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English learners with dyslexia benefit from English dyslexia intervention: an observational study of routine intervention practices

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Introduction: Learning to read when the language of the curriculum differs from one's home language can pose unique challenges. For example, compared to the language spoken at home, the learner may be less familiar with the sound structure and have relatively limited word knowledge in the language of instruction. In the United States, English is the primary language of reading instruction for students who are English Proficient (EP) and for English Learners (EL). Current evidence indicates that for both EP and EL students, code-based competencies and meaning-based skills are important for learning to read. English-language reading interventions have been shown to be beneficial for EPs and ELs with reading problems, though it is not clear if this is also true when the reading problem is a reading disorder like dyslexia.

Methods: The current study addresses this question by comparing EL and EP student's reading profile at baseline and changes over time in response to evidence-based English Language Dyslexia Instruction (ELDI) in public schools. One-hundred eighty-six students with dyslexia were followed over the course of two academic years. Assessments measured code and meaning-based reading skills. Multivariate profile analysis and linear mixed effects modeling were conducted to compare baseline reading profiles as well as growth in targeted skills over time.

Results: Findings reveal similar patterns of reading profiles across EL and EP groups, with more severe baseline deficits emerging for ELs. Groups performed equivalently on target reading skills after two years of intensive multi-componential reading intervention.

Conclusion: Findings confirm and extend previous research, suggesting ELs with Dyslexia can be identified and successfully served through routine practices, including ELDI.

KEYWORDS

English learner, dyslexia, dyslexia intervention, second language, reading outcomes

Introduction

A solid foundation in both oral and written language skills is key for the academic and occupational success of all children. However, not all students begin their academic journey similarly equipped to learn in the language of the educational curriculum. In the United States, where the language of the curriculum is typically English, approximately 1 in every 10 public school

students speaks a language other than English at home and lacks proficiency in English language skills (English Learners, ELs). Across the country this proportion continues to rise, and with it the urgency to discover ways in which to help ELs succeed (National Center for Education Statistics, 2022). Most ELs in the United States are learning English sequentially (i.e., some time after learning their native language) and demonstrate greater proficiency in their native language in one or more language domains compared to English (Rhodes et al., 2005; Rodríguez and Rodríguez, 2017). Multilingualism is associated with various cognitive, social, and linguistic benefits, but these benefits may not extend to those still developing proficiency in the non-native language (L2; Quinteros Baumgart and Billick, 2018; Bialystok et al., 2012). Learning to read in an L2 which is not one's home language poses unique challenges, including being less familiar with the sound structure of the language and limited word knowledge. Students in these situations are thus tasked with simultaneously developing L2 reading skills while still acquiring the L2 language itself. Languages can differ in many ways, including phonological, orthographic, syntactic, and morphological structure. Learning a new language sequentially requires the adjustment the phoneme boundaries of one's native tongue to accommodate the phonemic structure of the L2. For example, allophonic variations of the phoneme /*d*/ in Spanish (the first and second *d* in *dedo*) are distinct phonemes in English (/*d*/ in *dog* and /*th*/ in *mother*). Additionally, orthographic structure can vary greatly across languages. Children from logographic native orthographies who are learning English will have little knowledge of alphabetic principle, as logographic languages represent whole words and word parts using pictorial symbols with minimal reference to pronunciation. Those from other alphabetic native languages must learn to apply a new set of phoneme-grapheme correspondences and spelling rules to the L2. This process can be particularly arduous when the L2 is a quasiregular "opaque" orthography such as English, with variable consistency in phoneme-grapheme correspondences and spelling patterns. The similarities and differences across languages can impact L2 learning, both facilitating and inhibiting L2 performance (e.g., Frances et al., 2021; Siegel, 2016). Further complicating the picture, some ELs also struggle to develop reading skills due to underlying learning disabilities. Although ELs with learning disabilities are a distinct and identifiable group of students (e.g., Swanson et al., 2020), current identification methods are susceptible to various forms of bias in school settings and may not be well calibrated to identify learning disabilities in a timely and efficient manner for EL students (Hall et al., 2019; Moore, 2022; Odegard et al., 2020). Once identified, however, evidence supports the efficacy of similar intervention methods for ELs as those provided to their non-EL peers (see Goldenberg and Cárdenas-Hagan, 2023; Hall et al., 2019). Toward this end, the current study investigated the profiles of a sample of ELs with dyslexia (EL-DD) students and their English Proficient peers with dyslexia (EP-DD) identified through routine school procedures and receiving routine school-based English Language Dyslexia Intervention.

The simple view of reading and reading instruction

Skilled reading is supported by various underlying component skills, which often are generalized into distinct and broad linguistic categories corresponding to the Simple View of Reading: those related to deciphering a language's written or spoken code, and those related to understanding meaning conveyed by the language itself (Gough and Tunmer, 1986; Vaughn, 2018). Weaknesses in either of these domains can create significant disruptions in the reading process leading to reading failure. Furthermore, subskills exist within each of these domains which exert both direct and indirect effects on reading outcomes (e.g., Kim, 2017, 2020). The Simple View provides a conceptual framework for identifying broad categories of strengths and weaknesses in component skills across native language status, as well as typically developing and disordered populations.

Code-based competencies utilized in the process of recoding written orthographic information into its phonological counterpart are fundamentally involved in sound-symbol translation (e.g., phonological awareness, letter-sound knowledge, decoding, encoding) and are paramount in establishing accurate word-level reading skill (Byrne, 2014; Hatcher et al., 1994). Foundational to establishing proficiency in reading, code-based skills are acquired early in the typical progression of reading development and are highly predictive of later reading outcomes (Al Otaiba and Fuchs, 2006; Wanzek et al., 2018). Weak code-based skills are characteristic deficits in developmental dyslexia and are associated with disruptions in phonological processing, along with other cognitive and linguistic risk factors (Catts and Petscher, 2022; Ring and Black, 2018). Indeed, the primary characteristics of dyslexia are code-based, and often attributed to weaknesses in phonology, though deficits in meaning-based skills are not uncommon (e.g., Georgiou et al., 2022; Melby-Lervåg et al., 2012; Reis et al., 2020). Weaknesses in phonological processing for ELs have also been observed and may be due to relatively limited exposure to phonological properties of the L2 language. However, with instruction ELs tend to catch up to their peers on phonological processing tasks within a few years (Lesaux et al., 2007; Morrow et al., 2014). The extent to which students from minority language backgrounds tend to demonstrate deficiencies in other code-based skills is also unclear, and may vary as a function of L1 and L2 structure. For example, in a meta-analysis examining effects of native language on various reading skills across first and second language learners, language learners revealed small deficits for code-based skills compared to native speakers (Melby-Lervåg and Lervåg, 2014). Other studies report similar decoding performance across EL and EP groups, and still others report relative strengths for ELs, attributing superior performance to meta-linguistic awareness and flexibility in linguistic code (see August and Shanahan, 2006; Siegel, 2016).

Meaning-based skills leverage competency in oral language skills to support higher order reading skills such as comprehension. The meaning construed by a text—both at the individual word and passage levels—cannot be accessed through code-based skill alone. Rather, meaning is constructed through the integration of an individual's background knowledge, vocabulary, ability to analyze and synthesize information and draw inferences. Relative strengths in these skills can serve protective or promotive functions, allowing a reader to leverage language-based competencies to understand text, particularly in the face of code-based deficits (Haft et al., 2016). Over the course of the developmental timeline, meaning-based skills account for an increasingly large proportion of variance in reading, ultimately surpassing code-based skills as the strongest predictors of ability (Elleman and Oslund, 2019; Fletcher et al., 2018; Lervåg et al., 2017). In this way, meaning-based skills are critical facilitators of skilled reading. Unlike the word-level deficits characteristic of dyslexia, low reading performance in bilingual students was long understood to lie in meaning-based skills, attributable to oral English proficiency (August and Shanahan, 2006; Lesaux and Kieffer, 2010; Spencer and Wagner, 2017). Indeed, meaning-based skills play a larger role in reading outcomes for ELs in comparison to their EP peers,

although code-based skills also contribute significantly for both groups (Cho et al., 2019). Differences related to language acquisition status—specifically, weaknesses in phonological processing and vocabulary—may contribute to difficulties establishing high quality lexical representations for ELs, resulting in poor word reading performance.

