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Research Note

Positive Predictive Values Associated With Adapting the Redmond Sentence Recall Measure Into a Kindergarten Screener for Developmental Language Disorder

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ABSTRACT

Purpose: Researchers estimate the prevalence of developmental language disorder (DLD) in 5-year-olds to be between 7% and 12%. Current identification systems in public schools typically favor referral identification formats over targeted or universal screenings. Public schools face unique challenges when assessing the value of screening measures for DLD that include real-world considerations such as administration, time, and resource constraints. This study used the positive predictive value (PPV) of the Redmond Sentence Recall (RSR) to assess its fidelity when administered by special education paraprofessionals. Our obtained PPV was compared across three areas: (a) previous studies that have utilized the RSR, (b) rates extrapolated from the participating school district's preexisting referral system from a previous study, and (c) expectations based on DLD prevalence.
Method: Language screenings were conducted in two elementary schools using the RSR administered by school-based paraprofessionals trained on the screener protocol. One hundred sixty-four kindergarten students (age range: 5–6 years) were screened. Confirmatory testing was completed on all students who failed the screener.
Results: Of the 164 students screened, 19 failed the RSR (11.5%), and 14 met criteria (8.5%) for DLD (PPV = .74). Our PPV was similar to previously published studies that utilized the RSR using research assistants and was higher than the PPV associated with teacher-based referrals from the participating school district.
Conclusion: The RSR represents a potentially useful screener for identifying children at risk for previously unidentified language disorders in public schools.
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Developmental language disorder (DLD) represents one of the most common neurodevelopmental disorders (Bishop, 2010; Leonard, 2014). Researchers estimate the prevalence of DLD in 5-year-olds to be between 7% and 12% (Beitchman et al., 1986; Norbury et al., 2016; Tomblin et al., 1997). Negative short- and long-term impacts associated with DLD include elevated risks for poorer outcomes in academic achievement, difficulty establishing and maintaining supportive personal relationships, peer victimization, sexual abuse, and reduced vocational opportunities, among others (Alonzo et al., 2016; Botting, 2020; Conti-Ramsden & Botting, 2008; Durkin et al., 2017; Redmond et al., 2011; Sullivan & Knutson, 2000). As with many neurodevelopmental disorders, deficits relative to age expectations associated with DLD do not necessarily diminish with age. Verbal weaknesses can

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be reliably identified in adults with DLD (Clegg et al., 2005; Dubois et al., 2020; Poll et al., 2010). DLD unfortunately has a very low profile in public health and educational forums, specifically among educators working in public schools. This state of affairs is of particular societal concern as public schools represent the main stage for identifying, evaluating, and treating all children with disabilities, regardless of severity (Wright & Wright, 2007). Research has shown that a discouragingly low number of children who struggle with DLD, roughly 18%, are accurately identified and receive treatment (Beitchman et al., 2001; Tomblin & Nippold, 2014; Zhang & Tomblin, 2000) even though public schools in the United States are federally mandated to enact practical policy and procedure that ensures children with language difficulties are identified, located, and evaluated as stipulated by the Child Find section of the Individuals with Disabilities Education Act (Individuals with Disabilities Education Act, 2004; Wright & Wright, 2007). Unfortunately, in most states and school districts, there are no policies requiring targeted or universal screening of DLD in public schools, as is the case with other childhood impairments with similar or considerably lower prevalence levels such as hearing, vision, and reading (Ehren & Nelson, 2005).

Referral and Screening Formats in DLD Identification

Referral for language evaluation is typically initiated when educational professionals or parents are concerned about a child's communication skills relative to age expectations. Studies have shown mixed levels of congruence across parental levels of concern and children's performance on objective language measures (Adlof et al., 2017; Christopulos & Kean, 2020; Hendricks et al., 2019; Redmond et al., 2019; Skeat et al., 2010). Educational professionals, specifically general education teachers, often represent the primary referral source given their frequent interactions with students of various linguistic skill levels across culturally diverse backgrounds (Bedore et al., 2012; Pham et al., 2019; Restrepo, 1998). Studies, however, show that teachers routinely underperform in accurately identifying children at risk for DLD (Cabell et al., 2009; Hendricks & Jimenez, 2021; Jessup et al., 2008; Williams, 2006). Christopulos and Kean (2020) considered the congruence between referrals for language assessment made within a school district and whether these referrals resulted in language goals on children's Individualized Education Program. Results indicated general education teachers were the least accurate referral source relative to parents, early interventionists, and special education teachers, even though they accounted for nearly half of all referrals made within the school district. Studies have shown mixed results regarding potential teacher characteristics (e.g., age, sex, years of teaching experience, education level) that account for variation in referral accuracy (e.g., Christopulos & Kean, 2020; Girolamo et al., 2022).

