Neurolinguistic and Neuropsychological Assessment of Reading and Writing in Children with Attention-Deficit/Hyperactivity Disorder (ADHD): A Comparative Exploratory Case Study

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***Abstract*—Attention-Deficit/Hyperactivity Disorder (ADHD) is one of the most common neurodevelopmental disorders in childhood, affecting approximately 3–5% of children worldwide. Beyond its behavioral and attentional symptoms, ADHD is associated with significant academic and linguistic difficulties, particularly in reading and writing. This exploratory multiple-case study aimed to conduct a neuropsychological and neurolinguistic assessment of reading and writing in children with ADHD compared to their typically developing peers. The sample consisted of 10 primary school pupils (5 with ADHD and 5 typically developing), selected purposively from primary schools in Tizi Ouzou, Algeria. The Reading Test by Ghellab (1997) and the Writing Test by Bouzid (1991) were administered. The Mann-Whitney U test revealed statistically significant differences between the two groups in both reading (U = 1.000, p = 0.016, r = -0.76) and writing (U = 0.000, p = 0.009, r = -0.83), with large effect sizes. Children with ADHD exhibited slower reading fluency, higher error rates (predominantly omissions and substitutions), poorer general text organization, handwriting distortions, and moderate to severe writing difficulties. These findings are consistent with previous research and highlight the need for early assessment and specialized intervention. The study concludes with recommendations for neuropsychologists, speech-language pathologists, teachers, and parents.**

***Keywords*—ADHD, reading, writing, neuropsychological assessment, neurolinguistic assessment, Algerian context, multiple-case study.**

A. Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD) is one of the most common neurodevelopmental disorders in childhood, with global prevalence estimates ranging between 3% and 5% among children, with a clear predominance of the inattentive presentation in some clinical contexts (American Psychiatric Association, 2013). The impact of this disorder extends beyond behavioral and attentional aspects to encompass multiple academic, cognitive, and linguistic domains, raising fundamental questions about the nature of the relationship between attentional deficits and language learning disorders, particularly in reading and writing skills.

Recent research indicates that between 25% and 50% of children with ADHD have comorbid learning disorders, including difficulties in reading and writing (Pautet, 2025), and that this comorbidity is not merely a coincidental overlap but may reflect shared genetic factors or overlapping neural mechanisms.

At the neurocognitive level, Avramovich and Yeari (2024) pointed out that academic difficulties in individuals with ADHD are not solely attributable to attentional deficits but rather to a complex interplay of working memory deficits, executive function impairments, and slowed processing speed, which negatively affect the child's ability to self-regulate the learning process.

In this regard, Landínez-Martínez and colleagues (2025) conducted a study aimed at determining the impact of ADHD on neuropsychological and academic performance in a sample of Colombian children in primary and secondary education compared to a control group. The study employed a quasi-experimental design and included a sample of 194 children aged 5 to 14 years (97 with ADHD and 97 typically developing children), using tasks from the Child Neuropsychological Assessment Battery (ENI) to evaluate academic and neuropsychological performance. The results revealed that children with ADHD demonstrated lower cognitive, linguistic, and attentional performance with greater variability than their peers, with deficits in intelligence, metalinguistic skills, reading, writing, memory, attention, and executive functions (Landínez-Martínez et al., 2025). The same study also found statistically significant differences between the two groups in reading speed, text comprehension, writing accuracy, and the number of spelling errors.

To explain these difficulties, Miranda Casas and colleagues (2010) conducted a study aimed at examining the contribution of verbal fluency, reading fluency, and executive functions (working memory, attention, and inhibition mechanisms) in predicting the mental processes of text comprehension. The study included 42 students aged 12 to 16 years, clinically diagnosed with ADHD, and a battery of tests was administered to measure cognitive and reading processes. The results of the

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stepwise regression analysis revealed that verbal fluency scores were the best single predictor of reading comprehension, and that executive functions, rather than reading fluency, significantly contributed to reading comprehension (Miranda Casas et al., 2010).

Similarly, Miranda Casas and colleagues (2011) conducted a study on a sample of 84 students aged 12 to 16 years, divided into four equal groups: ADHD, Reading Comprehension Difficulties (RCD), ADHD+RCD, and a control group. Vocabulary, oral comprehension, lexical access, verbal and visual working memory, inhibition, and attention were measured. The results showed that the ADHD+RCD group exhibited the most significant linguistic deficits, followed by the RCD group, while the three clinical groups demonstrated greater performance difficulties in working memory compared to the control group, and both ADHD groups experienced greater problems in attention and inhibition. These findings suggest a dissociation between linguistic and executive deficits affecting the RCD and ADHD groups respectively, with a double deficit in language and executive functions in the comorbid group (Miranda Casas et al., 2011).

In another study, Miranda and colleagues (2017) compared reading performance between 30 young adults diagnosed with ADHD in childhood and 30 typically developing young adults, on measures of reading accuracy, fluency, and comprehension. The ADHD subgroup with reading difficulties (ADHD+RD) and the ADHD subgroup without reading difficulties (ADHD-RD) were also compared using the self-report and informant versions of the Behavior Rating Inventory of Executive Function for Adults (BRIEF-A). The results revealed that adults with ADHD performed significantly worse than the control group in reading speed, responses to literal questions, and the cloze test, and the ADHD+RD group exceeded the 85th percentile on a greater number of subscales, with particular impairment in working memory and metacognition (Miranda et al., 2017).