Together, proficiency in both code- and meaning-based domains are critical to orchestrate multiple simultaneous cognitive processes in a dynamic fashion to ensure accuracy and understanding while reading. However, less is known about the nature of these subskills and their relations in EL-DDs relative to their EP-DD peers, and whether they respond similarly over the course of ELDI. The current study aims to address this gap in the literature by evaluating similarities and differences across reading profiles of EL-DDs and EP-DDs.

Reading instruction and intervention for English learners

Comprehensive, multicomponent reading instruction addresses deficits in code-based skills such as phonological processing and orthographic pattern recognition, as well as supports meaning-based skills through vocabulary instruction, comprehension strategy instruction, and repeated opportunities for practice and exposure to written text (Castles et al., 2018). Several recent meta-analyses reveal significant positive effects of multicomponent interventions on reading outcomes for elementary students with or at risk for reading disabilities (e.g., Boucher et al., 2024; Gersten et al., 2020; Hall et al., 2023). Given the intensity and comprehensive nature of these interventions, instructional programs such as these include the same instructional targets necessary for supporting the characteristic weaknesses of ELs (i.e., language-based) within the context of remediating characteristic weaknesses of dyslexia (see August and Shanahan, 2006). Explicit instruction in English phonemic awareness can improve knowledge of English phonological structure, leading to improvements in phonological and orthographic domains (Yeung et al., 2013). Explicit, systematic instruction in decoding and encoding can help to elucidate language-specific orthographic patterns and spelling rules. Morphological knowledge and awareness are also critical components of instruction in a morphophonemic language such as English and are addressed through instruction in decoding and encoding of derivatives using combinations of prefixes, suffixes, and common word roots. Finally, activities designed to support reading comprehension may also bolster ELs' facility with language structure including grammar and syntax, inference, non-literal language use, as well as provide repeated opportunities for application and consolidation of learning. Although significant improvements in reading skills are documented in many intervention studies, ELs may need additional instruction to reach similar levels of English achievement as their non-EL peers (see Goldenberg and Cárdenas-Hagan, 2023; Hall et al., 2019).

It is of note that many studies investigating intervention outcomes for ELs with reading difficulties were conducted on early elementary students who received intervention for up to one academic year. EL students demonstrated relatively poor reading comprehension and similar or even superior decoding ability compared to their non-EL peers (e.g., Vaughn et al., 2011; Wanzek and Roberts, 2012). Given the variable nature and severity of deficit profiles in EL-DDs, longer and more extensive instruction may be warranted to address the severity of deficits and improve retention (see Wanzek et al., 2013 for review and discussion of extensive reading interventions).

Reading profiles of students with reading difficulties

Profiles of performance in struggling readers has drawn increasing interest from reading researchers in recent years, with the aim of characterizing specificity and/or severity of deficits for underlying subgroups. Severity of deficits may warrant increased intervention intensity whereas specificity can guide focus of instruction to align with specific weaknesses (Capin et al., 2021; Fuchs et al., 2017). Recent studies using latent profile analysis support multi-factorial reading profiles of struggling readers which differ in both severity and specificity of deficits, depending in part on the characteristics of the sample and the measures used to quantify performance. For example, several studies report global impairments (i.e., profiles marked by severity) for a majority of EP struggling readers, with some studies also reporting subgroups marked by specificity of deficits (e.g., Brasseur-Hock et al., 2011; Capin et al., 2021; Capin et al., 2022; Clemens et al., 2017; O'Connor et al., 2019). Similarly, EL students with reading difficulties are differentiated by both severity and specificity of deficits relative to unimpaired EL readers, with consistent reports of weaknesses in meaning-based skills (e.g., Capin et al., 2024; Li et al., 2022; Miciak et al., 2022; O'Connor et al., 2019). However, many of these studies also report substantial weaknesses in code-based skills for a majority of the sample, suggesting that the reading impairments experienced by ELs is not specific to meaning-based skills, but rather indicative of globally impaired profiles. Indeed, one study investigating latent profiles for a mixed sample of EP and EL students reported similar distributions of the two groups across profiles, suggesting that specificity of impairments may not be unique according to language background (Lesaux and Kieffer, 2010). Furthermore, both code- and meaning-based skills contribute significantly to reading comprehension performance for both EP and EL students (Cho et al., 2019). Taken together, the results of these studies confirm substantial deficits in meaning-based skills for ELs, with mixed results regarding performance on code-based skills, particularly for samples of struggling readers.

Two studies to date that investigated reading profiles for EL students also followed students to evaluate changes in performance over time. The first of these studies differentiated a sample of late elementary EL students into two groups based on severity of impairments: a group with global literacy impairments, and a group of their unimpaired EL peers (Miciak et al., 2022). Authors reported nearly perfect stability of profiles over the course of an academic year, with the achievement gap between groups growing over time. Based on these findings, authors concluded that the global deficit profile of ELs at risk for dyslexia warrants intensive, comprehensive, and long-term interventions to remediate deficits across multiple reading components (i.e., code and meaning-based reading skills). It is important to note, however, that information regarding the instructional supports received by the students identified as impaired readers in this sample were not available in this study.

Heterogeneity in reading profiles of ELs with reading difficulties is also linked to variability in patterns of intervention growth (Capin et al., 2024). In this study, four distinct profiles were reported which demonstrated similar below-average English vocabulary skills but were differentiated by code-based (i.e., word reading) performance. Whereas code-based skill performance suggesting heterogeneity in the reading profiles of this population which were differentiated mainly in word reading performance. Students in all profiles improved in reading comprehension over the course of intervention, but those

belonging to the most impaired group demonstrated the greatest growth. This may be attributable to (1) greatest room for improvement relative to age and grade-level expectancies, and (2) significant deficits in code-based skills which are more readily remediated.

These findings outline both severity and specificity in reading impairments for ELs with reading difficulties. It is important to note, however, that although many students in these samples also demonstrated weaknesses in word reading, these and many other studies of reading profiles operationalize reading difficulties using measures of comprehension. Few studies have explored the differential performance of EPs and ELs identified by the code-based deficits characteristic of dyslexia. Therefore, it is not clear whether and to what extent these findings can be generalized to students identified with dyslexia.

One study examined English intervention outcomes across EL-DD and EP-DD students with specific code-based deficits (i.e., word reading; Lovett et al., 2008). In this study, both EL-DD and EP-DD students benefitted more from a phonologically based reading intervention than from curricular control instruction. Notably, EL-DDs in this sample demonstrated expected inferior oral language skills relative to their EP-DD peers at baseline but demonstrated similar post-intervention performance and similar rates of growth for most reading outcomes as compared to their EP-DD peers. Furthermore, differential performance was observed for phonological processing, such that the EL-DD group demonstrated an accelerated rate of PA growth and marginally superior post-intervention PA performance. These findings provide further evidence that reading impaired students from linguistically diverse backgrounds demonstrate parallel responses to phonologically based reading intervention. Notably, however, the research interventions examined in this study did not address meaning-based skill development, as their focus was centered around developing basic word-reading skills and the application of decoding in passage-level contexts for students. The current study aims to address differences in performance profiles for EL-DDs and EP-DDs, as well as growth in code-based and meaning-based skills over the course of an intensive, extensive, multicomponent English reading intervention delivered to EL-DDs and EP-DDs as part of routine instruction over the course of two academic years.

The current study

We are unaware of any research to date which evaluates reading profiles of elementary-aged EL-DD students who have a school-based classification of dyslexia. Furthermore, no studies to date have specifically compared reading profiles and growth in reading skills for these EL-DD students compared to their EP-DD peers as they progress through intensive multicomponent ELDI. Given the well-established achievement gap between ELs and their non-EL peers, a comparison of intervention growth across these two groups is warranted to examine whether differences related to language classification status (EL, non-EL) are associated with differential patterns of response when dyslexia intervention is provided in English. These findings are particularly important in consideration of the risk of delayed referrals and isolated instruction for ELs in public schools. Understanding any underlying differences in these groups of students, both in terms of reading profiles and intervention response, can provide additional guidance toward determination of appropriate services for students with dyslexia with diverse language backgrounds. In short, this study aims to contribute to the evidence understanding the viability of standard English language dyslexia instruction for ELs with dyslexia.

