
# Early Identification of the Risk of Dyslexia: Can the Istation Indicators of Progress (ISIP) Screen for Risk in Kindergarten through Third Grade?

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# Abstract

Students who are at risk of dyslexia respond well to effective treatment or therapy if they are caught early enough in their school careers, and until recently most students were not identified until third grade. This research uses a formative assessment, Istation's Indicators of Progress, Early Reading (ISIP ER) to create risk factors based on patterns of strengths and weaknesses associated with a risk of dyslexia. When the risk factors are applied to a sample of kindergarten students, sensitivity is greater than .80, allowing for students to be identified at risk as early as winter of kindergarten. Cut scores for specific reading subtests for Reading Comprehension, Spelling, and Alphabetic Decoding from ISIP ER are provided for first through third grades.

# Introduction

Dyslexia is a neurological variation in brain development that affects how a person processes language and sound. Most people with dyslexia have difficulty identifying speech sounds and words, and this can lead to difficulties in reading and writing. They may also have problems with understanding what other people are saying (International Dyslexia Association, 2019). If students are identified early enough, and are able to obtain the appropriate intervention, these students can reach the same levels of achievement as students without dyslexia (International Dyslexia Association, 2019).

People with dyslexia will often have trouble with phonological awareness, which is the awareness and recognition of the sounds in language (Meyler & Breznitz, 2005). They may also have difficulty with the alphabet, phonics, and spelling or encoding (Adlof & Hogan, 2018; Niileksela & Templin, 2019). If they do not receive intervention, the difficulties can increase as a person ages (Lyytinen et al., 2006). Difficulties also show up in reading comprehension, which results from difficulties in learning to read (Padget, 1998). If students' dyslexia is discovered early enough, they will respond quickly to intensive intervention and treatment (Snowling, 1996).

The neurological basis of the disorder can be seen in brain imaging studies (B. A. Shaywitz, Lyon, & Shaywitz, 2006). People not at risk of dyslexia have different brain activity patterns than those at risk, with some areas over activated to compensate for other areas that are underactivated. In the study there was a group of people with reading difficulties that did not have this dyslexia signature, leading the authors to suggest their reading difficulties may be due to poor instruction.

# Literature Review

There are two types of dyslexia commonly reported: visual dyslexia and auditory dyslexia. Visual dyslexia is characterized by confusing letters and words that look alike, difficulty with sight vocabulary, letter reversals (e.g., b for d and u for n), and transpositions. Students with visual dyslexia often have trouble remembering visual sequences and sequences of letters (Mather & Wendling, 2012).

People with auditory dyslexia have difficulty hearing differences in speech sounds and have trouble remembering the sounds of letters. Discriminating between the short vowel sounds blending sounds and segmentation is also difficult, and they may be able to read better silently than aloud. A third type of dyslexia shows a mixture of auditory and visual characteristics (Mather & Wendling, 2012).

## Strengths and Weaknesses Associated with Dyslexia

People who are at risk for dyslexia also have strengths. They will typically have stronger language (Niileksela & Templin, 2019; van Viersen, de Bree, & de Jong, 2019) and vocabulary and listening comprehension skills that are above (Padget, 1998) or not significantly different from typically developing students (Everatt, Weeks, & Brooks, 2008). Early strengths in vocabulary may erode over the years, as other students are reading to learn while the student with dyslexia is still learning to read.

There is sparse research comparing the specific strengths with specific weaknesses of students who are at risk of dyslexia. Everatt, Weeks, and Brooks (2007) did a comprehensive review of strengths and weaknesses of students with dyslexia, dyspraxia, specific learning disabilities, and attention deficit and behavioral disorders, but they did not compare the specific weaknesses and strengths together. Niileksela and Templin (2018) conducted analysis with the normative sample from the Kaufman Test

of Educational Achievement – third edition (KTEA-3) to evaluate if there were latent classes. Students with dyslexia in first and second grade achieved lower scores in the basic reading and spelling skills when compared to average-achieving students, and they also had lower scores in phonological and naming facility subtests. There were no differences in math concepts and math fluency. Oral vocabulary was not assessed.

## Need for Early Screening

Traditional practice in identifying students with dyslexia has been to wait until they show a clear pattern of reading difficulties, typically by third grade (B. A. Shaywitz, Weiss, Saklofske, & Shaywitz, 2016). Under federal statutes, if students struggle in reading, they must be evaluated for a specific learning disability. Three procedures were authorized by the Individuals with Disabilities in Education Act (IDEA) in 2004: The ability/achievement discrepancy model, failure to respond to intervention, and a pattern of strengths and weaknesses (Youman & Mather, 2013). These models, however, left students often waiting until third grade for identification, when it can be more difficult to get them the intervention they need. Students who are at risk of dyslexia respond well to effective treatment or therapy if they are caught early enough in their school careers (Elbro & Petersen, 2004; Morrison, Hawkins, & Collins, 2020).

Several states, including Texas, New Mexico, Arkansas, and North Carolina, require screening of dyslexia as early as fall of kindergarten or first grade (International Dyslexia Association, 2018) so that students have the opportunity to receive intensive intervention and treatment early in order to prevent them from falling behind. To that end, there is a need for an early screener of reading difficulties that is easy to administer and does not require extra testing time. Some screening assessments can be time consuming for teachers to administer. Some assessments require that a teacher

complete a survey of child behavior and skills in the classroom(S. E. Shaywitz, 2018) or listen to a child read aloud while recording their reading rate and errors, which can be both time consuming and error prone in scoring.

It can also be difficult to assess the risk of dyslexia as early as kindergarten because students enter kindergarten with a variety of experiences, backgrounds, and exposure to academic concepts. Some children have attended rigorous prekindergarten programs, others have gone to Head Start, some have been schooled at home, while others have had limited to no exposure to reading. Children who attend center-based daycare or a preschool program have better reading and math achievement in the fall of kindergarten than children who attend Head Start (Dong, 2009). Achievement gaps based on socioeconomic status are present on the first day of kindergarten in reading and math skills, approaches to learning, and persistence in completing tasks (Garcia & Economic Policy, 2015). If a student is doing poorly in the classroom in the fall of kindergarten, the teacher may not know if it is because of the risk of a learning disability or inadequate preparation.

### *Formative Assessment*

Many school systems use formative assessment to monitor academic progress starting in kindergarten. Formative assessment is conducted in the classroom to determine how well students are doing, identify any learning needs, and adapt instruction to scaffold learning for an individual student or groups of students (Roskos & Neuman, 2012). It allows teachers to track students' progress and provide continuous progress monitoring to evaluate if students are making expected progress. Formative assessment for reading may be able to screen students for the risk of dyslexia beginning in kindergarten. Some research supports the use of group-administered assessments

such as the Test of Silent Word Reading Fluency and the Group Reading Assessment and Diagnostic Evaluation for screening for dyslexia and language impairment (Adlof, Scoggins, Brazendale, Babb, & Petscher, 2017). This research will evaluate whether Istation's Indicators of Progress Early Reading (ISIP ER) formative assessment can be used by schools to flag students who are at risk of dyslexia as early as kindergarten.

**ISIP ER.** ISIP ER is a formative assessment used by over 4 million school children in the United States. ISIP ER is currently an approved screener for dyslexia in several states, including Arkansas (Arkansas Department of Education, 2017) and Indiana (Indiana Department of Education, 2019). ISIP ER has a lower limit of marginal reliability at approximately .90, and its test-retest reliability between testing sessions ranges from .927 to .970 (Mathes, Torgesen, & Herron, 2016)

ISIP ER serves as a benchmarking as well as progress-monitoring assessment. Developed by reading specialists Joe Torgesen, Patricia Mathes, and Jeannine Herron, ISIP ER uses a two-parameter model that is a fully computer-adaptive testing (CAT) system that assesses the critical domains of reading in all tested grades, from prekindergarten through third grade (Mathes, Torgesen & Herron, 2016). Completing the assessment typically takes thirty minutes or less, and an entire classroom can take ISIP ER at the same time if computers or devices are available. After a student has completed the assessment, the Istation Integrated Learning System (ILS) places the student into adaptive curriculum designed to address the areas where the particular student needs additional instruction. Teachers receive detailed reports about student progress along with specialized lessons for intensive intervention to administer one-on-one or in small groups.

ISIP ER was based on the science of reading and recommendations from the National Reading Panel. The panel identified five areas of instruction known as the Big

Five: phonemic awareness, phonics, vocabulary, text comprehension, and fluency (National Reading Panel, 2000). ISIP ER contains the subtests Phonemic Awareness, Letter Knowledge, Vocabulary, Listening Comprehension, Alphabetic Decoding, Reading Comprehension, Spelling, Text Fluency, and Oral Reading Fluency. ISIP ER is administered in a game-like atmosphere to entice students to do their best and "show what you know." (Mathes, Torgesen & Herron, 2016).

