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Differentiating Reading Profiles of Children with Specific Comprehension Deficits from Skilled Readers: A Systematic Review

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Abstract:	Students with specific comprehension deficits (SCD), despite adequate decoding skills, are associated with poor reading comprehension, and thus need distinct instructional needs. Explicit instruction with this population should begin by understanding how students with SCD are identified and which reading related skills they may struggle with acquiring. Through a systematic review of 32 studies, we summarize four selection methods for classifying students with SCD and report reading skills used. Additionally, to develop a profile of students with SCD, we compared these students to skilled readers in terms of reading related skills via a meta-analytic approach. Results revealed that, although they had adequate decoding and fluency skills, students with SCD performed poorly on oral language (i.e., vocabulary and listening comprehension) and reading comprehension tests. Additionally, their struggles in reading comprehension (d=-3.28) were more severe than skills in oral language (d=-0.95). We provide recommendations and implications for future researchers and classroom teachers.

Abstract

Students with specific comprehension deficits (SCD), despite adequate decoding skills, are associated with poor reading comprehension, and thus need distinct instructional needs. Explicit instruction with this population should begin by understanding how students with SCD are identified and which reading related skills they may struggle with acquiring. Through a systematic review of 32 studies, we summarize four selection methods for classifying students with SCD and report reading skills used. Additionally, to develop a profile of students with SCD, we compared these students to skilled readers in terms of reading related skills via a meta-analytic approach. Results revealed that, although they had adequate decoding and fluency skills, students with SCD performed poorly on oral language (i.e., vocabulary and listening comprehension) and reading comprehension tests. Additionally, their struggles in reading comprehension (d=-3.28) were more severe than skills in oral language (d=-0.95). We provide recommendations and implications for future researchers and classroom teachers.

Keywords: specific comprehension deficit, systematic review, reading comprehension

Differentiating Reading Profiles of Children with Specific Comprehension Deficits from Skilled Readers: A Systematic Review

The newly released NAEP report (2019) shows that fourth and eighth graders' average reading scores decreased in 2019 compared to 2017, and approximately 65% of fourth and eight graders' reading scores are below the proficient level in the United States. What could be resulting in these declining reading scores? The NAEP results highlight the need to identify and specify the characteristics of struggling readers, a fundamental step for providing effective differentiated instruction (Fricke et al., 2013). Within this population, relevant research further demonstrated that approximately 10% of struggling readers have adequate decoding skills but still perform poorly on reading comprehension assessments (Nation & Snowling, 2000). This group was defined as students with *specific comprehension deficits* (SCD, Cain, 2003; Ricketts et al., 2014).

Despite the agreement on the definition of SCD, the complex nature of reading comprehension has resulted in challenges for identifying students with SCD, because understanding written text involves a set of reading skills beyond decoding, such as oral language (Cain, 2006; Oakhill et al., 2005) and higher-level language skills such as inference making (Silva & Cain, 2015) and comprehension monitoring (Cain & Oakhill, 2006). When teachers or school personnel are identifying students with SCD, there may be a lack of consistent conclusions regarding which specific reading skills should be included to best describe their characteristics. For example, Spencer & Wagner (2018) found students with SCD are more likely to perform poorly on oral language; however, this construct can be measured by multiple subskills, such as vocabulary knowledge (Nation & Snowling, 1998), listening comprehension, and syntactic awareness (Ehrlich & Remond, 1997). This complex interrelation of reading skills

makes identifying the specific skills for intervention difficult. More consistent criteria or skill identifiers would help teachers, school personnel, or researchers accurately identify students with SCD, allowing them to provide intervention or instruction on those skills.

To complicate this issue further, Keenan and colleagues (2014) found that variations in measurements of reading skills also result in discrepant findings of SCD. Specifically, when using four reading comprehension assessments to identify struggling readers (i.e., Peabody Individual Achievement Test, Dunn & Markwardt, 1970; Woodcock Johnson Passage Comprehension-3, Woodcock et al., 2001; Gray Oral Reading Test-3, Wiederholt & Bryant, 1992; Qualitative Reading Inventory-3, Leslie & Caldwell, 2001), Keenan et al., found "only about half the time (54%) does a comprehender who performs poorly on one type of test also perform poorly on another type" (Keenan et al., 2014, p. 10).

This discrepant finding may be due to the fact that these comprehension tests target different comprehension skills. Specifically, the Peabody Individual Achievement Test and Woodcock Johnson Passage Comprehension-3 tests relied more heavily on decoding than on comprehension. These two assessments used single sentences, which provided little context clues. Students were also asked to complete a blank test (e.g., cloze tests) for identifying words (Keenan et al., 2008). However, the other assessments (i.e., Gray Oral Reading Test-3 and Qualitative Reading Inventory-3) provided longer texts, such as a passage or a paragraph, requiring students to complete multiple-choice questions or answer open-ended questions after reading. With varying methods for assessing reading skills, it is no surprise that differences in identifying students would emerge. Therefore, there is a high probability that the decision on which reding comprehension test is implemented can lead to the inconsistent diagnosis of SCD (Keenan, 2014).

These findings raise concerns about inconsistencies of reading measurements which may significantly affect the identification of SCD and may have substantial consequences related to including students in specific intervention programs and for specific special education programs, misused resources or allocation of time and energy in ways that are not meeting the needs of students. However, there is scant research synthesizing the variations of reading assessments used to screen students with SCD.

Moreover, the variations in selection criteria also contributes to the discrepant findings for students with SCD. For example, decoding can be measured by word-reading, pseudoword reading or a combination of both (see García & Cain, 2014). In a recent study, Rønberg and Peterson (2016) found that when orthographic coding was also used as a criterion for adequate word reading, only 0.4-2.2% of the participants can be defined as SCD group, however, the numbers increased to 3–6%, when pseudoword reading was used as a criterion for adequate word reading. These findings reveal that using different selection criteria may affect the identification of students with SCD, and our interpretation of research findings can be inaccurate, although there is scant research highlighting these concerns.

Due to the complex nature of comprehension, researchers have measured different reading skills that are associated with reading comprehension and adopted different assessments and criteria to identify SCD. These variations, as such, have left confusion and less definitive answers to the questions, what are the common characteristics of reading skills of students with SCD? What selection methods that are best for identifying this group of students (Keenan et al., 2014)? To address these research gaps, we reviewed and synthesized the selection methods used to determine students with SCD in the existing literature, as well as developed a reading profile to describe the characteristics of students with SCD. This much needed research may provide

more specific criteria for identifying students with SCD that can be used alongside various measurement methods to ensure students are receiving the instruction they may need.

Supporting Theory and Literature Reviews of Reading Comprehension and SCD

An active process between the reader and text results in reading comprehension. To successfully comprehend text, readers need to simultaneously extract and construct meaning through this interaction (RAND, 2002). In the past few decades, numerous research of reading comprehension has merged to better define these interactions. In the following section, we discussed the reading skills related to comprehension and SCD, which informed our understanding of students with SCD.

Reading Skills Related to Comprehension

The Simple View of Reading (SVR) provides a theoretical framework to understand students with SCD and to interpret their reading comprehension. This theory explains that reading comprehension is a product of decoding and oral language comprehension (Gough & Tunmer, 1986; Hoover & Gough, 1990). Hoover and Gough (1990) defined decoding as "efficient word recognition" (p.130) and listening comprehension as "the ability to take lexical information and derive sentence and discourse interpretations" (p.131). Both components (decoding and listening comprehension) are equally important because deficits in either may lead to comprehension struggles. Over the past three decades, findings from numerous empirical studies have shown that these two factors account for a large proportion of variance in reading comprehension (e.g., Catts et al., 2005; Georgiou et al., 2009; Kirby & Savage, 2008), with an estimation range from 40% to 80% (Kendeou et al., 2009). However, the unexplained variance still exists, which leads to the debate about further revision on the SVR framework.