Research Question 1: Do EL-DDs demonstrate similar profiles of code- and meaning-based English reading skills as their EP-DD peers prior to intervention?

> **Hypothesis 1:** Reading profiles of EL-DD students will be marked by global weaknesses in component reading skills and will demonstrate more severe deficits compared to EP-DD peers.

Research Question 2: Do EL-DDs demonstrate similar growth in English reading skills as their EP-DD peers over the course of intervention? Specifically, we aimed to investigate comparative performance between EL-DDs and EP-DDs over time, as well as to identify potential areas of weakness that may warrant additional instruction for EL-DDs receiving ELDI.

> **Hypothesis 2a:** EL-DD students receiving ELDI will demonstrate similar growth in reading skills over time in comparison to a sample of EP-DD students.
>
> **Hypothesis 2b:** Post-intervention performance will be lower for the EL-DD group compared to the EP-DD group.

Methods

Participants

Participants were recruited from the pool of students recently identified by their public school as having developmental dyslexia (DD) and were scheduled to begin dyslexia instruction in one of four public school districts located in the Southwestern United States. Among the group of students newly identified with dyslexia, 19.4% were also identified by their public school as English learners (EL-DD); the remainder were proficient in English (EP-DD). This study targeted intervention outcomes for students in elementary school; thus, eligible students were entering grades 2–5 at time of enrollment to qualify.

Participating districts

Four public school districts participated in the research study. Districts ranged in size from 5,000 to 38,000 students, serving rural, suburban, and urban areas. Demographic characteristics and participation rates for each district are presented in Table 1.

Participating educators

Within each school district, elementary school educators assigned by their school to provide dyslexia instruction to small groups of elementary students newly identified with dyslexia. Educator recruitment was initiated through announcement by a school administrator to eligible educators about the opportunity to participate in the research study and the invitation to attend an information session presented by study personnel. Each educator who participated provided written informed consent. Educators were free to participate

TABLE 1 Demographic characteristics of participating districts.

	District 1	District 2	District 3	District 4
Participants				
Teachers	18	7	10	2
Students	97	50	31	8
NCES locale classification	City: Large	Town: Distant	Suburban: Large	Rural: Fringe
District enrollment data				
Approximate enrollment	38,000	6,000	16,000	5,000
Elementary (%)	57	41	46	55
Minority (%)	70	76	89	65
Economic disadvantage (%)	56	72	72	57
English learners (%)	28	27	17	17
Dyslexia (%)	9	10	6	5

in the research study or not, without penalty or modification of their dyslexia instruction assignment.

A total of 37 educators elected to participate and completed the research study. All educators had fulfilled training and education requirements outlined by their district and the curriculum publishers. From the educator cohort, 15 were credentialed dyslexia therapists; the remaining educators had completed state-mandated dyslexia training courses. All educators were trained in the implementation of the curriculum used in their classrooms. Educators ranged in classroom experience from 5 to 45 years (M = 19.42, SD = 8.91), with an average of 4 years in their current role (SD = 3.41). Fourteen of the 37 educators had EL-DD students in their classrooms. Of the 14, one was a certified bilingual educator, 10 were ESL certified, and certification information was not reported for three educators. Twelve of these educators provided dyslexia instruction to both EL-DD and EP-DD students in the current sample.

Participating students

Students were recruited from the pool of students in grade 2–5, newly identified with dyslexia, and scheduled to receive dyslexia instruction in a small group assigned to one of the participating educators. Recruitment communication with students' families began with the participating educator who distributed study information, in written and pre-recorded video formats, to parents/guardians of eligible students assigned to the educator's dyslexia instruction group. Parents/guardians of eligible students in each participating school district were also invited to attend an information session. For each enrolled student, parent/guardian informed consent and student informed assent was obtained. Recruitment materials and information sessions were presented in both English and Spanish. Participating students were enrolled in the study at entry to their dyslexia instruction program and followed for two academic years.

A total of 200 students enrolled in the study across two cohorts at the start of two successive academic school years (Cohort 1: n = 151, Cohort 2: n = 49). Of these, six did not meet study requirements and were considered screen failures, four were withdrawn by the study team due to changes in campus participation, and an additional four students were excluded due to unavailability of district data. The aggregate analytic sample was comprised of 186 students with sufficient data for analysis.

The average age of students in the aggregate sample was 8 years 6 months at baseline (SD = 12 months) with most students first entering dyslexia instruction at the start of third grade. The sample was 52.2% female, the majority of the sample was white/Caucasian (72.1%), non-Hispanic (62.4%), and economically disadvantaged (i.e., eligible for free/reduced lunch [FRL]; 52.2%). The distribution of student characteristics did not differ across cohorts (all $\chi^2 < 3.5$).

Language learner status

Thirty-six students were reported as having an active EL status at their school; these students were identified with dyslexia by their district using a combination of native language and L2 measures as outlined in their individual education plan and language program model (Texas Education Agency, 2021) and comprised the English learner with Developmental Dyslexia (EL-DD) group. English language proficiency varied within this group based on state assessment scores collected prior to treatment (Texas Education Agency, 2021). Three were identified as having Basic Proficiency, 21 with Intermediate Proficiency, and six with Advanced Proficiency based on a state English language proficiency assessment. Proficiency score was unavailable for six EL students. Native language varied across EL-DD students, with the majority speaking transparent phonemic Indo-European languages (Spanish n = 27), two from Semitic home languages (Arabic n = 1, Amharic n = 1), and the remaining students had unspecified home languages (other/not reported n = 7). The remaining 150 students included those without an active EL status, including monolingual English students and former ELs. Thus, these students were considered an English-proficient group (EP-DD). Students in EL-DD and EP-DD groups received the same instruction from the same educators and were often intermixed within instructional classes.

Intervention

All students identified with dyslexia in participating districts, including those enrolled in this study, received high-quality reading

instruction that is based on scientific best practices (National Institute of Child Health and Human Development, 2000; Texas Education Agency, 2021).

Intervention classes were designed to meet daily for 45–60 min depending on campus scheduling structure. All interventions are derived from Orton Gillingham based instruction that provides explicit, systematic, and intensive reading instruction for students with dyslexia. All instruction provided met state standards for dyslexia intervention, including activities to support phonological awareness, sound-symbol association, syllabication, orthography, morphology, reading fluency, reading comprehension, and other aspects of language processing (Texas Education Agency, 2021). Interventions used in the classes included *Take Flight: A Comprehensive Intervention for Students with Dyslexia* (Ring et al., 2017), *Bridges: A Dyslexia Intervention Connecting Teacher, Student and Avatar*, *Multisensory Teaching Approach* (Vickery et al., 1987), *Neuhaus Basic Language Skills, Language Enrichment* (Carreker et al., 2005), and others. Most students in the sample received instruction in the first two programs; the remaining students received instruction in one or more of the other programs. Growth in reading skills did not differ across instructional methods (all $ps > 0.45$); thus, students from all instructional groups were collapsed into a single sample for analysis.

Classroom observation

Due to the variability in intervention programming across districts, classroom observations were conducted with each participating educator once per semester to document the types of instructional activities completed during intervention sessions, session duration and class size, as well as evidence of teacher knowledge and skill (Varghese et al., 2021). All classroom observations were conducted by a member of the study team who was experienced in the implementation of dyslexia intervention and the nature and types of activities which address various component reading skills. Observations did not include feedback to educators but were intended to provide objective information regarding the structure and scope of instruction provided across classrooms. Observed classes ranged from 25 to 75 min each ($M = 53$, $SD = 8$), with a median class size of four students ($SD = 1.54$). Measured instructional activities included PA, word and sentence level reading, connected text reading, spelling, dictation, and reading comprehension. Any deviations from lesson sequence were noted including omissions, substitutions, or other structural deviations. Of the observations conducted for the study, 97.9% included measured instructional activities. Deviations from intended lesson structure were generally due to time constraints. Measures of instructional quality included whether the educator demonstrated appropriate pacing of the lesson, use of direct and immediate feedback, and educator knowledge; 98.1% of observed lessons were judged as demonstrating appropriate instructional quality.