Phonemic Awareness is comprised of beginning, ending, and rhyming sounds, and phonemic blending of two to six phonemes in a word. Letter Knowledge consists of letter recognition, which assesses how many letters a student can identify in one minute, and letter sounds, which assesses how many sounds a student can correctly identify in a minute. Vocabulary is designed to test a student's knowledge of words that are frequently encountered in text, but not necessarily used in daily conversation. Listening Comprehension assesses a student's ability to listen and understand grade-level sentences and paragraphs. Alphabetic Decoding measures the ability to blend letters into nonsense words. It contains items for vowel-consonant (vc) and consonant-vowel-consonant (cvc) combinations. Items that are more difficult include patterns with a silent e, four- or five-phoneme blends not represented by one letter, or two-syllable words with more complex blends. Reading Comprehension assesses a student's ability to read and understand grade-level sentences and paragraphs. Spelling assesses whether a student is developing orthographic representations of words (Mathes et al., 2016).

Text Fluency, which is not included in the overall ISIP score, uses a maze task to assess a student's ability to read the text and select the correct maze responses. This type of task is highly correlated to fluency and reading comprehension (Mathes, Torgesen, & Herron, 2016). An oral reading fluency (ORF) subtest was added in 2019. ISIP ORF has

an automated scoring feature that calculates words read correctly per minute (Istation, 2020).

In kindergarten, the subtests that are administered include Listening Comprehension, Letter Knowledge, and Phonemic Awareness. A theta score is calculated for each subtest and for the overall ISIP score. The CAT algorithm adapts across subtests, and after a child has demonstrated mastery of a subtest, then he or she will no longer receive that subtest and a more advanced subtest is administered. Thresholds are implemented so that when the first threshold is met, the student will no longer receive the Letter Knowledge or Phonemic Awareness subtests and will "gate out", and the next time they will "gate in" to Alphabetic Decoding. After another threshold is met, they will gate in to reading comprehension. The gating process is designed so that the overall ISIP score is based on the difficulties of all items, and thus when a student gates out of the easier subtests and instead receives items in a more difficult subtest, their overall ISIP score goes up. In first grade, students receive Phonemic Awareness, Alphabetic Decoding, Comprehension, Vocabulary, and Spelling, and by the winter benchmark, they may gate out of Phonemic Awareness and Alphabetic Decoding. During second and third grade, students receive Comprehension, Vocabulary, and Spelling. In these grades, the algorithm has thresholds so that if a student scores below the threshold, they may "gate down" to Phonemic Awareness, Alphabetic Decoding, and Letter Knowledge (Mathes, Torgesen & Herron, 2016).

## Research Questions

The first research question is whether ISIP ER can screen for the risk of dyslexia in kindergarten. We expect that students who are at risk of dyslexia will have a pattern of strengths and weaknesses in ISIP ER. Students who are at risk of dyslexia should

have strengths in the Vocabulary and Listening Comprehension subtests, and their weaknesses will show up in Phonemic Awareness and Letter Knowledge. Given that the overall ISIP score is calculated with information from all subtests, we expect that the students who are at risk of dyslexia will have higher percentile scores in Vocabulary and Listening Comprehension and that their percentile rank scores in these subtests will be higher than the percentile rank in the overall ISIP score. We also expect that they will have lower percentile rank scores in Phonemic Awareness and Alphabet Knowledge, and these percentile rank scores will be lower than the overall ISIP score.

The second research question will explore whether or not comparisons of specific strengths and weaknesses — such as comparing Listening Comprehension and Phonemic Awareness, Vocabulary and Phonemic Awareness, Letter Knowledge and Listening Comprehension, and Letter Knowledge and Vocabulary — will serve as risk indicators for students in kindergarten and if these patterns can be incorporated into a screener. Also, in question is whether the ISIP ER can serve as an effective screener for dyslexia in first grade. We expect that the patterns will be somewhat different in this grade and that more of the subtests administered are weaknesses for students who are at risk of dyslexia, including Spelling, Alphabetic Decoding, and Reading Comprehension. Therefore, the third research question is whether cut scores can be determined for students who are at risk of dyslexia in first grade.

## Data, Methods, and Results

The data for the research for the kindergarten screener came from a large suburban school district in northern Texas that has been a long-term user of the Istation ILS and consisted of students who were in the third grade in the 2018-2019 school year. The school district provided demographic information about the students and cognitive

ability scores from the Naglieri Non Verbal Ability Test – Second Edition (NNAT-2). As part of the demographic information, the school district indicated which students in the 2018-2019 third-grade cohort had been identified with dyslexia and in which grade. This file contained 4,628 students, of which 5.2% had an identification of dyslexia. Previous years' ISIP ER scores were collected from Istation data based. Kindergarten scores were not available for all students if they had not been enrolled in the school district. This school district is identified in this report as School District A.

For the first grade screener, we collected similar data from two additional districts, one in Texas (School District B) and one in New Mexico (School District C). Data from these districts was used to validate the results found for first grade using the data from School District A.

## Kindergarten Screener

We were concerned that imputing scores for the incomplete cases would bias the results since the data were not missing at random. Most had missing data because the students started attending schools in the district after kindergarten. Therefore, we selected students who had completed the winter benchmark in kindergarten. We selected this benchmark instead of the fall benchmark because early screening before a child has received sufficient instruction is imprecise (Poulsen, Nielsen, Juul, & Elbro, 2017). This subset of the data consisted of 1,835 students. Prevalence rates of dyslexia for this subset of the data were 6.4% of students.

Bivariate analyses for students who are at risk for dyslexia (in this instance, identified by the third grade) and those not at risk (they were not identified with

dyslexia by third grade) were conducted across the sample, and the results are in Table 1. For the entire sample, 40.1% of the students were Hispanic or Latino/a, 20.2% were African-American or black, 24.3% were white alone, and the remainder were Asian or other race/ethnicities. Nearly sixty percent (59.8%) of the student body received free or reduced-price lunch. Students who were non-Hispanic whites were the most likely to be identified with dyslexia (Chi Square = 26.40, $p < .001$). There were no

Table 1. Sample Demographics, Winter of Kindergarten, School District A

| N = 1,835 | All Students | Not at Risk 93.6% | Dyslexia 6.4% | Chi Square |
|---|---|---|---|---|
| **Gender** | | | | 1.05 |
| Female | 49.5% | 94.2% | 5.8% | |
| Male | 50.5% | 93.0% | 7.0% | |
| **Race/Ethnicity*** ** | | | | 26.40 |
| White Non-Hispanic | 24.3% | 88.9% | 11.1% | |
| African American or Black | 20.2% | 94.1% | 5.9% | |
| Hispanic or Latino/a | 40.1% | 94.3% | 5.7% | |
| Asian or Other | 15.4% | 98.3% | 4.2% | |
| **Socioeconomic Status** | | | | |
| Free/Reduced-Price Lunch | 59.8% | 59.9% | 58.5% | 0.39 |
| **Assessment Scores** | **Mean (SD)** | **Mean (SD)** | **Mean (SD)** | **F** |
| Overall ISIP Score*** | 198.15 (15.10) | 198.59(15.18) | 191.86 (12.22) | 22.21 |
| Percentile*** | 52.64 (25.83) | 53.51 (26.80) | 39.88 (23.88) | 28.95 |
| Phonemic Awareness*** | 196.12 (15.81) | 196.62 (15.73) | 189.36 (15.47) | 23.08 |
| Percentile*** | 52.66 (28.46) | 53.67 (28.33) | 39.06 (26.73) | 28.93 |
| 8.7% gated out | | | | |
| Letter Knowledge*** | 193.82 (17.04) | 194.73 (17.06) | 182.93 (12.57) | 48.49 |
| Percentile*** | 54.07 (28.61) | 55.83 (28.45) | 33.08 (21.36) | 64.67 |
| 25.3% gated out | | | | |
| Listening Comprehension* | 194.36 (16.85) | 194.36 (16.94) | 198.33 (15.15) | 5.95 |
| Percentile* | 57.37 (27.00) | 56.97 (27.20) | 62.80 (23.51) | 5.00 |
| 7.7% gated out | | | | |
| Vocabulary | 200.02 (20.33) | 200.17 (20.51) | 197.87 (17.40) | 1.42 |
| Percentile | 51.41 (33.85) | 51.69 (33.93) | 47.28 (32.5) | 1.88 |
| NNAT Score*** | 100.08 (16.09) | 100.48 (16.05) | 94.47 (15.63) | 15.45 |

*$p < .05$ **$p < .01$ *** $p < .001$

significant differences for gender nor socioeconomic disadvantage between the two groups. Students who were white had a higher risk of being identified with dyslexia.

We calculated mean ISIP ER scores for students who are at risk and students who are not at risk. The results showed that students who are at risk of dyslexia had significantly lower scores for the Overall ISIP ($F = 22.21$, $p < .001$), Phonemic Awareness ($F = 23.08$, $p < .001$), and Letter Knowledge subtests ($F = 48.49$, $p < .001$). Students who are at risk for dyslexia had higher scores in Listening Comprehension ($F = 5.95$, $p < .001$), and there were no significant differences in Vocabulary scores. Students who are at risk of dyslexia also had lower NNAT scores ($F = 15.45$, $p < .001$). Gating had already occurred in January with 8.7% of students gating out of Phonemic Awareness, 25.3% gating out of Letter Knowledge, and 7.7% gating out of Listening Comprehension. Correlations were run between the subtests. The strongest correlations were between Vocabulary and Listening Comprehension at .66, with the weakest correlation between Letter Knowledge and Listening Comprehension at .21, and these results are available in Table 2.

