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Characteristics of Students Identified With Dyslexia Within the Context of State Legislation

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Abstract

All but seven U.S. states have laws that govern some aspects of dyslexia screening, intervention, or teacher training in public schools. However, in the three states that mandate child-level reporting, data indicate lower than expected rates of dyslexia identification when compared with commonly accepted dyslexia prevalence rates. To better understand this apparent mismatch, this study explores factors that might predict the school-assigned identification of individuals with dyslexia. Deidentified data on 7,947 second-grade students in 126 schools from one U.S. state included a universal screening measure of literacy skills indicative of dyslexia (i.e., reading and spelling), school-assigned dyslexia classification, and demographic characteristics. As expected, behavioral characteristics of dyslexia from universal screening were associated with school-assigned dyslexia classification. However, dyslexia classification was less likely for minority students and individuals attending schools with a higher percentage of minority students. Students who showed behavioral characteristics of dyslexia and attended schools with a higher proportion of other students with similar poor literacy skills were more likely *not* to receive a school-assigned dyslexia classification. The findings suggest systematic demographic differences in whether a student is identified with dyslexia by schools even when using universal screening.

Keywords

diagnosis, dyslexia, learning, disability

Reading proficiency is an essential life skill that many children in U.S. public schools have yet to achieve. This reality is confirmed by the fact that 63% of fourth-grade students and 64% of eighth-grade students consistently fail to demonstrate reading proficiency on the National Association for Educational Progress (NAEP) reading achievement test (NAEP, 2017). The NAEP assesses reading comprehension. A student's ability to comprehend passages on the NAEP and similar high-stakes tests of reading achievement is influenced by reading accuracy and efficiency (Sabatini et al., 2018; Wang et al., 2019), highlighting that the nexus of difficulties comprehending written language can be rooted in the failure to develop the requisite ability to integrate orthographic and phonological information to achieve accurate and efficient word reading (Harm & Seidenberg, 2004; Perfetti, 2007; Perfetti & Stafura, 2014).

Poor reading comprehension as a result of deficient representations and processing of orthographic and phonological components of language is particularly applicable to the 5% to 17% of students with dyslexia. Within the English orthography, dyslexia negatively affects both word reading and spelling, representing the lower tail of a multidimensional distribution of these abilities (Fletcher, 2009; Lyon et al., 2003). These difficulties can manifest from various language processing deficits that include but are not limited to deficits in representing and processing the phonological structure of language (Pennington et al., 2012). Difficulty integrating the orthographic and phonological components of language is a central feature of dyslexia that has been observed both behaviorally and neurobiologically (Cao et al., 2006, 2008; Martin et al., 2015; Norton et al., 2015; Richlan et al., 2009). In addition to negatively impacting academic skills, the psychological well-being and mental health of students with dyslexia are negatively impacted by constant experiences with failure in school (for a review, see Livingston et al., 2018).

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Dyslexia Specific State Legislation

Given the implications of dyslexia for the overall well-being of students, addressing the needs of students with dyslexia has been a long-standing area of advocacy. In the past decade, advocacy efforts have resulted in the passage of dyslexia-specific legislation in 43 of the 50 U.S. states (National Center on Improving Literacy [NCIL], 2019). Most of these laws were advanced by parent groups which concerned that the educational needs of students with dyslexia were not addressed adequately in public schools, and the passage of legislation was intended to support the identification of students with dyslexia. One means of achieving this goal has been the inclusion of mandates for dyslexia screening. Youman and Mather (2018) reported that 18 states had passed laws requiring public schools to screen students for behavioral characteristics of dyslexia universally, and an updated listing provided by the NCIL a year later indicated that 29 U.S. states had screening provisions specified within dyslexia legislation (NCIL, 2019).

Different state laws specify different screening procedures, so implementation of screening for dyslexia varies from state to state (Petscher et al., 2019). However, there is relative consistency in the constructs that are measured based on state laws adopting a variation of the same definition of dyslexia—the consensus definition of dyslexia from the International Dyslexia Association (IDA; Lyon et al., 2003). Laws also vary as to the grade level at which students are to be screened universally. Some states require public schools to screen students for characteristics of dyslexia in all grades (e.g., Tennessee). Other state laws limit universal screening to within a restricted grade band; for example, Arkansas and California state law requires students to be screened universally in Grades K–2.

Identification of Dyslexia Within the Context of State Legislation

The explosion in dyslexia-specific state legislation over the past decade has been accompanied by publications describing aspects of these laws (Petscher et al., 2019; Worthy et al., 2017; Worthy, Salmerón, et al., 2018; Worthy, Svrcek, et al., 2018; Youman & Mather, 2013, 2015, 2018). The need for these laws and their potential impact has been a point of discussion in these publications, but these publications have not reported new data. There has been limited new empirical data published over the past decade to guide implementation efforts and gauge the potential impact of dyslexia laws on their intended outcomes. For example, identification of students with dyslexia is a central component of most dyslexia laws, but prevalence rates of dyslexia are still reported based on research conducted before the passage of the majority of these laws (e.g., Fletcher, 2009; Fletcher et al., 2018; Lyon et al., 2007). In the literature that predates the passage of all but a few dyslexia laws, dyslexia was defined as a reading disability (for reviews, see Fletcher, 2009; Fletcher et al., 2018; Fletcher & Grigorenko, 2017; Grigorenko, 2001; Grigorenko et al., 2020). It was operationally defined as a deficit in isolated word reading and/or phonological decoding, as confirmed by an individual scoring below a set percentile rank on a norm-referenced standardized test of reading. Individuals labeled as having dyslexia in this literature were also expected to score within the average to above-average range on a norm-referenced IQ measure. These primary defining characteristics were considered relative to exclusionary criteria that varied from study to study. This approach to the identification of dyslexia is outmoded in light of the current understanding of best practices for the identification of learning disabilities (for reviews, see Farris et al., 2020; Fletcher et al., 2018).