Outcome measures

Experienced diagnosticians who were blinded to student intervention assignment and EL status completed a comprehensive battery of English language assessments with each participating student. Assessments occurred at each student's home campus at the start of the intervention year (baseline), at the end of the first intervention year (mid-test), and at the end of the second intervention year (post-test). Measures used included standardized, norm-referenced measures of key component reading skills; standard scores were used for analysis to contextualize skill levels relative to developmental norms. Baseline measures of code- and meaning-based language skills included: PA, word reading, spelling, passage comprehension, listening comprehension, and vocabulary. As primary instructional targets, PA, word reading, and passage comprehension were evaluated as outcomes of interest in the examination of growth.

Phonological awareness

Phonological processing was measured using the Phonological Awareness composite from the Comprehensive Test of Phonological Processing 2nd Edition (CTOPP-2; Wagner et al., 2013). The PA composite score is derived from three subtests. The Elision subtest requires participants to elide individual phonemes from verbally presented words to form real word responses. The Blending Words subtest requires participants to combine verbally presented phonemes to form real word responses. The Phoneme Isolation subtest requires participants to provide the first, last, or middle sound from verbally presented real words. The composite measure has reported internal consistency of $\alpha = 0.92$.

Word identification

Single-word reading was measured using the Woodcock Reading Mastery Test 3rd Edition (WRMT-3; Woodcock, 2011). This test requires participants to read isolated real words with no time constraint. This subtest has an average split-half reliability of 0.98.

Spelling

Spelling was assessed using the Word Identification and Spelling Test (WIST; Wilson and Felton, 2004). The WIST is a nationally standardized assessment designed specifically for students who are struggling with reading and spelling. The Spelling subtest of the WIST includes stimuli sets of both regular and irregular words, allowing for a more granular assessment of spelling ability through error analysis. The Spelling subtest measure has a reported internal consistency of $\alpha = 0.98$, and strong convergent validity with other common and reliable measures of reading and spelling (i.e., WIAT-II, WRMT-R/NU, TWS; all $rs \geq 0.8$).

Reading comprehension

Reading comprehension was measured using the Passage Comprehension subtest of the WRMT-3 (Woodcock, 2011). This test utilizes a cloze-type procedure to measure comprehension of narrative and expository passages and has an average split-half reliability of 0.86.

Listening comprehension

Receptive language was measured using the Listening Comprehension subtest of the WRMT-3 (Woodcock, 2011). This test requires participants to listen to passages and dialogues and respond to orally-presented questions and has an average split-half reliability of 0.88.

Receptive vocabulary

Receptive vocabulary was assessed using the Peabody Picture Vocabulary Test 5th Edition (PPVT-5; Dunn, 2019). This test is an

individually administered instrument that assesses receptive vocabulary in standard American English. The PPVT-5 has reported internal consistencies of 0.89–0.97 and demonstrates convergent validity with other common and reliable measures of vocabulary (i.e., CELF-4, $r = 0.67–0.75$; EVT-2; $r = 0.80–0.84$).

Analyses

Demographic characteristics and intervention eligibility information was first compared across groups. Demographic variables included student age, gender, race, ethnicity, SES (as represented by free/reduced lunch eligibility), and comorbid diagnoses. Continuous variables were examined using Student's *t*-tests; categorical variables were examined using Pearson's chi-squared analyses. Demographic characteristics of the subgroups are presented in Table 2.

Missing data and data screening

Out of the 186 students included in the aggregate sample, approximately 17% were lost to follow up, with all but two attrited cases occurring within the second academic year after study enrollment (16%). Two students were unable to be evaluated at the baseline time period due to scheduling conflicts; mid- and post-test data were collected for both students. This level of attrition is in line with previous reports estimating attrition rates between 15 and 20% for longitudinal educational studies (Enders, 2003). This may further reflect increased student mobility and transfer rates observed in recent years post-COVID (Schueler and Miller, 2023). Furthermore, attrition rate across groups was similar (EL-DD: 16.7%, EP-DD: 19.4%). Those who completed the two-year study and those who were lost to follow up did not differ in demographic constitution except age (all $\chi^2 < 4.4$). Attrited students were older at study enrollment than those who completed the study $t(184) = 2.96$, $p = 0.002$. All major analyses were conducted with and without the 32 students who were lost to follow-up, producing similar results. Therefore, to maximize the analytic sample, students who were lost to follow up were included for analysis.

TABLE 2 Demographic characteristics of participant subgroups.

	EL-DD	EP-DD
Demographics		
Age (years; months)	8y; 11 m (1y; 1 m)	8y; 6 m (1y; 1 m)
Gender (Female)	50.0%	52.7%
Race		
White/Caucasian	86.1%	68.7%
African American	8.3%	20.0%
Other/Multiple	5.6%	11.3%
Ethnicity (Hispanic/Latino)	83.3%	25.3%
Free/reduced lunch eligible	97.20%	41.30%
Comorbidities		
ADHD	0.0%	9.3%
Language impairment*	13.9%	8.7%
Other	0.0%	2.0%

*Rates of students formally identified with a Specific Language Impairment or related disorder.

All outcome measures were evaluated for normality and presence of outliers. Four univariate outliers were identified; these values were windsorized to 90% prior to analysis. Outcome measures were normally distributed except for baseline PA and spelling, which were slightly positively skewed. However, data transformations did not impact results of major analyses. Original standard score values were retained to preserve interpretability of model outcomes.

Additionally, early changes in the assessment battery resulted in unavailable baseline standard scores on spelling ($n = 7$) and listening comprehension ($n = 34$) for a total of 36 students with missing baseline data in one or both of these measures; missing baseline scores for these variables were imputed using group means for the analysis related to Research Question 1 (reading profiles). Imputed means were not utilized in the analyses pertaining to Research Question 2 (reading growth), which examined performance in PA, word reading, and passage comprehension over time.

Reading profiles at baseline

Toward the first research question, we aimed to characterize differences in reading profiles across groups by examining baseline scores on code-based and meaning-based outcome measures. To do this, we employed a multivariate profile analysis using GLM repeated measures in SPSS as described in Tabachnick and Fidell (2019). This multivariate approach to repeated measures evaluates profiles across groups in terms of parallelism of profiles (differential performance across groups qualified by an interaction between level and flatness), flatness (deviations in one or more dependent variables compared to the average across measures), and level (group differences in performance averaged over dependent variables). To characterize the reading profiles of EL-DD and EP-DD, multivariate profile analysis was performed on tests of code-based (PA, word reading, spelling) and meaning-based (passage comprehension, listening comprehension, vocabulary) reading skills at baseline, using EL status as the grouping variable. Mean-centered age and FRL status were entered as covariates. Intercorrelations across baseline reading skills are presented in Table 3.

Growth in reading skills

To address the question of comparative growth across groups in reading scores over time, linear mixed effects modeling was used to account for nesting within the data (i.e., time within students). Models were fit using maximum likelihood estimation in the nlme package in R (Pinheiro and Bates, 2000; Pinheiro et al., 2023). Initial null models were built to assess variance accounted for at the student level; the intraclass correlation for each of the outcomes was large, ranging from 0.67 to 0.78. Separate linear mixed-effects models were then conducted to estimate growth for each outcome using the following terms: time, group, grand mean-centered age, FRL status, and time*group interaction. Significant interactions between Group and Time on were probed by running separate mixed effects models for each group independently. The models specified were the same as the full model described above, excluding the main effect of group and group*time interaction. Dichotomous variables were sum coded to aid in the interpretation of fixed effects (i.e., Group: EP-DD = −1, EL-DD = 1; FRL: No = −1, Yes = 1). Random intercepts and slopes were included in each model. For all models, normality of residuals and random effects were evaluated using histograms and Q–Q plots. Residuals for all models were

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TABLE 3 Bivariate correlations among outcome variables at baseline.

	1.	2.	3.	4.	5.	6.
1. Phonological awareness	–					
2. Word identification	0.45***	–				
3. Spelling	0.55***	0.65***	–			
4. Passage comprehension	0.48***	0.75***	0.56***	–		
5. Listening comprehension	0.26**	0.16*	0.19*	0.32***	–	
6. Vocabulary	0.40***	0.34***	0.33***	0.44***	0.54***	–

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

normally distributed with a mean of approximately zero. Subgroup performance across time is presented in Table 4.