Targeted and universal screenings provide alternatives to referral-based identification formats and are routinely used across various clinical and educational settings to identify early health concerns (e.g., diabetes, cancer, hearing, vision, reading). Correspondingly, screenings of language abilities in early school–age children in conjunction with referrals might appreciably improve identification rates. Studies exploring the usefulness and feasibility of screenings for DLD and the benefits of early identification continue to grow (Adlof & Hogan, 2019; Adlof et al., 2017; Ebert et al., 2020; Hendricks et al., 2019; Kaiser et al., 2022; Komesidou & Summy, 2020). Recent studies, however, have highlighted educators' frustrations regarding the perceived lack of practical screening tools (Komesidou et al., 2022).

Screening Considerations for Public Schools

Administration in Real-World Conditions

Since 2014, clinical researchers have sought to integrate implementation science into the field of speech-language pathology by looking for ways to bridge the gap between research and clinical practice (Douglas & Burshnic, 2019; Douglas et al., 2022; Olswang & Prelock, 2015). A critical element of reducing this gap focuses on how to facilitate the process of (a) agreement and acceptance of evidence-based practices among speech-language pathologists (SLPs) and (b) implementation of these practices with high fidelity in real-world settings (Brown et al., 2017; Goldstein et al., 2019; Orlikoff et al., 2022). Investigation into how real-world elements impact adoption speaks directly to external validity. For example, an assessment protocol that may be shown to be accurate in controlled lab settings (i.e., efficacy studies; Curran et al., 2012; Glasgow et al., 2003) but requires 60 min of uninterrupted time for comprehensive administration, scoring, and interpretation might be impractical due to time and resource constraints within school settings. Therefore, the impact of real-world conditions, such as administration demands and resource considerations, needs to be part of the ongoing evaluation of the long-term benefits (i.e., effectiveness studies) of clinical measures in clinical settings (Curran et al., 2012; Glasgow et al., 2003).

Sentence Recall

Optimized screening measures require respectable validity and reliability as well as quick and easy administration if they are going to scale to school-wide use. Sentence recall measures require test takers to immediately repeat sentences presented to them. This type of task

targets a variety of underlying cognitive mechanisms and processes including short-term verbal memory, working memory, and morphosyntactic abilities. These areas represent key weaknesses in children with DLD (Archibald & Joanisse, 2009; Conti-Ramsden et al., 2001; Eadie et al., 2002; Laws & Bishop, 2003). The particular strength of sentence recall tasks lies in their ability to assess collective weaknesses across these areas of language. The diagnostic accuracy of sentence recall measures has been widely investigated with promising results (Rujas et al., 2021).

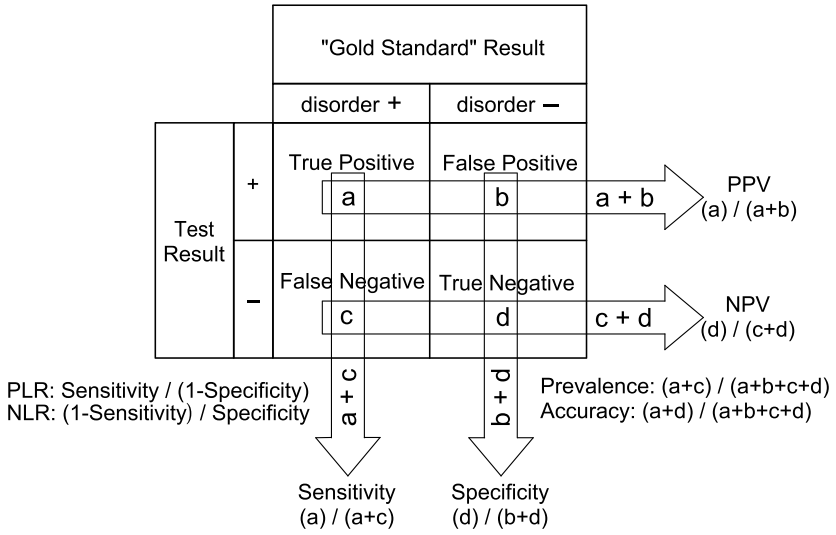
Other administrative considerations, such as the personnel best suited to administer screenings, must be weighed when looking at sentence recall's potential within a particular school context. At first blush, SLPs and general education teachers represent optimal choices for conducting language screenings because of their training and backgrounds. However, this does not consider competing case and workload demands. Other personnel such as paraprofessionals (e.g., speech-language pathology assistants [SLPAs]), teaching assistants, or parent aides could conduct screenings and minimize resource costs for school districts if the task demands involved with administration are low. Screening measures, therefore, need to meet minimal administration requirements such as high levels of classification accuracy as well as easy, fast, and inexpensive administration.