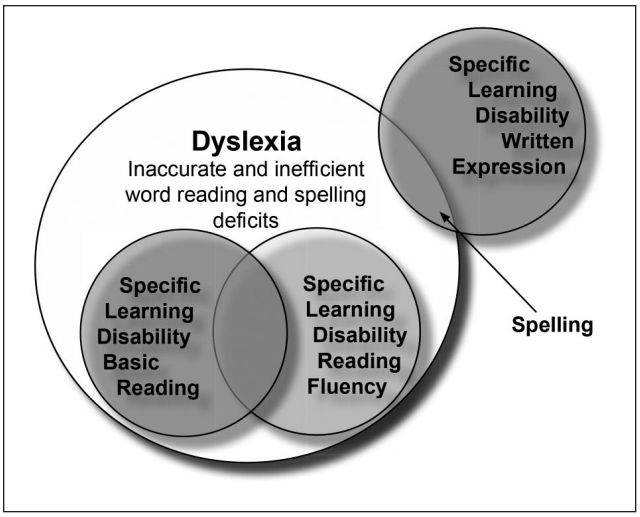

Figure 1. Relationship between dyslexia and SLD in reading and written expression.
Note. SLD = specific learning disability.

More importantly, this manner of operationally defining dyslexia is not in alignment with the definition of dyslexia adopted across the United States as part of dyslexia legislation. The lack of alignment arises from the fact that state laws almost uniformly define dyslexia as a specific learning disability (SLD) impacting reading and spelling, whereas, in the research literature, dyslexia is operationally defined as a variation of a specific reading disability. Defining dyslexia as impacting reading and spelling also does not conform well to the eligibility categories specified within the definition of SLD provided as part of the reauthorization of the Individuals with Disabilities Education Act (IDEA, 2004). As depicted in Figure 1, the commonly adopted eligibility categories of an SLD in basic reading and an SLD in reading fluency are both captured within the definition of dyslexia adopted in most dyslexia laws because dyslexia negatively affects word reading accuracy and efficiency. However, dyslexia, as defined within the definition adopted in state laws, also captures part of the eligibility category of

Table 1. Number of School Districts Reporting and the Percentage of Students Identified With Dyslexia in Arkansas, Tennessee, and Texas.

	School districts		Percentage of students in Grades 1 to 12 identified with dyslexia			
State × Year	Total number	Number reporting	*M*	Median	Minimum	Maximum
Texas						
2013–2014	862	768	3.44	3.01	0.21	16.69
2014–2015	1,023	820	3.67	3.27	0.17	15.67
2015–2016	1,025	851	3.95	3.58	0.22	14.72
2016–2017	1,203	1,095	3.55	3.36	0.00	14.95
2017–2018	1,200	1,094	3.83	3.62	0.00	17.69
2018–2019	1,201	984	4.51	4.29	0.00	20.33
Arkansas						
2015–2016	237	215	2.19	1.25	0.00	27.07
2016–2017	262	262	3.41	2.36	0.00	35.03
2017–2018	262	262	6.66	4.55	0.00	44.13
2018–2019	267	267	7.74	6.26	0.00	47.01
Tennessee						
2017–2018	146	146	4.52	2.67	0.00	28.41
2018–2019	144	143	5.53	3.82	0.00	34.91

an SLD in written expression because spelling is captured under this variant of an SLD.

These variations in federal and state guidelines raise practical questions as to how well schools are succeeding at meeting the goal of identifying students with dyslexia within the context of dyslexia legislation. Schools are held accountable for implementing IDEA and reporting the number of students qualifying under the eligibility category of SLD to ensure funding. The passage of dyslexia laws has not impacted the identification rates of SLD across the country reported under Plan B of IDEA (Phillips & Odegard, 2017). However, these data are not directly applicable to dyslexia prevalence and identification rates because the SLD eligibility category includes other areas of impairment, such as math. These data are also not directly representative of dyslexia identification rates due to dyslexia falling along a continuum of severity. Not every student who presents with the primary behavioral characteristics of dyslexia will qualify for eligibility under IDEA. Instead, some students with documented deficits in word reading and spelling may still meet educational expectations overall, and their documented deficits in literacy may not sufficiently impair their adaptive functioning. However, word reading and spelling are educational standards, and students with deficits in these areas should receive instruction and intervention to address their deficits even if they do not qualify as having an SLD under IDEA.

In light of these challenges, one source of data that has been used to document the impact of dyslexia legislation on the identification of dyslexia has been provided by the adoption of reporting requirements in legislation implemented in Arkansas, Tennessee, and Texas (Arkansas Department of Education, 2017, 2018, 2019; Phillips & Odegard, 2017; Tennessee Department of Education, 2018, 2019; Texas Education Agency, 2017, 2018, 2019). In these states, public schools are required to report if an identification of dyslexia has been made for each student. Emerging research reporting on these data suggests that the efforts of these states to identify students with dyslexia may be missing the mark. Table 1 expands on data summarized by Phillips and Odegard (2017) about the identification rates of students with dyslexia in Texas and Arkansas to include more recent data, and includes data on the identification rates of students with dyslexia in Tennessee schools. Although identification rates increase over the years each state has provided them, the magnitude of the increase varies between the states. The most conservative estimate of the prevalence of dyslexia is 5%. However, the identification rates for student populations did not reach this minimal level until the 2017–2018 academic year in Arkansas schools and the 2018–2019 academic year in Tennessee schools (see Table 1). In contrast, the identification rates have been relatively flat in Texas, only rising from 3.44% in 2013–2014 to 4.51% in 2018–2019.

An essential aspect of these data is that both Arkansas and Tennessee report identification data disaggregated by grade. As highlighted earlier, Arkansas and Tennessee vary in which grades public schools are mandated to screen for characteristics of dyslexia. Arkansas mandates schools to screen universally in Grades K–2, and after Grade 2, the decision to assess for dyslexia is based on teacher discretion. However, Tennessee public schools are mandated to screen universally for characteristics of dyslexia within the state's response to instruction framework in Grades K–12.

Table 2. Percentage of Students in Public School Identified with Dyslexia in Arkansas and Tennessee for Each of Grades 1 to 12.