Results

Descriptive statistics for the demographic characteristics of subgroups are presented in Table 2. The EL-DD and EP-DD groups did not differ on gender, race, or comorbidities. However, groups did differ in age, ethnicity, and SES. Students in the EL-DD group were approximately 6 months older compared to the EP-DD group at baseline, $t(184) = 2.30$, $p = 0.01$. Furthermore, the grade distribution across groups was weighted more heavily in earlier grades for the EP-DD group compared to later grades for the EL-DD group ($\chi^2(3) = 13.36$, $p = 0.004$). Although the two groups had similar proportions of 3rd and 4th grade students, the EP-DD group was comprised of more 2nd grade students (approximately 38%) than 5th grade students (11%), whereas the opposite pattern was true for the EL-DD group (11% in 2nd grade, 28% in 5th grade). The EL-DD group also represented a greater proportion of Hispanic/Latino students and those from economically disadvantaged households ($ps < 0.001$). Grand mean centered age and FRL status were included in subsequent analyses as covariates.

Reading profiles at baseline

As shown in Figure 1, the profiles across groups were parallel after adjusting for covariates, $F(4,177) = 0.61$, $p = 0.66$, partial $\eta^2 = 0.01$, with 90% confidence limits 0.00–0.03.

When averaged over groups, performance profiles deviated significantly from flatness, suggesting differential performance across code- and meaning-based skills, $F(4,177) = 22.77$, $p < 0.001$, partial $\eta^2 = 0.34$, with confidence limits from 0.24 to 0.41. Relative strengths were found for the combined sample on meaning-based skills relative to code-based skills. Significant heterogeneity was also found across individual measures for code- and meaning-based skills. For the combined sample, students demonstrated significant weaknesses in spelling ($M = 72.81$, $SE = 0.85$) relative to other code-based reading skills (PA: $M = 86.87$, $SE = 1.35$; word reading: $M = 79.68$, $SE = 1.15$; all $ps < 0.001$). Word reading was also a weakness relative to PA ($p < 0.001$). For meaning-based skills, passage comprehension was a significant weakness relative to other measures (passage comprehension: $M = 85.17$, $SE = 1.31$; listening comprehension: $M = 94.86$, $SE = 1.10$; vocabulary: $M = 93.50$, $SE = 1.08$; all $ps < 0.001$). Vocabulary and listening comprehension did not differ at baseline.

For the levels test, groups differed significantly in overall performance when averaged over measures, $F(2,179) = 8.11$, $p < 0.001$, partial $\eta^2 = 0.08$, with confidence limits from 0.03 to 0.15. The EP-DD group outperformed the EL-DD group on the combined dependent variables. EL-DDs demonstrated greater weaknesses relative to EP-DDs in meaning-based skills (partial $\eta^2 = 0.08$) than code-based skills (partial $\eta^2 = 0.03$). The EP-DD group outperformed the EL-DD group on all measures, though these effects were small and did not reach significance after setting alpha to 0.008 to reflect a familywise error rate of 0.05 (see Table 5). The only skills which reliably differentiated groups at this level were passage comprehension ($p = 0.003$) and listening comprehension ($p = 0.001$).

Growth in reading skills

Phonological awareness

Parameter estimates and model fit indices for each of the pull models estimating growth in reading skills are presented in Table 6 and depicted in Figure 2. Results of the full model estimating growth in PA skills revealed significant variability in intercepts across participants, $SD = 9.72$, $\chi^2(1) = 252.11$, $p < 0.001$. Slopes did not vary across participants, $SD = 0.58$, $\chi^2(2) = 0.20$, $p = 0.90$. There was a small positive correlation between random slopes and intercepts, $r = 0.12$. Results revealed significant fixed effects of group, $b = -4.02$, $t(182) = -2.50$, $p = 0.01$, and time, $b = 4.04$, $t(333) = 7.66$, $p < 0.001$, qualified by a significant interaction between group and time, $b = 1.52$, $t(333) = 2.88$, $p = 0.004$. The performance gap between EL-DDs and EP-DDs narrowed over time, as the rate of change for EL-DDs was more than double that of EP-DDs (see Figure 2). There was also a significant effect of SES on PA performance; students eligible for free/reduced-price lunches performed significantly below their FRL ineligible peers on PA, $b = -3.41$, $t(182) = -3.32$, $p = 0.001$. There was not a reliable effect of age on PA, $b = -0.002$, $t(182) = -0.04$, $p = 0.97$.

The interaction between group and time on PA was probed by running separate mixed effects models for each group independently. For the EL-DD group, there was a significant effect of time, with standard scores increasing nearly six points per time period on average, $b = 5.58$, $SE = 0.99$, $t(64) = 5.64$, $p < 0.001$. Age and SES did not reliably predict PA for the EL-DD group. For the EP-DD group, the effect of time was also significant and positive, but smaller, $b = 2.52$, $t(268) = 5.54$, $p < 0.001$. The interaction between group and time for PA reflects a difference in slopes across groups, with the EL-DD group improving at over twice the rate estimated for their EP-DD peers. SES was associated with PA performance for the EP-DD group, $b = -3.76$, $SE = 1.06$, $t(147) = -3.54$, $p < 0.001$.

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TABLE 4 Average student performance per subgroup on outcome measures across timepoints.

	English Learners with Dyslexia (EL-DD)						English Proficient with Dyslexia (EP-DD)					
	Time 1	*n* miss	Time 2	*n* miss	Time 3	*n* miss	Time 1	*n* miss	Time 2	*n* miss	Time 3	*n* miss
PA	80.81 (11.82)	0	89.25 (12.63)	0	91.62 (13.57)	7	90.25 (14.36)	2	93.98 (14.18)	2	96.53 (14.05)	26
WID	73.89 (12.57)	0	75.14 (12.96)	0	82.79 (14.46)	7	82.62 (12.37)	2	84.14 (13.43)	2	88.49 (13.63)	25
PC	76.06 (12.13)	0	80.50 (10.26)	0	85.24 (10.94)	7	90.55 (14.73)	2	90.42 (13.30)	2	93.23 (14.18)	25

Standard deviations in parentheses.

PA, Phonological Awareness; WID, Word Identification; PC, Passage Comprehension. The number of missing cases at each timepoint for each measure are reported.

Word reading

The relationship between language status and word reading varied significantly across participants, $SD = 11.54$, $\chi^2(1) = 342.18$, $p < 0.001$. Slopes also significantly varied across participants, $SD = 2.95$, $\chi^2(2) = 12.93$, $p = 0.002$. Random intercepts and slopes were negatively correlated, $r = -0.32$. Results revealed significant fixed effects of group, $b = -3.00$, $t(182) = -2.11$, $p = 0.04$, and Time, $b = 3.16$, $t(334) = 6.83$, $p < 0.001$. The EP-DD group significantly outperformed the EL-DD on word reading. However, word reading increased over time for the sample as a whole. The interaction between group and time trended toward significance, $b = 0.80$, $t(334) = 1.72$, $p = 0.09$. There was also a significant effect of SES on word reading performance; students eligible for free/reduced-price lunches performed significantly below their FRL ineligible peers on word reading, $b = -3.51$, $t(182) = -3.65$, $p < 0.001$. A reliable effect of age was found on word reading, $b = -0.20$, $t(182) = -2.90$, $p = 0.004$. Students who were older than the sample mean at baseline tend to score more poorly on word reading, whereas those younger than the sample mean had higher scores.

Passage comprehension

The relationship between language status and passage comprehension varied significantly across participants, $SD = 12.59$, $\chi^2(1) = 173.40$, $p < 0.001$. There was a trend toward significant variability across participants in slope, $SD = 3.06$, $\chi^2(2) = 5.14$, $p = 0.08$. Random intercepts and slopes were negatively correlated, $r = -0.65$. Results of fixed effects revealed a main effect of group, $b = -6.05$, $t(182) = -3.62$, $p < 0.001$, as well as a significant effect of time, $b = 2.75$, $t(334) = 4.61$, $p < 0.001$. The interaction between Group and Time was also significant, $b = -1.85$, $t(334) = 3.10$, $p = 0.002$. A main effect of age was found, $b = -0.23$, $t(182) = -3.51$, $p < 0.001$, such that standard score performance decreased as age increased. Lastly, a significant main effect of FRL status, $b = -4.09$, $t(182) = -4.52$, $p < 0.001$, indicated that students from lower SES homes performed more poorly than their peers from higher SES homes on passage comprehension.