We conducted a logistic regression analysis to verify that it would demonstrate the appropriate relationship with the risk of dyslexia, namely that higher Vocabulary and Listening Comprehension scores were positively associated and that the lower Phonemic Awareness and Letter Knowledge subtest scores would be negatively associated. Results are available in Table 3. We used the percentile ranks for this analysis, and all expected relationships were confirmed, with the exception of the Vocabulary scores, which were not significant. Students who gated out of a subtest were not included in this analysis.

We did not set cut scores for specific subtests. Since kindergarten students enter school with a variety of skill sets and experiences, it can be difficult for teachers to determine whether a student might be at risk due to dyslexia or has not had sufficient exposure to academic concepts. Cut scores at this young age will capture the more

severely at-risk students and could miss higher-performing students who may be overlooked if they attended a rigorous preschool, center-based daycare, or Head Start program.

To answer the first research question, we created variables based on expected relationships between the subtest percentile scores and the overall ISIP ER percentile score. Since the overall ISIP ER score is calculated with item difficulties across all subtests, some of which are strengths for students with dyslexia, we included a comparison between the overall score and separate subtest scores, as well as comparing percentiles for the subtests themselves.

Table 2. Correlations of ISIP ER Subtests

| | Phonemic Awareness | Letter Knowledge | Vocabulary | Listening Comprehension |
|---|---|---|---|---|
| Phonemic Awareness | | .52** | .53** | .46** |
| Letter Knowledge | .52** | | .25** | .21** |
| Vocabulary | .53** | .25** | | .66** |
| Listening Comprehension | .46** | .21** | .66** | |

** $p < .01$

Table 3. Estimates, Standard Errors, and Risk Ratios for ISIP ER Subtests' Percentile Scores and the Risk of Dyslexia

| N = 1346 | Estimates | Risk Ratio |
|---|---|---|
| Intercept*** | −2.07 (.28) | |
| Letter Knowledge*** | −.031 (.005) | .97 |
| Phonemic Awareness** | −.014 (.005) | .99 |
| Vocabulary | .003 (.005) | 1.030 |
| Listening Comprehension*** | .025 (.005) | 1.025 |
| −2LL = 639.39 | | |

*** $p < .001$

Students with a risk of dyslexia should have strengths in Listening Comprehension and Vocabulary (Everatt et al., 2008; Padget, 1998) and weaknesses in Phonemic Awareness and Letter Knowledge (Gonzalez & Brown, 2019; Ozernov - Palchik et al., 2017). Vocabulary can be considered a strength in this sample, as the students who are at risk of dyslexia did not have significantly lower scores than students who are not at risk. We created dummy variables for the risk factors that measure student strengths, including having Vocabulary scores higher than the overall ISIP score

(VOC > O) and Listening Comprehension higher than the Overall ISIP Score (LC > O). Weaknesses were having Letter Knowledge scores lower than the overall score (LK < O), and Phonemic Awareness lower than the overall score (PA < O). Students who had gated out of Phonemic Awareness, Letter Knowledge, and Listening Comprehension were put into the referent group.

To answer the second research question, we created dummy variables for the risk factors comparing the specific subtests to evaluate if specific patterns of strengths and weaknesses were better predictors of the risk of dyslexia. One risk factor was having the percentile score for Letter Knowledge lower than Vocabulary (LK < VOC), another was having Letter Knowledge lower than Listening Comprehension (LK < LC). A third risk factor was having Phonemic Awareness lower than Listening Comprehension (PA < LC), and a fourth risk factor is having Phonemic Awareness lower than Vocabulary (PA < VOC). Students who had gated out were put into the referent group.

We conducted a Chi Square analysis to determine if these relationships were significant. Results are available in Table 4. The risk factors with the strongest sensitivity (true positives) were having high Listening Comprehension and having Listening Comprehension higher than Letter Knowledge or Phonemic Awareness, followed by having Vocabulary stronger than Letter Knowledge. The risk factor with the strongest specificity (true negatives) was having a low percentile rank for Letter Knowledge as compared to the overall score.

Given that students who are at risk of dyslexia are not all alike — some may have visual dyslexia and others auditory, come from different backgrounds, and have different patterns of strengths and weaknesses — we anticipated that not all students who are at risk would have all of the risk factors. For these eight risk factors, students

who are at risk had a mean of 5.01 factors, and students who are not at risk had a mean of 2.9.

Next, we reviewed the risk factors to determine which would explain the most variance between true positives and true negatives. Because students who are at risk of dyslexia had a mean of five risk factors, our goal was to identify a set of five risk factors that for any three selected would have sensitivity of .80 or greater while having an

Table 4. Risk Factors Identification and Prevalence

| | | Chi Square | Specificity | Sensitivity |
|---|---|---|---|---|
| **Weaknesses:** | | | | |
| LK < O | Letter Knowledge < Overall Score | 65.45*** | .82 | .49 |
| PA < O | Phonemic Awareness < Overall Score | 12.80*** | .69 | .48 |
| **Strengths:** | | | | |
| VOC > O | Vocabulary > Overall Score | 8.74*** | .54 | .60 |
| LC > O | Listening Comprehension > Overall Score | 36.47*** | .42 | .86 |
| **Relationship between Weaknesses and Strengths** | | | | |
| LK < VOC | Letter Knowledge < Vocabulary | 53.44*** | .78 | .52 |
| LK < LC | Letter Knowledge < Listening Comprehension | 99.05*** | .69 | .76 |
| PA < LC | Phonemic Awareness < Listening Comprehension | 41.12*** | .51 | .80 |
| PA < VOC | Phonemic Awareness < Vocabulary | 9.51** | .63 | .51 |
| Mean Number of Risk Factors: All Eight*** | | | | |
| | Students not at risk of dyslexia | 2.9 (2.4) | | |
| | Students at risk of dyslexia | 5.01 (2.24) | | |

**$p$ <.01 ***$p$ < .001

area under the curve (AUC) greater than .70, a satisfactory threshold for a screener (Adlof et al., 2017). The AUC comes from Receiver Operating Characteristics that evaluate the true positive rate against the false positive rate (Poulsen et al., 2017). We excluded risk factors that were lower than .60 in sensitivity and kept the risk factors with sensitivity greater than .60. These risk factors included LC > O, LK < LC, and PA < LC. We also kept LK < O because while it had lower sensitivity, it had specificity greater

than .818. This left us with a decision between keeping VOC > O or LK < VOC. Both of these items assessed the strength of the Vocabulary score for students who are at risk of dyslexia.

We conducted separate analyses for the separate combinations of risk factors, and results are available in Table 5. The first combination, using LK > VOC had an AUC of .72 and sensitivity of .75, with specificity at .70. The second combination, using VOC > O had an AUC of .71 with sensitivity of .81, and specificity at .60. While the higher sensitivity meant more students would be screened, we selected this combination because we deemed it more important to ensure that the screener reached at least .80 for sensitivity.

Using this final combination of risk factors, we also evaluated the number of risk factors for students who are not at risk versus at risk, and results are available in Table 6. For students who are not at risk, 60% had two or fewer risk factors, and 18.7% of students who are at risk had two or fewer risk factors. These results clearly indicate that while some students who are at risk have all risk factors, most do not, and setting a standard of having all five risk factors would not catch enough students, particularly those that might be high achieving in kindergarten, and thus more difficult to screen.

We reviewed the combinations of three risk factors. Results are available in Table 7. All combinations had means of greater than .33, with the highest at .657. To capture the variety of risk factors that these students may exhibit, we evaluated the impact of having any three risk factors and conducted a classification analysis, comparing it to the classification analysis for the separate sets of risk factors. Results are available in Table 8. For the separate sets, specificity was higher than sensitivity, and the AUC ranged from .61 to .71. When the screener allows students to have any three risk factors, sensitivity is .81, and the AUC is .71.

ISIP ER provides meaningful differences in scores for students who are at risk of dyslexia versus those who are not. Recognizing that students who are at risk of dyslexia have strengths as well as weaknesses allows more students to be identified as at risk for dyslexia.