	Percentage of students identified with dyslexia			
Grade	Arkansas		Tennessee	
Year	2017–2018	2018–2019	2017–2018	2018–2019
1	6.42	6.72	6.23	8.60
2	9.19	10.26	6.40	9.80
3	11.07	11.75	5.40	8.30
4	9.72	12.31	4.89	7.30
5	8.73	10.62	4.09	6.40
6	5.93	9.16	2.74	4.20
7	4.29	6.32	2.23	3.40
8	2.90	4.67	1.99	3.10
9	2.24	3.10	1.33	1.60
10	1.50	2.52	0.95	1.30
11	1.12	1.79	0.63	0.89
12	0.76	1.28	0.28	0.45

These variations in screening practices across the two states provide an opportunity to consider the potential impact of universal screening on identification rates. As depicted in Table 2, even though Arkansas does not mandate universal screening in third to seventh grade, educators in Arkansas schools identified more students with dyslexia in these grades than did educators in Tennessee schools during both school years for which Tennessee data were available (i.e., the 2017–2018 and 2018–2019 school years). Also, identification rates in high school are below the most conservative estimate of dyslexia in both states. In Arkansas, 2.17% of high school students were identified with dyslexia during the 2018–2019 school year, and only 1.06% of high school students in Tennessee were identified with dyslexia, despite Tennessee state law requiring public schools to screen all of these students for characteristics of dyslexia.

Overall, these findings suggest that even when screening data are available, educators may struggle to identify students with dyslexia. These state data are informative in that they highlight concerns and indicate that schools need help when striving to identify students with dyslexia. However, the identification data are not accompanied by any information about the screeners that schools may be using or if schools are in compliance with the state law and are screening for characteristics of dyslexia in the first place. In other words, these data are not diagnostic and do not specify the nature of the needs of educators. Given the focus on universal screening, it would be advantageous to have student screening data and explore the correspondence between these data and the identification of dyslexia. Doing so would confirm that screening data were available for students without having to infer this to be the case based on a mandate at the state level. These data would provide an opportunity to explore student-level factors that may influence the likelihood of a student being classified with dyslexia by their school. Moreover, a review of Table 1 highlights that there is considerable variation from school to school in the identification rate of dyslexia, and student-level data from a large sample of schools would allow for an exploration of the influence of school-level factors on the identification rate of dyslexia.

Current Study

To date, there has not been a study exploring these emerging state-wide identification data when taking into account student literacy skills characterized using universal screening data. This study was intended to provide critical data in this area and to provide empirical data to inform the public discourse surrounding dyslexia. This study explored factors at the student-level and school-level that might predict the likelihood of a student being classified as having characteristics of dyslexia by their school. This study also explored factors that predict when a student with a negative school-assigned dyslexia status will present with core behavioral indicators of dyslexia (i.e., reading and spelling deficits) on universal screening measures.

Data from a sample of second-grade public school students in one state were used in this study. This grade was selected because it was the highest grade in which public schools in this state are mandated by state law to universally screen for dyslexia. Also, it was selected because second-grade students are expected to read and spell, and educators would have had up to 2 years to support the reading and spelling abilities of these students. For the children attending second grade in this state, we had three critical sets of information: (a) their dyslexia classification status from their school, (b) their performance on a universal screener of literacy skills, and (c) their demographic characteristics. Data from a subsample of the students in this state whose

schools adopted a universal screener that provided behavioral indicators of oral reading fluency, spelling, reading comprehension, and vocabulary were used. Doing so provided behavioral indicators of primary characteristics (i.e., reading and spelling) and secondary consequences (i.e., reading comprehension and vocabulary) of dyslexia. School personnel compare a student's scores to benchmark values to determine whether deficits are present or not. Thus, the student's performance is represented dichotomously as being below or above the benchmark. These data were modeled statistically to answer the following research questions using a multilevel logistic regression approach to account for the nesting of individual students within their schools and to explore the influence of both student-level and school-level factors on identification of dyslexia.

Research Question 1: What are the profiles of literacy skills observed for students classified by their schools as having dyslexia?

As an initial step to characterize the sample used in this study, we first explored the profile of literacy skills deficits observed across the different classifications of students: those without any dyslexia or SLD status, those identified with dyslexia, those identified with SLD, and those identified with dyslexia and an SLD. We characterized these students based on being at risk in different combinations of literacy skills: oral reading fluency, spelling, vocabulary, and reading comprehension. These profiles speak directly to the empirically observed patterns of literacy skills prevalent in this state, providing much-needed data to inform the discourse surrounding the instructional needs of students.

Research Question 2: What is the correspondence between documented skills deficits in reading and spelling and a school-assigned classification of dyslexia?

We continued our characterization of the sample by examining the correspondence between a student's classification status and universal screening performance. We looked at students who either were or were not identified with dyslexia by their schools (i.e., positive or negative school-assigned dyslexia status). We also characterized the students based on whether or not their performance on the universal screening instrument indicated the presence of dyslexia. Students who scored below the benchmark on both oral reading fluency and spelling were considered to exhibit the behavioral characteristics of dyslexia. Then, we examined how often the presence or absence of behavioral characteristics of dyslexia matched the student's school-assigned dyslexia status. The resulting percentages illustrate how well-calibrated the school-assigned dyslexia status is to the universal screening data. These data provide much-needed information as to the potential over- or under-identification of dyslexia in the public schools in this state relative to the documented reading and spelling abilities of the students in the study.

Research Question 3: What factors influence the odds of a child being identified with dyslexia?

Specifically, we examined whether a student's ethnicity, free/reduced lunch status, and sex influenced his or her school-assigned dyslexia status. School-level variables were the percentage of students who (a) perform below a benchmark criterion on a measure of oral reading fluency and a measure of spelling (i.e., had behavioral characteristics of dyslexia), (b) identify as a minority, (c) receive free/reduced lunch, and (d) are male.

Research Question 4: What student-level and school-level factors influence the likelihood that a student with a negative school-assigned dyslexia status, nevertheless, demonstrates core behavioral characteristics of dyslexia (i.e., reading and spelling deficits) on a universal screening measure?

The same student-level and school-level characteristics named above were used to predict the likelihood a student with a negative school-assigned dyslexia status would present with below-benchmark weaknesses in both oral reading fluency and spelling, which are behavioral indicators of dyslexia.