Positive Predictive Values

School districts are particularly dependent on policy and procedural decision making that minimizes costs and maximizes existing resources. As a result, school districts need the flexibility to utilize existing resources (e.g., school records) when making decisions regarding the incurred costs and benefits received from adopting targeted or universal screening procedures for DLD. One method that supports this need, particularly when looking at the usefulness of a particular language screener, is a district's ability to routinely assess the capacity of screening cutoff scores to capture cases of language disorder. Positive predictive values (PPVs) represent a practical index that meets these needs.

A PPV is defined as the proportion of participants with a positive screening result (i.e., cases who fail the screener) who have the target disorder (Dollaghan, 2007). Figure 1 outlines a traditional 2 × 2 table format frequently used among researchers to examine the accuracy of a diagnostic measure. Rates of true/false positives and true/false negatives associated with an index measure targeting a reference standard are used to establish various indices of diagnostic accuracy (e.g., sensitivity/specificity, likelihood ratios, and predictive values). PPV is specifically calculated by dividing the number of true-positive rates by the sum of true- and false-positive rates (see Figure 1). Information provided by PPVs is incomplete on its own. It only utilizes half of the information associated with calculating sensitivity and specificity because it does not track true- and false-negative rates. Under ideal circumstances, best practice would be for school districts to select screening measures that have demonstrated high-quality external evidence of diagnostic accuracy across all four cells of the 2 × 2 table (see Figure 1). Nonetheless, PPV represents a low-cost compromise that can be

Figure 1. A 2 × 2 diagnostic table. CELF-4 = Clinical Evaluation of Language Fundamentals–Fourth Edition; DLD = developmental language disorder; RSR = Redmond Sentence Recall; PPV = positive predictive value; NPV = negative predictive value; PLR = positive likelihood ratio; NLR = negative likelihood ratio.



extracted from the record keeping regularly conducted in schools and used to inform policy decisions (Christopulos & Kean, 2020). School districts lack the time and resources to collect and analyze all the data needed to generate sensitivity, specificity, and likelihood ratios because they are not in a position to regularly administer confirmatory testing to students who pass screenings. School districts could, however, generate PPVs from their existing referral sources and determine the rates at which different referral sources yield positive cases of language impairment (i.e., resulted in a language goal on a student's Individualized Education Program). These rates could be compared directly to alternative identification procedures (i.e., low scores gathered from targeted or universal screenings that resulted in low confirmatory test scores during follow-up testing). These comparisons provide a basis for cost–benefit calculations.

Redmond Sentence Recall

Redmond (2005) developed an experimental sentence recall measure that has been shown in later studies (Archibald & Joanisse, 2009; Redmond et al., 2011, 2019) to have acceptable levels of diagnostic accuracy (sensitivity, specificity, likelihood ratios) in children with DLD between the ages of 5;0 and 9;9 (years;months; Redmond, 2007). The Redmond Sentence Recall (RSR) protocol (see Supplemental Materials S1 and S2) consists of 16 stimulus sentences, each composed of 10 words with each sentence containing 10–14 syllables. Of the 16 sentences, eight are active and eight are passive. See Supplemental Material S1 for the RSR clinician manual and Supplemental Material S2 for the RSR scoring sheet. Three design features of the RSR make it a potentially compelling option for a language screening tool. First, the sentences are challenging enough to ensure that typically developing (TD) controls do not reach ceiling. Second, the sentences draw on the clinical markers of past tense in their active sentences and on affected children's documented weaknesses with passive sentences (Montgomery & Evans, 2009; van der Lely, 1996). Third, the sentences are scored on a graded scoring system (0–2) as opposed to a binary system (i.e., correct/incorrect). The last feature contributes to the task's ability to guard against floor effects or limited sensitivity at differentiating across low levels of performance. Logistically speaking, administration of the RSR can be completed by nonspecialized serviced personnel such as general education teachers, paraprofessionals, classroom aides, and classroom volunteers. Interrater consistency for the RSR has been reported as high at .988 ($r = .990$; $p < .001$; Redmond, 2007), and estimates have been confirmed across independent study samples (Archibald & Joaniesse, 2009). Administration and scoring training for the measure require minimal time and resources. Direct administration time for the measure averages 3.5 min (Redmond et al., 2011).