Among all the attempts to determine reading skills that contribute to comprehension, some raise concerns on whether the two factors (i.e., decoding and listening comprehension) are accurately designated. Based on its original conceptualization, listening comprehension is supposed to embrace all linguistic knowledge in oral language (Gough & Tunmer, 1986). However, to better predict reading comprehension, the inclusion of listening comprehension is not enough. Multiple underlying skills should be considered (e.g., Cutting et al., 2009; Foorman et al., 2015a, 2015b; Ouellette & Beers, 2010), such as vocabulary knowledge (Braze, Tabor, Shankweiler, & Mencl, 2007; Foorman et al., 2015b; Melby-Lervåg & Lervåg, 2011), syntactic awareness (Catts et al., 2006; Foorman et al., 2015b), and morphological awareness (Carlisle, 2000; O'Reilly et al., 2012). For example, vocabulary knowledge and syntactic awareness have shown their unique contribution to reading comprehension after controlling for listening comprehension (Foorman et al., 2015b; Ouellette & Beers, 2010). In a recent meta-analysis on poor comprehenders, Spencer and Wagner (2017) used the term, oral language, to replace listening comprehension in the SVR. This construct synthesizes all the skills mentioned above and better demonstrates the specific comprehension-related characteristics. Therefore, when developing the profile of students with SCD, the present study implements oral language instead of listening comprehension.

Moreover, one of the criticisms relating to the SVR is whether additional reading skills should be included into the model and roles of these skills (Adlof et al., 2006; Kirby & Savage, 2008). Several studies have suggested that fluency should be included as an independent construct rather than a component loaded on decoding (Kirby & Savage, 2008; Pikulski & Chard, 2005). Specifically, fluency consists of three components, accuracy, speed and prosody, which has been found to share a reciprocal relationship with reading comprehension (Klauda &

Guthrie, 2008). Furthermore, evidence has been also found that fluency forms a bridge between decoding and reading comprehension (Pikulski & Chard, 2005) and serve as a mediator within the modeling (Li & Wu, 2015; Silverman et al., 2013). Therefore, the contribution of fluency to reading comprehension is unique. Álvarez-Cañizo and colleagues (2015) found even when we control for decoding and listening comprehension, deficits in fluency may still cause poor comprehension. As such, we include fluency as an independent construct besides decoding in this systematic review.

In summary, informed by aforementioned research, we aim to examine students' word-level reading skills and oral language skills to build a profile for students with SCD. Following the example of Spencer and Wagner (2018), we used the term oral language to encompass all the comprehension-related skills.

The Previous Review of Students with SCD

In a recent meta-analysis, Spencer and Wagner (2018) examined comprehension gaps for students with SCD by comparing them with age-matched average readers. Spencer and Wagner synthesized 86 studies to develop a profile for students with SCD. All included studies:(a) reported original quantitative data; (b) measured at least one of the reading skills (i.e., reading comprehension, decoding and oral language); (c) focused on 4-12 years old native speakers; (d) included students with SCD based on their comprehension and decoding abilities; and (e) included a typically developing group of readers for comparisons. Results demonstrated that students with SCD had deficits in oral language (d=-0.78), but these deficits were less severe than their reading comprehension difficulties (d=-2.78).

Although Spencer and Wagner's study provides insights regarding characteristics of students with SCD, limited information was reported regarding the selection criteria for students

SCD and average readers. Therefore, in our systematic review, we attempted to address this research gap through a systematic synthesis of the variations in the selection method, especially the cut-off criteria that were used to distinguish SCD and skilled readers. We also examined whether selection methods have a moderating effect on the presentation of reading profiles for students with SCD. In other words, we explore what selection methods were used to identify students with SCD and whether those various selection methods resulted in different reading profiles for students. Our review builds on the work of Spencer & Wagner (2018) by including these two important components, which were not part of the original work.

Moreover, in Spencer &Wagner's study, it should be noted that decoding and fluency were not clearly distinguished from each other. Despite the strong correlation between decoding and fluency, previous research highlighted the unique contribution of fluency to reading comprehension, and therefore, decoding and fluency should be considered as two distinctive reading skills (Silverman et al., 2013). Specifically, decoding is typically assessed by word reading, pseudoword reading tasks (e.g., word or pseudoword identification, word attack), or both. However, the measures of fluency involve measuring automaticity, "the speed and accuracy of reading pseudowords, words, and connected text" (Silverman et al., 2013, p.111). Considering these different approaches to measuring decoding and fluency, it is clear that they represent different skills, even if those skills complement and intersect each other. Based on this research, we considered fluency and decoding as distinctive reading skills in our study. We reported more specific findings of the two reading skills to establish a detailed profile for students with SCD.

The Present Study

Informed by previous research and syntheses, the purpose of the present study is to further examine the identification methods of students with SCD. First, we aim to synthesize the selection methods of students with SCD and measures of reading skills in the screening tests in our article sample. Second, we developed a reading profile that clearly demonstrates the characteristics of students with SCD by comparing them with age-matched skilled readers through a meta-analysis. Our review extends prior research by focusing more specifically on the assessments used to screen students with SCD and providing more convergence about what characteristics reflect the true nature of students with SCD in regard to reading. Specifical research questions and hypotheses are listed below.

Research question one: How are students with SCD identified across studies? We examined the variations regarding how the students with SCD were identified across studies. In general, we synthesized deficits for various reading skills of students with SCD from studies using different identification approaches, which will provide insights for future research to conduct scientific screening research.

Research question two: Do students with SCD perform more poorly on assessments of oral language or reading comprehension? Our hypothesis is that students with SCD will perform poorly on oral language tasks. Moreover, informed by Spencer and Wagner (2018), we anticipate that students with SCD show oral language deficits that are less severe than reading comprehension deficits. To further expand Spencer and Wagner's (2018) work, we also examine the performance of students with SCD on decoding and fluency tasks.

Research question three: Do the selection methods to classify students with SCD moderate their reading profiles? As aforementioned, Keenan et al. (2014) found that using different instruments to assess a specific reading skill leads to inconsistent identification of the

students with SCD group. To extend this work, we are interested in examining other variables that may moderate our identification of students with SCD. Specifically, we asked, if a study defines SCD as those who performs in the lowest 25th percentile of a reading comprehension test, will this result be consistent with those used in other selection methods (e.g., with adequate decoding skill, one's comprehension score is one standard deviation below the mean)? Our hypothesis is that selection methods will moderate the reading profile of students with SCD.

Methods

Searching Process and Selection Criteria

We searched articles and dissertations published between 1988 and 2018. The initial search was conducted in four databases (i.e., Eric, PsycINFO, Education Source, and Proquest) and ten peer-reviewed journals (i.e., *Reading and Writing: An Interdisciplinary Journal*, *Journal of Learning Disabilities*, *Scientific Studies of Reading*, *Annals of Dyslexia*, *Journal of Educational Psychology*, *British Journal of Educational Psychology*, *International Journal of Language & Communication Disorders*, *Journal of Experimental Child Psychology*, *Journal of Research in Reading*, *and Contemporary Educational Psychology*). We used the key terms "reading deficit", "poor comprehender", "struggling comprehender", "low comprehender", and "less skilled comprehender", in a Boolean combination with terms of reading skills (e.g., "decoding", "vocabulary", "reading comprehension", "oral language", "fluency"). During the initial search, 3097 articles were located.