Furthermore, Miller and colleagues (2013), in a study that included 87 adolescents aged 13 to 18 years, using standardized tests to measure word recognition, expressive vocabulary, and reading comprehension, found that adolescents with ADHD scored significantly lower on standardized measures of reading comprehension, and that expressive vocabulary and word recognition were the primary mediators of the relationship between ADHD symptoms and reading comprehension impairment (Miller et al., 2013).

Turning to the Arab context, Khodeir, Mohamed, and Abdel-Fattah Hegazi (2024) conducted a study aimed at determining the linguistic profiles of Arabic-speaking children with ADHD. The study included 30 Egyptian children aged 4 to 7 years, diagnosed according to DSM-V criteria and the Conners' Parent Rating Scale-Revised. The study used the Preschool Language Scale (PLS-4) Arabic version, the Arabic articulation test, and the Egyptian Arabic Pragmatic Language Test. The results revealed that 70% of children with ADHD scored below the 5th percentile on pragmatic skills, with a statistically significant negative correlation between hyperactivity/impulsivity and inattention symptoms on one hand, and receptive, expressive, and pragmatic language age on the other (Khodeir et al., 2024).

Similarly, Abdelhamid and colleagues (2013) conducted an Egyptian comparative study between 30 children with ADHD with language impairment and 15 children with Specific Language Impairment (SLI), aged 3 to 6 years, using the Arabic Language Test-Revised (ALT-R) and the Arabic articulation test, in addition to electroencephalography (EEG). The results demonstrated that the ADHD group achieved significantly lower scores in total language skills, semantics, receptive syntax, phonological quotient, and pragmatic skills compared to the SLI group, with statistically significant differences ($p < 0.05$) in the age of acquisition of the first word and two-word sentences (Abdelhamid et al., 2013).

In Saudi Arabia, Hariri (2016) conducted a study aimed at describing Arabic language deficits and developing a theoretical model of the potential associations between phonological language deficits and ADHD in Arabic-speaking children. Quantitative and qualitative analyses revealed that the ADHD group failed to acquire most Arabic consonants as expected, indicating a comorbid relationship between ADHD and speech sound disorder in Arabic (Hariri, 2016).

In Oman, Al-Shekaili and colleagues (2025) conducted a study aimed at determining the prevalence of ADHD among students with learning disabilities. The study included a sample of 861 students, using a standardized measure to assess ADHD symptoms according to DSM-5 criteria, and revealed that 28.10% of students with learning disabilities met ADHD criteria, with a predominance of the inattentive subtype (58.26%), and the disorder was more prevalent among males (73.14%) and in the first cycle of basic education (75.21%), with 63.22% of ADHD cases identified among students with difficulties in Arabic, particularly in reading and writing (Al-Shekaili et al., 2025).

In Algeria, Labouk and Bechlague (2022) conducted a study to verify the effectiveness of a proposed therapeutic program to alleviate writing learning difficulties and ADHD among a sample of third and fourth-year primary school pupils. The study employed a quasi-experimental design and included a total sample of 24 pupils divided into a control group (12 pupils) and an experimental group (12 pupils) in four primary schools in the Wilaya of Sidi Bel Abbes, using a questionnaire to diagnose writing learning difficulties and a questionnaire to diagnose ADHD, in addition to a proposed therapeutic program applied over ten sessions. The results revealed statistically significant differences in favor of the experimental group after undergoing the therapeutic program, demonstrating the effectiveness of the proposed program (Labouk & Bechlague, 2022).

Despite these findings, the picture remains incomplete regarding the qualitative nature of neurolinguistic difficulties in reading and writing among children with ADHD in Algeria, as studies lack detailed analysis of writing error patterns (spelling, morphological, syntactic), the dimensions of reading deficits (accuracy, speed, comprehension, phonological awareness), and the relationship of these factors to the clinical subtype of ADHD and the severity of attentional symptoms.

B. Study Questions and Hypotheses

1) Study Questions

Based on the central problem that this study seeks to address, which is to uncover the nature of reading and writing skills in children with Attention-Deficit/Hyperactivity Disorder (ADHD) compared to their typically developing peers, the following questions can be formulated:

C. Main Question:

What is the nature of reading and writing skills in children with Attention-Deficit/Hyperactivity Disorder (ADHD) compared to their typically developing peers?

D. Sub-Questions:

1. Are there statistically significant differences between children with ADHD and their typically developing peers in reading skills (reading time, reading accuracy, error type and classification)?
2. Are there statistically significant differences between children with ADHD and their typically developing peers in writing skills (general text form and organization, handwriting quality and legibility, degree of writing difficulties)?

1) Study Hypotheses

Based on the theoretical framework and previous studies, the following hypotheses can be formulated:

E. Main Hypothesis:

There are statistically significant differences between children with ADHD and their typically developing peers in reading and writing skills.

F. Sub-Hypotheses:

1. There are statistically significant differences between children with ADHD and their typically developing peers in reading skills, with typically developing children obtaining higher scores on the Reading Test compared to children with ADHD.
2. There are statistically significant differences between children with ADHD and their typically developing peers in writing skills, with children with ADHD obtaining higher scores (indicating greater difficulties) on the Writing Test compared to typically developing children.