The interaction between group and time on passage comprehension was probed by running separate mixed effects models for each group independently. For the EL-DD group, there was a significant effect of time on passage comprehension ability, with standard scores increasing approximately 4.5 standard score points per time period on average, $b = 4.64$, $SE = 1.03$, $t(64) = 4.49$, $p < 0.001$. There was not a reliable effect of age or SES on passage comprehension for the EL-DD group. For the EP-DD group, the effect of time was also positive and trended toward significance but was smaller, $b = 0.90$, $SE = 0.53$, $t(270) = 1.70$, $p = 0.09$. Thus, the interaction between group and time for passage comprehension reflects a difference in slopes across groups, with the EL-DD group demonstrating a much steeper slope than the EP-DD group.

Discussion

The current study employed an observational comparison of reading achievement across EL and EP students with dyslexia who were receiving routine, evidence-based dyslexia instruction in English. The first goal of the study was to determine whether baseline differences in code- and meaning-based reading skills

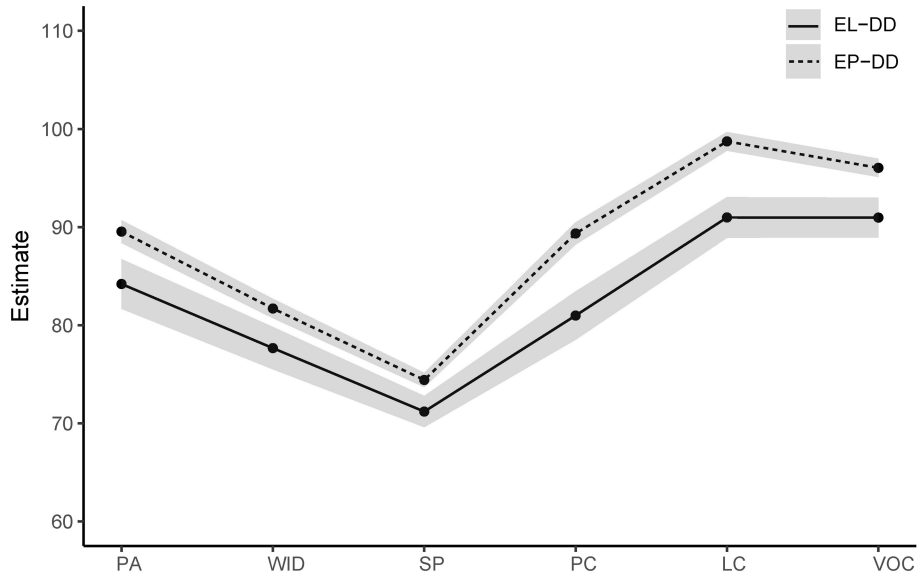

FIGURE 1
Baseline reading profiles of EL-DD and EP-DD subgroups. Values represent adjusted group means. The shaded region represents standard error. PA, phonological awareness; WID, word identification; SP, spelling; PC, passage comprehension; LC, listening comprehension; VOC, receptive vocabulary.

TABLE 5 Results from the multivariate profile analysis, univariate effects of level.

	df1, df2	*F*	partial η^2
Phonological awareness	1, 180	3.43	0.02
Word identification	1, 180	2.70	0.02
Spelling	1, 180	3.16	0.02
Passage comprehension	1, 180	8.89**	0.05
Listening comprehension	1, 180	10.75**	0.06
Vocabulary	1, 180	4.76*	0.03

*$p < 0.05$, **$p < 0.01$.

were evident at the onset of intervention. Toward this end, multivariate profile analysis was used to compare performance across EL-DD and EP-DD groups in terms of profile parallelism (similar patterns of scores), levels (between-groups differences in performance), and flatness (differential performance across skills). As expected, and consistent with the literature reporting heterogeneous reading profiles for both EL and EP struggling readers, profiles differed with respect to level, and to some extent flatness, though the lack of an interaction between group and skill indicated parallel profiles. Patterns of relative strengths and weaknesses across reading skills were similar for both the EL-DD and EP-DD groups, with the EL-DD group performing reliably poorer than the EP-DD group on all measures. The second goal of the study was to examine growth in targeted reading skills for the two groups over the course of extensive dyslexia intervention lasting two academic years. A series of linear mixed models revealed significant improvements in standard scores for all outcomes and a trend of differential growth rates favoring the EL-DD group. This study builds upon the extant literature examining reading profiles in samples of ELs with and without risk of reading failure, as well as in comparison to non-EL samples.

Unlike previous research, the current study examines both code- and meaning-based skills in a sample of ELs identified with dyslexia. Additionally, the current study evaluates growth in target reading skills in these EL-DD students relative to their EP-DD peers over the course of an extensive intervention.

Several constitutional differences emerged between the EL-DD and EP-DD groups which are in line with previously documented patterns in the EL literature. First, EL-DD students were approximately 6 months older at the start of intervention start in comparison to their English proficient peers. Although baseline age in this study reflects student age at the start of the first intervention year, rather than age at identification, this finding suggests that ELs may be delayed in receiving an identification of dyslexia and, in turn, are beginning services at an older age than EP peers. This difference in age across groups coincides with a differential distribution across grades for EL-DD and EP-DD groups: although similar rates of 3rd and 4th grade students were enrolled in the study across groups, the EL-DD group had fewer 2nd grade students and more 5th grade students than the EP-DD groups. These findings are in line with previous reports of underidentification of EL-DD in early elementary grades due to a tendency for schools to delay identification for ELs in hopes oral

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TABLE 6 Parameter estimates for longitudinal models of code-based and meaning-based skills.

Parameters	Phonological awareness	Word identification	Passage comprehension
	B (SE)	*B (SE)*	*B (SE)*
Fixed effects			
Intercept	83.47 (1.56)***	76.21 (1.37)***	82.30 (1.63)***
Age	−0.003 (0.07)	−0.20 (0.07)**	−0.23 (0.06)***
FRL	−3.41 (1.03)**	−3.51 (0.96)***	−4.09 (0.91)***
Group	−4.02 (1.61)*	−3.00 (1.42)*	−6.05 (1.67)***
Time	4.04 (0.53)***	3.16 (0.46)***	2.75 (0.60)***
Time*Group	1.52 (0.53)**	0.80 (0.46)+	1.85 (0.60)**
Random effects variance			
Intercept	125.6	137.3	158.55
Time	0.33	9.62	9.37
Residual	54.38	24	53.45
Model Fit			
AIC	3,959.74	3,760.1	3,960.16
BIC	4,002.3	3,802.68	4,002.73
Conditional R^2	0.74	0.87	0.74
Marginal R^2	0.11	0.19	0.23

AIC, Akaike information criterion; BIC, Bayesian information criterion. $+p < 0.1$, $*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