We applied the following inclusion criteria: (a) includes screening tests of reading comprehension and other reading skills; (b) includes K-12 *students with SCD* as a focus group and *skilled readers* as a comparison group; (c) reports the selection criteria, assessments, and cut-off values that were used to determine SCD students and skilled readers; (d) has the two groups

matched on age and decoding and/or reading accuracy, but significantly differed in reading comprehension; (e) assesses participants in their first language; and (f) reports sufficient quantitative information that allows for the computation of effect sizes. We removed the duplicates and excluded articles that did not meet the inclusion criteria by reading the abstract of each article. A total of 192 articles were retained for a full review.

Using the same inclusion criteria as above, we read the full text of the 192 articles to determine if they met all items. We excluded an additional 163 articles at this stage. Therefore, we included a total of 29 articles in our final corpus. Notably, three articles included more than one study that met our inclusion criteria, so the articles represent more than one study in our meta-analysis. Therefore, the sample of the present review includes 32 studies.

Coding Process and Inter-rater Reliability

We conducted a two-step coding process. The first and second authors independently coded 30% of the samples using a pre-constructed coding scheme. Then we discussed ambiguous items and established a consistent coding theme that included both qualitative and quantitative information. A detailed coding scheme is provided in appendix A. After consensus was reached, the first author coded the remaining samples. Finally, the second author double-coded the entire sample to establish the coding reliability. The overall results of the coding system yielded a sufficient interrater agreement (>92.8% agreement). We discussed disagreement to reach 100% consensus across coding.

Synthesis of Studies

First, we synthesized samples to investigate the variations in screening methods, criteria, and assessments that were used to assess students' reading skills. We extracted the key relevant information regarding selection methods, reading skills, and related instruments from the

reviewed studies as tentative codes. Then we compared the commonalities and differences of the codes and categorized codes to generate common schemas in relation to our first research question: *How are students with SCD defined across studies?*.

To answer our second and third research question, we quantified the individual effect sizes for differences between students with SCD and skilled readers, as well as calculated an overall effect size per study. Then, we conducted a meta-analysis using Comprehensive Meta-Analysis (Version 2, Borenstein et al., 2005) and R packages, Metafor (Viechtbauer, 2017) and Robumeta (Fisher & Tipton, 2017). We calculated effect sizes using Hedges' *g* (Hedges, 1982), considering the correction for small sample sizes presented in this study. The average weighted effect sizes were calculated using random-effects models which allow for differences in the treatment effect (i.e., participants are identified as SCD rather than skilled readers) across studies. We also calculated 95% confidence intervals (CI) for all the average weighted effect sizes. Indices such as I^2, which demonstrates the proportion of variance due to heterogeneity, and *tau-squared*, which indicates the variance of true effect sizes, were also reported. We examined publication biases using Egger test for funnel plot asymmetry (Egger, et al., 1997).

In this review, there were many instances that one single study reported multiple effect sizes for a reading skill. To resolve the issue of the dependency among effect sizes, we used robust variance estimation with the small sample size correction (Hedges et al., 2010; Tipton & Pustejovsky, 2015). The robust variance estimation allows the inclusion of dependent effect sizes without requiring the covariance matrix of these effect sizes (Tanner-Smith & Tipton, 2014). The R package *Robumeta* (Fisher & Tipton, 2017) was used for calculating dependent effect sizes with the robust variance estimation method. We used the R package *Metafor* (Viechtbauer, 2017) to calculate independent effect sizes.

Results

Syntheses of Systematic Literature Review

The primary goal of the present study was to examine the criteria and measures used for assessing students with SCD. Our results revealed that the approaches to identify students with SCD and cut-off values used to distinguish them from skilled readers varied across studies.

The Identification of Students with SCD. We identified four approaches to classify students with SCD: (a) comparing students' comprehension age with their chronological age, reading accuracy age or both (n=13); (b) using the lowest percentiles (n=9); (c) comparing SCD scores with the population norm (n=6); and (d) using statistical techniques to set the cut-off value (n=4).

The predominant approach for identifying students with SCD was by comparing comprehension age with chronological age, reading accuracy age, or both. In total, 40.6% of the included studies applied this method. However, in many cases, researchers only provided an approximate cut-off value (lower bound) instead of clarifying a specific range (lower and upper bound) regarding the discrepancy in the two values. In other words, an estimated a cut-off value served as a criterion which included a more limited sample of students as SCD. A student who score slightly above this criterion may still need to be identified as SCD, resulting in limited intervention or support for this student. Moreover, different assessments may use a different approximation. Therefore, even using the same method to determine students with SCD and skilled readers, the varied scales could result in inconsistent identifications. Multiple groups of researchers identified SCD as a deficit of *at least six months* between comprehension age and chronological age as well as reading accuracy age (e.g., Cain et al., 2000). However, other researchers set their criterion as a *12-month-gap,* which indicates a broader discrepancy (e.g.,

Cain, 2006). Such discrepancies across studies and assessments may result in mis-, over-, or under-identification of students with SCD.

Another prevalent approach is to use a specified lowest percentile, as we found in 28.1% of the included studies. Researchers usually choose the lowest 25th percentile as a baseline (e.g., Carretti et al., 2016). However, we did find two studies that use the lowest 30th percentile as cut-off values (e.g., Megherbi & Ehrlich, 2005). Interestingly, although this approach was easy to implement, and thus, was used in approximately one-third of the studies, limited research demonstrates the rationale for selecting a specific percentile value rather than another.

We also found six studies identified students with SCD by comparing their scores with population norms. For instance, Ricketts and colleagues (2007) labeled students with SCD as those who scored at least one standard deviation below the population norm (i.e., standard score < 85) on The Neale Analysis of Reading Ability-II, reading comprehension subtest (Neale,1997). Additionally, the groups were matched on decoding. Similarly, less attention was given to explain how the lower bound of this selection criteria was set up. For instance, while six studies used this method, it was not clear why one standard deviation below the population norm should indicate a SCD, particularly when the groups were matched on decoding levels.

Finally, we found four groups of researchers who defined SCD through advanced statistical analyses. For instance, Cain and Oakhill (2011) "plotted the *z*-score for word reading accuracy and reading comprehension and created two 'buffer zones' of 0.5 of a *z*-score" (p. 434). Through this method, students with SCD were those whose reading comprehension *z*-scores were at least 0.5 below the overall sample, and word reading accuracy was 0 or above the overall sample. Similarly, Elwer and colleagues (2015) used *z*-scores as cut-off values to identify SCD as decoding *z*-scores above -0.67 but reading comprehension z-scores below -0.67. Again,

though the studies used a similar method of *z*-scores, each study applied the *z*-scores in a different way, resulting in differences across which students were identified as having SCD.

To conclude, we found four methods used to identify students with SCD. In each of the four methods, we also found inconsistent treatment of the cut-off values. The scales are rarely consistent and may result in different outcomes, which could be problematic for researchers and teachers.