Table 5. Any Three of Five Risk Factors, Sensitivity, Specificity, and AUC

| | Specificity | Sensitivity | AUC |
|---|---|---|---|
| **Any 3**:<br>LK < O<br>LC > O<br>LK < VOC<br>LK < LC<br>PA < LC | .70 | .75 | .72 |
| **Any 3**:<br>LK < O<br>LC > O<br>VOC > O<br>LK < LC<br>PA < LC | .60 | .81 | .71 |

Table 6. Incremental Value of Risk Factors for Students at Risk and Not at Risk of Dyslexia

| | Not at Risk | At Risk |
|---|---|---|
| Mean Number of Risk Factors*** | 2.04 (1.37) | 3.5 (1.37) |
| Zero Risk Factors | 22.2% | 3.4% |
| One Risk Factor | 21.1% | 6.8% |
| Two Risk Factors | 16.7% | 8.5% |
| Three Risk Factors | 20.7% | 27.1% |
| Four Risk Factors | 9.7% | 24.6% |
| Five Risk Factors | 9.6% | 29.7% |

***$p < .001$

Table 7. Prevalence of Sets of Risk Factors for Students at Risk and Not at Risk of Dyslexia

| | Not at Risk | At Risk | F |
|---|---|---|---|
| Set 1: LK < O, VOC > O, LC > O*** | .11 | .33 | 45.89 |
| Set 2: LK < O, LC > O, LK < LC*** | .15 | .45 | 72.99 |
| Set 3: LK < O, LK < LC, PA < LC*** | .12 | .38 | 61.62 |
| Set 4: LK < O, VOC > O, LC > O*** | .12 | .38 | 63.28 |
| Set 5: VOC > O, LC < O, LK < LC*** | .17 | .46 | 56.74 |
| Set 6: VOC > O, LK < LC, PA < LC*** | .16 | .42 | 52.13 |
| Set 7: LC < O, LK < LC, PA < LC*** | .24 | .66 | 95.64 |

***$p < .001$

Table 8. Classification Accuracy: Any Three Risk Factors

| | Chi Square | AUC | Specificity | Sensitivity |
|---|---|---|---|---|
| Set 1: LK < O, VOC > O, LC > O*** | 48.42 | .61 | .89 | .33 |
| Set 2: LK < O, LC > O, LK < LC*** | 76.79 | .66 | .86 | .45 |
| Set 3: LK < O, LK < LC, PA < LC*** | 68.39 | .64 | .88 | .38 |
| Set 4: LK < O, VOC > O, LC > O*** | 69.98 | .64 | .88 | .38 |
| Set 5: VOC > O, LC < O, LK < LC*** | 56.33 | .64 | .83 | .46 |
| Set 6: VOC > O, LK < LC, PA < LC*** | 52.63 | .63 | .84 | .42 |
| Set 7: LC < O, LK < LC, PA < LC*** | 94.49 | .71 | .76 | .66 |
| Any 3 or more risk factors*** | 77.39 | .71 | .60 | .81 |

***$p < .001$

## First-Grade Screener

All screeners provide false positives and false negatives, and we were interested in comparing students that the screener identified to those that it did not. To help answer the third research question, we evaluated the trajectory of the four groups created by this screener: True Negatives, the screener correctly identified that they were not at risk; False Negatives, the students that the screener did not catch; False Positives, students that the screener identified as at risk that were not; and True Positives, students who are at risk that the screener caught.

Table 9 contains the mean scores for the Overall ISIP, Reading Comprehension, Spelling, and Vocabulary subtests for the first-grade winter benchmark for the four groups, along with their kindergarten NNAT Scores. While there are still mean differences between the True Negatives and False Positives, by the first-grade winter benchmark the False Positives are beginning to catch up to the higher-performing students, while the False Negatives are starting to trend down to meet the True Positives. The same risk factors are not available in first grade as in kindergarten

Table 9. Mean Scores and Standard Deviation by Screener Type: First-Grade Winter Benchmark

| N = 1,999 | True Negatives | False Negatives | False Positives | True Positives | F |
|---|---|---|---|---|---|
| Overall ISIP | 220.34 (17.80) | 204.55 (10.11) | 214.71 (13.94) | 203.02 (10.40) | 51.89*** |
| Vocabulary | 199.53 (21.78) | 200.39 (20.54) | 201.89 (14.61) | 198.38 (12.43) | 1.58 |
| Spelling | 218.78 (17.80) | 202.91 (11.29) | 211.89 (14.60) | 198.38 (12.44) | 67.50*** |
| Reading Comprehension | 220.31 (24.06) | 191.37 (12.93) | 208.50 (19.83) | 190.81 (13.25) | 96.62*** |
| Alphabetic Decoding | 221.37 (21.43) | 204.24 (12.19) | 212.75 (16.85) | 199.46 (13.70) | 61.11*** |
| NNAT | 99.12 (15.84) | 94.69 (16.44) | 99.71 (14.75) | 93.74 (15.00) | 5.32** |

**$p < .01$, ***$p < .001$

because Listening Comprehension, a differentiator in kindergarten, is not available in first grade in ISIP ER.

Given the differences in the subtest scores in Table 9, we evaluated whether we could create a meaningful cut score using the ISIP ER subtests. For this analysis, we used students in the original data set that had overall ISIP ER scores in the winter of first grade. Table 10 shows the demographic characteristics of the sample. It resembles the kindergarten sample; however, the sample size is now larger, and there is a higher percentage of students receiving free or reduced-price lunch. The strengths that students at risk for dyslexia have in Vocabulary have begun to erode, and they now score significantly below their peers in the classroom. Table 11 shows the correlations between the subtests. Alphabetic Decoding, Reading Comprehension and Spelling are highly correlated with one another; however, Vocabulary is moderately correlated with the other subtests.

For the winter benchmark, we created cut scores for the Spelling, Alphabetic Decoding, and Comprehension subtests at the 40th percentile, 35th percentile, and 30th percentile. Results are available in Table 12. For Spelling, a cut score at the 30th percentile had an AUC of .75, with specificity at .72 and sensitivity at .79. For

Alphabetic Decoding a cut score at the 40th percentile had the best sensitivity at .70, and a cut score for Reading Comprehension at the 30th percentile shows sensitivity at .78, specificity at .76, and an AUC of .77. Table 13 shows the incremental value of risk factors for students who are not at risk and students who are at risk of dyslexia. For students who are not at risk, 74.5% had one or fewer risk factors. Table 14 shows the final results for the classification accuracy for the first grade screener. The criteria is set as having two or more risk factors. Sensitivity is .81, specificity is .75, and the AUC is .77.

Table 10. Sample Demographics, Winter of First Grade, School District A

| N = 1999 | All Students | Not at Risk | Dyslexia | Chi Square |
|---|---|---|---|---|
| *Gender* | | | | 1.04 |
| Female | 49.5% | 93.5% | 6.5% | |
| Male | 50.5% | 92.4% | 7.6% | |
| *Race/Ethnicity**** | | | | 26.40 |
| White Non-Hispanic | 24.5% | 89.8% | 10.2% | |
| African American or Black | 21.1% | 92.2% | 7.8% | |
| Hispanic or Latino/a | 38.9% | 93.4% | 6.6% | |
| Asian or Other | 15.6% | 97.8% | 2.2% | |
| Free/Reduced-Price Lunch | 61.0% | 60.5% | 68.1% | 3.72 |
| *Assessment Scores* | Mean (SD) | Mean (SD) | Mean (SD) | F |
| Overall ISIP Score*** | 217.50 (17.07) | 218.55 (17.02) | 203.62 (10.28) | 105.60 |
| Alphabetic Decoding*** | 217.47 (20.51) | 218.69 (20.44) | 201.44 (13.38) | 97.18 |
| Reading Comprehension*** | 214.79 (23.77) | 216.59 (23.43) | 191.08 (13.13) | 163.16 |
| Spelling*** | 215.41 (17.36) | 216.47 (17.15) | 200.11 (12.21) | 125.11 |
| Vocabulary*** | 222.67 (20.67) | 223.13 (20.77) | 216.59 (18.30) | 13.17 |
| NNAT Score | 101.37 (13.18) | 101.80 (13.16) | 95.81 (12.21) | 29.96 |

***$p < .001$

Table 11. First Grade Correlations of ISIP ER Subtests, School District A

| | Alphabetic Decoding | Reading Comprehension | Spelling | Vocabulary |
|---|---|---|---|---|
| Alphabetic Decoding | | .76** | .77** | .57** |
| Reading Comprehension | .76** | | .75** | .60** |
| Spelling | .77** | .75** | | |
| Vocabulary | .57** | .60** | .55** | .55** |

** $p < .01$

Table 12. Winter Benchmark First Grade: Cut Scores Spelling, Alphabetic Decoding, and Reading Comprehension, School District A

| | Cut Score | Chi Square | Specificity | Sensitivity | AUC |
|---|---|---|---|---|---|
| Spelling | | | | | |
| <= 40th percentile | 213 | 108.22 | .57 | .89 | .73 |
| <= 35th percentile | 210 | 141.46 | .66 | .84 | .75 |
| <= 30th percentile | 208 | 155.71 | .72 | .79 | .75 |
| Alphabetic Decoding | | | | | |
| <= 40th percentile | 208 | 98.63 | .71 | .70 | .70 |
| <= 35th percentile | 207 | 97.01 | .73 | .67 | .70 |
| <= 30th percentile | 204 | 73.22 | .78 | .54 | .66 |
| Reading Comprehension | | | | | |
| <= 40th percentile | 205 | 142.98 | .64 | .88 | .76 |
| <= 35th percentile | 203 | 167.20 | .70 | .84 | .77 |
| <= 30th percentile | 200 | 193.99 | .76 | .78 | .77 |

Table 13. First-Grade Incremental Value of Risk Factors for Students at Risk and Not at Risk of Dyslexia, School District A

| | Not at Risk | At Risk |
|---|---|---|
| Zero Risk Factors | 57.0% | 8.5% |
| One Risk Factor | 17.5% | 10.6% |
| Two Risk Factors | 13.2% | 27.0% |
| Three Risk Factors | 12.3% | 53.9% |

Chi Square = 227.81, $p$ <.001.