Several previously published studies have utilized the RSR in diagnostic accuracy studies. We review these below. In some cases, we calculated indices based on information provided by the respective authors. Archibald and Joanisse (2009) used the RSR during community screenings of 400 students and conducted detailed confirmatory testing on 88 children (ages 5.3–9.49) using cutoff scores of ≤ 10 (percentile) for the RSR and ≤ 80 (standard score) for their confirmatory measure (Clinical Evaluation of Language Fundamentals–Fourth Edition [CELF-4]). Diagnostic values were as follows: sensitivity (.85), specificity (.90), positive likelihood ratio (8.74), negative likelihood ratio (.17), PPV (.79), and negative predictive value (.93). The RSR outperformed a nonword repetition screening task that was also under consideration.

Redmond et al. (2011) administered the RSR to their clinically ascertained participants with specific language impairment (SLI) or attention-deficit/hyperactivity disorder (ADHD) as well as to a comparison group of participants with typical development ($n = 60$). TD–SLI comparisons involved 40 children (ages 7;0–7;11 and 8;0–8;11) using cutoff scores of ≤ 14.5 (raw score) for the RSR and ≤ 16 (percentile; ages 7;0–7;11) and ≤ 18 (percentile; ages 8;0–8;11) for their confirmatory measure (CELF-4 screening test). Diagnostic values were as follows: sensitivity (.90), specificity (.90), positive likelihood ratio (9.0), negative likelihood ratio (.11), PPV (.84), and negative predictive value (.93). Values associated with ADHD–SLI comparisons were very similar to those associated with TD–SLI comparisons, indicating that the RSR could be useful in differential diagnosis decisions.

Redmond et al. (2019) used the RSR during community screenings of 1,060 K–3 (kindergarten through third grade) grade students and administered confirmatory testing to 251 children (ages 5;1–9;9) using cutoff scores of ≤ 78.5 (standard score) for the RSR and ≤ 80 (standard score) for their confirmatory measure (CELF-4). Diagnostic values were as follows: sensitivity (.88), specificity (.89), positive likelihood ratio (7.8), negative likelihood ratio (.14), PPV (.59), and negative predictive value (.97). The RSR outperformed a tense-marking elicitation task that was also under consideration. Redmond et al. (2019) provided additional diagnostic accuracy information for the RSR relative to other commonly used reference standards (e.g., receipt of services, significant levels of parental concern), documenting similar optimal cutoff values across different reference standards.

As a collection, these studies provide replications of reliability and validity estimates associated with the RSR and document consistencies across reports with regard to optimal cutoff scores using a range of reference standards. The RSR has also demonstrated the capacity to

differentiate cases of DLD from cases of ADHD, another common neurodevelopmental disorder that can present with secondary symptoms similar to DLD (e.g., difficulty following classroom instructions). It is unclear, however, if the RSR can be implemented within school settings given their resource limitations with comparable levels of fidelity.

Aim and Research Questions

This study examines further the potential usefulness of the RSR as a screening tool for school-based SLPs in identifying kindergarten students with possible DLD. In particular, we sought to conduct our language screenings with the RSR implemented under real-world conditions in public school settings using on-site school personnel and facilities rather than research assistants in order to answer the following research questions:

1. How does the PPV of the RSR, administered by school personnel under real-world conditions with kindergarten students, compare to previously published experimental studies?
2. How does the PPV of the RSR administered under real-world conditions compare to PPVs associated with primary referral sources used within the same school district?
3. Does the observed failure rate associated with the RSR, when administered by school-based personnel in school settings, align with prevalence expectations of DLD based on epidemiological reports?