Reading Skills and Instruments. Based on our inclusion criteria, included studies should measure reading comprehension as a primary focus (*n*=32) with other reading skills. Our findings showed that the included studies measured three reading skills, including decoding (*n*=5), fluency (*n*=24), and oral language (*n*=23). Although, in a majority of studies, measurements were frequently reported at the subskill level (e.g., reading accuracy, word reading), very few studies explicitly clarified or defined the reading skills (or constructs) they aimed to measure (e.g., fluency or decoding). Moreover, within each category, a variety of instruments were used to measure each subskill. Notably, although a majority of studies used standardized tests or adapted versions of those tests, few reported the reliability of instruments. Similarly, among those which employed self-designed instruments, we also found limited information regarding instrument reliability and validity.

Reading comprehension. When measuring reading comprehension, three instruments were most frequently used: the Neale Analysis of Reading Ability test (NARA; Neale, 1989; 1997), the MT test (Cornoldi & Colpo, 1998; 2011), and the Woodcock Reading Mastery Tests (WRMT; Woodcock, 1987). Although all tests measure students' reading comprehension at the passage level, the measurement formats are slightly different. For instance, WRMT required students to complete a cloze test while reading the passage, whereas NARA asked students to

read aloud a series of short stories and answer a set of comprehension questions afterward. Additional information was not provided about the structure of the MT test, so we cannot provide those details here. As a result, completing these tests may require students to apply different reading comprehension strategies, which may measure different domains of reading comprehension.

Decoding. A majority of studies used researcher-designed instruments to measure students' decoding ability through word reading and/or pseudoword reading tasks. Specifically, we found that researchers used various instruments to measure word reading, including word recognition (i.e., Ehrlich & Remond, 1997), word identification (e.g., Tong et al., 2011) and word search (e.g., Carretti et al., 2013). Although researchers reported that all these tasks aimed to measure students' word reading skills, it is important to note the subtle differences among the three tasks. For instance, word identification refers to the ability of children to sound out a word, whereas word recognition usually involves the ability to connect a word's pronunciation with its meaning (Sullivan, 2014). Again, using different measures and tasks of word reading may illuminate different skills that are not as comparable as needed to determine SCD.

Fluency. Fluency was often measured through accuracy and speed tasks using the Neale Analysis of Reading Ability test (Neal, 1989; 1997). However, only one study measured both subskills, reading accuracy and rate (or speed), when screening students with SCD (i.e., Tong et al., 2011). Most of the studies focused solely on reading accuracy and thus it could be misleading when they indicated the sample was controlled for fluency. According to recent research, fluency should measure accuracy, rate, and prosody. When only one of those subskills are measured, a biased result of a students' fluency may result. Moreover, two studies assessed students' semantic fluency using the word association subtest from Clinical Evaluation of Language

Fundamentals-Revised (Semel et al., 1987). Unlike reading accuracy and speed tests, semantic fluency tasks require students to produce the greatest number of words in a specific category in a given time period, which partly involves vocabulary knowledge. Moreover, this type of assessment may not accurately assess reading fluency, but rather comprehension or knowledge generating. Thus, we identified many limitations in how fluency was assessed.

Oral language. Among the 32 included studies, oral language was measured through vocabulary tests (n=16), listening comprehension tests (n=2), or both (n=3). Specifically, vocabulary knowledge was measured through a variety of assessments, which targeted different vocabulary skills. For example, we found three groups of researchers who specified that both sight vocabulary and receptive vocabulary (e.g., Cain, 2006; Cain & Oakhill, 2011; Cain et al., 2005) were measured through distinctive vocabulary assessments (e.g., The Gates MacGinitie Vocabulary Subtest, MacGinitie et al., 2000; The British Picture Vocabulary Scale, Dunn et al., 1992). Interestingly, we only identified two studies measuring listening comprehension, either focused on syntactic comprehension (Bonnotte & Casalis, 2010) or a cross-modal naming task (Megherbi & Ehrlich, 2005). There were only two studies which measured both vocabulary and listening comprehension skills (i.e., Cain, 2003; Elwer et al., 2015). Like other reading subskills, oral language was inconsistently measured in terms of which skills constituted oral language and what types of tasks were used to assess the skills.

Developing a Reading Profile for Students with SCD through a Meta-Analysis

To answer our second research question, we compared the reading profiles of students with SCD to those of skilled readers in order to quantify the characteristics of SCD through a meta-analysis. This examination focused on four reading skills: (1) decoding, (2) fluency, (3) oral language, and (4) reading comprehension. In the following sections, we specify the effect

sizes of each comparison in terms of each reading skill and reported the analyses of publication bias.

Reading Comprehension. 34 effect sizes of reading comprehension were extracted from 32 studies (see Table 1). The average weighted effect size of reading comprehension was large and statistically significant (g=-3.28, 95%CI=[-3.89, -2.68]). Considering our first hypothesis, this estimate was also much larger than that of oral language measures. The test of heterogeneity suggested large variability across studies (I^2=91.38%). Sensitivity analysis indicated the robustness of effect sizes across different ρ values. Finally, the Egger test of funnel plot asymmetry showed that the estimates were asymmetric (z=-5.42, p<0.01, see Figure 1).

[*Table 1* about here]

[*Figure 1* about here]

Decoding. We extracted 19 effect sizes for decoding from 15 studies (see Table 1). The average weighted effect size of decoding was not statistically significant from zero (g=-0.07, 95%CI=[-0.23, 0.08]), which indicated that decoding performances of students with SCD matched that of skilled readers. The majority of studies measured decoding by either word reading (n=5) or pseudoword reading (n=7). Three studies employed word and pseudoword reading, and one of the three studies reported a composite score of the two measures. Both types of measures had statistically non-significant average weighted effect sizes (g=-0.18, 95%CI=[-0.57, 0.21] for word reading; g=0.01, 95%CI=[-0.11, 0.13] for pseudoword reading).

About 9.82% of the variation across studies was due to heterogeneity for decoding. The estimate was higher for word reading measures (I^2 = 66.51%, $Q_{df=7}$=18.22, p = 0.01) but almost zero for pseudoword reading ($Q_{df=9}$=1.99, p>0.05). Sensitivity analyses suggested that varying

rho (ρ) values did not change the estimation of effect sizes and the result was robust. The Egger test of funnel plot asymmetry was not statistically significant (z=-1.78, p>0.05, see Figure 1).

Fluency. We extracted 27 effect sizes of fluency from 24 studies (see Table 1). The average weighted effect size of fluency was also not statistically significant from zero (g=0.03, 95%CI=[-0.17, 0.22]), which indicated that students with SCD were matched with skilled readers for fluency. When reporting the skills of students with SCD, most studies only included measures of reading accuracy (n=16). On the other hand, three studies relied solely on reading speed as a control measure for students with SCD. In addition, three studies took both accuracy and speed measures into consideration, and the remaining two studies used a composite measure that considered accuracy and speed simultaneously. The average weighted effect sizes for both reading accuracy and speed were not statistically significant (g=-0.04, 95%CI=[-0.21, 0.14] for reading accuracy (g=0.27, 95%CI=[-0.23, 0.77] for reading speed). Variability due to heterogeneity was around 45.91% for fluency. The test for heterogeneity was rejected for reading accuracy ($Q_{df=18}$=22.68, p>0.05), but not for reading speed (I^2=67.41%, $Q_{df=4}$=11.96, p=0.02). Sensitivity analyses indicated the robustness of effect sizes regardless of the change ρ values. The Egger test of funnel plot asymmetry did not show publication bias (z=-1.43, p>0.05, see Figure 1).

