectives outlined in it. These results suggest homogeneity among the various specified tests in the battery.

Test Stability

To measure the stability of the dyslexia diagnosis test, Cronbach's alpha coefficient was used on a sample of 30 elementary school students. The test stability coefficients for its various tasks were as follows:

TABLE 2: Stability Test Result

Split-Half Reliability	Cronbach's Alpha Coefficients	Test Task Stability
0.74	0.87	**Letter Recognition**
0.72	0.89	**Word Recognition**
0.78	0.81	**Word-Picture Association**
0.81	0.82	**Foreign Word**
0.74	0.76	**Synonyms**
0.83	0.93	**Sentence Completion**
0.71	0.85	**Phonological Awareness**
0.72	0.78	**Auditory Discrimination**
0.83	0.84	**Frequent Spelling**
0.78	0.84	**Infrequent Spelling**
0.77	0.83	**Frequent Reading**
0.77	0.82	**Infrequent Reading**
0.83	0.87	**Pseudoword Reading**
0.85	0.88	**Frequent Spelling**
0.77	0.85	**Infrequent Spelling**
0.86	0.95	**Pseudoword Spelling**

In the second stage, the study applied the final version of the tool to a group of 165 students from each class (3rd, 4th, and 5th grade).

The study data underwent evaluation by a panel of experts with diverse backgrounds, including specialists in speech therapy, researchers in education and linguistics, teachers specializing in curriculum, and inspectors, to gather their opinions and make necessary adjustments to the test items. The feedback from the experts helped in refining the test items by removing those deemed inappropriate and replacing them as needed.

2.1. The Components of the Battery

The battery includes linguistic tests covering all linguistic levels, phonological, lexical, semantic, morphological, as well as non-linguistic tests. Furthermore, the battery comprises a test guide, along with an examination booklet intended for the examinee.

The test items comprise frequent words, infrequent words, and pseudowords. Additionally, the length factor and the orthographic complexity factor were taken into account.

- **Phonological Level**
    - **Auditory Discrimination of Words:** This refers to the child's ability to distinguish and perceive auditory differences between words and similar sounds in pronunciation, helping to identify any cognitive disorders at the lowest level of language auditory perception. This test aims to ensure the learner's auditory processing integrity. It consists of a series of similar and dissimilar words presented auditorily to the examinee, who is then asked to determine whether the heard words are similar or dissimilar.

- **Phonological Awareness:** Phonological awareness skills involve recognizing that language is comprised of words, syllables, and sounds, and that these components can be manipulated in various ways, which is closely linked to reading success in the early years of education. The phonological awareness test involves identifying the picture among the four pictures that begins with the same letter as the target picture located at the top.
- **The spelling assessment test :** aims to evaluate the child's phonological memory capacity and adherence to letter sequencing, as well as adherence to spelling rules. To assess the extent of the examinee's retention of phonological sequencing memory, the examinee segments the heard word into letters, respecting their order and sequence within the word. The test includes two lists of words: a list of frequent words and a list of infrequent words.

- **The lexical level**
  - **Reading word lists:** The test involves reading words, whether they are frequent, infrequent, or pseudowords, aiming to understand the approach the learner will adopt in reading. It consists of reading a list of words in one minute while counting the number and type of errors. At this stage of the test, the length, spelling complexity, and grammatical complexity of the words are studied.
  - **Reading the text "The Camel":** The aim is to determine reading speed and accuracy by calculating the number of errors made by

the examinee and the time taken to read. This helps determine the child's actual age in reading as well as identifying the type of reading difficulty the examinee may be experiencing.

- **The semantic level**
  - **Synonym Test:** Consisting of 14 target words and 42 distractor words. Among the three distractor words located below the target word, one of them is a synonym of the target word. It is up to the examinee to find the word that has the same meaning as the target word. For example, the distractors share the same overall morphological structure with the target word (the target word: / **عين**/ assign, the distractors: **جدَّدَ** : renewed, **حِدَادٌ** : mourning, **حَدَّدَ** : defined.
  - **Word-Image Association Test:** Consisting of 13 items, each item composed of 3 words similar in form but different in meaning, accompanied by an image corresponding to one of the words. One of the words represents the label of the image. For example:
  - عَلَمٌ : **flag**
  - عِلْمٌ: **knowledge**
  - عَلَّمَ: **taught**

And the picture is a flag.

