Understanding the significance of syntactic errors in dyslexic writing

Anindita Sahoo, Priyanka Mowlali & Shobhith Vadlamudi *

Abstract. Dyslexia is a neuro-developmental disorder that affects learning ability. Dyslexics find it challenging to correlate orthographic and phonetic representations despite normal intelligence. Though orthographic errors in dyslexia has been widely researched, syntactic error based discussion remains underexplored. In this research, we highlight the relevance of syntactic errors which may help identify dyslexia at an early stage. By investigating these errors, we aim to improve the understanding of dyslexic writing patterns and assess syntactic errors as potential diagnostic indicators, facilitating early intervention. Data for the current research have been collected from children aged seven to nine years from two schools in the Indian Institute of Technology Madras Campus, Chennai, India. A dictation-based method has been used, where participants wrote down ten sentences. Both groups exhibit orthographic errors, but syntactic errors are disproportionately higher among dyslexic children. Statistical analysis of the data reveals a strong correlation between orthographic and syntactic errors (r = 0.692, $p < 0.01$), emphasizing the significance of syntactic structures in dyslexia assessment. These findings suggest that syntactic errors, alongside orthographic errors, could serve as diagnostic markers for dyslexia, enabling a more comprehensive screening approach and informing targeted educational interventions.

Keywords. Dyslexia; Orthographic errors; Syntactic errors; Language disorders in children

1 Introduction

Dyslexia is a neurodevelopmental disorder marked by persistent difficulties in reading and writing despite normal intelligence (Lyon et al. 2003). It is widely regarded as having a genetic basis, with implicated genes influencing brain development (Raschle et al. 2011). Nonetheless, research has also documented cases of acquired dyslexia resulting from brain injury or neurological damage (Nicolson et al. 2010). Neuroimaging studies reveal reduced activity in the occipital and parietal lobes of individuals with dyslexia, regions crucial for language processing (Sun et al. 2010). These neurobiological differences contribute to difficulties in decoding words and comprehending sentence structures. For example, a dyslexic individual may write 'teacher' as *teecher*, reflecting a misalignment between phonological and orthographic representations.

Research on dyslexia spans over a century, encompassing epidemiological, cognitive, neurobiological, developmental, and linguistic perspectives. Early studies conceptualized dyslexia as a general language-based learning disability (Lerner 1989 ; Lyon 1995 ; Fletcher & Foorman 1994), whereas more recent work emphasizes its neurobiological underpinnings (Fletcher et al. 2002 , Lyon et al. 2003). While considerable focus has been placed on single-word decoding and phonological deficits, current inquiries have begun to expand the scope by examining sentence-level processing to understand better the broader linguistic challenges faced by individuals with dyslexia. Although phonological deficits are the hallmark of dyslexia, they often result in broader

* Authors: Anindita Sahoo , Indian Institute of Technology Madras (anindita@zmail.iitm.ac.in) & Priyanka Mowlali, Indian Institute of Technology Madras (priyankamowlali@gmail.com). & Shobhith Vadlamudi, Indian Institute of Technology Madras (shobhith.v@gmail.com).

difficulties with reading fluency and comprehension. These challenges can slow the development of a child's vocabulary and limit their accumulation of background knowledge, ultimately impacting their academic progress. One particularly troubling issue is the difficulty dyslexic learners face in connecting sounds with their written forms. For example, Backman et al. (1984) observe that a ten-year-old student with dyslexia frequently misspelled words, writing *plaing* instead of 'playing' and *battelships* instead of 'battleships'.

Understanding both orthographic and syntactic errors in the writing of children with dyslexia provides valuable insight into their specific linguistic impairments. Such analysis can reveal patterns, such as overgeneralization, the omission of grammatical elements, or the insertion of unnecessary phrases. Importantly, identifying these patterns can inform targeted interventions by educators and therapists, improving both diagnosis and instructional strategies.

2 Dyslexia and errors in language use

The existing literature on errors describes them as 'incorrect forms' of the standard variety of language. In the context of language learning errors, Ridge (2013) claims that the sentences learners produce are not in alignment with the normal or 'correct' sentence in the target language. Extending Ellis (1994)'s definition of error, we note that the tokens of errors collected in our data fall into four categories: lexical, morphological, syntactic, and orthographic. Another major category of errors that is overwhelmingly discussed in the literature is phonological errors Moats (1996).This has also been found in our data repository.