Oral Language. There were 28 effect sizes of oral language from 23 studies (see Table 1). The average weighted effect size of oral language was moderate and statistically significant (g=-0.95, 95%CI=[-1.39, -0.51]). Eighteen studies only used vocabulary measures while three studies focused on listening comprehension measures. The remaining two studies included both vocabulary and listening comprehension to measure oral language. The average weighted effect

size for vocabulary (g=-0.61, 95%CI=[-0.91, -0.31]) was much smaller than that for listening comprehension (g=-2.72, 95%CI=[-4.05, -1.38]), but both were statistically significant.

About 84.08% of between-study variation for oral language was related to heterogeneity. The estimates were also large when testing heterogeneity for vocabulary (I^2=71.74%, $Q_{df=22}$=69.50, p<0.01) and listening comprehension (I^2=92.59%, $Q_{df=4}$=28.63, p<0.01) independently. Sensitivity analysis did not indicate that changing ρ values resulted in variation of the observed effect sizes. The Egger test of funnel plot asymmetry for oral language was statistically significant (z=-4.10, p<0.01), which suggested the existence of asymmetry in estimates (see Figure 1).

Moderator Analysis

To test the third research question: *Do the selection methods to classify students with SCD moderate their reading profiles?,* we included four methods for categorizing students with SCD as a moderator and examined whether different classification approaches would impact the profiles of students with SCD. Specifically, this analysis intended to see whether the differences of reading skill measures between students with SCD and skilled readers would vary upon how students with SCD were selected using different methods. Interestingly, findings showed that none of the effect sizes of the four reading skills were statistically significantly impacted by the method in which students with SCD were identified (see Table 2). In other words, the differences of students with SCD and skilled readers' reading profiles were robust regardless of how students with SCD were grouped in a certain study.

[*Table 2* about here]

Discussion and Implications

Based on our synthesis and meta-analysis, we found four approaches to identify students

with SCD. Additionally, we found that each study used different subskills and instruments to determine students with SCD, making comparisons across studies more challenging. Finally, we found that SCD had comparable performance levels for decoding and fluency as their skilled reading counterparts but their deficit in reading comprehension was more severe than that in oral language. Through these findings, we are able to specify a starting point for a profile of students with SCD. In the following sections, we discussed these findings further.

Identification of Students with SCD

Our first research question asked how students with SCD were identified across studies. To answer this question, we synthesized the selection methods used to identify students with SCD. Despite the fact that the terms, "less-skilled readers" (e.g.,Cain et al., 2005), "less skilled comprehenders" (e.g., Bonnotte & Casalis, 2010), and "less-skilled readers" (e.g., Ehrlich & Remond, 1997) were interchangeably used across studies, we found researchers used different criteria to classify students with SCD as following: (a) comparing students' comprehension age with their chronological age, reading accuracy age, or both; (b) using lowest percentiles; (c) comparing SCD scores with the population norm; and (d) using statistical techniques to set up the cut-off point. While we acknowledge that the four methods could be useful to teachers, researchers, and policymakers for different purposes when discussing the best instructional plan for individual children, we suspect the varying approaches may yield confusion and inconsistency. This inconsistency could provide a limitation for school personnel who are trying to decide how best to help specific groups of children (Lee & Tsai, 2017).

Consequently, from our findings of research question one, we proposed another research question, as we anticipated that selection criteria for students with SCD may moderate our findings about their reading comprehension performance. However, our meta-analytic results did

not show statistically significant differences for SCD reading performances as related to the variation of approaches to identify the students with SCD. This result may be due to the small sample size, for example, we only identified four studies that use statistical techniques to set up the cut-off point. However, with a *p-value* approaching .05 on reading comprehension, it is likely that a larger sample size may result in a stronger conclusion and provide a statistically significant result. Future research with more samples may help in addressing this concern.

Measurements of Reading Skills

Additionally, we synthesized the measurements of reading skills. All the included studies in this review measured reading comprehension as the primary interest, however we found the measurements of reading comprehension varied. Keenan and colleagues (2014) found that variations in comprehension assessments resulted in discrepant findings of SCD. For example, using a long passage and open-ended questions to assess comprehension may yield different findings on SCD, compared to the use of a cloze test, because the two tests focus on different comprehension skills (Keenan, 2018). Notably, we not only found variations in comprehension measurements across studies but also a wide range of measurements used for assessing other reading skills, such as fluency, decoding and oral language. Although the small sample size impedes our examination of how these variations in measurements may moderate the identification of students with SCD, we recommend future endeavors continue the exploration of reading comprehension measurements.

Moreover, it should be noted that when examining the screening instruments, we also noted a limitation in reporting of reliability estimates. Although a majority of studies that used standardized measures reported the measure reliability, few reported reliability at the level of the study. For studies that used researcher-created measures, none reported reliability or pilot study

information. According to the American Educational Research Association (AERA), all studies should report evidence of reliability (AERA, 2009). This information ensures that high-quality instruments with strong evidence of reliability are used and that the results can be trusted and replicated. Our findings indicate an inherent limitation on measurement across studies on SCD.

A Profile for Students with SCD

To answer our research question: *Do students with SCD perform more poorly on assessments of oral language or reading comprehension?,* we attempted to develop a profile for students with SCD through a meta-analysis. Consistent with Spencer and Wagner's (2018) findings, we found that when compared to skilled readers, students with SCD had a deficit in oral language (d = -0.95) but a more severe deficit in reading comprehension (d = -3.28), despite their adequate decoding (d= -0.07). This finding supports the theoretical perspective, Simple View of Reading, which emphasized the important roles of decoding and oral language in reading comprehension (Gough & Tunmer, 1986; Hoover & Gough, 1990). When students have adequate decoding skills, oral language deficits could lead to reading comprehension difficulties (Allington, 2013).

Moreover, to extend Spencer and Wagner's (2018) meta-analysis, we examined decoding and fluency as distinctive skills in our analysis. Unsurprisingly, we did not find a significant gap between SCD and skilled readers in terms of their fluency skills (d= 0.03). However, we found that when measuring fluency, nearly all studies focused on accuracy and/or automaticity, despite fluency consisting of three components (i.e., accuracy, automaticity, and prosody, National Reading Panel, 2000). Therefore, we questioned whether students with SCD would struggle with prosody, the ability to read with inflection and tone, an overlooked skill in formal fluency assessment. In fact, previous research demonstrated that children who overlay emotion to the text

would exemplify a stronger understanding of the text's meaning (Deeney, 2010). We recommend that teachers and researchers assess prosody to determine if students are making meaning of the text as they read, rather than simply decoding the words with accuracy and speed (Deeney, 2010).

In terms of oral language, literacy research has long shown connections between oral language development and reading comprehension, through links of vocabulary and listening comprehension (Hart & Risley, 2003). Interestingly, our results show that students with SCD have a more severe deficit in listening comprehension (d= -2.72), compared to vocabulary (d= -0.95). Although informative, we also found very few studies explicitly defined the components of listening comprehension. In a recent study, Kim (2016) proposed that in addition to vocabulary, syntactic knowledge, comprehension monitoring, and theory of mind all directly related to listening comprehension. When connecting our findings with Kim's study (2016), we recommend future research test more specific language and cognitive skills that account for listening comprehension in the screening assessment. This may allow the field to better understand the specific strengths and needs of students with SCD. Consequently, classroom practitioners should provide instructional strategies that can improve vocabulary, syntactic knowledge, and comprehension monitoring for students with SCD.