- **The morphological level**
  - **Foreign Word Test:** Among three words, determine the word that does not belong to the same semantic field as the previous two words, such as:

قاطرة : **locomotive**

قطار : **train**

قطرة : **drop**

- **Sentence Completion Test:** Present the child with 30 incomplete sentences containing blanks, with the root of the complementary word next to the blank. The student is required to use the provided letters to construct a word that completes the context of the sentence. Such as:

كان إبْراهيم يُرَاقِبُ .....الشَّمْس: (غ، ر، ب)

Ibrahim was watching ..... the sun: (/gh/, /r/, /b/)

Upon forming the word, the examinee adds /waw/"و" before "ر" /ra/ to make the word: غروب (sunset)

- **Comprehension Level**
  - **Spelling Decision Test:** This is a test specifically designed for spelling decisions. It aims to examine the highest level of reading processing. It consists of a passage presented to the examinee for reading, containing words that do not fit into the context of textual comprehension. The examinee is required to read the passage thoroughly, understand it, and then extract the words that are inappropriate for the context of the passage.

- **Writing Level**
  - **spelling tests:** Writing is considered the foundation upon which learners rely in learning to read. To examine this ability, the study have prepared three spelling tests to assess the examinee's ability to use spelling rules, taking into consideration that the content of these tests includes frequent words, infrequent words, and pseudo words.

- **Non-linguistic Tests**

- **Rapid Naming Test:** The Rapid Naming Test aims to ensure access to the mental lexicon. It is an oral test that examines the examinee's phonological retrieval abilities. The test contains 25 categorized images in boxes with 5 columns and 5 rows. The position of the image changes with each row. The examinee is required to name the images as quickly as possible following the direction of reading. If the child pauses for 5 seconds, they are asked to continue naming.
- **Matching Model Test:** This test aims to assess the quality of selective attention and visual-spatial analysis. It includes a set of shapes arranged in sequences, with each sequence containing 5 shapes including one model shape. The examinee is required to find the matching model among the shapes presented to the right of the other shapes.
- **Search for the Intruder*:*** The purpose of this test is to assess the quality of selective attention and visual-spatial analysis. The examinee is required to find the intruding shape among the other shapes in the same column.
- **Shape Redrawing Test (Frosting):** This test evaluates the strategy followed by the child and spatial guidance, assessing accuracy in respecting each point. The test is typically used by visual evaluation specialists to observe both tracking and visual agitation. The child's task is to transfer the model located on the right side while respecting the lines with utmost accuracy, which requires establishing a spatial relationship.
- **Bell Test:** Developed by "Gauthier, Dehaut, and Joanette, 1989,"[13] this test is part of the "Odedys" reading assessment. It aims to assess the learner's visual strategies and visual-attentional abilities in searching for the target stimulus. It also

measures visual neglect and visual-cognitive difficulties. The Bell Test includes a board containing 280 black drawings representing common objects: "house, horses, teapot..." distributed throughout the entire board, including 35 bells vertically arranged in 7 columns, each column containing 5 bells. The learner is required to find and ring as many bells as possible within a time limit of two minutes.

The reliability coefficients of the subtests ranged from a minimum of 0.78 to a maximum of 0.95. This indicates that the test developed for diagnosing dyslexia in the Algerian school enjoys a high level of stability, suggesting consistency and coherence among the different subtest items. Therefore, the test is ready for use as a tool for diagnosing dyslexia.

The study resorted to extracting percentiles by comparing the specific results of a student with the results of the normative group using the defined percentile scale across all tests. Through this scale, the threshold at which children with difficulties in learning to read and write are centered was determined, specifically at the tenth percentile or lower. The presence of students extends to the fiftieth percentile, indicating average performance, while the seventy-fifth percentile and above indicate excellence.

Based on the extracted percentiles from the three levels (third, fourth, and fifth), the percentile distribution was defined as follows:

Table 3: percentile distribution

PERCENTILE DISTRIBUTION	QUALITATIVE DESCRIPTION	TYPE OF LEARNING
5-10	Weak	LEARNING DIFFICULTIES (DYSLEXIA)
11-25	Below Average	WEAK LEARNER
26-50	Average	AVERAGE

51-75	Above Average	AVERAGE
76-90	Good	GOOD
95 and above	Superior	EXCELLENT

Analyzing the results extracted from this test allows us to identify the profile of dyslexia, whether it is surface dyslexia, phonological dyslexia, or mixed dyslexia.

3. Case study

To illustrate what can be highlighted with the tool DysTeflexia, we will describe a case, that of Youcef, which is quite prototypical of the variety of profiles that can be encountered in the context of developmental dyslexias.

The child K-Youcef, aged 10 years and 11 months, is the oldest of three siblings, with no pathological history; his psychomotor and linguistic development has shown no anomalies. He is stable within the family. His visual and auditory acuity is normal. Youcef is enrolled in the 4th year of primary school at the state school of Bachdjarrah, Algiers East Province, and has never repeated a year.