Method

Participants

Individual student-level data from 32,189 students who were in the second grade during the 2018–2019 academic year were deidentified and shared from a state department of education under a data-sharing agreement and institutional review board protocol. Across the state, three different instruments were used to obtain universal screening data for these students. The data from one instrument, Istation's Indicators of Progress Early Reading (ISIP-Early Reading; Mathes et al., 2016), were chosen for analysis because scores were available for specific skills comprising the core characteristics and secondary consequences of dyslexia. This reduced the sample size to 8,062 students with complete data who were nested in 126 schools. Based on state reporting requirements, each student was classified as having characteristics of dyslexia ($n = 783$), an SLD ($n = 150$), both ($n = 87$), or neither ($n = 6{,}927$) after excluding students who were identified with Other Health Impairments (OHIs) through Special Education ($n = 115$) due to possible confounds that may be involved in that broad category. See Table 3 for descriptive statistics for average student-level

Table 3. School-Level Characteristics by Subgroup.

	Full sample (N = 32,189) 477 schools		Istation (n = 8,062) 126 schools		Identification status within the Istation sample			
School Characteristics	*M* (*SE*)	Minimum–maximum	*M* (*SE*)	Minimum–maximum	None (n = 6,927)	Dyslexia (n = 783)	SLD (n = 150)	Both (n = 87)
Percent Caucasian	62%	0–100	70%	0–100	68.3%	79.8%	70.7%	73.6%
Percent African American	20%	0–100	13%	0–94	13.3%	8.7%	12.0%	13.8%
Percent Hispanic	14%	0–74	15%	0–73	15.2%	9.6%	13.3%	12.6%
Percent Other Ethnicity	4%	0–39	3%	0–18	3.2%	1.9%	4%	0%
Percent Free Reduced Lunch	66%	0–100	68%	22–100	67%	70%	85%	82%
Percent ELL	10%	0–69	11%	0–69	11%	6%	13%	10%
Percent Male	51%	0–100	51%	33–100	50%	54%	63%	71%

Note. SLD = specific learning disability; ELL = English language learner.

characteristics within this sample of second-grade students subdivided by the four classification subgroups named above (i.e., dyslexia, SLD, both, or neither). Table 3 also provides demographic characteristics for the full population of second-grade students in the state. A review of Table 3 highlights that the reduced sample used in the analyses reported in this study was representative of the population of second-grade students in the state.

One purpose of universal screening instruments is to cast a wide net to find students who are at risk of struggling academically to provide differentiated instruction. The behavioral manifestation of dyslexia is difficulties in reading and spelling, which may or may not co-occur with difficulties in comprehension or vocabulary. Therefore, a dichotomous variable reflecting a conservative estimate of the presence of behavioral characteristics of dyslexia was created. Any student who was below benchmark on both spelling and oral reading fluency (described below), regardless of their performance in the other two domains, was coded as 1, and students with other patterns of performance were coded 0.

Dyslexia identification procedures. The selection of second-grade students for this study was based on the developmental expectations that these students should be capable of reading and spelling words and had received 2 years of formal instruction. Also, there are procedural differences in the requirements for universal screening that limit the availability of data for students in Grades 3 and higher to address the research questions. For students in Grades 3 and above, screening is limited to those students suspected of experiencing difficulties in reading due to dyslexia based on the observations of their classroom teacher. If dyslexia is suspected, the state recommends further testing and characterization of literacy skills through a Level 2 dyslexia screening that adopts norm-referenced measures of the areas specified for Level 1 screening. The procedures explicitly specify that Level 2 dyslexia screening is based on the logic of unexpected underachievement in reading, spelling, and phonological awareness relative to cognitive ability.

In Grades K–2, state policy requires the universal screening of all students using one of three screeners: NWEA, Renaissance STAR, or Istation (Mathes et al., 2016). Students identified as at-risk based on the universal screener are given a Level 1 dyslexia screener and referred to response to instruction and intervention (RTI) processes to determine the needs of the student. The Level 1 dyslexia screening is a process used to gather additional information that includes progress monitoring data, work samples, formative literacy assessments, parent interviews, teacher questionnaires, and early indicator checklists in addition to age and grade-appropriate dyslexia screening tools. The determination as to whether or not a child has characteristics of dyslexia can be established through either the Level 1 or Level 2 dyslexia screening process.

Measures

As part of state-mandated procedures, the reading skills of all second-grade students were examined to identify those students either at risk or at some risk for not meeting grade-level standards in reading. This universal screening was conducted using Istation (Mathes et al., 2016), which is a web-delivered computer adaptive testing system for universal screening and continuous progress monitoring of reading in students from pre-K to Grade 3. Data from Istation were used in this study because that data provide behavioral indicators of the primary characteristics of dyslexia—reading and spelling, and secondary consequences of dyslexia—vocabulary and reading comprehension.

The Vocabulary subtest measures students' knowledge of vocabulary words commonly found in text. Students hear a word and are asked to identify which of four simultaneously presented pictures has the same meaning, or to choose

which of four words (presented visually with an auditory option) has a similar meaning (e.g., identify synonyms). The Comprehension subtest measures a student's ability to read and understand text presented in sentences and paragraphs. To do this, students match one of four pictures presented on the screen to a sentence they have read or choose one of four words that complete a sentence or short passage. The Spelling subtest measures a student's knowledge of orthographic patterns and spelling concepts. Students hear a word and are shown an array of letters. They must select each letter in the correct order to spell the word. The scores for the Spelling, Vocabulary, and Comprehension subtests are reported as scaled scores ranging from 140 to 289.

The Text Fluency subtest measures students' efficiency reading passages with fluency and comprehension for 2 min using a maze task in which every fifth or sixth word in the passage is left blank, and the child must choose which of three visually presented words best support the sentence structure and meaning. Text fluency scores are calculated using a proprietary scoring mechanism (Mathes et al., 2016).

Students whose scores are below the 40th percentile are considered to be performing below grade-level expectations, and the data analyzed included variables indicating this status for the Spelling (Spell), Text Fluency (ORF), Comprehension (RC), and Vocabulary (Vocab) subtests.