Limitation

Our study has several limitations. Through a systematic review, we found our samples mainly focused on four major reading skills (i.e., reading comprehension, decoding, reading fluency, and oral language) and seven reading subskills (i.e., word reading, pseudoword reading, reading accuracy, speed, vocabulary, listening comprehension, and reading comprehension). Due to the small sample size, we were not able to retrieve information regarding other language skills

to develop a more comprehensive profile for SCD students, such as their syntactic awareness and morphological awareness. Moreover, we were also interested in evaluating SCD students' cognitive skills. However, we identified that few studies reported students' IQ (n=6), short-term memory (n=2), and working memory (n=1), so we were unable to generate a conclusion regarding their cognitive skills, which may potentially affect their reading performance (Cain, 2006). Finally, our study focused on monolingual students. Therefore, the study scope narrows our conclusion about students with SCD to those who were tested in their native language. Future investigations are needed to examine second-language learners.

Conclusion

Through a systematic review, we found a wide range of selection methods and measurements used for identifying students with SCD. However, very few studies reported the instrument reliability. We advocate for a consistent definition and rigorous process for identifying SCD. Second, our results show that despite comprehension deficits, students with SCD also have deficits in vocabulary and listening comprehension. However, very few studies reported what skills were involved in listening comprehension. As such, we recommend that future research examine the variables that account for listening comprehension deficits. From a practice perspective, our review concludes that teachers may need to include direct, focused instruction on vocabulary and listening comprehension for students with SCD. Finally, our meta-analytic results did not show statistically significant differences for SCD reading performances as related to the variation of approaches to identify the students with SCD. This result may be due to the small sample size. Future research is needed to reexamine this issue with larger samples.

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Table 1.

Average Weighted Effect Size Estimates, 95% Confidence Intervals, and Heterogeneity Statistics for the Comparison between Students with Specific Comprehension Deficit and Skilled Readers (Random-effect Model)

	k	*d*	95% CI	τ^2	I^2
Decoding	19	-0.07	[-0.23, 0.08]	0.01	9.82%
Word Reading	8	-0.18	[-0.57, 0.21]	0.08	52.57%
Pseudoword Reading	10	0.01	[-0.11, 0.13]	-	-
Reading Fluency	27	0.03	[-0.17, 0.22]	0.09	45.91%
Reading Accuracy	19	-0.03	[-0.19, 0.13]	-	-
Reading Speed	5	0.27	[-0.23, 0.77]	0.21	67.41%
Oral Language	28	-0.95***	[-1.39, -0.51]	0.67	84.08%
Vocabulary	23	-0.61***	[-0.91, -0.31]	0.30	71.74%
Listening Comprehension	5	-2.72***	[-4.05, -1.38]	2.05	92.59%
Reading Comprehension	34	-3.28***	[-3.89, -2.68]	2.22	91.38%

Note. k = number of effect sizes; *d* = average weighted effect size estimate; CI = confidence interval. ***: $p<.001$.

Table 2

Moderator Analyses for the Comparison between Students with Specific Comprehension Deficit and Skilled Readers

Construct	Cutting-off Method	β	95%CI	I^2
Decoding	Methods 2 and 3	-0.24	[-0.84, 0.37]	12.51%
Reading Fluency	Methods 1 and 3	0.01	[-0.35, 0.36]	41.40%
Oral Language	Methods 1, 2, and 4	-0.52	[-1.50, 0.46]	80.93%
Reading Comprehension	Methods 1, 2, and 3	-0.64	[-1.32, 0.03]	90.40%

Notes. Method 1: Compare SPC students' comprehension age and chronological age/grade level; Method 2: Use lowest percentile; Method 3: Compare students' score with the population norm; Method 4" Apply statistical techniques.

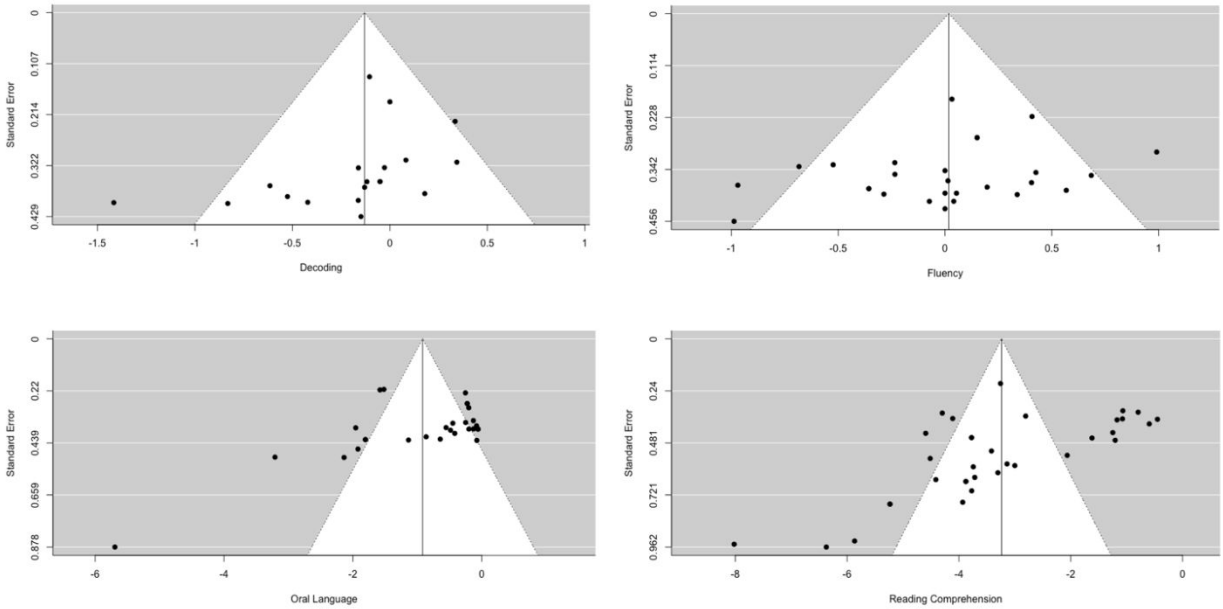

Figure 1. Funnel plots for between-group comparisons.

Appendix A

Coding of Qualitative Information (Study=32)

Study	Age and Language	SCD Selection Criteria	Skilled Readers	Construct	Skills	Instruments	Reliability
Bonnotte & Casalis, 2010	4th grade, French	Less-skilled comprehenders fall below the 25th percentile of RC ECOSSE norm.	The scores of skilled comprehenders fall into normal range.	Decoding	Word reading	The Alouette standard test (Lefavrais, 1967)	N/A
				Decoding	Nonword reading	A pseudo-word test (from Casalis, 1995)	N/A
				Oral language	Listening comprehension	The syntactic comprehension ECOSSE test (Lecocq, 1996), and a comprehension task of sentences constructed with a relative clause (Casalis & Leuwers, 2005).	N/A
				Reading comprehension	Reading comprehension	The L4 test (Lobrot, 1973)	N/A
				Fluency	Semantic fluency	Did not report details	N/A
Borella, Carretti, & Pelegrina, 2010 (Exp. 1)	10-11-year-old, Italian	Poor comprehenders obtained scores below the 25th percentile, whereas good comprehenders scored above the 75th percentile.	Good comprehenders scored above the 75th percentile.	Reading comprehension	Reading Comprehension	An inhibitory task – Response to distracter inhibition - text with distracters. (Adapted from Connelly et al., 1991)	N/A
				Decoding	Word reading	Distracters. (adapted from Connelly et al., 1991)	N/A
Borella, Carretti, & Pelegrina, 2010 (Exp. 2)	10-11-year-old, Italian	Poor comprehenders obtained scores below the 25th percentile, whereas good comprehenders scored above the 75th percentile.	Good comprehenders scored above the 75th percentile.	Reading comprehension	Reading Comprehension	An inhibitory tasks – Response to distracter inhibition -text with distracters. (Adapted from Connelly et al., 1991)	N/A
				Decoding	Word reading	A word reading task (Defior, Fonseca, & Gottheil, 2006)	N/A
Bowyer-Crane & Snowling, 2005	2nd-6th grade, English	The 10 children with the lowest NARA II comprehension standard scores made up the less-skilled group.	The 10 children with the highest NARA II comprehension standard scores were classified as skilled comprehenders.	Reading comprehension	Reading Comprehension	The Neale Analysis of Reading Ability (NARA II; Neale, 1989)	"The mean inter-rater reliability was acceptable at .84 for the NARA II,"
				Fluency	Reading accuracy	The Neale Analysis of Reading Ability (NARA II; Neale, 1989)	N/A
				Reading comprehension	Reading Comprehension	The Wechsler Objective Reading Dimensions (WORD; Wechsler, 1990)	The mean inter-rater reliability was acceptable is at .80 for the WORD tests.