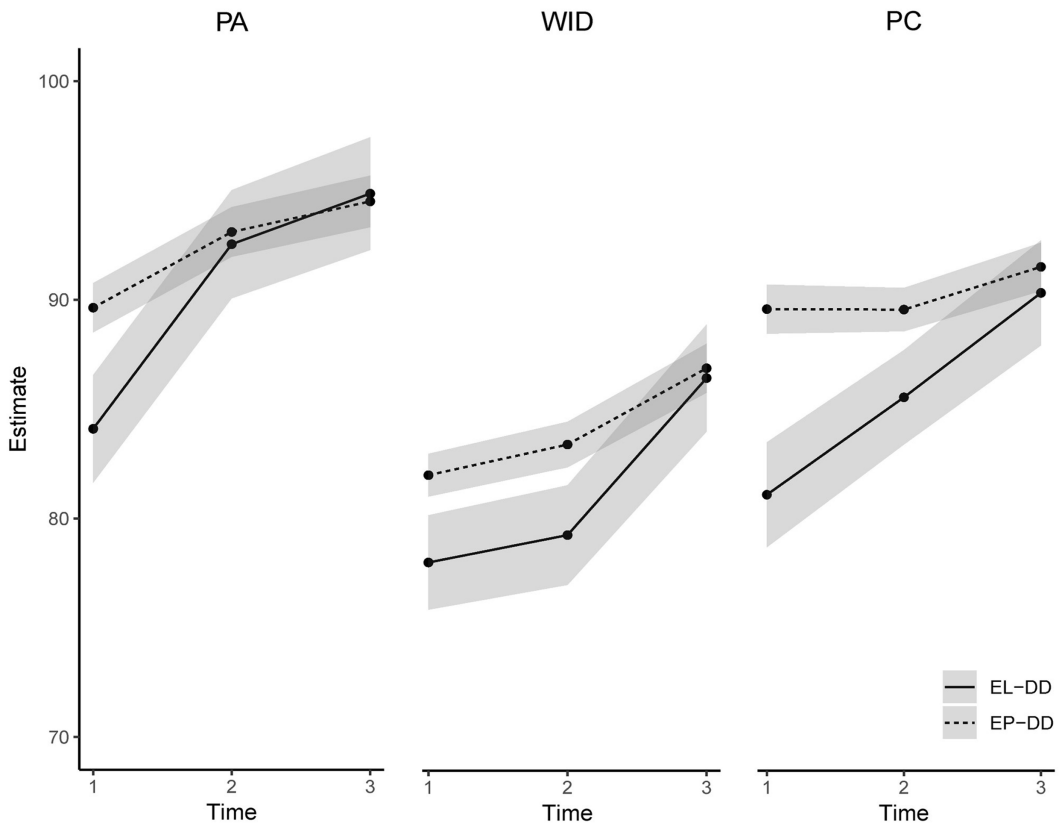

FIGURE 2
Estimated growth in targeted reading skills. Values represent adjusted group means. The shaded region represents standard error.

language skills will improve over time (Limbos and Geva, 2001; Samson and Lesaux, 2009). Despite the later identification of EL-DD students in the current sample, however, both oral and written language skills remained weak relative to EP-DD students.

Multivariate profile analysis of code- and meaning-based reading skills

The pre-intervention reading profiles reported in the current study are consistent with findings suggesting reading profiles of ELs differ in deficit severity rather than specificity in comparison to their EP peers (e.g., Miciak et al., 2022; O'Connor et al., 2019; Vargas et al., 2023). Global reading deficits found for EL-DDs were evident across code- and meaning-based reading skills. Furthermore, reading deficits for EL-DDs were apparent relative to not only population norms, but also in comparison their proficient English-speaking peers with dyslexia. The effects of native language status on reading outcomes can be difficult to disentangle from effects other risk factors such as SES (see Solari et al., 2014). The current findings revealed a moderate effect of group after controlling for age and SES, indicating additional variability in reading skills is attributable to language status. When examined at the level of individual outcomes, group performance differed only on a measure of passage comprehension, and to a lesser extent, listening comprehension. Future study is warranted to evaluate the relative contribution of these risk factors in larger samples.

Although groups differed in overall skill level, their reading profiles were remarkably similar. Interestingly, PA was a relative strength among code-based skills for both groups. Although PA is often a weakness in students with dyslexia, it is neither necessary nor sufficient to determine the presence of a reading disability (Fletcher et al., 2018; Miciak and Fletcher, 2020). It is not possible to examine whether and to what extent PA and related instructional supports were provided to these students prior to the start of the study which may have influenced PA performance. What is clear, however, is that despite relative strengths in PA, profiles for both groups reflected characteristic code-based weaknesses of dyslexia, including notable weaknesses in word-level reading and spelling skills. These weaknesses exist despite relative strengths in PA and oral language measures (vocabulary and listening comprehension).

Whereas both groups exhibited significant discrepancies between oral language measures and passage comprehension, the EL-DD group demonstrated similar deficit magnitudes for both word-level and passage-level written language measures. The average-level oral language skills of EP-DD may have served as a protective or compensatory mechanism, bolstering reading comprehension for this group (Haft et al., 2016). Conversely, the EL-DD group had globally weaker reading profiles with which to support comprehension. This is in line with previous findings suggesting that both code- and meaning-based skills are associated with comprehension deficits in ELs (Cho et al., 2019; Capin et al., 2024). In line with the Simple View of Reading, however, greater deficit levels for code- and meaning-based skills in the EL-DD group may have led to greater achievement gaps on passage comprehension between the two groups prior to receiving ELDI.

The relative contributions of code- and meaning-based skills to reading comprehension ability varies across ages, skill levels, and language background. Meaning-based skills play a larger role in comprehension for children in later grades as children solidify code-based skills and the focus of instruction shifts to content knowledge (Chall, 1986). Oral language may also play a larger role in reading difficulties for ELs compared to their non-EL peers (Cho et al., 2019). Interestingly, in the current sample word identification predicted reading comprehension over and above vocabulary and listening comprehension for both EP-DD and EL-DD groups, suggesting that code-based deficits contribute more to comprehension weaknesses than oral language skills for these students (cf., Kim, 2017, 2020). It is important to note that because students in the current sample demonstrated relative strengths in meaning-based skills, these data may not be generalizable to EL-DDs with more pronounced oral language deficits.

Parallel patterns of global deficits across EL-DD and EP-DD profiles further support the differentiation of performance as a function of severity rather than specificity. The global impairments seen in EL-DD students' code- and meaning-based skills support their need for intensive multicomponent intervention toward remediation of various reading skills, including explicit and systematic instruction in phonological awareness, word study, reading comprehension, and oral language. Furthermore, the parallel profiles across groups suggest that these students will require multicomponent interventions to remediate a wide and varied range of reading skills.

Longitudinal evaluation of performance

The second aim of the current study was to examine growth in targeted reading skills across the two groups over the course of intensive ELDI delivered daily for two academic years. Findings support the use of evidence-based ELDI in an instructional setting which includes both EL-DD and EP-DD students without requiring substantial modifications to intervention content or implementation. Students in the current sample significantly improved in standard score performance for code- and meaning-based reading skills, reaching or approaching age-level proficiencies in these skills over the course of intervention. The results of the mixed models estimating growth in PA, word identification, and passage comprehension indicated significant growth in age-based rank status over a two-year intervention period. Importantly, this growth represents a reliable trend in the data reflecting an improvement in targeted skills which reduces deficit magnitude relative to age-based developmental norms. Students in the current sample were below the average range (<90 SS) at baseline across all three targeted reading measures. However, by the end of treatment, mean student performance was within the average range for both PA and passage comprehension, and just below the average range for word identification, narrowing the gap on these measures with their age-equivalent peers with dyslexia. Despite significant growth, however, many students in both groups remained below average at post-test on key reading measures and may require additional intervention supports to achieve age- or grade-level expectations.

Growth in targeted reading skills was qualified by interactions between groups and time. In general, the growth exhibited by the EL-DD group was greater than that of the EP-DD group, with slopes ranging between 1.5 and 5 times steeper for EL-DDs. At the beginning of the intervention, the EL-DD group was well below average in PA whereas the EP-DD group had average baseline scores. Despite these

differences in baseline ability, both groups achieved significant improvements over time, performing within the average range (≥90 SS) at the end of the intervention. Additionally, most of the growth exhibited in PA occurred within the first year of intervention, with continued standard score improvements found the second year. This was true for the combined sample and for each group independently, with EL-DDs catching up to EP-DDs by the mid-intervention testing period. Relative weaknesses in PA for ELs is often attributed to reduced familiarity with the phonological structure of the non-native language. However, PA skills are highly malleable and improve rapidly with explicit instruction, even for non-native language learners (e.g., Cirino et al., 2013; for review see Hall et al., 2019). The explicit, systematic PA integrated into the interventions delivered in this study may have contributed to closing this gap by increasing knowledge of phonological structure for EL-DDs. Previous studies report similar findings, with explicit L2 PA instruction leading to significant growth in L2 PA as well as positive reading and spelling outcomes (Yeung et al., 2013).