Table 14. Classification Accuracy of First-Grade Screener: Any Two or More Risk Factors, School District A

| | Chi Square | Specificity | Sensitivity | AUC |
|---|---|---|---|---|
| Spelling <= 30th percentile | | | | |
| Alphabetic Decoding <= 40th percentile | | | | |
| Reading Comprehension <= 30th percentile | | | | |
| 2 or more risk factors | 193.31 | .75 | .81 | .78 |
| 3 or more risk factors | 176.13 | .88 | .54 | .71 |

For the spring benchmark, we also created cut scores at the 40th percentile, 35th percentile, and 30th percentile. The sample is described in Table 15 and it now consists of 2,049 students, and the demographics are similar to the winter benchmark. The results for the cut points are available in Table 16. For Spelling, a cut score at the 30th percentile had an AUC of .76, with sensitivity at .79 and specificity at .74. For Alphabetic Decoding a cut score at the 35th percentile had sensitivity at .78, and a cut score for Reading Comprehension at the 30th percentile shows sensitivity at .85,

specificity at .76, and an AUC of .80. Table 17 shows the incremental value of risk factors for students who are not at risk and students who are at risk of dyslexia. For students who are not at risk, 76.2% had one or fewer risk factors. Table 18 shows the results for the classification accuracy for the first-grade screener at the spring benchmark. The criteria are set as having two or more risk factors. Sensitivity is .84, specificity is .76, and the AUC is .80.

Table 15. Sample Demographics, Spring of First Grade, School District A

| N = 2049 | All Students | Not at Risk | Dyslexia | Chi Square |
|---|---|---|---|---|
| Gender | | | | 1.27 |
| Female | 50% | 93.6% | 6.4% | |
| Male | 50% | 92.3% | 7.7% | |
| Race/Ethnicity*** | | | | 22.32 |
| White Non-Hispanic | 23.8% | 89.3% | 10.7% | |
| African American or Black | 20.4% | 92.1% | 7.9% | |
| Hispanic or Latino/a | 39.9% | 93.5% | 6.5% | |
| Asian or Other | 15.9% | 97.8% | 2.2% | |
| Free/Reduced-Price Lunch | | | | |
| *Assessment Scores* | Mean (SD) | Mean (SD) | Mean (SD) | F |
| Overall ISIP Score*** | 226.14 (17.88) | 227.38 (17.70) | 209.83 (10.98) | 138.60 |
| Alphabetic Decoding*** | 226.55 (22.88) | 228.12 (22.72) | 205.88 (12.66) | 135.72 |
| Reading Comprehension*** | 226.88 (23.73) | 228.84 (23.11) | 201.16 (15.20) | 201.33 |
| Spelling*** | 224.81 (18.09) | 226.08 (17.87) | 208.21 (11.78) | 140.34 |
| Vocabulary*** | 229.14 (21.86) | 226.08 (17.87) | 208.21 (11.78) | 15.15 |

***$p < .001$

Table 16. Spring Benchmark First Grade: Cut Scores for Spelling, Alphabetic Decoding, and Reading Comprehension, School District A

| | Cut Score | Chi Square | Specificity | Sensitivity | AUC |
|---|---|---|---|---|---|
| Spelling | | | | | |
| <= 40th percentile | 213 | 146.00 | .64 | .88 | .76 |
| <= 35th percentile | 210 | 149.16 | .68 | .82 | .75 |
| <= 30th percentile | 208 | 178.95 | .74 | .79 | .76 |
| Alphabetic Decoding | | | | | |
| <= 40th percentile | 208 | 165.85 | .69 | .83 | .76 |
| <= 35th percentile | 207 | 183.75 | .75 | .78 | .76 |
| <= 30th percentile | 204 | 165.6 | .80 | .67 | .73 |
| Reading Comprehension | | | | | |
| <= 40th percentile | 205 | 205.63 | .71 | .87 | .79 |
| <= 35th percentile | 203 | 230.85 | .74 | .86 | .80 |
| <= 30th percentile | 200 | 241.60 | .76 | .85 | .80 |

Table 17. First-Grade Incremental Value of Risk Factors for Students at Risk and Not at Risk of Dyslexia: Spring Benchmark, School District A

| | Not at Risk | At Risk |
|---|---|---|
| Zero Risk Factors | 59.9% | 6.2% |
| One Risk Factor | 16.3% | 9.7% |
| Two Risk Factors | 11.9% | 20.0% |
| Three Risk Factors | 11.9% | 64.1% |

Chi Square = 315.40, $p$ <.001.

Table 18. Classification Accuracy of First-Grade Screener: Any Two or More Risk Factors Spring Benchmark, School District A

| | Chi Square | Specificity | Sensitivity | AUC |
|---|---|---|---|---|
| Spelling <= 30th percentile | | | | |
| Alphabetic Decoding <= 35th percentile | | | | |
| Reading Comprehension <= 30th percentile | | | | |
| 2 or more risk factors | 243.06 | .76 | .84 | .80 |
| 3 or more risk factors | 278.76 | .88 | .64 | .76 |

## Verification of First Grade Cut Scores

To verify the cut scores based on the school district, we obtained data from two additional school districts, one in New Mexico, and the other in Texas, where students had been assessed with the ISIP ER since the first grade. Table 19 displays the demographics across the three school districts. Overall the sample consists of students who are white at 20.6%, students who are African American or Black at 18.9%, students

who are of Hispanic or Latino origin at 51.9%, and the remainder are Asian or other race/ethnicities. Students in School District A have the highest overall ISIP ER score. School District B had the highest percentage of students assessed with dyslexia by the end of third grade at 18.4%, and School District C had the least at 1.5%. For the entire sample, 8.6% of students had an identification of dyslexia at third grade. Across all of the school districts, the cut points were validated. If a student falls below the cut point on any two of the criteria, the sensitivity is .79, and the AUC is .76. These results are available in Table 20. Next, we verified the cut points for the Spring of first grade. Again, we selected those students who had an overall ISIP score in May of the 2016-2017 school year. Demographics across the sample are reported in Table 21. The demographics are comparable as would be expected.

Table 19. Demographics by School District for the First Grade Cut Scores - Winter

| | School District A Texas $N$ = 1,999 | School District B Texas $N$ = 1,348 | School District C New Mexico $N$ = 1,304 | Total $N$ = 4,651 |
|---|---|---|---|---|
| *Gender* | | | | |
| Female | 49.0% | 48.8% | 48.4% | 49% |
| Male | 51.0% | 51.2% | 51.6% | 51% |
| *Race/Ethnicity**** | | | | Chi Square = 23.46 |
| White Non-Hispanic | 24.1% | 17.1% | 18.9% | 20.6% |
| African American or Black | 21.1% | 32.3% | 1.8% | 18.9% |
| Hispanic or Latino/a | 38.9% | 46.1% | 77.8% | 51.9% |
| Asian or Other | 16.0% | 4.5% | 1.5% | 8.6% |
| Free/Reduced-Price Lunch | 53.9% | 77.2% | 83.7% | 69.3% |
| | | | | Chi Square = 250.63 |
| Dyslexia Identification*** | 7.1% | 18.4% | 1.5% | 8.6% |
| | | | | F = 39.84 |
| Overall ISIP score*** | 217.5 | 212.6 | 214.4 | 215.2 |

***$p < .001$

Table 20. Specificity (Spec), Sensitivity (Sens) and the Area Under the Curve for the cut scores and final screener, Winter of First Grade

| | School District A | | School District B | | School District C | | Total | | AUC |
|---|---|---|---|---|---|---|---|---|---|
| | Spec | Sens | Spec | Sens | Spec | Sens | Spec | Sens | |
| Spelling <= 30th percentile | .72 | .79 | .70 | .70 | .72 | .70 | .71 | .74 | |
| Alphabetic Decoding <= 40th percentile | .71 | .70 | .64 | .72 | .65 | .73 | .67 | .71 | |
| Reading Comprehension <= 30th percentile | .72 | .82 | .72 | .73 | .66 | .74 | .71 | .76 | |
| Any 2 | .73 | .82 | .71 | .78 | .70 | .79 | .72 | .79 | .76 |

We analyzed the specificity and sensitivity results across all three districts, separately and overall. These results are available in Table 22, and they verify that the cut points for the screener in the spring of first grade can be used across school districts. If a student falls below the cut point in any two of the subtests, the sensitivity is .81, and the area under the curve is .76.