G. Significance of the Study

This study derives its significance from addressing a vital topic at the intersection of several scientific disciplines, pertaining to a group of children who are most vulnerable to academic and linguistic difficulties. Theoretically, the study contributes to filling a clear knowledge gap in the Arabic and Algerian literature, as studies addressing the neuropsychological and neurolinguistic assessment of reading and writing in children with ADHD using tools appropriate for the Arabic language remain scarce. It also contributes to clarifying the controversial relationship between ADHD and reading and writing difficulties through precise analysis of neurolinguistic skills and the identification of qualitative patterns of errors and deficits. Practically, the study provides assessment tools and methodologies that assist neuropsychologists and speech-language pathologists in conducting more accurate and comprehensive assessments. It also provides a scientific basis for developing more personalized and effective intervention programs, and equips teachers with information to help them adapt teaching strategies and support school inclusion. Methodologically, the study contributes to developing Arabic assessment tools that consider the linguistic and cultural characteristics of Algerian society, adopting an integrative methodology combining neuropsychological and linguistic assessment. Socially, the study contributes to improving the quality of life of children with ADHD and their families by promoting understanding, early intervention, reducing educational loss, and enhancing mental health.

H. Objectives of the Study

The present study aims to conduct a neuropsychological and neurolinguistic assessment of reading and writing skills in children diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD) within the Algerian context, and to identify the characteristic features of deficits and impairments in these skills relative to typically developing peers. In pursuit of this general aim, the study seeks to achieve the following specific objectives:

First, to identify the nature of writing errors—specifically spelling, morphological, and syntactic errors—produced by children with ADHD in comparison with their non-ADHD peers, through both qualitative and quantitative analysis of error patterns.

Second, to diagnose the dimensions of reading deficits, including accuracy, speed, comprehension, and phonological awareness, among children with ADHD, and to determine which reading components are most affected by the disorder.

Third, to examine differences in neuropsychological and neurolinguistic skills between children with ADHD and typically developing children in the domains of reading and writing, and to determine the magnitude and statistical significance of these differences.

Fourth, to investigate the relationship between the clinical subtype of ADHD—whether the predominantly inattentive presentation, the predominantly hyperactive/impulsive presentation, or the combined presentation—and patterns of neurolinguistic difficulties in reading and writing.

Fifth, to determine the correlational relationship between the severity of attentional symptoms, as measured by Conners' scales, and the extent of deficits in reading and writing skills within this population.

I. Operational Definitions of the Study

1) Neuropsychological and Neurolinguistic Assessment

Operational Definition: The total score obtained by the child on the assessment battery used in this study, which consists of two stages: the first involves diagnosing the disorder and determining its clinical subtype and severity using the Conners' Rating Scales, and the second involves assessing reading skills using the Reading Test developed by Saliha Ghellab and writing skills using the Writing Test developed by Saliha Ben Bouzid, with the aim of identifying the features of linguistic deficits in these two skills.

2) Reading

Operational Definition: The score obtained by the child on the Reading Test developed by researcher Saliha Ghellab, which reflects the child's performance level across three indicators:

1. **Reading Time**: The score reflecting the duration taken to read the 267-word text.
2. **Reading Accuracy**: The score reflecting the number of errors made during oral reading.
3. **Error Type and Classification**: The score reflecting the quality of errors (substitution, omission, addition, reversal) and their quantitative and qualitative classification.

3) Writing

Operational Definition: The score obtained by the child on the Writing Test developed by researcher Saliha Ben Bouzid, which reflects the child's performance level across three indicators:

1. **General Text Form and Organization**: The score reflecting the extent to which spacing between words, lines, and continuity of writing on the page are observed.
2. **Handwriting Quality and Legibility**: The score reflecting the extent to which writing is free from graphomotor distortions (letter reversal, omission, misplaced dots).
3. **Degree of Writing Difficulties**: The score determining the level of difficulty (from mild to severe) according to a point-based scoring scale.

4) Attention-Deficit/Hyperactivity Disorder (ADHD)

Operational Definition: The score obtained by the child on the Conners' Rating Scales used in this study, which reflects the severity of symptoms according to DSM-5 criteria, and upon which the child is classified into one of three subtypes: predominantly inattentive presentation, predominantly hyperactive/impulsive presentation, or combined presentation.

5) Typically Developing Peers

Operational Definition: Children who do not meet the diagnostic criteria for ADHD according to DSM-5, do not exhibit noticeable academic or linguistic difficulties, and are selected to match the experimental group in age, gender, educational level, and socioeconomic status.

6) Clinical Subtype of ADHD

Operational Definition: The sub-classification determined based on the scores obtained by the child on the Conners' Rating Scales, including: predominantly inattentive presentation, predominantly hyperactive/impulsive presentation, and combined presentation.

7) Severity of Attentional Symptoms

Operational Definition: The total and subscale scores obtained by the child on the Conners' Rating Scales (Parent and Teacher versions), which reflect the severity of inattention, hyperactivity, and impulsivity symptoms.

8) Comparison with Typically Developing Peers

Operational Definition: A systematic comparison between the scores obtained by children with ADHD and those obtained by typically developing children on the Reading Test by Saliha Ghellab and the Writing Test by Saliha Ben Bouzid, with the aim of identifying statistically significant differences between the two groups.

J. Methodology

1) Research Method

This study employed a **descriptive-analytical comparative method**, given its suitability to the nature of the topic and the objectives set (Ghellab, 1997; Labouk & Bechlague, 2022). This method aims to describe the phenomenon under study (reading and writing skills in children with ADHD) and analyze it, then compare it with typically developing peers to identify statistically significant differences between the two groups.

Given the exploratory nature of this study and the small sample size (5 children per group), the study was designed as a **multiple-case comparative study** rather than a population-based study. The aim is not statistical generalization, but rather an in-depth exploration of the nature of reading and writing difficulties in children with ADHD, and the generation of hypotheses for future research. This design is consistent with the recommendations of Yin (2018) for multiple-case studies, which allow for analytical generalization rather than statistical generalization.