Results

Examination of Prevalence of Various Profiles of Difficulties

Initially, we characterized the literacy profiles of students based on their performance on the universal screening data to address Research Question 1. Performance below the benchmark indicates a student is at risk for experiencing deficits within that academic area, and students experiencing reading difficulties may present with different patterns of deficits across academic areas. Table 4 indicates how these patterns of deficits correspond to a student being at risk for having a profile reflecting various types of reading difficulties. A pure dyslexia profile encompasses difficulties (i.e., below benchmark performance) in oral reading fluency and/or spelling. A student presenting with only comprehension problems would likely perform below benchmark only on the reading comprehension and/or vocabulary areas of the universal screening measure. In contrast, students who perform below benchmark in a mixture of areas including combinations of oral reading fluency or spelling with either reading comprehension and/or vocabulary as well make up the mixed type profile.

Some troubling findings emerge when turning our focus to the group of 6,927 students whose school-assigned dyslexia and SLD status is negative. First, a substantial portion of these students present as fitting a dyslexia profile (14%). Second, an even larger proportion of these students appear to fit a mixed profile of reading deficits (39%). The students with a mixed-type profile exhibit risk for difficulties in reading fluency and/or spelling and are also at risk for difficulties in other areas. Thus, it is the students falling into the mixed-type profile who are at greatest risk of experiencing the behavioral characteristics of dyslexia (i.e., inefficient word reading and poor spelling) as well as the frequently discussed secondary consequences of difficulties with comprehension and background knowledge. Given that across the subgroups of students based on their school classification, the most highly prevalent profile is the mixed type; it appears as though many students' reading struggles are quite pervasive.

Descriptive Comparison of Universal Screening Data and School Classification

Next, we addressed Research Question 2, by examining how well a student's school-assigned dyslexia status aligns with the student's performance on the universal screening measure. We contrasted school classification within the 7,710 students making up the dyslexia and the none subgroups and our conservative estimate of risk for the core behavioral characteristics of dyslexia—below benchmark criterion on both spelling and oral reading fluency with or without additional deficits in vocabulary or reading comprehension (see Table 4). Within this sample of students, who are further analyzed in the sections below, approximately 10% ($n = 783$) of the students have been identified with characteristics of dyslexia by their schools (see Table 5). Furthermore, out of the entire analysis sample ($n = 8,062$) when prevalence is estimated from students with school classification of dyslexia and both dyslexia and SLD, the dyslexia identification rate in second grade is 11%. However, Table 5 also illustrates that although 33.76% of students exhibit behavioral characteristics of dyslexia on the universal screener, only 7.26% are identified as having dyslexia by their school. This leaves 26.53% ($n = 2,043$) of these students with a negative school-assigned dyslexia status remaining unidentified and ineligible for dyslexia intervention through the school under state law.

This raises an overarching question about what factors influence the discrepancy between behavioral risk for dyslexia on a universal screening and a positive school-assigned dyslexia status. Our third research question examined student-level and school-level factors that potentially influence the likelihood of a student being classified with a positive school-assigned dyslexia status.

Predicting Dyslexia Status

The outcome of a positive school-assigned dyslexia status was examined through a multilevel logistic regression analysis using the generalized linear mixed models (GENLINMIXED) procedure in SPSS v.25. An intraclass

Table 4. Percentage of Students Below Benchmark Across Academic Areas Related to Reading.

	School-based classification			
Reading deficit profile	None	Dyslexia	SLD	Both
Dyslexia				
Spell only	6.8	3.4	1.3	0
ORF only	3.7	2.2	0	0
Spell + ORF[a]	3.8	5.5	4.7	0
Total dyslexia	14.3	11.1	6	0
Comprehension				
RC only	2.8	1.8	0	0
Vocab only	3.9	1.3	0.7	0
RC + Vocab	1.1	0.3	0.7	1.1
Total comprehension	7.8	3.4	1.4	1.1
Mixed type				
Spell + RC	2.6	3.3	2	2.3
ORF + Vocab	2	0.3	0.7	0
Spell + Vocab	1.7	0.9	2.7	0
ORF + RC	3.3	4.1	4	1.1
Spell + ORF + RC[a]	8.8	28.4	20	20.7
Spell + ORF + Vocab[a]	2	2.3	0.7	2.3
Spell + RC + Vocab	1.6	1.7	0.7	0
ORF + RC + Vocab	2.5	4.2	2	0
Spell + ORF + RC + Vocab[a]	14.9	35.4	59.3	71.3
Total mixed	39.4	80.6	92.1	97.7
Total from all profiles below benchmark	61.5	95.1	99.5	98.8

Note. SLD = specific learning disability; ORF = Text Fluency; RC = Comprehension.
[a]Profiles summed to provide a conservative estimate of behavioral risk for dyslexia. All students presenting with these profiles were below the benchmark on both spelling and oral reading fluency.

Table 5. School-Assigned Classification Compared With Performance on the Universal Screener.

		Behavioral characteristics of dyslexia		
		Yes	**No**	**Total**
School-assigned identification of dyslexia	**Yes**	7%	3%	10%
	No	27%	63%	90%
	Total	33%	66%	

correlation coefficient (ICC) was calculated with this subset of 7,710 participants and revealed that the between-school differences accounted for 24% of the variance in the identification of students with dyslexia.