2.1 Orthographic errors

Orthography refers to the correct way of writing a particular language (Franklin 2014). The term originates from the Greek words meaning 'correct writing'. It encompasses the standardized conventions of a language's writing system, including spelling, punctuation, word breaks, and emphasis. Orthographic errors occur when these conventions are violated, typically through incorrect spelling. While often inadvertent, such errors can significantly hinder comprehension. Gieve & Miller (2006) suggest that orthographic errors are cognitive in nature. Common characteristics of orthographic errors include phonologically plausible misspellings, e.g., *prefre* for 'prefer' and errors in uncommon or borrowed words, e.g., *datem* instead of 'datum'.

Orthographic errors are not a homogeneous category and are particularly common among second language learners. These errors frequently appear in low-frequency or borrowed vocabulary. In the case of dyslexia-related orthographic errors, the influence of phonological similarity is often more prominent than other factors.

2.2 Morphological errors

Morphological errors occur when the grammatical structure of words is incorrectly formed or applied (Zaid et al. 2017). According to Richards (1971), the morphological errors can be categorized in four prominent types, i.e. overgeneralization, ignorance of rule restrictions, incomplete application of rules and false concept hypothesis. Overgeneralization occurs when a learner applies a grammatical rule too broadly, based on previous language patterns, e.g. *goed* instead of 'went'. This indicates overgeneralization of the regular past tense formation. In the category of ignorance of rule restrictions, we notice that learners apply certain grammatical rules in contexts where they are not necessary, due to a lack of awareness about exceptions or limitations in

English grammatical rules. For example, we notice instances such as *she can sings well*, misapplying the third-person singular *-s* in a modal construction. The third type of morphological error lies in incomplete application of rules where the learner fails to implement the learned rule appropriately. Thus they produce constructions such as *He going to school* instead of 'He is going to school', omitting the auxiliary verb. The final category is the false concept hypothesis that states when the learner misunderstands the function or usage of a rule, it leads to errors based on incorrect assumptions. For example, *She like to read* is found in dyslexic learners' utterances due to the false belief that subject-verb agreement is optional or uniform across subjects.

These errors typically reflect developmental stages in language learning, highlighting the cognitive processes involved in acquiring morphological rules. They are especially common among second language learners who are still internalizing the grammatical structure of the target language.

2.3 Phonological errors

Phonological errors are found when there is a mismatch between the mapping of sounds (phonemes) of a word with their written forms (graphemes). This discordance between phonemic and graphemic representations leads to spelling errors that reflect underlying difficulties in phonological processing. Such errors often suggest a limited reliance on lexical (whole-word) spelling strategies, as noted by Snowling et al. (1986). In some cases, these errors are semiphonetic, where the written form only partially represents the intended sound structure of the word. For example, a child might write *frend* instead of 'friend', capturing some of the sounds but omitting the irregular spelling. Another example is *sed* for 'said' or *skool* for 'school'. These attempts show an effort to spell phonetically but fall short of the correct orthographic form. Phonological errors highlight the child's difficulty in integrating phonological awareness with orthographic knowledge, which is a key characteristic of dyslexia. Understanding and identifying these patterns is essential for accurate diagnosis and targeted intervention.

2.4 Syntactic errors

Human creativity generates novel expressions and can produce unlimited output from a limited set of rules. Jackendoff (2002) demonstrates how finite principles in syntax can yield infinite productivity. Taking reference from his seminal work "Foundations of Language", we notice that such combinatorial complexity of language emerges from its syntactic organization. This organization is a set of words that is created through the permutation and combination of a small set of phonetic segments that constitute language in the most natural and biological way. This is originally proposed by Chomsky (1957) where he argues that human speech has a limited set of words and grammatical rules that can produce an unlimited set of meaningful expressions. This is called language competence and this competence can generate infinite number of grammatically correct sentences in any natural language. These sentences occurred in conversational and other discourses may contain certain errors. These syntactic errors are classified into four major categories; errors of omission, errors of addition, errors of selection and errors of ordering. Errors of omission refer to leaving out a mandatory part of the sentence entirely. Errors of addition describe cases where some element is present which should not be there. Errors of selection is understood as choosing wrong phrases in the place of right ones. Finally, errors of ordering denotes that the required elements are present in the sentence but they are wrongly sequenced. Corder (1982) and Ndeze (2018) elaborate on these errors and state the various specific possible

errors in each case. Selection errors may consist of wrong choice of preposition, article or pronoun, selection of verbs or adjectives instead of nouns or selection of noun instead of verbs and adjective instead of adverbs. While addition errors consist of pluralization overuse, tense marker overuse, singularization errors, preposition, article as well as pronoun overuses. Omission errors are those in which compulsory elements such as prepositions, articles, tense markers, subjects or passive voice are omitted and misordering errors includes auxiliary misplacement and subject-verb misplacement and adjective and adverb misplacement.