Table 21. Demographics by School District for the First Grade Cut Scores - Spring

| | School District A Texas $N$ = 2,049 | School District B Texas $N$ = 1,371 | School District C New Mexico $N$ = 1,312 | Total $N$ = 4,732 |
|---|---|---|---|---|
| *Gender* | | | | |
| Female | 50.0% | 49.0% | 48.1% | 49.2% |
| Male | 50.0% | 51.0% | 51.9% | 50.8% |
| *Race/Ethnicity**** | | | | Chi Square = 821.88 |
| White Non-Hispanic | 23.8% | 17.0% | 19.0% | 20.5% |
| African American or Black | 20.4% | 32.3% | 1.8% | 18.7% |
| Hispanic or Latino/a | 39.9% | 46.1% | 77.7% | 52.2% |
| Asian or Other | 15.9% | 4.6% | 1.4% | 8.6% |
| Free/Reduced-Price Lunch | 53.9% | 77.2% | 83.7% | 69.3% |
| | | | | Chi Square = 252.97 |
| Dyslexia Identification*** | 7.1% | 18.4% | 1.4% | 8.8% |
| | | | | F = 28.98 |
| Overall ISIP score*** | 226.14 | 221.75 | 223.35 | 224.09 |

*** $p < .001$

Table 22. Specificity (Spec), Sensitivity (Sens) and the Area Under the Curve for the cut scores and final screener, Spring of First Grade

| | School District A | | School District B | | School District C | | Total | | AUC |
|---|---|---|---|---|---|---|---|---|---|
| | Spec | Sens | Spec | Sens | Spec | Sens | Spec | Sens | |
| Spelling <= 30th percentile | .74 | .79 | .73 | .63 | .68 | .79 | .72 | .69 | |
| Alphabetic Decoding <= 35th percentile | .75 | .77 | .73 | .73 | .69 | .84 | .73 | .76 | |
| Reading Comprehension <= 30th percentile | .76 | .85 | .74 | .76 | .67 | .84 | .73 | .80 | |
| Any 2 | .75 | .84 | .74 | .78 | .70 | .88 | .73 | .81 | .76 |

## Second Grade Screener

We used similar methodology for the second-grade screener. We used two separate samples for this analysis. For Reading Comprehension, we used the sample from all three school districts, and for Spelling we eliminated school district B. This district had spelling scores that appeared to be out of pattern, perhaps due to instructional practices in the classroom. Tables 23 and 24 give information on the samples used in this analysis.

Table 23. Sample Demographics, Second Grade, Spelling

| | Fall N = 3,023 | | Winter N = 3,826 | | Spring N = 3,984 | |
|---|---|---|---|---|---|---|
| | Not at Risk | Dyslexia | Not at Risk | Dyslexia | Not at Risk | Dyslexia |
| | | | | | | |
| Gender | | $X^2$=.20 | | $X^2$=1.09 | | $X^2$=.643*** |
| Female | 48.7% | 46.8% | 48.9% | 45.1% | 48.9% | 45.9% |
| Male | 51.3% | 53.2% | 51.1% | 54.9% | 51.1% | 54.1% |
| Race/Ethnicity*** | | $X^2$=31.90*** | | $X^2$=32.89*** | | $X^2$=40.05*** |
| White Non-Hispanic | 20.1% | 34.5% | 20.3% | 32.6% | 19.5% | 33.9% |
| African American or Black | 12.1% | 20.1% | 13.7% | 21.2% | 13.7% | 21.3% |
| Hispanic or Latino/a | 58.9% | 42.4% | 55.5% | 42.4% | 56.5% | 41.0% |
| Asian or Other | 8.9% | 2.9% | 10.5% | 3.8% | 10.3% | 3.8% |
| Assessment Scores | | | | | | |
| Overall ISIP Score | 227.41 (16.34) | 211.54 (11.08) F=128.18*** | 235.08 (18.13) | 215.51 (12.22) F=209.40*** | 240.92 (19.20) | 219.99 (13.66) F=212.15*** |

| | | | | | | |
|---|---|---|---|---|---|---|
| Spelling | 224.06 (17.08) | 207.41 (11.22) F=129.47*** | 231.69 (18.30) | 211.53 (11.60) F=218.69*** | 237.35 (19.10) | 237.35 (19.10) F=223.83*** |
| Vocabulary | 228.33 (16.41) | 223.50 (14.79) F=11.56*** | 238.40 (21.83) | 229.72 (17.72) F=28.13*** | 244.84 (24.02) | 233.26 (21.08) F=40.95*** |

***$p < .001$

Table 24. Sample Demographics, Second Grade, Reading Comprehension

| | Fall N = 4,537 | | Winter N = 5,368 | | Spring N = 5,611 | |
|---|---|---|---|---|---|---|
| | Not at Risk | Dyslexia | Not at Risk | Dyslexia | Not at Risk | Dyslexia |
| | | | | | | |
| Gender | | $X^2$=.14 | | $X^2$=.001 | | $X^2$=.01 |
| Female | 48.8% | 48.9% | 48.8% | 48.7% | 49.0% | 49.1% |
| Male | 51.2% | 50.2% | 51.2% | 51.3% | 51.0% | 50.9% |
| Race/Ethnicity | | $X^2$=20.92*** | | $X^2$=26.26*** | | $X^2$=26.18*** |
| White Non-Hispanic | 18.8% | 24.1% | 19.1% | 24.2% | 18.4% | 24.4% |
| African American or Black | 18.9% | 21.7% | 19.2% | 22.5% | 19.1% | 22.0% |
| Hispanic or Latino/a | 54.6% | 51.5% | 52.7% | 50.2% | 53.6% | 50.2% |
| Asian or Other | 7.7% | 2.7% | 9.1% | 3.1% | 8.9% | 3.4% |
| Assessment Scores | | | | | | |
| Overall ISIP Score | 226.53 (16.34) | 211.18 (10.48) F=347.32*** | 234.64 (17.98) | 216.61 (12.03) F=464.32*** | 240.48 (19.24) | 245.05 (24.38) F=421.25*** |
| Reading Comprehension | 229.41 (20.07) | 208.13 (15.16) F=436.25*** | 238.56 (22.98) | 213.94 (16.38) F=538.82*** | 245.05 (24.38) | 221.19 (17.26) F=428.56*** |
| Vocabulary | 227.04 (16.60) | 220.01 (13.96) F=68.49** | 237.33 (21.48) | 227.17 (17.46) F=96.65*** | 243.69 (23.84) | 232.14 (18.94) F=103.76*** |

***$p < .001$

We reviewed several cut points for Spelling and Reading Comprehension, including the 20th, 30th, 35th, and 40th percentiles for each benchmark period. In these tables, we show only the results for the selected percentile cut points that we selected for the screener.

Table 25. Fall Benchmark Second Grade: Cut Scores for Spelling and Reading Comprehension

| | Cut Score | Chi Square | Specificity | Sensitivity | AUC |
|---|---|---|---|---|---|
| Spelling | | | | | |
| <= 30th percentile | 215 | 161.99 | .71 | .80 | .76 |
| Reading Comprehension | | | | | |
| <= 35th percentile | 218 | 400.38 | .74 | .74 | .74 |

Table 26. Second-Grade Incremental Value of Risk Factors for Students at Risk and Not at Risk of Dyslexia: Fall Benchmark

| | Not at Risk | At Risk |
|---|---|---|
| Zero Risk Factors | 63.4% | 10.8% |
| One Risk Factor | 18.9% | 23.0% |
| Two Risk Factors | 17.7% | 66.2% |

Table 27. Classification Accuracy of Second-Grade Screener: One or Two Risk Factors Fall Benchmark

| | Chi Square | Specificity | Sensitivity | AUC |
|---|---|---|---|---|
| Spelling <= 30th percentile | | | | |
| Reading Comprehension <= 35th percentile | | | | |
| 1 risk factor | 154.38 | .63 | .89 | .76 |
| 2 risk factors | 195.09 | .82 | .66 | .74 |

Table 28. Winter Benchmark Second Grade: Cut Scores for Spelling and Reading Comprehension

| | Cut Score | Chi Square | Specificity | Sensitivity | AUC |
|---|---|---|---|---|---|
| Spelling | | | | | |
| <= 20th percentile | 218 | 127.05 | .71 | .68 | .70 |
| Reading Comprehension | | | | | |
| <= 30th percentile | 223 | 429.01 | .71 | .77 | .74 |

Table 29. Second-Grade Incremental Value of Risk Factors for Students at Risk and Not at Risk of Dyslexia: Winter Benchmark

| | Not at Risk | At Risk |
|---|---|---|
| Zero Risk Factors | 63.8% | 26.1% |
| One Risk Factor | 17.1% | 14.1% |
| Two Risk Factors | 19.1% | 59.8% |

Table 30. Classification Accuracy of Second-Grade Screener: One or Two Risk Factors Winter Benchmark

| | Chi Square | Specificity | Sensitivity | AUC |
|---|---|---|---|---|
| Spelling <= 20th percentile | | | | |
| Reading Comprehension <= 30th percentile | | | | |
| 1 risk factor | 105.61 | .64 | .74 | .69 |
| 2 risk factors | 174.64 | .81 | .60 | .70 |

Table 31. Spring Benchmark Second Grade: Cut Scores for Spelling and Reading Comprehension

| | Cut Score | Chi Square | Specificity | Sensitivity | AUC |
|---|---|---|---|---|---|
| Spelling | | | | | |
| <= 20th percentile | 222 | 84.51 | .64 | .69 | .67 |
| Reading Comprehension | | | | | |
| <= 30th percentile | 230 | 325.21 | .64 | .79 | .71 |

Table 32. Second-Grade Incremental Value of Risk Factors for Students at Risk and Not at Risk of Dyslexia: Spring Benchmark

| | Not at Risk | At Risk |
|---|---|---|
| Zero Risk Factors | 56.8% | 26.8% |
| One Risk Factor | 17.4% | 9.8% |
| Two Risk Factors | 25.8% | 63.4% |

Table 33. Classification Accuracy of Second-Grade Screener: One or Two Risk Factors Spring Benchmark

| | Chi Square | Specificity | Sensitivity | AUC |
|---|---|---|---|---|
| Spelling <= 20th percentile | | | | |
| Reading Comprehension <= 30th percentile | | | | |
| 1 risk factor | 63.71 | .57 | .73 | .65 |
| 2 risk factors | 174.64 | .74 | .63 | .69 |

## Third Grade Screener

The third grade screener used data from all three school districts, and they are reported as an entire sample. Table 34 shows the demographics by Fall, Winter, and Spring. There are no significant differences between males and females.