Method

Participants

The same school district that participated in the work of Christopulos and Kean (2020) approved us to conduct screenings and confirmatory testing at two elementary school sites. Students, ages 5–6 years, were recruited from all kindergarten-level classrooms at both elementary schools. Table 1 provides participant age and sex demographic information. The participating school district did not release information on participant students' race, ethnicity, and languages/dialect. District-wide data, although not a perfect substitute for these details, provide rough approximations for these features for our study sample. The largest groups categorized by race in the district's student body are White (82.1%) and Hispanic/Latino (10.9%). Over 96% of students speak English as their first language. Fourteen percent of students in the district are eligible to participate in the federal "free and reduced-price meal" program.

Screenings took place during the first semester of the 2018 school year. This grade level aligns with the age when designations of children's DLD are conventionally made (Beitchman et al., 1986; Tomblin et al., 1997). Potential participants were required to meet the participating school district's eligibility for kindergarten enrollment (i.e., must be at least 5 years of age on or before September 1, certified copy of birth certificate, immunization record is completed and up-to-date, and valid social

Table 1. Individual failed screening results.

Student (no.)	Age[a]	Sex	RSR[b]	CELF-4[b,e]	NNAT[b]	Findings DX[c]	Service status[d]
1	6;2	F	67	72	90	DLD	N
2	6;1	M	69	78	97	DLD	N
3	6;0	F	63	50	78	DLD	Y
4	5;9	M	78	82	95	TD	N
5	5;4	F	68	70	93	DLD	Y
6	6;0	M	71	87	95	TD	N
7	5;7	F	67	78	108	DLD	N
8	6;0	M	75	78	86	DLD	N
9	5;5	M	74	99	116	TD	N
10	5;5	M	72	78	87	DLD	N
11	5;10	F	67	79	100	DLD	N
12	5;5	F	74	70	81	DLD	Y
13	5;3	M	66	82	114	TD	N
14	6;3	M	80	70	93	DLD	N
15	6;3	M	71	64	105	DLD	N
16	5;9	M	64	73	102	DLD	N
17	5;3	M	76	88	116	TD	Y
18	6;6	M	60	79	113	DLD	N
19	5;5	M	68	46	99	DLD	Y

Note. RSR = Redmond Sentence Recall; CELF-4 = Clinical Evaluation of Language Fundamentals–Fourth Edition; NNAT = Naglieri Nonverbal Ability Test; DX = diagnosis; F = female; M = male.

[a]Years;months. [b]Standard score: $M = 100$, $SD = 15$. [c]DLD = developmental language disorder; TD = typically developing. [d]N = not receiving services at time of testing; Y = receiving services at time of testing. [e]Core Language score.

security number) and to speak English as their primary language. Students identified as having autism or intellectual disability (i.e., Down syndrome, nonverbal cognitive deficit) did not participate in our study.

Although negative consent (i.e., "reverse" or "opt-out" consent) was regularly used by the participating school district for all existing screenings of kindergarten students' hearing, vision, and reading, the school district required us to use a positive or "opt-in" consent, given the exploratory nature of our research questions. Kindergarten teachers gave consent forms to parents of all students from the two participating school sites as part of a back-to-school-night packet during the first week of school. Permission to administer the RSR was obtained from 165 parents out of 182 eligible students, yielding a participation rate of 90.66%. This suggests that our positive consent procedure provided comparable levels of participation had we been able to pursue a negative consent procedure, although the potential risks of ascertainment bias could not be eliminated. All children who had returned a consent form indicating parental permission to participate, and who had provided examiners with their assent, were included in the sample.

Procedure

In our initial strategy planning sessions with the participating school district, potential administrators of our language screenings included SLPs, general education teachers, parent/classroom volunteers, and speech-language teaching assistants (SLTAs). The SLTA designation is a unique special education paraprofessional position within the participating district. The SLTA was created to address personnel shortages within the district and is different from the more familiar SLPA position in that the SLTA does not require specialized training/education in communication disorders, whereas the SLPAs do. The participating school district was not employing SLPAs at the time of our study. Factors such as availability, skill set needed to achieve training reliability, and workload were considered when selecting the final group. SLPs and general education teachers were not chosen for workload reasons. Parents/classroom volunteers were not chosen due to a lack of needed background and familiarity with language-based topics. Ultimately, SLTAs were selected as the optimal choice for this project. The district's full complement of 10 SLTAs participated in the training for the RSR. Six of the SLTAs were available to conduct language screenings for us. Project flow and data collection consisted of three phases: mandatory training by the SLTAs on the RSR protocol, the kindergarten student screening, and confirmatory testing.