2) Study Population and Sample

3) Study Population

The study population consists of primary school pupils (third year of primary education) enrolled in primary schools in the wilaya of Tizi Ouzou, aged between 8 and 11 years.

4) Study Sample

The study sample was selected using a **purposive (non-probability) sampling method**, given the nature of the study, which requires participants to possess specific characteristics, such as a diagnosis of ADHD and the absence of sensory, motor, or severe psychiatric comorbidities (Landínez-Martínez et al., 2025).

The sample consisted of **10 pupils**, divided into two equal groups:

- **Experimental group**: 5 pupils with ADHD.
- **Control group**: 5 typically developing pupils.

5) Characteristics of the Experimental Group (Children with ADHD)

TABLE I.
PRESENTS THE DEMOGRAPHIC AND EDUCATIONAL CHARACTERISTICS OF THE EXPERIMENTAL GROUP.

TABLE I.
CHARACTERISTICS OF CHILDREN WITH ADHD

Case	Age	Gender	Educational Level	Speech Therapy	Comorbid Disorders
01	9 years	Male	Third year primary	Not reported	None
02	11 years	Male	Third year primary	Not reported	None
03	8 years	Male	Third year primary	Not reported	None
04	9 years	Male	Third year primary	Not reported	None
05	11 years	Female	Third year primary	Not reported	None

Notes on Table 1:

- The ages of the experimental group range from 8 to 11 years.
- Males predominate in the group (4 males and 1 female).
- All participants are in the same educational level (third year of primary education).
- None of the participants receive reported speech therapy.
- No comorbid disorders (such as learning disabilities or sensory/motor impairments) are present in any participant (American Psychiatric Association, 2013).

6) Characteristics of the Control Group (Typically Developing Children)

TABLE II.
PRESENTS THE DEMOGRAPHIC AND EDUCATIONAL CHARACTERISTICS OF THE CONTROL GROUP.

- The ages of the control group range from 9 to 10 years.
- The group consists of 3 males and 2 females.
- All participants are in the same educational level (third year of primary education).

TABLE II.
CHARACTERISTICS OF TYPICALLY DEVELOPING CHILDREN

Case	Age	Gender	Educational Level
01	10 years	Female	Third year primary
02	09 years	Female	Third year primary
03	10 years	Male	Third year primary
04	09 years	Male	Third year primary
05	09 years	Male	Third year primary

Notes on Table 2:

7) Matching of the Two Groups

The two groups were **matched** on the following variables:

- **Educational level**: All participants are in the third year of primary education.
- **Chronological age**: Comparable ages between the two groups (8–11 years).
- **Gender**: Comparable distribution of males and females.
- **Absence of comorbid disorders**: None of the participants have sensory, motor, or severe psychiatric disorders (American Psychiatric Association, 2013).
- **No speech therapy**: None of the experimental group participants receive reported speech therapy.

8) Study Instruments

The study employed the following instruments:

9) Conners' Rating Scales

Definition: The Conners' Rating Scales are standardized diagnostic tools developed by C. Keith Conners in the 1960s (Conners, 2008). They are among the most widely used instruments worldwide for assessing Attention-Deficit/Hyperactivity Disorder (ADHD) in children and adolescents (Conners, 2008; American Psychiatric Association, 2013). In this study, both the Parent and Teacher versions were used.

I. OBJECTIVE:

- To diagnose ADHD according to DSM-5 criteria (American Psychiatric Association, 2013).
- To determine the clinical subtype of the disorder (predominantly inattentive, predominantly hyperactive/impulsive, or combined) (American Psychiatric Association, 2013).
- To assess the severity of attentional and behavioral symptoms from both parents' and teachers' perspectives (Conners, 2008).

Components: The scale consists of items measuring:

- **Inattention**: difficulty sustaining focus, forgetfulness, distractibility, failure to complete tasks (American Psychiatric Association, 2013).
- **Hyperactivity/Impulsivity**: fidgeting, inability to stay seated, interrupting, blurting out answers (American Psychiatric Association, 2013).
- **Associated dimensions**: behavioral problems, social interaction, mood (Conners, 2008).

A. Administration:

- **Respondents**: Parents and teachers.
- **Rating type**: Likert-type scale.
- **Duration**: Approximately 10–20 minutes per version.

B. Scoring:

- Total and subscale scores are calculated for each dimension.
- Scores are compared to normative percentiles to determine whether symptoms fall within the normal or clinical range (Conners, 2008).
- Diagnosis is confirmed if scores exceed the cut-off points specified in DSM-5 criteria (American Psychiatric Association, 2013).

C. Psychometric Properties:

- Validity and reliability have been established in numerous Arabic and international studies (Conners, 2008).
- High reliability coefficients (Cronbach's alpha typically ranging between 0.85 and 0.95) (Conners, 2008).

D. Suitability for the Present Study:

- It is the most widely used and reliable tool for ADHD diagnosis (Conners, 2008).
- It provides two versions (parents and teachers) for more accurate diagnosis.
- It allows classification of children into clinical subtypes (American Psychiatric Association, 2013).
- It is widely used in the Algerian and Arab context (Al-Shekaili et al., 2025).

1) Reading Test (by Saliha Ghellab)

Definition: The Reading Test used in this study is an assessment tool adapted from the French Reading Test L'Alouette by P. Le Favrais (1965), which aims to determine pupils' reading level and compare it with their chronological age, thereby allowing the diagnosis of reading learning disabilities in primary school pupils (Le Favrais, 1965). The test was Arabized and adapted to the Algerian school environment by researcher Saliha Ghellab (1997) in her Master's thesis entitled "Reading Learning Disabilities in the Algerian School," applied to a sample of 140 pupils (Ghellab, 1997).