Table 34. Sample Demographics, Third Grade

| | Fall N = 4,680 | | Winter N = 5,634 | | Spring N = 5,256 | |
|---|---|---|---|---|---|---|
| | Not at Risk | Dyslexia | Not at Risk | Dyslexia | Not at Risk | Dyslexia |
| | | | | | | |
| Gender | | $X^2$=.03 | | $X^2$=.03 | | $X^2$=.60 |
| Female | 48.4% | 48.8% | 49.1% | 49.5% | 48.6% | 50.6% |
| Male | 51.6% | 51.2% | 50.9% | 50.5% | 51.4% | 49.4% |
| Race/Ethnicity*** | | $X^2$=11.68** | | $X^2$=18.58*** | | $X^2$=19.19*** |
| White Non-Hispanic | 17.8% | 22.7% | 16.3% | 21.7% | 16.4% | 23.6% |
| African American or Black | 19.7% | 20.1% | 19.9% | 20.0% | 19.9% | 20.0% |
| Hispanic or Latino/a | 55.6% | 53.6% | 56.2% | 55.1% | 56.4% | 52.8% |
| Asian or Other | 6.8% | 3.6% | 7.6% | 3.2% | 7.2% | 3.6% |
| Assessment Scores, Means, Standard Deviations, and *F* test results | | | | | | |
| Overall ISIP Score | 240.25 (18.03) | 224.29 (11.14) F=318.64*** | 245.31 (19.50) | 227.05 (14.35) F=388.85*** | 249.36 (21.11) | 231.29 (15.29) F=288.41*** |
| Reading Comprehension | 244.45 (22.06) | 225.14 (15.59) F=308.16*** | 250.27 (25.35) | 228.47 (17.66) F=329.77*** | 254.47 (27.52) | 232.62 (19.63) F=248.39*** |
| Spelling | 237.28 (19.12) | 219.20 (12.39) F=361.10)*** | 241.68 (19.29) | 221.38 (14.14) F=490.30*** | 245.32 (20.14) | 225.74 (14.98) F=371.25*** |
| Vocabulary | 240.61 (19.03) | 232.35 (14.86) F=74.93*** | 250.33 (24.25) | 237.91 (20.43) F=114.55*** | 256.56 (26.20) | 243.38 (22.27) F=98.00*** |

***$p < .001$

Table 35. Fall Benchmark Third Grade: Cut Scores for Spelling and Reading Comprehension

| | Cut Score | Chi Square | Specificity | Sensitivity | AUC |
|---|---|---|---|---|---|
| Spelling | | | | | |
| <= 20th percentile | 226 | 366.78 | .73 | .73 | .73 |
| Reading Comprehension | | | | | |
| <= 38th percentile | 235 | 341.46 | .71 | .74 | .72 |

Table 36. Third-Grade Incremental Value of Risk Factors for Students at Risk and Not at Risk of Dyslexia: Fall Benchmark

| | Not at Risk | At Risk |
|---|---|---|
| Zero Risk Factors | 62.6% | 15.2% |
| One Risk Factor | 20.4% | 27.7% |
| Two Risk Factors | 17.1% | 57.1% |

Table 37. Classification Accuracy of Third-Grade Screener: One or Two Risk Factors Fall Benchmark

| | Chi Square | Specificity | Sensitivity | AUC |
|---|---|---|---|---|
| Spelling <= 20th percentile | | | | |
| Reading Comprehension <= 38th percentile | | | | |
| 1 risk factor | 354.79 | .63 | .85 | .74 |
| 2 risk factors | 195.09 | .83 | .57 | .70 |

Table 38. Winter Benchmark Third Grade: Cut Scores for Spelling and Reading Comprehension

| | Cut Score | Chi Square | Specificity | Sensitivity | AUC |
|---|---|---|---|---|---|
| Spelling | | | | | |
| <= 27th percentile | 231 | 489.30 | .72 | .77 | .75 |
| Reading Comprehension | | | | | |
| <= 38th percentile | 239 | 286.96 | .68 | .72 | .70 |

Table 39. Third Grade Incremental Value of Risk Factors for Students at Risk and Not at Risk of Dyslexia: Winter Benchmark

| | Not at Risk | At Risk |
|---|---|---|
| Zero Risk Factors | 58.8% | 13.5% |
| One Risk Factor | 22.6% | 23.9% |
| Two Risk Factors | 18.7% | 62.6% |

Table 40. Classification Accuracy of Third-Grade Screener: One or Two Risk Factors Winter Benchmark

| | Chi Square | Specificity | Sensitivity | AUC |
|---|---|---|---|---|
| Spelling <= 27th percentile | | | | |
| Reading Comprehension <= 38th percentile | | | | |
| 1 risk factor | 352.29 | .59 | .87 | .73 |
| 2 risk factors | 474.18 | .81 | .63 | .72 |

Table 41. Spring Benchmark Third Grade: Cut Scores for Spelling and Reading Comprehension

| | Cut Score | Chi Square | Specificity | Sensitivity | AUC |
|---|---|---|---|---|---|
| Spelling | | | | | |
| <= 27th percentile | 235 | 329.32 | .70 | .74 | .72 |
| Reading Comprehension | | | | | |
| <= 38th percentile | 241 | 188.20 | .67 | .67 | .67 |

Table 42. Third-Grade Incremental Value of Risk Factors for Students at Risk and Not at Risk of Dyslexia: Spring Benchmark

| | Not at Risk | At Risk |
|---|---|---|
| Zero Risk Factors | 56.8% | 18.0% |
| One Risk Factor | 23.5% | 23.4% |
| Two Risk Factors | 19.7% | 58.6% |

Table 43. Classification Accuracy of Third Grade Screener: One or Two Risk Factors Spring Benchmark

| | Chi Square | Specificity | Sensitivity | AUC |
|---|---|---|---|---|
| Spelling <= 27th percentile | | | | |
| Reading Comprehension <= 38th percentile | | | | |
| 1 risk factor | 229.40 | .57 | .82 | .69 |
| 2 risk factors | 326.07 | .80 | .57 | .70 |

## Discussion

Screening for dyslexia can be time consuming for teachers and other educational professionals, and there is an advantage to using regular progress monitoring measures, such as ISIP ER, to screen for the risk of dyslexia in the early grades. While ISIP ER was not designed as a clinical assessment and therefore cannot be used to identify a student with dyslexia, this research demonstrates that it can be used to screen students who are at risk of dyslexia that need further evaluation or intervention. A summary of the cut points is available in Table 44.

Table 44. Cut Points for ISIP ER subtests by Grade and Benchmark Period

| | Alphabetic Decoding | Spelling | Reading Comprehension |
|---|---|---|---|
| First Grade - Winter | 40th - 209 | 30th - 208 | 30th - 200 |
| First Grade - Spring | 35th - 215 | 30th - 216 | 30th - 212 |
| Second Grade - Fall | | 30th – 215 | 35th - 218 |
| Second Grade - Winter | | 20th - 218 | 30th - 224 |
| Second Grade - Spring | | 20th - 222 | 30th - 230 |
| Third Grade - Fall | | 20th - 226 | 38th - 235 |
| Third Grade - Winter | | 27th - 231 | 38th - 239 |
| Third Grade - Spring | | 27th - 235 | 38th - 241 |

One of the most important aspects of this research is being able to identify at-risk students early, before their trajectory becomes a downward trend that intensifies each year. For the four separate subgroups we identified with the results from the kindergarten screener, we calculated mean differences for the overall ISIP score from kindergarten through third grade for the fall, winter, and spring benchmarks; for Reading Comprehension, Vocabulary, and Spelling through the third grade; and

Alphabetic Decoding through the first grade for the fall, winter, and spring benchmark periods. Figure 1 shows graphs by subtest of our four groups. The benchmark


Figure 1. Depictions of Academic Trajectories through Third Grade

periods are on the *X* axis (KF = kindergarten fall, KW = kindergarten winter, KS = kindergarten spring, 1F = first grade fall, etc.), and the ISIP scores are on the *Y* axis. These graphs clearly indicate the need for earlier screening. By the end of first grade, students who are at risk of dyslexia, even the false positives produced by our screener, were clearly differentiating themselves from students who are not at risk. Vocabulary scores had trended down as other students were beginning to read to learn, while the students who are at risk were still learning to read.