According to Ndeze (2018), the most predominant errors in all language areas are wrong verb form, wrong choice of verb tense, tense marker omission or unnecessary tense marker addition as well as subject-verb agreement errors.“ It appears that tenses and verbs are the major problematic areas. Yet not all syntactic errors are the same for all English learners.” (Ndeze 2018). The major sources of the errors may be due to rules over-generalizations, language transfer, poor motivation and practices, inherent natural complexity of the language, problem of language input and most importantly error treatment among others.

3 Data and methodology

This study analyzes writing samples from 19 students aged seven to nine years, enrolled in two different schools located within the Indian Institute of Technology Madras (IIT Madras) campus in Chennai, Tamil Nadu, India. All participants were native Tamil speakers who had received formal instruction in English as part of their school curriculum. Of the 19 participants, 11 were identified by the schools as potentially dyslexic, based on prior assessments and educational records. The remaining eight students, considered non-dyslexic, were selected randomly from the same academic setting. A purposive sampling method was employed to ensure a balanced representation of both groups for comparative analysis.

3.1 Data collection

To elicit writing samples, participants were asked to write down a series of dictated sentences. These sentences were carefully chosen to span a range of syntactic constructions, incorporating various linguistic elements such as verbs (transitive and intransitive), nouns, prepositions, and numerical expressions. The selection was designed to probe specific grammatical structures where children with dyslexia might face challenges, particularly in identifying and reproducing functional elements within sentences.
The sentences used for dictation were as follows:

1. *This is a book.* (copular)
2. *I put the bag on the table.* (transitive/ditransitive with locative argument)
3. *I slept at 9 p.m.* (intransitive)
4. *The bumblebee is dancing merrily.* (intransitive with adverbial)
5. *God created the Earth.* (transitive/universal truth)
6. *Dog is a faithful animal.* (copular)

These constructions were selected to systematically vary in syntactic complexity and assess the learners' ability to process copular forms, transitivity, prepositional phrases, adverbs, and auxiliary usage. By including this range, the study seeks to identify the nature and location of syntactic disruptions, which may not be apparent through isolated word-level assessments. This design also enables a more nuanced evaluation of both omission and insertion errors, common indicators of dyslexic writing difficulties.
Each student was given a blank sheet and instructed to write down the dictated sentences verbatim. No assistance or intervention was provided during the task. The entire data collection process spanned approximately 30 minutes, with adequate pauses between sentences to ensure that all participants had sufficient time to complete their responses.

4 Statistical analsyis of orthographic and syntactic errors

In this study, we examine the statistical significance of orthographic and syntactic errors in the writing samples of both dyslexic and non-dyslexic children.[1] Orthographic errors refer to deviations in spelling, while syntactic errors indicate structural inconsistencies in sentence formation. By statistically assessing these errors, we aim to elucidate the linguistic challenges faced by children with dyslexia and determine whether syntactic errors can serve as a distinguishing characteristic of dyslexia. To achieve this, following Lockiewicz et al. (2019), we conducted independent t-tests and employed boxplot visualizations using the Python programming language.

4.1 Orthographic error analysis

To determine whether dyslexic participants exhibit significantly more orthographic errors than their non-dyslexic counterparts, a t-test is conducted under the following hypotheses:

i) Null Hypothesis (H0): There is no significant difference in the frequency of orthographic errors between dyslexic and non-dyslexic participants.

ii) Alternative Hypothesis (H1): Dyslexic participants exhibit a significantly higher frequency of orthographic errors than non-dyslexic participants.

Table 1: Orthographic Error Statistics

Measure	**Value**
Mean orthographic errors (Dyslexic Group)	9.33
Mean orthographic errors (Non-Dyslexic Group)	0.75
T-value	6.7811
p-value	3.474e-05
Degrees of Freedom	10.7
Effect size (Cohen's d)	3.2237

Given that the p-value < 0.001, the null hypothesis can be rejected. These findings suggest that children with dyslexia make significantly more orthographic errors than their non-dyslexic

[1] Although the sample size is small the analysis offers meaningful insights while considering the alternative hypothesis (H1).

peers. Furthermore, the large effect size ($d = 3.2237$) supports the notion that spelling difficulties are a prominent and distinguishing feature of dyslexic writing. Aligned with Cohen (1988), this case study provides additional evidence reinforcing this established understanding.