II. OBJECTIVE:

- To measure reading fluency speed (reading time) (Ghellab, 1997).
- To assess reading accuracy (number of errors) (Ghellab, 1997).
- To analyze error types and classification (substitution, omission, addition, reversal, repetition, segmentation) (Ghellab, 1997).
- To determine reading rhythm (fast, slow, mechanical, automatic, or normal) (Ghellab, 1997).
- To diagnose reading disabilities in primary school pupils (Ghellab, 1997).

A. Components:

- **Text**: Consists of **267 words**, divided into four paragraphs of short and simple or complex sentences (Ghellab, 1997).
- **Content**: Includes verbal sentences (e.g., "Behind the vehicle"), nominal sentences, spatial adverbs (North, South, Center), temporal adverbs (morning, season, time), and color names (green, blue, yellow) (Ghellab, 1997).
- **Illustrations**: Included in the text (Appendix 1) to measure speed of recognition of size and color (Ghellab, 1997).

B. Administration:

- **Instructions**: The pupil is asked to sit properly, then instructions are read aloud (Ghellab, 1997).
- **Procedure**: The pupil reads the text aloud (Ghellab, 1997).
- **Recording**: The examiner records reading time, number of errors, error type, and reading speed (Ghellab, 1997).

C. Scoring:

- **Time**: Recorded in seconds or minutes (Ghellab, 1997).
- **Errors**: Counted according to the following criteria:
  - Words read incorrectly.
  - Words omitted.
  - Words added.
  - Words substituted.
  - Pronunciation errors (e.g., omission, repetition, addition, reversal).
  - Intonation errors (e.g., slow, fast, mechanical, automatic reading) (Ghellab, 1997).
- **Score**: Total score is calculated based on the number of correct words, time, and number of errors (Ghellab, 1997).

D. Psychometric Properties:

- The tool is validated in the Algerian context and was used in Saliha Ghellab's study (1997) on a sample of 140 pupils (Ghellab, 1997).
- It is considered a reliable tool for assessing reading disabilities in Algeria (Ghellab, 1997).

E. Suitability for the Present Study:

- It is specifically designed for the Algerian context (Ghellab, 1997).
- It measures multiple reading indicators (time, accuracy, error type) (Ghellab, 1997).
- It allows quantitative and qualitative assessment of pupil performance (Ghellab, 1997).
- It is suitable for primary school level (Ghellab, 1997).
- It is validated in previous studies in Algeria (Ghellab, 1997).

1) Writing Test (by Saliha Ben Bouzid)

Definition: The Writing Test used in this study is an assessment tool developed by researcher Saliha Ben Bouzid to assess writing skills (spelling and handwriting) in primary school pupils in the Algerian context (Bouzid, 1991). The test was originally based on the work of PEGUIS (1979) and Ajuriaguerra et al. (1979), then adapted and standardized for the Algerian context by Saliha Ben Bouzid (1991).

III. OBJECTIVE:

- To identify writing problems in pupils in the first cycle of basic education (Bouzid, 1991).
- To assess writing skills (spelling and handwriting) through a set of scoring criteria (Bouzid, 1991).
- To diagnose dysgraphia in pupils (Bouzid, 1991).

Components: The test consists of three main sections:

Section 1: General Text Form and Organization (Items 1–11)
This section assesses:

1. Alignment and line adherence.
2. Margins (right and left).
3. Spacing between words.
4. Spacing between lines.
5. Continuity and linking.
6. Letter size.
7. Writing type (legibility).
8. Word compression.
9. Text segmentation.
10. Text containment (fitting the text on the page).
11. Punctuation marks (Bouzid, 1991).

Section 2: Letter Copying Accuracy (Items 12–25)
This section assesses the accuracy of writing Arabic letters in terms of:

- Distortion of isolated letters (e.g., Alif, Ba, Ta, Tha, Jeem, Ha, Kha, Dal, Dhal, Ra, Zay, Seen, Sheen, Sad, Dad, Ta, Za, Ain, Ghain, Fa, Qaf, Kaf, Lam, Meem, Noon, Ha, Waw, Ya).
- Distortion of connected letters (e.g., La, Laa, Li, Lu).
- Distortion of letters at the beginning, middle, and end of words.
- Letter omission (e.g., omitting Alif, Lam, Seen, Sheen).
- Letter addition (e.g., adding Alif, Waw).
- Letter reversal (e.g., reversing Ba and Ta, or Ra and Zay).
- Distortion of similar letters (e.g., B/T/Th, J/H/Kh, D/Dh, R/Z, S/Sh, S/D, T/Z, A/Gh, F/Q) (Bouzid, 1991).

Section 3: Writing Test Scoring Sheet
Contains a table for recording scores according to the following criteria:

- **Criteria**: 25 criteria divided into three sections.
- **Scores**: For each criterion, three scores are assigned:
  - **1**: No distortion.
  - **2**: Distortion appears once.
  - **3**: Repeated distortion (Bouzid, 1991).

A. Administration:

- **Instructions**: The pupil is asked to write a text or take dictation according to the test instructions (Bouzid, 1991).
- **Procedure**: Individual or group administration.
- **Recording**: The examiner records scores on the scoring sheet.
- **Duration**: Varies according to the writing task.

B. Scoring:

- **Total score**: Sum of the 25 criteria scores.
- **Interpretation**:
  - **Score 1**: No distortion (normal writing).
  - **Score 2**: Distortion appears once (mild difficulty).
  - **Score 3**: Repeated distortion (moderate to severe difficulty) (Bouzid, 1991).