A model was examined that had six student-level and four school-level predictors as fixed effects (see Table 6). The dependent variable in this multilevel logistic regression model is the student's school-assigned dyslexia status. It is coded as a dichotomous variable with 1 for dyslexia and 0 otherwise. There were four continuous school-level predictors, and a total of six student-level predictors (four categorical and two continuous) entered as fixed effects. The associated regression equation is provided below using notation for combined equations (Heck, Thomas, & Tabata, 2012; Raudenbush & Bryk, 2002; Snijders & Bosker, 2012). Dichotomous variables are named to reflect the option receiving a code of 1.

$$\begin{aligned}\text{School-assigned dyslexia status} = {} & \gamma_{00} + \gamma_{01}\text{Percent Behavioral Characteristics} + \\ & \gamma_{02}\text{Percent Minority}_j + \gamma_{03}\text{Percent Free Reduced Lunch}_j + \\ & \gamma_{04}\text{Percent Male}_j + \\ & \gamma_{10}\text{No Behavioral Characteristics}_{ij} + \\ & \gamma_{20}\text{Ethnicity}_{ij} + \gamma_{30}\text{Free Reduced Lunch}_{ij} + \\ & \gamma_{40}\text{Male}_{ij} + \gamma_{50}\text{Read Comprehension}_{ij} + \\ & \gamma_{60}\text{Vocabulary}_{ij} + u_{0j}\end{aligned} \quad (1)$$

The four separate school-level predictors were each created by dummy coding each student in a school as a 1 if the student (a) presented with behavioral characteristics of dyslexia on the universal screener, (b) identified as a minority (i.e., not Caucasian), (c) received free/reduced lunch, or (d) was male. Then the percentage of students with each characteristic was calculated to create a continuous measure for each predictor with a possible range of 0 to 1.

Table 6. Fixed Effects and Variance Estimates Predicting Dyslexia Status for Research Question 3.

					95% confidence interval for odds ratio	
Fixed effects	Estimates	*SE*	*t*	Odds ratio	Lower	Upper
Intercept (Υ_{000})	−0.22	0.90	−0.24	0.81	0.14	4.72
Student covariates						
No Behavioral Characteristics	−1.27**	0.12	10.99	0.28	0.23	0.35
African American Status	−0.65*	0.19	−3.40	0.52	0.36	0.76
Hispanic Status	−0.39†	016	−2.44	0.68	0.50	0.93
Others Status	−0.40	0.31	−1.28	0.67	0.37	1.23
FRL Status	0.03	0.10	0.76	1.03	0.84	1.27
Male	−0.004	0.09	−0.05	1.00	0.84	1.19
Read Comprehension	−0.05**	0.003	−13.56	0.96	0.95	0.96
Vocabulary	0.01*	0.003	3.09	1.01	1.00	1.02
School covariates						
Percent Behavioral Characteristics	−0.72	1.07	−0.67	0.49	0.06	3.97
Percent Minority	−1.44*	0.56	−2.60	0.24	0.08	0.70
Percent FRL	−0.79	0.72	−1.10	0.45	0.11	1.85
Percent Male	−1.40	1.47	−0.95	0.25	0.01	4.43
Random effects	Estimate	*SE*	*Z*			
School	1.35**	0.24	5.62			

Note. Behavioral characteristics denotes behavioral characteristics of dyslexia. RFL = Free Reduced Lunch.
†$p < .05$. *$p < .01$. **$p < .001$.

The student-level predictors of the student's performance on the universal screening measures of reading comprehension and vocabulary are also continuous predictors, and the scores were grand-mean centered before being entered in the model. The four remaining student-level predictors were each entered as categorical variables. Behavioral characteristics is a dichotomous variable for the presence of the behavioral characteristics of dyslexia. Students were coded 0 if they were below benchmark on spelling and oral reading fluency, and coded 1 otherwise. Note that this coding is in the reverse direction of the associated school-level predictor to simplify interpretation of the resulting log odds at the student-level. Ethnicity is a categorical variable coded 0 for Caucasian as the reference group, 1 for African American, 2 for Hispanic, and 3 for other. The model syntax allowed for ethnicity to be represented as a single item, although the model calculations, degrees of freedom, and output present it as three variables reflecting comparison of each minority category to the Caucasian reference group. Also, in contrast to the separation of ethnicity categories at the individual student level, the school-level ethnicity predictor described above grouped the African American, Hispanic, and other categories together as minorities to report the percentage of minority students within a school. Free Reduced Lunch was coded 1 for yes and 0 for no, and Sex was coded 1 for male and 0 for female.

The model had a classification accuracy of 91.3%. The corrected model and fixed effects of student-level behavioral characteristics, ethnicity, comprehension, and vocabulary were significant, all ps $< .003$, although the fixed effects of the student's free/reduced lunch status and sex were not, $p = .76$ and $p = .96$, respectively. Furthermore, the fixed effect of the percentage of students within a school who identify as a minority was significant, $p = .009$, although the remaining school-level predictors were not, all ps $> .26$.

Next, odds ratios and their associated 95% confidence intervals (CIs) were examined (see Table 6). A fixed effect is considered significant when the 95% confidence interval for the odds ratio does not contain 1 (Sommet & Morselli, 2017) and a strong relationship is indicated if the log odds value (i.e., estimate in Table 6) is positive and the associated odds ratio is 3 or more, or if the resulting log odds value is negative and the associated odds ratio is less than 0.33 (Haddock et al., 1998). The continuous predictors of the student's performance in reading comprehension and vocabulary were statistically significant in our large sample, although the effects are quite small.

The student-level predictors of being African American or Hispanic as compared with Caucasian also exhibited significant relationships with identification status. However, the small effect of the student's ethnicity is practically meaningful when considering the implications of these

results. Specifically, a student being African American, or Hispanic was associated with odds ratios of 0.52 and 0.68, respectively, CI = [0.36, 0.76; 0.50, 0.93], indicating students with these ethnic identities are less likely to have a positive school-assigned dyslexia status. Next, we used the model to estimate the identification rates of Caucasian, Hispanic, and African American students in this sample. Due to how behavioral characteristics were coded in the regression model, these estimates represent the rate of identifying students in each of these racial or ethnic groups when behavioral characteristics of dyslexia were identified through universal screening. When controlling for the other factors in the model, 6% of Caucasian students were estimated to be classified as having dyslexia. The estimate drops to 4% for Hispanic students and 3% for African American students.

Furthermore, there was a strong relationship with the percentage of students identifying as any ethnic or racial minority in a school such that as this percentage increased the likelihood a given student would have a positive school-assigned dyslexia status decreased with an odds ratio of 0.24, CI = [0.08, 0.70]. Finally, the student-level predictor of behavioral characteristics exhibits a strong relationship with identification status.