Part 1: RSR Training

The participating school district's SLTAs took part in a 1-hr training session held at the district's Related Services building in August of 2018. Training consisted of a brief overview of the project, an introduction of the RSR, administration procedures, and scoring procedures via a PowerPoint presentation. Practice opportunities were given to each participant to administer and score the measure while listening to previously recorded child audio sample files. SLTAs were required to pass a training quiz with a score of 100%, practice administering the task to two adults, and pass scoring reliability with 100% on a child audio sample file. One hundred percent (100%) of all SLTAs passed their reliability targets.

Part 2: RSR Screening Phase

Student intake information was provided by school district personnel prior to the school-based screenings. Positive consent procedures were followed as outlined by the University of Utah Institutional Review Board and the district's Department of Assessment. Student participants were given the opportunity to provide a district screening team member with their assent prior to RSR administration. The total screening time needed for each student after collecting them from their classroom (i.e., introducing them to the screener, confirming their assent, administering, and scoring the screener) was approximately 8 min. All screenings took place in the school libraries of the respective participating elementary school during October and November of 2018.

Part 3: Confirmatory Testing Phase

The CELF-4 Core Language score (CLS; Semel et al., 2004) was used for our reference standard of DLD status. The CELF-4 CLS assesses morphological and syntactic abilities in concepts and following directions, word structure, recalling sentences, formulated sentences, and sentence structure. Editions of the CELF have been widely used in the literature for standardized assessment and differential diagnosis of DLD (Conti-Ramsden et al., 2001; Lloyd et al., 2006; Loucas et al., 2008; Marton et al., 2007; Plante & Vance, 1995; Wetherell et al., 2007). The use of the CELF-4 was purposeful in light of the availability of the Clinical Evaluation of Language Fundamentals–Fifth Edition (Wiig et al., 2013) at the time of confirmatory testing. Use of the CELF-4 provided us an opportunity to directly compare our results to previous studies that also used the CELF-4 (i.e., Archibald & Joanisse, 2009; Redmond et al., 2019). The Naglieri Nonverbal Ability Test (NNAT; Naglieri, 2003) was also used during confirmatory testing to provide an estimate of participants' nonverbal intelligence. We included the NNAT primarily for descriptive purposes because it allows readers to compare our study sample with other study samples that have used nonverbal IQ thresholds above cutoffs conventionally associated with intellectual disability status for language impairment classification (e.g., SLI designations). The

NNAT assesses individual differences in pattern completion, reasoning by analogy, and serial reasoning. These two confirmatory measures were used to determine the PPV of the RSR when administered by district SLTAs. DLD was confirmed if a student's Core Language standard score on the CELF-4 was ≤ 80 *and* NNAT standard score was ≥ 70 (Bishop et al., 2016). Using this particular cutoff score for the CELF has shown adequate levels of identification accuracy for DLD (Spaulding et al., 2006; Tomblin et al., 1996). All test results were made available to the participating school district and parents of participants.

Analysis

Screener pass/fail groups were constructed using a standard score of 80 as the cutoff with the RSR (raw scores: ages 5;0–5;5: ≤ 6; ages 5;6–5;11: ≤ 8; ages 6;0–6;5: ≤ 10; ages 6;6–6;11: ≤ 14). To examine the PPV of the RSR, a cutoff standard score of ≤ 80 on the CLS from the CELF-4 was used as the reference standard to confirm students' language status (i.e., atypical language vs. typical language). True- and false-positive rates were used to generate the PPV (Dollaghan, 2007). Estimated occurrence rates associated with the screenings were calculated by dividing the total number of confirmed cases by the total number of students screened (165) from the kindergarten student population of the two schools.

Results

District SLTAs administered the RSR to 165 kindergarten students. Eighty-eight percent of the students screened (146) performed above our cutoff with a mean standard score of 100.49 (range: 81–129). Eleven percent of the students screened (19) performed below our cutoff with a mean standard score of 70 (range: 63–80). Confirmatory testing was completed on all 19 students who failed the RSR. As stipulated by the school district, students who passed the RSR did not participate in confirmatory testing. Group means for students who failed our screener on the CELF-4 and the NNAT were 74.89 (12.31) and 98.32 (11.51), respectively. No adverse events from participants were reported during screening and confirmatory testing.