C. Psychometric Properties:

- The tool is validated in the Algerian context (Bouzid, 1991).
- It was standardized by Saliha Ben Bouzid (1991).
- It is used to assess dysgraphia in primary school pupils (Bouzid, 1991).

D. Suitability for the Present Study:

- It is specifically designed for the Algerian context (Bouzid, 1991).
- It measures multiple writing indicators (form, handwriting, difficulty) (Bouzid, 1991).
- It allows quantitative and qualitative assessment of pupil performance (Bouzid, 1991).
- It is suitable for primary school level (Bouzid, 1991).
- It is validated in previous studies in Algeria (Bouzid, 1991).

1) Study Procedures

The study procedures were carried out according to the following steps:

1. **Sample selection**: The sample was purposively selected from primary schools after obtaining the necessary approvals from the relevant educational authorities, schools, and parents.
2. **Diagnosis of cases**: Children with ADHD were diagnosed using the **Conners' Rating Scales** (Parent and Teacher versions), according to DSM-5 criteria, and the disorder subtype and severity were determined (Conners, 2008; American Psychiatric Association, 2013). The control group was confirmed not to meet the diagnostic criteria.
3. **Administration of the Reading Test**: The **Reading Test by Saliha Ghellab** was administered to all participants in both groups, recording reading time, number of errors, and error type (Ghellab, 1997). The test consists of a 267-word text that the pupil is asked to read aloud.
4. **Administration of the Writing Test**: The **Writing Test by Saliha Ben Bouzid** was administered to all participants, assessing general text form, handwriting quality, and degree of difficulty according to the scoring scale (25 criteria divided into three sections) (Bouzid, 1991).
5. **Data collection and coding**: Data were collected and coded into statistical tables to facilitate analysis.
6. **Data analysis**: Data were analyzed using appropriate statistical methods, including comparison between the two groups.

2) Statistical Methods

Given the small sample size (5 pupils per group), the following were used:

- **Means and standard deviations** to describe the performance of each group.
- **Mann-Whitney U test** for comparison between two independent groups, a non-parametric test suitable for small samples (Miranda Casas et al., 2011).
- **Effect size (r)** was calculated using the formula $r = Z / \sqrt{N}$, and interpreted according to Cohen's (1988) criteria.
- **Percentages and frequencies** to analyze error types and classification.

3) Ethical Considerations

The study adhered to the following ethical standards:

- Obtaining informed consent from the parents of participating children.

- Ensuring data confidentiality and using data solely for research purposes.
- Anonymizing participants using codes instead of names.
- The right of participants to withdraw from the study at any time without consequences (American Psychiatric Association, 2013).

4) Study Limitations

1. **Spatial Limitations**: The study was limited to primary schools in the wilaya of Tizi Ouzou.
2. **Temporal Limitations**: The study was conducted during the academic year 2025/2026.
3. **Human Limitations**: The sample was limited to 10 pupils (5 with ADHD and 5 typically developing) from the third year of primary education.
4. **Subject Limitations**: The study was limited to assessing reading and writing skills in children with ADHD compared to typically developing children.
5. **Sample size limitation**: The small sample size (5 children per group) constitutes the main limitation of this study. Therefore, the results cannot be generalized to the entire population of children with ADHD, but rather serve as an exploratory basis for generating hypotheses and guiding future research with larger samples.

E. Results

1) Raw Results of the Reading and Writing Tests

TABLE III.
PRESENTS THE RAW SCORES OBTAINED BY THE PARTICIPANTS ON THE READING AND WRITING TESTS, ALONG WITH THEIR CORRESPONDING PERCENTAGES.

TABLE III.
RAW RESULTS OF THE READING AND WRITING TESTS

Case	Group	Reading Test (out of 267)	Percentage	Writing Test (out of 50)	Percentage
01	Experimental (ADHD)	40	14.9%	30	60%
02	Experimental (ADHD)	27	10.1%	42	84%
03	Experimental (ADHD)	127	46.01%	16	32%
04	Experimental (ADHD)	95	35.58%	33	66%
05	Experimental (ADHD)	60	22.47%	40	80%
06	Control (Typically Developing)	160	59.92%	06	12%
07	Control (Typically Developing)	169	63.29%	04	08%
08	Control (Typically Developing)	115	43.07%	07	14%
09	Control (Typically Developing)	176	65.91%	04	08%
10	Control (Typically Developing)	150	56.17%	07	14%

Notes on Table 3:

- **Reading Test**: Percentages in the experimental group ranged from **10.1%** to **46.01%**, while in the control group they ranged from **43.07%** to **65.91%**. This indicates a clear difference between the two groups.
- **Writing Test**: Percentages in the experimental group ranged from **32%** to **84%** (these percentages reflect the degree of difficulty, where a higher percentage indicates greater difficulty), while in the control group they ranged from **08%** to **14%**. This also indicates a clear difference between the two groups.

2) Descriptive Statistics

TABLE IV.
PRESENTS THE MEANS AND STANDARD DEVIATIONS FOR BOTH GROUPS ON THE READING AND WRITING TESTS.

TABLE IV.
MEANS AND STANDARD DEVIATIONS FOR BOTH GROUPS

Group	N	Reading (Mean ± SD)	Writing (Mean ± SD)
ADHD	5	69.80 ± 38.55	32.20 ± 10.43
Typically Developing	5	154.00 ± 24.02	5.60 ± 1.52

3) Statistical Results of the Reading Test

TABLE V.
PRESENTS THE RESULTS OF THE MANN-WHITNEY U TEST FOR COMPARISON BETWEEN THE TWO GROUPS IN THE READING TEST.