				Decoding	Nonword decoding	The Graded Non-word Reading Test (GNWRT; Snowling, Stothard, & McLean, 1996)	N/A
Cain, 2003	7-8-year-old, English	The less-skilled comprehenders all had age-appropriate reading accuracy, but their comprehension ages were below their chronological ages, and at least six months below their reading accuracy age.	The skilled comprehenders also had age-appropriate reading accuracy but their comprehension scores were at or above that predicted by their reading accuracy age.	Fluency	Reading accuracy	The Neale Analysis of Reading Ability (Revised UK edn., Neale 1989).	N/A
				Oral language	Listening comprehension	Did not report details	N/A
				Oral language	Vocabulary	The Gates–MacGinitie Primary Two Vocabulary Test (Gates & MacGinitie, 1965)	N/A
				Reading Comprehension	Reading Comprehension	The Neale Analysis of Reading Ability (Revised UK edition., Neale 1989).	N/A
Cain, 2006	9-10-year-old, English	The poor comprehenders obtained reading comprehension ages that were at least 12 months below both their reading accuracy age and their chronological ages.	The good comprehenders obtained comprehension ages that were at or above that predicted by their reading accuracy age. The two groups differed significantly on reading comprehension.	Decoding	Nonword reading	The Graded Non-word Reading Test (Snowling, Stothard, & McLean, 1996)	N/A
				Fluency	Reading accuracy	The Neale Analysis of Reading Ability Revised (Neale, 1997)	Neale word reading accuracy are .90 for ages 8,0 to 9,11 and .84 for ages 10,0 to 11,11.
				Oral language	Sight vocabulary	The Gates-MacGinitie Primary Two Vocabulary (MacGinitie & MacGinitie, 1989)	N/A
				Oral language	Receptive vocabulary	The British Picture Vocabulary Scale (Dunn, Dunn, Whetton, & Burley, 1997)	N/A
				Reading comprehension	Reading comprehension	The Neale Analysis of Reading Ability Revised (Neale, 1997)	N/A
Cain & Oakhill, 1999	7-8-year-old, English	The less skilled comprehenders' comprehension ages were below their chronological ages, and at least 6 months below their reading accuracy age.	Skilled comprehenders obtained age-appropriate reading accuracy levels but their comprehension scores were at or above that predicted by their reading	Fluency	Reading accuracy	The Neale Analysis of Reading Ability (Revised UK edn., Neale, 1989).	N/A
				Oral language	Vocabulary	The Gates-MacGinitie Primary Two Vocabulary Test (Gates & Mac-Ginitie, 1965).	N/A
				Reading Comprehension	Reading Comprehension	The Neale Analysis of Reading Ability (Revised UK edition., Neale, 1989).	N/A

			accuracy age.				
Cain & Oakhill, 2011	7-8-year-old, English	They plotted the z scores for word reading accuracy and reading comprehension and created two "buffer zones" of .5 of a z score. 21 good comprehenders were selected. Their word reading accuracy z score was 0 or above and whose reading comprehension z score was .5 or above that of the whole sample.	Good comprehenders' e word reading accuracy z score was 0 or above and whose reading comprehension z score was .5 or above that of the whole sample.	Fluency	Word reading accuracy	The Neale Analysis of Reading Ability (Neale,1989)	The test–retest reliability for this age range is between .82 and .86.
				Oral language	Receptive vocabulary	The British Picture Vocabulary Scale (Dunn, Dunn,Whetton, & Pintillie, 1992)	The reported reliability (median of Cronbach's alpha over year groups) is .93.
				Oral language	Sight vocabulary	The Gates MacGinitie Vocabulary Subtest (MacGinitie, MacGinitie, Maria, & Dreyer, 2000)	Cronbach's alpha for this age range is between .90 and .95.
				Reading comprehension	Reading comprehension	The Neale Analysis of Reading Ability (Neale, 1989)	The test–retest reliability for this age range is between .93 and .95.
Cain, Oakhill, & Bryant, 2000a	7-8-year-old, English	Less skilled comprehenders have comprehension ages that are below their chronological ages and at least 6 months below their word reading accuracy age.	Skilled comprehenders' word reading accuracy ages are also within the 'normal' range for their chronological age, and their comprehension scores are either at or above that predicted by their word reading accuracy ages.	Fluency	Word reading accuracy	The Neale Analysis of Reading Ability-Revised (1989).	N/A
				Oral language	Vocabulary	The Vocabulary subtest of the Gates-MacGinitie Primary Two Test (MacGinitie & MacGinitie 1989)	N/A
				Reading comprehension	Reading comprehension	The Neale Analysis of Reading Ability-Revised (1989).	N/A
Cain, Oakhill, & Bryant, 2000b	7-9-year-old, English	The less-skilled comprehenders all had age-appropriate reading accuracy ability, but their comprehension ages were at least 6 months below their reading accuracy.	The skilled comprehenders had age-appropriate reading accuracy but their comprehension scores were at or above their reading accuracy.	Fluency	Reading accuracy	The Neale Analysis of Reading Ability (Revised UK edn., Neale 1989).	N/A
				Oral language	Vocabulary	The Gates-MacGinitie Primary Two Vocabulary test (Gates & MacGinitie 1965)	N/A
				Reading comprehension	Reading comprehension	The Neale Analysis of Reading Ability (Revised UK edn., Neale 1989).	N/A
Cain et al., 2001	7-8-year-old,	Less skilled comprehenders had a	The skilled readers' reading-	Fluency	Reading accuracy	The Neale Analysis of Reading Ability-Revised British Edition (Neale, 1989)	N/A