A boxplot analysis (Figure 1) is performed to illustrate the distribution of orthographic errors across both groups. The results indicate that:

i) Dyslexic participants exhibit a higher median error count and greater variability in orthographic errors compared to non-dyslexic participants.

ii) Non-dyslexic participants demonstrate minimal error dispersion, with the interquartile range nearly collapsing to the minimum and maximum values.

iii) Outliers are present among dyslexic participants, indicating that some individuals exhibited particularly high error rates.

These findings align with prior research highlighting the phonological processing deficits underlying dyslexic spelling difficulties (Rack et al. 1992; Landerl et al. 1997; Snowling 2000).

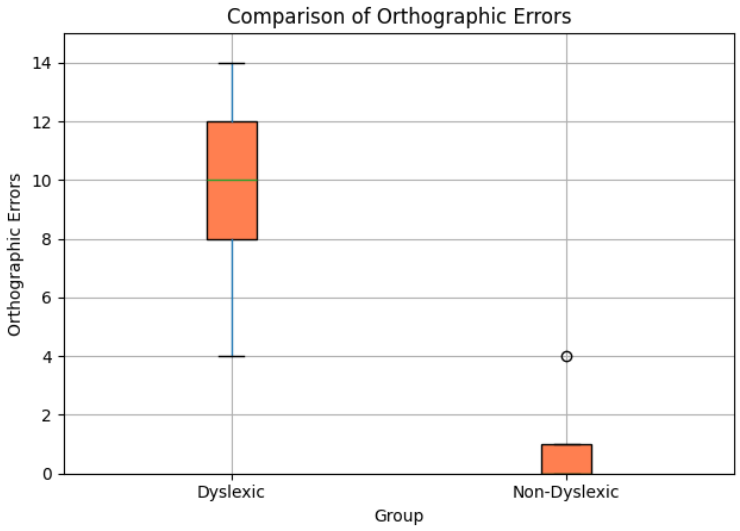

Figure 1: Boxplot comparing orthographic errors between the two groups.

4.2 Syntactic error analysis

Following the orthographic analysis, we examine syntactic errors using a similar t-test approach to assess whether dyslexic participants display significantly higher syntactic error rates.

i) Null Hypothesis (Ho): There is no significant difference between the frequency of syntactic errors between dyslexic and non-dyslexic children.

ii) Alternative Hypothesis (H1): Dyslexic participants exhibit significantly more syntactic errors than non-dyslexic participants.

Table 2: Syntactic Error Statistics

Measure	Value
Mean syntactic errors (Dyslexic Group)	5.22
Mean syntactic errors (Non-Dyslexic Group)	0.0
T-value	4.3971
p-value	0.002295
Degrees of Freedom	8
Effect size (Cohen's d)	2.0728

The results of the t-test for syntactic errors is shown below:

The results reveal a substantially higher rate of syntactic errors among dyslexic participants compared to their non-dyslexic peers. The large effect size (d = 2.0728) indicates that syntax-related difficulties are a major linguistic deficit in the writing of individuals with dyslexia. The boxplot analysis (Figure 2) highlights the disparity in syntactic errors between the two groups:

i) Dyslexic participants display a substantially higher number of syntactic errors than their non-dyslexic peers.

ii) The interquartile range is wider, indicating greater variability in syntactic performance among dyslexic children.

iii) Non-dyslexic participants exhibit negligible syntactic errors, reinforcing the statistical significance of the observed differences.

These findings suggest that syntactic processing difficulties may serve as a diagnostic indicator of dyslexia, complementing assessments of phonological and orthographic deficits.

4.3 Correlation between orthographic and syntactic errors

To examine the relationship between orthographic and syntactic errors, Pearson's correlation coefficient (r) was calculated: r=0.64371
A strong positive correlation, as indicated by r being greater than 0.5, suggests that dyslexic children who exhibit higher orthographic error rates are also more prone to making syntactic errors. This finding reinforces the notion that linguistic deficits in dyslexia extend beyond spelling difficulties to encompass broader impairments in grammatical processing.

4.4 Summary of statistical findings

These findings lead to the claim that syntactic errors, in addition to orthographic inaccuracies, should be considered diagnostic markers for dyslexia. In addition, the research reveals that non-dyslexic children do not make many syntactic errors, though there are quite a few spelling errors in their writing. Another significant observation includes dyslexic children making both syntactic and spelling errors almost equally. Furthermore, the analysis of the data suggests that during clinical diagnosis, assessors should pay attention to the patients' syntactic awareness.