The Spelling and Reading Comprehension subtests clearly depict two distinct groups: students who were identified with dyslexia by the third grade and those who were not. The gaps were evident in first grade, and they widened by the fall of second grade. By the winter of second grade, students who are at risk of dyslexia were a full grade level behind the students who are not at risk in Spelling and Reading Comprehension. There was also clear differentiation for students with the Alphabetic Decoding subtest, with distinct groupings by the end of first grade.

Of particular interest is the difference between the False Negatives and the True Positives from the kindergarten screener. Throughout first grade, the scores for the False Negatives remained higher than the True Positives. This advantage started to erode by the beginning of second grade, and by the end of second grade, they were indistinguishable from one another.

A second advantage this research brings is the ability to use a pattern of strengths and weaknesses in the kindergarten screener. More capable or advanced students who are at risk of dyslexia may have high Vocabulary and Listening Comprehension scores, and this brings up their average on the Overall ISIP score. Sometimes these are the students who get overlooked in the classroom, or worse, are at risk of being held back, since students with unidentified learning disabilities are at higher risk of grade retention

(Locke & Sparks, 2019). A teacher may think that these students just need more time to catch up with their Letter Knowledge and Phonemic Awareness skills although they clearly show signs of dyslexia. Higher achieving students in kindergarten may still be at risk and using traditional cut scores would not identify these students.

To illustrate, Figure 2 shows a graph of an ISIP ER report for a student in this data set who was identified in third grade with dyslexia. The graphs are from when the student was in kindergarten. The overall reading scores are in Tier 1, and these graphs demonstrate strong Listening Comprehension and Vocabulary, while the student is struggling in Phonemic Awareness and Letter Knowledge. This is a typical student who may be overlooked since the overall scores are not in a range where a teacher might be concerned.

Since dyslexia is neurobiological, which has been confirmed in brain imaging studies (Buchweitz et al., 2019; Setten, Maurits, Maassen, & van Setten, 2019; B. A. Shaywitz et al., 2006), early intervention is critical to help these students learn to read. In a study that evaluated brain imaging and intervention, young students who had been identified with dyslexia had brain images recorded before and after an intervention program. Eight students received structured intervention in phonological processing and the alphabetic principle, and in post-test brain imaging, the students had more brain activity associated with word reading and they had improved reading scores. Another group of students received structured intervention in phonological processing

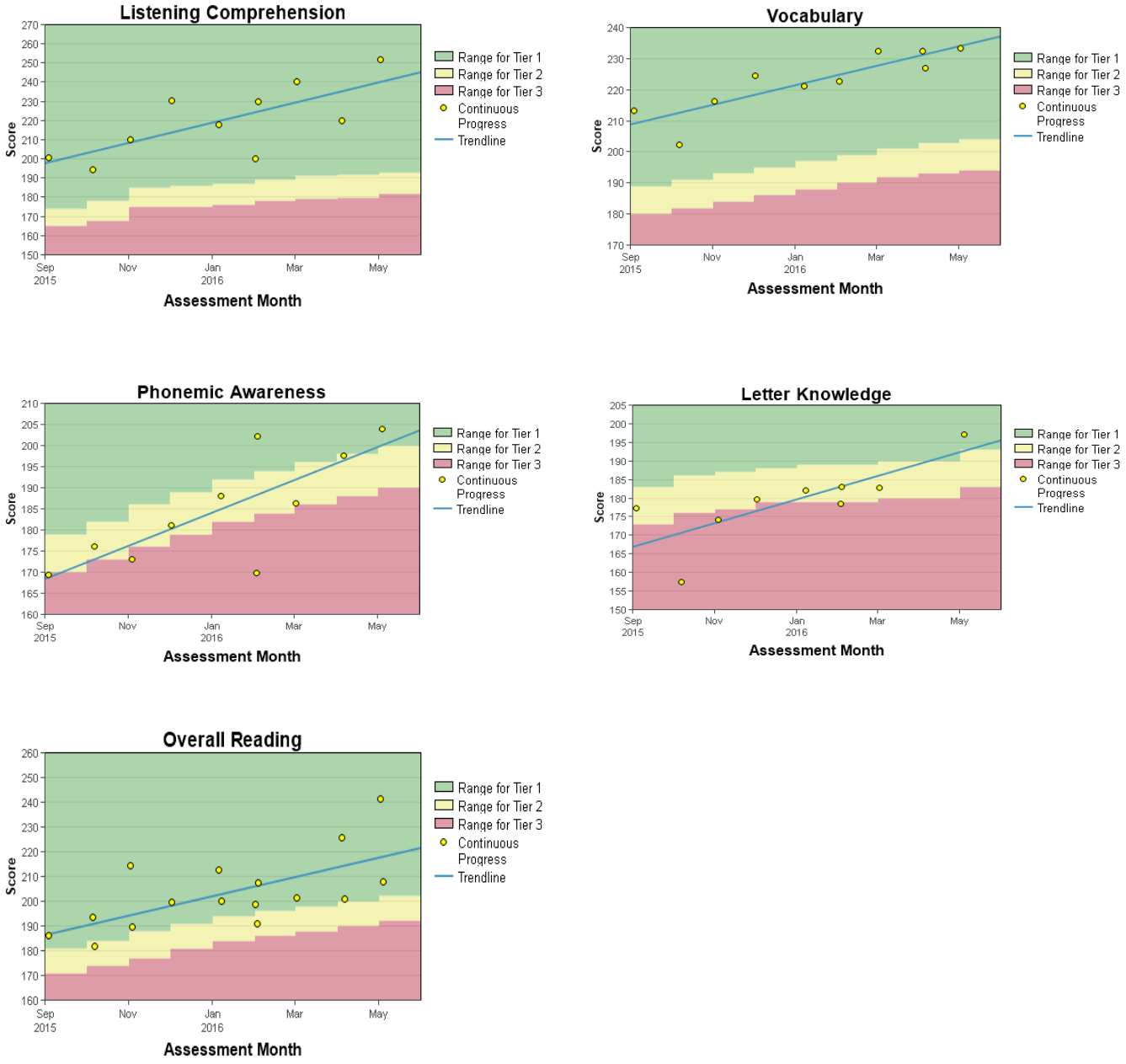


Figure 2. Kindergarten Student at Risk of Dyslexia

and fluency, and while the phonics program produced more pervasive gains, the brain imaging showed greater activity in areas associated with reading (Simos et al., 2006).

Multisensory approaches, including visual, auditory, kinesthetic, and tactile types, can help students who are at risk of dyslexia make progress in reading. In a case

study of a seven-year-old boy who received 30 weeks of multisensory therapy, the student made significant progress in reading (Oviedo & Gonzalez, 2013). The Orton-Gillingham multisensory approach emphasizes introducing phonograms and uses visual, auditory, and kinesthetic information to help children learn sound-letter relationships. This approach has a long history; however it has been updated, and recent research documents its efficacy in students with dyslexia (Ring et al., 2017). Both the structured and multisensory approaches produce gains in reading for students with dyslexia (Schlesinger & Gray, 2017). Students with dyslexia may need ongoing support, as early identification should represent the beginning of the intervention process (Colenbrander, Ricketts, & Breadmore, 2018), which will need to include interventions for increasing fluency and reading comprehension (Mather & Wendling, 2012).

## Limitations

There are some limitations with using ISIP ER, and with this research. While ISIP ER includes Rapid Letter Naming within the Letter Knowledge subtest, there is a need for a stronger Rapid Automatized Naming subtest that uses letters, numbers, shapes, and colors. RAN is highly predictive of the risk of dyslexia (Mather & Wendling, 2012), and the use of RAN would enhance the sensitivity and specificity of using ISIP ER scores by possibly lowering the false-positive rate. An additional limitation is the ISIP ER does not ask for students to produce sounds. This is included in the Istation Oral Reading Fluency subtest (ISIP ORF), a new subtest that was released in 2019, and therefore not included in this analysis as data were not available. Another limitation is that this research came from one school district that was familiar with ISIP ER and has used it for several years. A larger sample from several districts in multiple states would help improve the generalizability of these results. There may also be some bias given

that we evaluated students that had been in the district since kindergarten or first grade, and therefore they have not had a significant interruption in their education. These students may look somewhat different from students who transferred into the district in later years.

## Conclusion

ISIP ER is an assessment designed to help schools identify students who are at risk of reading failure. When the subtest scores are reviewed separately, it can also help teachers and other administrators identify students who may be at risk for dyslexia as early as kindergarten, thus helping these students receive intervention services before they experience failure. This research also uses risk factors to help identify higher-achieving students in kindergarten, which may increase the number of higher-achieving students who can be identified as at risk.

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