The administration of the Raven intelligence test and the Draw-a-Man test indicated preservation of a normal intellectual quotient, estimated at 95 in the Raven test and 92 in the Draw-a-Man test.

K. Youcef was screened for a learning disorder by the psychologist and the speech therapist at the UDS of Bachdjarrah, following which speech therapy support was deemed essential. Thus, a practical application of our DysTeflexia test was carried out for a diagnosis of these written language disorders. The complete administration of the test required 3 sessions.

4. Results and discussion

The forward digit span score, which measures sequential memory, is deficient; the child Youcef obtained a score of 2, meaning a maximum span of 3 digits, and cannot retain more than 3 digits. In contrast, for the backward digit span, he did not achieve any score, despite several attempts. This disorder

indicates a phonological memory impairment in Youcef. The phonological coding in Youcef's short-term memory and working memory is very weak, with scores significantly below average. In terms of visual processing, Youcef shows no difficulties and completed the task in a relatively short time. The same applies to the score of the clock task. The table below shows Youcef's results compared to the average of the control group.

Table 4: Youcef's results in Non-verbal Cognitive Tests compared to the average of the control group

Controls	Case k. Youcef	Tests
		short-term memory
4	2	**forward digit span**
3	0	**backward digit span**
		visual tasks
3.4 (±0.77)	4	**identical drawing**
3.49 (±0.81)	4	**intruder**
28.16 (±4.66)	32	**clock barrage**

In the reading test of the text 'بازل', Youcef obtained a precision index score of 37.58, which is in the pathological range (the 5th percentile), and a speed index score of 101.82, also in the pathological range at the 5th percentile, as he shows a significant delay in reading acquisition (of more than 2 years). This indicates the presence of developmental dyslexia.

In order to determine the type of dyslexia, we conducted a reading test of isolated words (frequent, infrequent, pseudo-word) from the tool DysTeflexia battery. According to the results, the patient Youcef presents a selective disorder in reading and writing pseudo-words, with a score of 3 in reading and 1 in dictation. For infrequent words, he scored 4 in reading and 0 in dictation. These results place him in the 5th percentile compared to the norms for 4th-grade students. In contrast, for frequent words, Youcef scored 15 points in reading and 9 in dictation, which corresponds to a percentile between 25 and

50 in the norms table. This suggests a dysfunction in phonological processing, which may explain his difficulties with short-term phonological memory.

The errors in reading pseudo-words manifest as lexicalization errors, which explains that Youcef relies on the lexical process when reading pseudo-words and infrequent words and does not resort to grapheme-phoneme conversion.

Table 5: Results of Youcef's isolated words reading

Translation	Arabic Word
Door باب	أبّاً
Little قَليل	قيلاً
Match شَوْطٌ	شُواظٌ
Horse حِصَانٌ	حصحصَ
Seven سَبْعٌ	سَبَأٌ
Activity نَشَاطٌ	النَشْأَةُ
Folder مِحْفَظَةٌ	مفحظة
Was كَانَ	كأل
Envelope ظَرْفٌ	ضرء
Fruit فَوَاكِهٌ	فاكِهُةٍ
Animal حَيَوانٌ	حِيُوَانٌ
Intelligence ذَكاءٌ	ذُوكٌ

While dictation errors are marked by phonological errors, they manifest as:

Omission of Long Vowels: Among the errors made by the case, there is the omission of long vowels; for example, "فتاة" (girl) becomes "فتة" and "مواصلات" (transportation) becomes "موسلة."

Confusion Between Voiced and Voiceless Letters: Youcef faced difficulty distinguishing between voiceless and voiced letters that share the same

articulation point but differ in quality, such as confusing the letter "س" (s) with "ص" (s) in the word "مواصلات" and "ج" (ž) with "ش" (š).

Adding "ن" Instead of "Nunation": This refers to the confusion where Youcef incorrectly adds a letter or sound in contexts where " Nunation" should be used.

Confusion Between Phonetically Similar Letters: This includes errors where Youcef switches letters that look similar visually, leading to spelling mistakes.

Table 6 : Results of dictating Youcef's words

Dictation	Response
صمتٌ	سمتن
فتاةٌ	فتة
مواصلات	موسلة
مستشفى	مستشف
أرض	أرصن
ذخيراتٌ	دجرتن

Additionally, we did not identify any difficulties in Youcef's ability to recognize letters and words; his scores (10.14) are positioned at the 50th percentile for both assessments, indicating that this patient does not exhibit lexical difficulties or visual processing impairments. However, in the synonym test, Youcef obtained a score of 9, which falls below the 50th percentile. This finding can be interpreted as evidence of the absence of semantic disorders in the aforementioned patient.