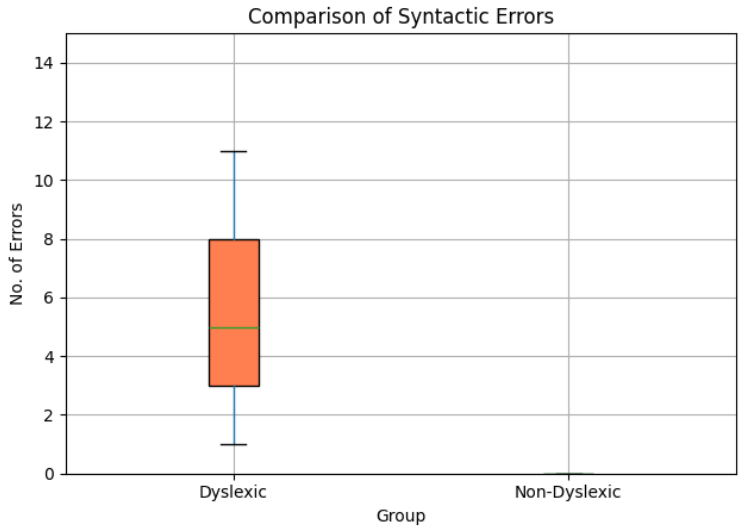

Figure 2: Boxplot comparing syntactic errors between the two groups. The plot shows a clear disparity, with one group exhibiting significantly more syntactic errors.

Table 3: Summary of Orthographic and Syntactic Error Statistics

Error Type	**Dyslexic (n=11)**	**Non-Dyslexic (n=8)**	**T-Test p-value**	**Effect Size**
Orthographic Errors	86 total Mean = 9.33	6 total Mean = 0.75	3.47e-05	3.22
Syntactic Errors	47 total Mean = 5.22	0 total Mean = 0.00	0.0023	2.07

5 Summary and further research

In the present investigation, we observe that dyslexic errors occur not only in the orthographic domain but also significantly in the syntactic domain. A notable pattern in orthographic errors among dyslexic children is the frequent omission of letters, which occurs more often than other error types.

While orthographic errors are noticed in both dyslexic and non-dyslexic children, syntactic errors hold particular importance in understanding the linguistic complexity associated with dyslexia. Writing samples collected from dyslexic children indicate extreme errors in both syntax and orthography. This reveals the challenges dyslexic individuals face in processing complex sentence constructions. These constructions require an organized pattern of words, which often proves difficult for the dyslexic brain to interpret in a meaningful way. This difficulty manifests in errors such as the unnecessary insertion of phrases (e.g., *The goad krat the what*) and the omission of essential sentence components (e.g., *The bumblebee dancing maryly*). Such insertions and deletions not only render the sentence ungrammatical but also point to cognitive difficulties in processing syntactic structures.

Our analysis reveals that syntactic errors are significantly more frequent in dyslexic children than in their non-dyslexic peers, supporting the notion that syntactic complexity plays a crucial role in

the identification and indication of dyslexia. While non-dyslexic children exhibit some spelling errors, their syntactic constructions are generally intact and error free. In contrast, dyslexic children tend to produce a higher number of extreme errors, especially in syntax.

Comparative data further supports our claims. In a sample of seven sentences from non-dyslexic children, we found no syntactic errors and only three orthographic errors. This stark contrast highlights the diagnostic value of syntactic error analysis, suggesting that such errors are more distinguishing than orthographic ones. Despite the small sample size, the consistency of this pattern underscores the importance of focusing on syntax as a critical diagnostic marker. To validate these findings, we examined the linguistic output of 11 dyslexic children and compared it with that of eight non-dyslexic children, all from the same school in Chennai. Our observations reveal that children with dyslexia consistently produce more frequent and severe syntactic errors. While the difference in mild to moderate errors is less pronounced, it remains significant. In contrast, syntactic irregularities are virtually absent in the non-dyslexic group. Orthographic errors are present in both groups, though in non-dyslexic children, they are typically mild or moderate, with no instances of extreme errors.

In conclusion, following Bourassa & Treiman (2008), we contend that although orthographic error analysis remains essential, it is important to prioritize syntactic error analysis in dyslexia research and diagnosis. Our findings further underscore that by paying closer attention to sentence construction difficulties, clinicians, therapists, and educators can gain deeper insights into the cognitive dimensions of dyslexia and develop more effective diagnostic tools. This focus also fills a critical gap in the current literature, where syntactic impairments in dyslexia remain underexplored.

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