Predicting the Presence of Behavioral Characteristics of Dyslexia in Students With Negative School-Assigned Dyslexia Status

As illustrated in Table 5, a substantial number of students who had a negative school-assigned dyslexia status still had scores on the universal screener consistent with behavioral characteristics of dyslexia (i.e., 26.5%). Thus, in the sample of 6,927 students who had no school assigned label indicating risk of reading difficulties (i.e., dyslexia or SLD), we investigated factors impacting whether or not that student exhibited the behavioral characteristics of dyslexia using multilevel logistic regression analysis. Here, the dependent variable of whether or not the student exhibited the behavioral characteristics of dyslexia is coded as 1 for yes (i.e., below benchmark on spelling and oral reading fluency) and 0 otherwise. An intraclass correlation coefficient (ICC) was calculated and revealed that between-school differences explain only 9% of this variance.

The model used to address this research question is the same as the one used previously with the exclusion of the student-level predictor of whether or not a student has behavioral characteristics of dyslexia on the universal screener because that variable was the outcome variable in the current model. All variables were coded in the same way as they had been previously except for the dependent variable, and the associated regression equation is provided below.

$$\begin{aligned}\text{Behavioral characteristics present} = {} & \gamma_{00} + \gamma_{01}\text{Percent Behavioral Characteristics} + \\ & \gamma_{02}\text{Percent Minority}_{j} + \gamma_{03}\text{Percent Free Reduced Lunch}_{j} + \gamma_{04}\text{Percent Male}_{j} + \\ & \gamma_{10}\text{Ethnicity}_{ij} + \gamma_{20}\text{Free Reduced Lunch}_{ij} + \\ & \gamma_{30}\text{Male}_{ij} + \gamma_{40}\text{Read Comprehension}_{ij} + \\ & \gamma_{50}\text{Vocabulary}_{ij} + u_{0j}\end{aligned} \quad (2)$$

The model had a classification accuracy of 84.2%. The corrected model and fixed effects of student-level free/reduced lunch, sex, comprehension, and vocabulary were significant, all ps $< .007$, although the fixed effect of the student's ethnicity was not, $p = .08$. Furthermore, the fixed effects of the percentage of students within a school with behavioral characteristics of dyslexia, and receiving free/reduced lunch were significant, $p < .003$, although the remaining school-level predictors were not significant, all ps $> .53$.

The same criteria used to evaluate the predictors from the previous model was applied when interpreting the results of this model. The student-level predictors of receiving free/reduced lunch, being male, and a student's reading comprehension and vocabulary scores exhibited statistically significant but small effects. Similarly, there is also a small but statistically significant relationship with the percentage of students receiving free/reduced lunch in a school and the outcome variable (see Table 7).

In contrast, there is a strong relationship between the percentage of students within a school who had behavioral characteristics of dyslexia and the likelihood that an individual student would have the behavioral characteristics of dyslexia as illustrated by the odds ratio of 41.95, CI = [21.20, 83.00]. Using the data associated with this model, the mean percentage of students in a school who have behavioral characteristics of dyslexia is 36.04% (SD = 11.73%). Holding other factors constant and compared with a school whose percentage of students with behavioral characteristics of dyslexia is at the mean, increasing the percentage of students within a school who have behavioral characteristics of dyslexia by approximately 12% (1 SD) increases the probability of having behavioral characteristics of dyslexia by 41.95 times. Put more simply, when more students in a school struggle to read and spell, the likelihood that an individual student will have behavioral characteristics of dyslexia increases dramatically.

Discussion

Dyslexia legislation is being implemented in all but a few states across the United States, and there has been considerable public discourse about the potential impact of these laws on education policy and practice (Petscher et al., 2019; Worthy et al., 2017; Worthy, Salmeron et al., 2018; Worthy, Svrcek et al., 2018; Youman & Mather, 2013, 2015, 2018).

Table 7. Fixed Effects and Variance Estimates Predicting Behavioral Characteristics of Dyslexia for Research Question 4.

					95% confidence interval for odds ratio	
Fixed effects	Estimates	*SE*	*t*	Odds ratio	Lower	Upper
Intercept (Υ_{000})	−2.38**	0.31	−7.57	0.09	0.05	0.17
Student covariates						
African American Status	−0.23	0.12	−2.02	0.79	0.63	0.99
Hispanic Status	−0.13	0.10	−1.27	0.88	0.72	1.07
Others Status	−0.39	0.20	−1.89	0.68	0.45	1.01
FRL Status	0.27*	0.08	3.25	1.32	1.12	1.55
Male	0.18*	0.07	2.71	1.20	1.05	1.37
Read Comprehension	−0.08**	0.03	−31.50	0.92	0.92	0.93
Vocabulary	−0.02**	0.003	−9.01	0.98	0.97	0.98
School covariates						
Percent Behavioral Characteristics	3.74**	0.35	10.74	41.95	21.20	83.00
Percent Minority	0.12	0.19	0.62	1.12	0.78	1.62
Percent FRL	−0.78*	0.25	−3.18	0.46	0.28	0.74
Percent Male	−.08	0.56	−0.13	1.12	0.78	1.62
Random effects	Estimate	*SE*	*Z*			
School	0	0				

Note. Behavioral characteristics denotes behavioral characteristics of dyslexia. RFL = Free Reduced Lunch.
$^{\dagger}p < .05$. $^{*}p < .01$. $^{**}p < .001$.

However, there has been scant new data shared to help inform the public debate around these topics. This study explored identification rates of dyslexia in relation to student literacy skills, and other student- and school-level factors. Three major findings emerged from the study. First, literacy profiles of the students in this study indicated that the majority of second-grade students presented a mixed profile of deficits in print reading skills, oral reading fluency, and/or spelling, and deficits in comprehension skills, vocabulary, and/or reading comprehension. Second, African American and Hispanic students were less likely than Caucasian students to be classified as having dyslexia after controlling for literacy skills and free/reduced lunch status. Third, the likelihood that a student who struggles with reading and spelling will be missed by their school and not classified as having dyslexia increases as the number of students in the student's school who also struggle to read and spell increases.