TABLE V.
RESULTS OF THE DIFFERENCE BETWEEN CHILDREN WITH ADHD AND THEIR TYPICALLY DEVELOPING PEERS IN READING

Group	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Sig.	Effect Size (r)
Children with ADHD	5	3.20	16.00	1.000	0.016	-0.76
Typically Developing	5	7.80	39.00			
Total	**10**					

F. Analysis of Results:

- **Mean Rank** for the experimental group (children with ADHD) was **3.20**, while for the control group (typically developing) it was **7.80**. This means that the control group obtained higher ranks in the Reading Test.
- **Mann-Whitney U value** was **1.000**.
- **Significance value (Sig.)** was **0.016**, which is less than the significance level of **0.05**, indicating **statistically significant differences** between the two groups in the Reading Test.
- **Effect size (r)** was **-0.76**, indicating a **large effect size** according to Cohen's (1988) criteria.

1) Statistical Results of the Writing Test

TABLE VI.
PRESENTS THE RESULTS OF THE MANN-WHITNEY U TEST FOR COMPARISON BETWEEN THE TWO GROUPS IN THE WRITING TEST.

TABLE VI.
RESULTS OF THE DIFFERENCE BETWEEN CHILDREN WITH ADHD AND THEIR TYPICALLY DEVELOPING PEERS IN WRITING

Group	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Sig.	Effect Size (r)
Children with ADHD	5	8.00	40.00	0.000	0.009	-0.83
Typically Developing	5	3.00	15.00			
Total	**10**					

G. Analysis of Results:

- **Mean Rank** for the experimental group (children with ADHD) was **8.00**, while for the control group (typically developing) it was **3.00**. This means that the experimental group obtained higher ranks in the Writing Test (indicating greater difficulties).
- **Mann-Whitney U value** was **0.000**.
- **Significance value (Sig.)** was **0.009**, which is less than the significance level of **0.05**, indicating **statistically significant differences** between the two groups in the Writing Test.
- **Effect size (r)** was **-0.83**, indicating a **large effect size** according to Cohen's (1988) criteria.

1) Qualitative Analysis of Reading Errors

Beyond the quantitative analysis, a qualitative examination of the reading errors produced by children with ADHD revealed several recurring patterns. The most frequently observed errors were **omissions** (skipping words or parts of words) and **substitutions** (replacing a word with another that is visually or phonologically similar). **Additions** and **reversals** were also observed in some cases, particularly among children with more severe attentional symptoms. These error patterns are consistent with those reported in previous studies (Ghellab, 1997; Abdelhamid et al., 2013), and suggest underlying difficulties in phonological processing and visual attention, which are commonly associated with ADHD. In contrast, the typically developing children produced very few errors, and when errors occurred, they were mostly self-corrected, indicating more efficient self-monitoring and metacognitive skills.

2) Qualitative Analysis of Writing Components

The qualitative analysis of the writing samples revealed that children with ADHD exhibited noticeable difficulties across all three components assessed by the Writing Test. Regarding **general text form and organization**, the majority of children with ADHD failed to respect margins, spacing between words, and line adherence, producing texts that were visually disorganized. Concerning **handwriting quality and legibility**, several graphomotor distortions were observed, including letter reversals, omissions, and misplaced dots, which sometimes made the written text difficult to read. As for the **degree of writing difficulties**, most children with ADHD fell within the moderate to severe range, indicating significant challenges in

written expression. In contrast, the typically developing children produced well-organized texts with legible handwriting and no significant graphomotor distortions. These findings align with those reported by Bouzid (1991) and Zawi et al. (2022).

H. Discussion

1) Discussion of Reading Results

The results revealed statistically significant differences between the two groups in the Reading Test (Sig. = 0.016), with the control group obtaining higher ranks (Mean Rank = 7.80) compared to the experimental group (Mean Rank = 3.20). This means that children with ADHD experience clear difficulties in reading.

I. Interpretation of Results in Light of Previous Studies:

- These results are consistent with the study by **Landínez-Martínez et al. (2025)**, which showed that children with ADHD exhibit deficits in reading speed and text comprehension.
- They are also consistent with the study by **Miller et al. (2013)**, which indicated that adolescents with ADHD scored lower on standardized reading comprehension measures.
- They are also consistent with the study by **Miranda et al. (2017)**, which showed that adults with ADHD performed worse in reading speed.

J. Theoretical Interpretation:

- **Attentional Deficit**: Inattention affects the child's ability to focus during reading, leading to increased errors and slower performance (American Psychiatric Association, 2013).
- **Working Memory Deficit**: Working memory deficits affect the child's ability to retain and process information during reading (Miranda Casas et al., 2010).
- **Metalinguistic Skills Deficit**: Phonological awareness deficits affect the child's ability to decode words (Abdelhamid et al., 2013).

The qualitative analysis of reading errors further supports these interpretations. The predominance of omissions and substitutions suggests difficulties in phonological processing and visual attention, which are core deficits in ADHD. The presence of additions and reversals, particularly in children with more severe attentional symptoms, indicates additional challenges in inhibitory control and visual-spatial processing.

1) Discussion of Writing Results

The results revealed statistically significant differences between the two groups in the Writing Test (Sig. = 0.009), with the experimental group obtaining higher ranks (Mean Rank = 8.00) compared to the control group (Mean Rank = 3.00). This means that children with ADHD experience clear difficulties in writing.