Table 1 shows the individual results of the participants within our failing screener score group, including demographics, findings, likely DLD status, and receipt of services at the time of testing. Table 2 reports the descriptive statistics for participants associated with the screening and confirmatory measures. Two categories were used to classify results of confirmatory assessments: (a) DLD: Students were classified as DLD if the CELF-4 result was below the cutoff score of 80 and the NNAT result was above 70. Fourteen of the 19 students were classified as DLD. (b) TD: Students were classified as TD if the CELF-4 score was 80 or above and the NNAT score was 70 or above. Five of the 19 students were classified as TD. CELF-4 standard scores associated with observed false positives ranged from 82 to 99.

Our first and second research questions involved comparisons of PPVs from our sample to previously published studies that have used the same measure and referral sources commonly used in public schools. Table 3 provides true positives, false positives, and PPVs of the RSR associated with comparison sources from the participating school district provided by Christopulos and Kean (2020). Our PPV for the RSR was .74.

Our third research question compared estimated DLD occurrence rates from our sample to prevalence expectations. The estimated identification rate associated with this study utilizing the RSR within the district mirrors closely expectations based on epidemiological reports at 8.48%.

Discussion

Adopting a measure for targeted or universal screening for DLD by school districts requires multiple and

Table 2. Descriptive statistics for screening and confirmatory measures.

Area tested	Measure	Subtests	Failed screening group (*n* = 19) 13 male (68.42%)	Passed screening group (*n* = 146) 70 male (47.95%)
Morphosyntax/verbal memory	RSR (screening)	N/A	70 (5.27)[a]	100.49 (10.56)
Language	CELF-4 (confirmatory)	Concepts & Following Directions Word Structure Recalling Sentences Formulating Sentences	74.89 (12.31)[a,b]	N/A
Nonverbal intelligence	NNAT (confirmatory)	N/A	98.32 (11.51)[a]	N/A

Note. RSR = Redmond Sentence Recall; CELF-4 = Clinical Evaluation of Language Fundamentals–Fourth Edition; NNAT = Naglieri Nonverbal Ability Test; N/A = not applicable.

[a]Standard score: *M* = 100, *SD* = 15. [b]Core Language score.

Table 3. True/false positives and positive predictive values.

Identification process	True positives	False positives	Positive predictive values
School district: referral[a]			
General education teacher	7	13	.35
Early interventionist	9	1	.90
Parent	11	3	.79
RSR measure			
School district: current study	14	5	.74
Redmond et al. (2019)	42	29	.59
Redmond et al. (2011)[b]	16	3	.84
Archibald & Joanisse (2009)	22	6	.79

Note. RSR = Redmond Sentence Recall.

[a]Christopulos and Kean (2020). [b]Values obtained from the study's authors.

potentially competing considerations, including screener accuracy, administration considerations, and resource limitations. Previous studies have reported widely on the diagnostic accuracy of many screening measures, but little attention has been paid to real-world factors. Implementation science emphasizes that real-world issues, such as the impact of an organization's existing resources on adoption, require careful consideration. In this study, we continued the investigation of potential screening protocols for DLD by using PPVs as a proxy measure of diagnostic accuracy to the RSR, administered under real-world conditions by school district paraprofessionals. Previous studies have used both clinically ascertained and community-ascertained study samples to evaluate the psychometric properties of the RSR from several perspectives, including differential diagnosis. However, these studies were conducted under optimal laboratory conditions by trained research assistants. To address this potential research-to-practice gap, we executed our screenings onsite in participating schools using school-based paraprofessionals. We compared our PPV to previously published studies that have used the RSR as a screener for DLD (Archibald & Joanisse, 2009; Redmond et al., 2011, 2019) and referral sources within the same school district (early interventionists, general education teachers, and parents).

Comparison of RSR to Previously Published Reports

Previous studies have looked at the particular sentence recall measure we used (see Archibald & Joanisse, 2009; Redmond et al., 2011, 2019). In this study, we aimed to replicate observed PPVs from these studies associated with a different community-based study sample. We also sought to evaluate the extent to which these results could be extended into real-world conditions routinely experienced by public school stakeholders. In addition, the number of kindergarten participants screened in this study was higher than that in previous studies. Our obtained PPV value of .74 from this study provided important replications of previous reports. In aggregate, these studies add to a growing body of literature that calls for further exploration of sentence recall measures as useful and inexpensive screening tools. Our data are promising and warrant further examination and replication of the RSR in other school districts.