Consistent with current identification methods for identifying dyslexia, word reading was a significant weakness for both the EL-DD and EP-DD groups prior to intervention. Although the growth rate of the EL-DD group was approximately 1.5 times faster than EP-DDs on word-level reading, this interaction did not reach a level of statistical significance. The severe word-reading deficits experienced by EL-DD and EP-DD students in this sample appear to be malleable and improve over the course of treatment Like the intervention implemented by Lovett et al. (2008), the interventions utilized in the current study targeted phonemic awareness at various levels of manipulation and integrated phonemic awareness and decoding/encoding activities to improve orthographic knowledge. Thus, the structured approach to decoding instruction integrated within the interventions utilized in this study may have contributed to the greater growth in word reading for EL-DDs by increasing familiarity with the phonological structure of the English language while simultaneously bolstering orthographic knowledge. These effects appear to be cumulative, with greater growth for both groups occurring within the second intervention year. However, students in both groups remained below average in word reading skill at the end of the intervention period and will require additional support to continue to improve these skills and achieve age-appropriate word reading performance.

Growth in meaning-based reading skills, as measured by passage comprehension, revealed a similar pattern of effects. The EP-DD group outperformed the EL-DD group on passage comprehension, but the magnitude of differences across groups narrowed over time as the EL-DD group improved their comprehension skills at a faster rate than the EP-DD group. This is in line with the findings reported by Capin et al. (2024), who reported greatest growth in passage comprehension for the group with the most severe global deficits. The explicit, systematic comprehension instruction provided through the interventions in this study is in line with empirically supported best practices for improving reading comprehension in both EP and EL students, including vocabulary instruction, comprehension monitoring, discourse, grammar, and morphology (August and Shanahan, 2006). Moreover, the structured and repeated practice opportunities embedded in comprehension instruction allow for consolidation of learned skills which may further support the development of language proficiency in non-native speakers (Hall et al., 2019). Importantly, although the passage comprehension skills of the EL-DD group improved significantly at each timepoint, the severe deficits experienced by this group did not reach the average range until the end of the second year of treatment. The current study extends previous findings by (1) demonstrating significant growth in comprehension skills is evident for ELs with dyslexia over the course of ELDI, and (2) reading comprehension may follow a protracted growth pattern supported directly by explicit instruction in comprehension skills as well as indirectly through the remediation of foundational code-based skills.

Together, the findings of the current study confirm global reading deficiencies for ELs with dyslexia in comparison to their English-proficient peers prior to receiving ELDI. Overall, EL-DDs performed significantly below their EP-DD peers in both code- and meaning-based reading skills prior to intervention, though the achievement gap between groups significantly narrowed by the end of treatment. Whereas phonological skills improved early within the intervention period, growth in word reading and comprehension was more consistent during the second year of instruction, suggesting that both EP-DD and EL-DD students benefit from intensive and extensive multicomponent reading instruction (daily sessions for at least two academic years) to provide opportunity for practice and consolidation of higher order skills such as word reading, spelling, and comprehension. These findings provide additional evidence to suggest that ELs should not be excluded from ELDI on the basis of language status alone. As suggested by Siegel (2016), EL status is not a barrier to achieving proficient literacy skills, even for students with dyslexia. In the current study, EL-DDs benefitted as much or more from English-language instruction in comparison to their EP-DD peers. Although these findings provide encouraging evidence to support ELDI as a practicable approach to remediating the severe reading deficits observed in ELs identified with dyslexia, the generalization of these findings is cautioned given the limitations discussed below.

Limitations

The findings presented should be considered in context of several important caveats and limitations. Primarily, the observational design of this study has inherent experimental limitations that limit what questions the study can inform. It was not possible to standardize the diagnostic criteria and procedures for dyslexia identification and EL status determination across districts. There was limited information available about prior instruction and the length of time from identification to beginning intervention was variable. Educator assignment to curriculum and student assignment to educator was pre-determined by the school and, appropriately, not done so randomly or with any influence from the research team; for example, all the EL-DD students were assigned to educators with appropriate ESL certification.

A significant scientific limitation to the evaluation of intervention outcomes is the lack of a control group that did not receive instruction. This limits generalizability of our findings to some extent. It is not possible to determine from this study how much of the growth in this sample is attributable to the intervention as opposed to maturational effects. Similarly, we are unable to parse the amount of growth demonstrated by the EL-DD group which due to increasing English language proficiency or other factors, such as potential other native language instruction as opposed to the dyslexia intervention. Therefore, the current study cannot answer questions about whether native language instruction would

produce different results, or whether similar patterns of growth would be reflected in the students' native language. Furthermore, the current study does not address how variability in the native language may impact L2 outcomes. However, the naturalistic observation model across school districts of varying sizes does suggest that dyslexia intervention can be beneficial for students of various levels of English language proficiency in routine school functioning where bias cannot, and likely should not, be scientifically managed.

Finally, constitutional differences across groups in age and SES were found across groups in this study, and though they were statistically controlled, these factors may conflate findings of group differences in standard scores in several ways. First, although standardized assessments of achievement are becoming increasingly sensitive to diverse populations, a well-documented bias for higher SES and non-minority backgrounds persists (Mancilla-Martinez et al., 2021; Rhodes et al., 2005). Second, ELs in the US are disproportionately from economically disadvantaged households, a factor which is negatively associated with reading achievement (Hoff, 2006; National Center for Education Statistics, 2022; Samson and Lesaux, 2015; Solari et al., 2014). In the current sample, all but one student in the EL-DD group were from economically disadvantaged homes (96.6%), whereas less than half of the EP-DD group fell in this same category. Despite this difference, the EL-DD group demonstrated accelerated growth relative to their EP-DD peers over course of treatment. Lastly, students in the EL-DD group were older than their EP-DD peers at baseline by approximately 6 months. It is of note that the same level of raw performance on a given test will result in a lower age-based standard score as age-level expectations increase. However, the amount of growth achieved by the EL-DD group was greater than that of the EP-DD group, indicating that the EL-DD group was (1) further behind their age-equivalent peers prior to intervention and (2) vastly improved in their rank status relative to age-based norms over two academic years.

Conclusion

The findings of the current study suggest that EL-DDs with at least intermediate proficiency of the English language demonstrate similar patterns of reading performance as their EP-DD peers: significant and substantial deficits in code-based skills with relative strengths in meaning-based skills. Despite similar patterns across reading skills, the EP-DD group consistently outperformed the EL-DD group; these effects persisted after controlling for demographic differences across groups. Whereas the EP-DD group demonstrated average meaning-based skills in comparison to below average code-based skills, both code-and meaning-based skills were below average for the EL-DD group.

Despite significant underperformance relative to their EP-DD peers at the start of the intervention, EL-DDs demonstrated greater rates of growth in code- and meaning-based reading skills over the course of intervention. These findings suggest that EL-DDs can benefit from ELDI, as demonstrated by the current sample achieving similar levels of reading mastery as their EP-DD peers by the end of the intervention across targeted reading skills. This is in line with previous studies reporting significant and large effects of reading interventions for ELs with reading difficulties. Furthermore, the current study demonstrates that these effects were found even in areas of significant pre-intervention weakness for EL-DDs which revealed the greatest amount of growth (i.e., PA and reading comprehension). Weaknesses in these areas are well documented for ELs, who can experience pronounced difficulties in acquiring phonological and semantic aspects of their non-native language (Melby-Lervåg and Lervåg, 2014). The intensive, multicomponent, and extensive nature of the reading interventions provided in this study may have helped to support the additional instructional needs of the EL-DD group related to language status in addition to characteristic weaknesses of dyslexia. Future studies are warranted which utilize data-based approaches to identifying underlying profiles for EL-DD and EP-DD students, as well as experimental approaches to further understanding the effects of ELDI on the global deficit profiles of EL-DDs.

Finally, disproportionality across groups in terms of grade and age suggests that routine procedures for the identification of dyslexia in ELs may not allow for early identification of students from varied language backgrounds. Earlier identification may help to lessen the severity of deficits prior to intervention, thereby narrowing the magnitude of the differences across groups and giving EL-DDs greater chances for academic success.

Data availability statement

The datasets presented in this article are not readily available because aspects of data are the property of participating districts. Requests to access the datasets should be directed to anna.middleton@tsrh.org.

Ethics statement

The studies involving humans were approved by University of Texas Southwestern Medical Center IRB. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

AM: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. MD: Conceptualization, Data curation, Project administration, Writing – review & editing. SF: Conceptualization, Funding acquisition, Investigation, Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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