In the phonological awareness assessment, the results indicated that the patient achieved 9 correct responses out of a total of 15 in the task of identifying the initial letter corresponding to the target. This score is situated below the 5th percentile, suggesting the presence of a phonological awareness disorder.

Table 7: Phonological awareness test results

Response	Target image
خبز (bread)	قبعة (hat)
نملة (ant)	طبيب (doctor)
زرافة (giraffe)	فيل (elephant)
شاحنة (truck)	حمار (donkey)
فستان (dress)	خاتم (ring)
سلحفاة (turtle)	أذن (ear)

In the context of the oral spelling assessment, which evaluates phonological awareness of letters within words and the awareness of letter elongation, we noted suboptimal performance across both frequency levels (frequent and infrequent words). The patient demonstrated a pathological response time of 5 minutes and 28 seconds for frequent words, with an average time of 2 minutes and 40 seconds per word (1.48). For infrequent words, the response time was 6 minutes and 9 seconds, averaging 2 minutes and 51 seconds per word, with a maximum of 1 minute and 33 seconds. Youcef's spelling difficulties are characterized by omissions, notably a significant absence of long vowel omissions, along with substitution and inversion errors for both frequent and infrequent words. These findings suggest a lack of awareness of the letters contained within words.

Table 8: Oral Spelling Result

عصا	ع	ا	ع	س				
صفر	س	ف	ر	ن				
ذكاء	ذ	ك	Ø	ن				
لاعبان	ل	Ø	ع	ب	Ø	ن		
التّمر	Ø	Ø	ت	م	ر			
تذكّروا	ت	د	ك	ر	Ø	Ø		
صبورة	س	ب	Ø	ر	ت	ن		
لاجئون	ل	Ø	ج	ا	Ø	ن	ل	
مكتبات	م	ك	ت	ب	Ø	ت	ن	

The errors observed in the subject's oral spelling test, which relies on both the lexical and phonological buffers, suggest the potential presence of a buffer phonological impairment. These errors are often manifested as the addition of letters, such as diacritical marks, or the inclusion of extraneous letters, exemplified by the insertion of the letter "L" in the word "لاجئون" (refugee).

Such patterns of errors indicate difficulties in phonological processing, given the buffer phonological's critical role in retaining and accurately retrieving phonological information during reading and spelling. These challenges may reflect a deficit in accessing the phonological representations of words or difficulty in managing the phonological processes required for correct spelling.

The errors exhibited by the subject in oral spelling demonstrate a pattern indicative of a phonological awareness disorder. This is evident in the complete omission of long vowels from words, which suggests a deficiency in either perceiving or applying these phonological elements. Such a disorder points to difficulties in manipulating the small phonological units that form the foundation of words, an essential component of phonological awareness.

Furthermore, when dealing with irregular or exceptional words that rely more heavily on the lexical pathway rather than the phonological one, the subject committed phonological errors. This implies an inefficiency in effectively utilizing the lexical store, resulting in phonological-related errors during spelling attempts.

These patterns may reflect a weakness in integrating lexical and phonological processes, highlighting the need for targeted intervention programs. Such programs should focus on enhancing phonological awareness and improving strategies for accessing and utilizing the lexical store efficiently.

- Conclusion

The current study developed and tested a diagnostic battery for dyslexia in a fourth-grade student. The objective was to assess his reading abilities and establish an initial diagnosis within a formal and inclusive educational setting. Our case, Youcef, who is enrolled in fourth grade, suffers from phonological developmental dyslexia, characterized by phonological errors such as omissions, substitutions of voiced/voiceless sounds, and confusion of orthographically similar phonemes, along with a near absence of long vowels.

Youcef's results present a heterogeneous cognitive profile. His poor performance in short-term memory, both forward and backward, suggests difficulties in executive functions and working memory. In contrast, his superior results in visual tasks indicate that he possesses strong visual and perceptual skills.

Overall, Youcef's profile indicates a specific type of dyslexia characterized by difficulties in phonological processing and a reliance on lexical strategies for reading. His struggles with pseudo-words and infrequent words suggest that targeted interventions focusing on phonological awareness and decoding skills may be beneficial in improving his reading abilities.

The patterns of errors observed in Youcef's dictation indicate a profound phonological processing deficit, which affects his ability to decode and encode language accurately. These difficulties are likely interconnected, as challenges in phonological awareness can lead to errors in both spelling and reading.

To support Youcef's development, targeted interventions focusing on phonological awareness, auditory discrimination, and visual processing skills could be beneficial. These strategies may help him improve his ability to

distinguish between similar sounds and letters, ultimately enhancing his overall literacy skills.

In conclusion, this battery not only facilitated the diagnosis of developmental dyslexia but also specified the deficits and thus the type of disorder, along with the nature of the errors made by the child.

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