Comparison of RSR to District Referral Sources

Christopulos and Kean (2020) reported on the outcomes of primary referral sources to special education for the evaluation of language disorders in public schools such as general education teachers, parents, and early interventionists. Of those sources, general education teachers accounted for nearly half of all referrals but were found to be the least accurate (PPV of .35; see Table 3). This study's reported PPV of .74 for the RSR greatly improves on that rate. One reason general education teachers' referral accuracy was low is they may lack the expertise to identify less overt characteristics of DLD such as impaired verbal working memory and difficulty with expressive morphosyntax.

Occurrence Rate of DLD as Identified by the RSR

This study, mirroring previous studies, suggests that roughly two children in an average kindergarten classroom of 24–25 students will have a clinically significant idiopathic language disorder that could potentially negatively impact academic learning, interpersonal development, and socioemotional behavior. Identification rates under referral-based formats have been shown to greatly underrepresent this population. We were in a position to directly compare the PPV associated with our screening protocol to a PPV estimate associated with "business-as-usual" policies and procedures. Christopulos and Kean (2020) used records from the same school district participating in this study and reported an estimated rate of successful referrals at 1.38%, almost 6 times lower than the expected prevalence rate of 7%–12%. In contrast, the occurrence rate identified with use of the RSR in this

study sample (8.48%) aligned with prevalence findings from the most widely cited epidemiological studies pertaining to DLD among kindergarten students: Norbury et al. (2016) – 7.58%, Tomblin et al. (1997) – 7.4%, and Beitchman et al. (1986) – 8.04%. We note these comparison studies were large-scale population studies with sample sizes in the thousands compared to our study sample of 165.

Limitations and Future Direction

Research studies conducted in real-world settings present unique challenges. For example, limitations placed on the study by the participating school district precluded testing students who passed the RSR. As a result, important data regarding rates of false and true negatives were unavailable for calculating sensitivity/specificity and positive/negative likelihood ratios. These estimates are important because school districts should be interested in and regularly monitor cases of DLD missed by a screener. It is noted, however, that these values for the RSR are available from previous studies (i.e., Archibald & Joanisse, 2009; Redmond et al., 2011, 2019), and given our alignment with reported rates of true and false positives from these studies, it would be reasonable to expect similar levels of alignment with true and false negatives that would have occurred had we been allowed to test students who passed the screener, although this is not a certainty.

As a result of study stipulations imposed on the study by the participating school district, a single confirmatory tester, who was aware that all children participating in confirmatory testing had failed the screener, was used. This may have introduced a potential bias.

Complete administration time and scoring of the RSR by district SLTAs took approximately 8 min. Our sample size of 165 students represents 22 direct service hours for individuals administering the screener.

Outcomes from this study apply primarily to monolingual English-speaking children. Studies looking at sentence recall in children speaking languages other than English have been limited, and increased research efforts should focus on bilingual populations (Rujas et al., 2021). The study's participating school district did not provide information on participants' race, ethnicity, and languages/dialect spoken. This limitation was offset somewhat by our high participation rates, suggesting our study sample probably aligned fairly well with the overall demographic profile of the school district.

Conclusions

Most public schools in the United States routinely identify children with DLD through teacher and parent referrals. This arrangement provides schools with a relatively low-cost method for addressing federal mandates to identify children with disabilities, but it also has well-documented limitations. Chief among them is the disproportionately high number of children affected by DLD that go overlooked (Morgan et al., 2016). Targeted and universal screening methods offer school districts a more evidence-based alternative that is less prone to disparities in service provision. However, more studies are needed that address gaps between controlled efficacy research studies and those that investigate factors impacting the systematic uptake of screenings for DLD in public schools. Studies with an implementation focus and framework are needed that address areas such as how to improve the heterogeneity of participant pools, ways to incorporate more diverse study (i.e., school) locations, and the identification of barriers and facilitators by primary stakeholders to a wider embracement of universal screenings for DLD.

In this study, we examined further the potential of the RSR, one of many language screener options available for school districts to consider when weighing the costs and benefits of implementing either targeted or universal screening procedures. Our results suggest that paraprofessionals can effectively administer the RSR after modest personnel training investments, with overall accuracy levels comparable to previous research studies yielding an identification rate among kindergarten students more in line with epidemiological estimates. For example, greater efficiencies may be gained through screening groups of students simultaneously rather than individually (e.g., Adlof et al., 2017; Hendricks et al., 2019). Overall, however, we see the arrival of robust kindergarten screeners as a benefit to public schools if care is taken to consider potential barriers to their implementation.

Data Availability Statement

The data sets generated and/or analyzed during this study are available from the corresponding author on reasonable request.

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