K. Interpretation of Results in Light of Previous Studies:

- These results are consistent with the study by **Labouk and Bechlague (2022)**, which showed that children with ADHD experience difficulties in learning to write.
- They are also consistent with the study by **Zawi et al. (2022)**, which showed that children with ADHD suffer from dysgraphia.
- They are also consistent with what was indicated by **Ajuriaguerra et al. (1979)** regarding the relationship between writing difficulties and the development of fine motor skills.

L. Theoretical Interpretation:

- **Executive Function Deficits**: Planning and organization deficits affect the child's ability to organize the text (Avramovich & Yeari, 2024).
- **Fine Motor Skill Difficulties**: These affect handwriting quality and legibility (Ajuriaguerra et al., 1979).
- **Metalinguistic Skills Deficit**: Morphological processing deficits affect writing accuracy (Abdelhamid et al., 2013).

The qualitative analysis of writing components further supports these interpretations. The poor general text form and organization reflect executive function deficits in planning and organization. The graphomotor distortions reflect fine motor skill difficulties. The moderate to severe degree of writing difficulties reflects the cumulative impact of these deficits on written expression.

1) Neurocognitive Mechanisms Underlying Reading and Writing Difficulties in ADHD

The reading and writing difficulties observed in children with ADHD can be explained by several neurocognitive mechanisms:

1. Working Memory Deficits: Children with ADHD often exhibit deficits in working memory, which is essential for decoding words, retaining information during reading, and organizing text during writing (Miranda Casas et al., 2010).

2. Executive Function Impairments: Planning, organization, and inhibition deficits affect the child's ability to plan and organize written text, and to monitor and correct reading errors (Avramovich & Yeari, 2024).

3. Phonological Awareness Deficits: Phonological awareness is a key predictor of reading success. Children with ADHD often exhibit phonological processing deficits, which affect their ability to decode words (Abdelhamid et al., 2013).

4. Attentional Deficits: Inattention affects the child's ability to focus during reading and writing tasks, leading to increased errors and slower performance (American Psychiatric Association, 2013).

5. Fine Motor Skill Deficits: Difficulties in fine motor skills affect handwriting quality and legibility, which are essential components of written expression (Ajuriaguerra et al., 1979).

M. Conclusion

This exploratory multiple-case study aimed to conduct a neuropsychological and neurolinguistic assessment of reading and writing in children with Attention-Deficit/Hyperactivity Disorder (ADHD) compared to their typically developing peers. The study employed the Reading Test by Saliha Ghellab and the Writing Test by Saliha Ben Bouzid, administered to a sample of 10 pupils (5 with ADHD and 5 typically developing) in primary education.

The results revealed statistically significant differences between the two groups in both reading and writing skills. In reading, children with ADHD exhibited clear difficulties, manifested in slow reading fluency, a high number of errors, and a predominance of omission and substitution errors. Statistical analysis using the Mann-Whitney U test confirmed significant differences between the two groups (Sig. = 0.016), with the control group obtaining higher ranks (Mean Rank = 7.80) compared to the experimental group (Mean Rank = 3.20), and a large effect size (r = -0.76). In writing, children with ADHD exhibited clear difficulties, manifested in poor general text form and organization, distortions in handwriting quality and legibility, and moderate to severe degrees of writing difficulties. Statistical analysis confirmed significant differences between the two groups (Sig. = 0.009), with the experimental group obtaining higher ranks (Mean Rank = 8.00) indicating greater difficulties, compared to the control group (Mean Rank = 3.00), and a large effect size (r = -0.83).

These findings are consistent with previous studies that reported deficits in written language skills among children with ADHD (Landínez-Martínez et al., 2025; Miller et al., 2013; Miranda et al., 2017; Labouk & Bechlague, 2022; Zawi et al., 2022). The study concludes that ADHD is associated with significant impairments in reading and writing skills, which necessitate early identification and specialized intervention. However, given the exploratory nature of the study and the small sample size, these findings should be interpreted as preliminary evidence that requires confirmation through future studies with larger samples.

N. Recommendations

Based on the results obtained, the following recommendations are proposed:

First, the necessity of conducting a comprehensive neuropsychological and neurolinguistic assessment for children with ADHD at an early stage, in order to detect reading and writing difficulties and provide appropriate intervention before these difficulties become entrenched and negatively affect academic achievement and self-esteem.

Second, the design of specialized intervention programs that target the specific skills experiencing deficits, whether linguistic (such as phonological awareness and morphological processing), cognitive (such as working memory and attention), or executive (such as planning, organization, and inhibition), rather than adopting a one-size-fits-all approach.

Third, the adoption of an interdisciplinary approach, through working within multidisciplinary teams including neuropsychologists, speech-language pathologists, teachers, and parents, to provide comprehensive and integrated support for this population, ensuring consistency between home, school, and clinical settings.

Fourth, the adaptation of teaching strategies to suit the needs of this population, with additional support provided in reading and writing, and the provision of an organized learning environment that reduces distractions and enhances focus and attention.

Fifth, the development and standardization of Arabic assessment tools that take into account the linguistic and cultural characteristics of Arab society, to enable accurate and culturally appropriate assessment of reading and writing skills in children with ADHD.

Sixth, the provision of training programs for teachers and educators on how to identify and support children with ADHD who experience reading and writing difficulties, and the promotion of community awareness about ADHD and its associated academic challenges.

Seventh, future research should replicate this study with larger samples, using longitudinal designs, to confirm the findings and explore the developmental trajectories of reading and writing difficulties in children with ADHD.

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