Regarding the first major finding, the literacy profiles generated using universal screening data revealed 61% of the students in the sample who were not identified with dyslexia or an SLD were below the benchmark on at least one measure of reading, spelling, reading comprehension, or vocabulary. Moreover, the least prevalent literacy profile was an isolated set of deficits in reading comprehension and/or vocabulary. Twice as many students in this sample had a literacy profile of isolated deficits in oral reading fluency and/or word spelling. However, the majority of students in this sample were presented with a mixed deficit literacy profile struggling to read or spell words and struggling to comprehend written language or know the meanings of words.

These findings raise questions as to what factors influence the likelihood of a student having a school-assigned status of dyslexia. The results of this study demonstrated that students who scored below the benchmark on measures of reading and spelling were more likely to be classified as having dyslexia by their schools. This result would be expected given that reading and spelling deficits are the primary academic skills deficits associated with dyslexia. In addition, it indicates that educators are using screening data to inform the identification of dyslexia. However, the results of the study also demonstrated that the correspondence between behavioral characteristics of dyslexia and a classification of dyslexia by school personnel was not well-aligned, suggesting that other factors impacted a student's dyslexia status. In this regard, the identification of dyslexia was influenced by a student's race and ethnicity. African American and Hispanic students had a decreased likelihood of being classified with dyslexia by their schools. This finding was observed even when controlling for a student's reading comprehension and vocabulary abilities and their free and reduced lunch status. The finding is particularly troubling because of its practical implications.

Moreover, the percentage of students in a school who were from an ethnic or racial minority group also negatively influenced the probability of a student being classified as

having dyslexia by their school. However, a student receiving free or reduced lunches did not influence the likelihood of the student being classified with dyslexia, nor did the percentage of students in a school receiving free or reduced lunches influence the dyslexia status. Together, these findings suggest that a student's race and ethnicity, but not socioeconomic status, may introduce bias in their perceived eligibility for intervention services. These results replicate an emerging trend demonstrating students from racial and ethnic minority groups to be identified with an SLD at lower rates when compared with Caucasian students with equivalent academic achievement (Morgan et al., 2015; Morgan, Farkas, Cook, et al., 2017; Morgan, Farkas, Hillemeier, & Maczuga, 2017). In this study, we extended this finding to dyslexia and different areas of literacy skills.

We did not demonstrate a student's likelihood of being classified as dyslexic to be influenced by the percentage of students in their school who demonstrated behavioral characteristics of dyslexia. This initially surprised us, but as revealed in Table 2, the results demonstrated the majority of the students in the state to be below benchmark in at least one component area associated with dyslexia. This led to an additional research question which sought to investigate factors that predict whether a student would have behavioral characteristics of dyslexia even when they have not been identified with dyslexia by their school. In signal detection theory terminology, this question asks what predicts the likelihood of a student being a false negative. Similar to the analyses discussed above, as a student's comprehension scores decreased, the student's likelihood of having characteristics of dyslexia increased. However, unlike the results described above, when we focus on predicting false negatives, the most significant predictor was the composition of a student's school. As the percentage of students within a school who were below benchmark on reading and spelling increased, the likelihood that an individual student whose school reports indicate has no risk of reading problems would perform below the benchmark increased. Thus, it appears that if many students in a school are struggling to read, it is even more challenging to find the students whose struggles are likely to be more severe and long-lasting, such as those with dyslexia. These findings, coupled with the finding that the majority of students fail to meet the benchmark on the universal screening, point to a need to address the core reading instruction provided to all students. The lack of quality core reading curriculum leads to challenges with identifying students with reading and spelling deficits due to dyslexia.

Limitations

This study adds value because it is unique in focusing on linking school-assigned identification of dyslexia to universal screening data in a relatively large sample of students. By doing so, it provides empirical data to inform the public discourse surrounding dyslexia legislation. However, it must be contextualized in light of a few limitations. First, this is a case study of the identification rates in a single state with dyslexia-specific state legislation. Future research is needed to determine if similar patterns are observed in the other states with laws intended to affect the identification of students with dyslexia.

Similarly, this study reports findings based on a single universal screening instrument. It is not clear if the observed findings would replicate and extend to screening undertaken using different instruments. Also, we explore factors in second-grade students. This limits the scope of this research. Future research is needed to address the implications of the findings of this study to other grades and other screening instruments.

Practical Implications

It would seem that a renewed and continued interest in a teach-then-test approach to provide instruction to all students and support the identification of individuals with learning disabilities, including those with dyslexia, is warranted (Fletcher et al., 2018). The need to focus on prevention was included as part of the 2004 reauthorization of IDEA. These efforts led to the now widespread adoption of multitiered systems of support to reduce inappropriate identification. However, the impact of these practices in the area of reading when taken to scale have been minimal, being limited by insufficient guidance and oversight, and inconsistent implementation (Fuchs & Fuchs, 2017). As such, it would seem that these efforts should be coupled with continued large-scale evaluations of the impact of this investment on addressing the two fundamental challenges highlighted by this study. First, 61% of the second-grade students in the state under investigation struggle with foundational literacy skills. Based on historical NAEP findings, the proportion will remain the same in fourth and eighth grade unless something is done differently than in the past. One option is to address these struggles with targeted direct instruction coupled with opportunities for deliberate practice applying the skills taught (Fletcher et al., 2018). The delivery of this instruction should be differentiated based on each student's literacy deficits and need for exposure to text to increase vocabulary and background knowledge (Al Otaiba et al., 2009; Connor & Morrison, 2016). These opportunities should be provided to all students, regardless of racial or ethnic background, level of economic status, or current diagnostic category.

Second, even when we do address the needs of the vast majority of the students, there will be individuals who exhibit persistent reading and spelling deficits. This study provides empirical support to the notion that it is difficult to differentiate such students, who exhibit all three behavioral

characteristics of dyslexia (i.e., reading deficits, spelling deficits, slow response to instruction), from a garden variety struggling reader due to the high percentage of students with deficient reading and spelling abilities. However, continued difficulties on the part of educators to create the educational context needed to differentiate these students does not negate the reality of dyslexia as a construct. Instead, the overall pattern of findings provided by this initial study further highlights the real and pressing need to elevate the reading instruction provided to every student. Doing so will help create the enabling context intended by state legislation to support the identification of students with dyslexia.

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