	English	specific comprehension deficit in the presence of age-appropriate word-reading skills. The less skilled students' comprehension scores were depressed relative to their word-reading age.	comprehension scores were at or above those predicted by their reading-accuracy ability. The mean difference between reading accuracy and reading comprehension for the less skilled group was 25 months.	Oral language	Vocabulary	The Gates-MacGinitie Primary Two Vocabulary Test (MacGinitie & MacGinitie, 1989)	N/A
				Reading comprehension	Reading comprehension	The Neale Analysis of Reading Ability-Revised British Edition (Neale, 1989)	N/A
Cain, Oakhill, & Lemmon, 2005	9-10-year-old, English	The poor comprehenders' comprehension ages below their chronological ages and at least 12 months below their reading accuracy ages.	The 14 good comprehenders also obtained age-appropriate word reading accuracy levels, but their comprehension scores were at or above the levels predicted by their reading accuracy ages.	Decoding	Non-word reading	The Graded Nonword Reading Test (Snowling, Stothard, & McLean, 1996)	N/A
				Fluency	Accuracy	The Neale Analysis of Reading Ability-Revised, Form 1(Neale, 1997)	N/A
				Fluency	Semantic fluency	The Word Association subtest from the Clinical Evaluation of Language Fundamentals-Revised (Semel, Wiig, & Secord, 1987)	N/A
				Oral language	Vocabulary	The Gates-MacGinitie Primary Two Vocabulary Test (MacGinitie & MacGinitie, 1989)	N/A
				Oral language	Vocabulary	The British Picture Vocabulary Scale (Dunn, Dunn, Whetton, & Pintillie, 1982)	N/A
				Reading comprehension	Reading comprehension	The Neale Analysis of Reading Ability-Revised, Form 1(Neale, 1997)	N/A
Carretti et al., 2005	8-11-year-old, Italian	Poor readers obtained scores below the 25th percentile.	Good readers obtained scores above the 75th percentile.	Decoding	Word search	The Word Search Subtask of the PRCR-2 Test (Cornoldi, Miato, Molin, & Poli, 1992)	N/A
				Reading comprehension	Reading comprehension	The MT Test (Cornoldi & Colpo, 1998)	N/A
Carretti, Motta, & Re, 2016	8-10-year-old, Italian	Poor readers obtained scores below the 25th percentile.	Good readers obtained scores above the 75th percentile.	Decoding	Word decoding	A lexical decision task (Caldarola, Perini, & Cornoldi, 2012).	N/A
				Oral language	Vocabulary	The PMA vocabulary test	N/A
				Reading comprehension	Reading comprehension	The MT test (Cornoldi & Colpo, 2011)	N/A
Carretti, Re, &	8-10-year-old,	Poor comprehenders obtained scores below the	Good comprehenders obtained scores above	Decoding	Word-search	A word search subtask (Cornoldi, Miato, Molin, &Poli, 2009).	N/A

Arfè, 2013	Italian	25th percentile.	the 75th percentile.	Oral language	Vocabulary	The vocabulary subscale of the Primary Mental Ability Intelligence Test (PMA; Thurstone & Thurstone, 1963)	N/A
				Reading comprehension	Reading comprehension	A standardized reading comprehension test appropriate for their age (Cornoldi & Colpo, 1998).	N/A
Ehrlich & Remond, 1997	3rd grade, French	The less- skilled readers are children with scores failing in the lowest 30 percent.	The skilled readers are classified as the highest 30 percent.	Oral language	Vocabulary	The French Translation of the Synonym Subtest of the California Test (Claes, Dehant, Lamy & Gille, 1967),	N/A
				Reading comprehension	Reading comprehension	The standardized French 'Test de lecture silencieuse' (Aubret & Blanchard, 1991).	N/A
Elwer et al., 2015	4th grade, English	Followed Nation et al. (2010) low performance on reading comprehension (z-scores below -0.67), adequate decoding (z-scores above -0.67) and importantly, a discrepancy between the two z-scores (with comprehension being lower than decoding) of at least 0.67 (M = 1.26, SD = 0.41, range = 0.68–2.18). SPC is 7% of the full sample. A group of poor reading comprehenders was selected at the end of Grade 4.	Reading comprehension results above the mean of the full sample (z>0) best individuals match on decoding ability to the poor reading comprehenders.	Decoding	Decoding	In Grade 4, the TOWRE was used again, but only one list each of words and non-words was used. Two additional tests were included at Grade 4, the Word ID and Word Attack Subtests from the Woodcock Reading Mastery Test (Woodcock, McGrew & Mather, 2001).	N/A
				Fluency	RAN	The Comprehensive Test of Phonological Processing (Rashotte,Torgesen, Wagner, 1999)	N/A
				Phonological awareness	Phonological awareness	A test measured phoneme deletion skills (Olson, Forsberg, Wise & Rack, 1994).	N/A
				Oral language	Listening comprehension	The Woodcock-Johnson Oral Comprehension Test (Woodcock et al., 2001).	N/A
				Oral language	Vocabulary	The Boston Naming Test (Kaplan, Godglass & Wintraub, 2001)	N/A
				Oral language	Vocabulary	The Peabody Picture Vocabulary Test (Dunn & Dunn, 1997)	N/A
				Reading comprehension	Reading comprehension	The Woodcock Passage Comprehension Test (Woodcock, 1987).	N/A
				Reading comprehension	Reading comprehension	The Gates MacGinitie Reading Comprehension of Passages (MacGinitie & MacGinitie, 1989).	N/A
Megherbi & Ehrlich,	7-9-year-old,	Less skilled comprehenders, who	Skilled comprehenders, who	Decoding	Non-word reading	The non-word reading MIM test (Mousty, Leybaert, Alegria, Content, & Morais, 1994).	N/A

2005	French	obtained reading comprehension scores in the lowest third.	obtained reading comprehension scores in the highest third.	Oral language	Listening comprehension	A cross-modal naming task	N/A
				Reading comprehension	Reading comprehension	The French adaptation of the Neale comprehension test - Revised (1988)	N/A
Nation Snowling, & Clarke, 2007	8-9-year-old, English	Children in the poor comprehender group were matched to the control children for non-word reading score and chronological age but scored below 85 (1 SD) on the reading comprehension test.	All of the controls had at least average-for-age non-word reading and obtained standard scores of at least 95 on the NARA-II reading accuracy and reading comprehension tests.	Decoding	Nonword reading	The Standardized Graded Nonword Reading Test (Snowling, Stothard, & McLean, 1996)	N/A
				Fluency	Text accuracy	The Neale Analysis of Reading Ability-II (Neal, 1989)	N/A
				Phonological awareness	Phoneme deletion	A phoneme deletion test (McDougall, Hulme, Ellis, & Monk, 1994)	N/A
				Oral language	Vocabulary knowledge	A word definition test (BAS-II; Elliot et al., 1996)	N/A
				Vocabulary	Word definition	A word definition test (BAS-II; Elliot et al., 1996).	N/A
				Reading comprehension	Reading comprehension	The Neale Analysis of Reading Ability-II	N/A
				Reading comprehension	Text comprehension	The WISC-III (Wechsler, 1992)	N/A
Nesi et al. 2006	2nd grade, Italian	The MT Battery classifies children at four qualitatively different levels. The children whose comprehension skills scored at level 1 and 2 were considered less-skilled text comprehenders.	Those at Level 3 and 4 were considered skilled text comprehenders. Skilled and less skilled readers didn't differ in reading accuracy nor speed.	Fluency	Accuracy	The MT Test (Cornoldi & Colpo, 1998)	N/A
				Fluency	Speed	The MT Test (Cornoldi & Colpo, 1998)	N/A
				Reading comprehension	Reading comprehension	The MT Test (Cornoldi & Colpo, 1998)	N/A
Nesi et al. 2006	4th grade, Italian	Same as above	Same as above	Fluency	Accuracy	The MT Test (Cornoldi & Colpo, 1998)	N/A
				Fluency	Speed	The MT Test (Cornoldi & Colpo, 1998)	N/A
				Reading comprehension	Reading comprehension	The MT Test (Cornoldi & Colpo, 1998)	N/A
Oakhill & Cain, 2000	7-8 years-old, English	The researchers compare groups who are matched on their ability to read	Good and poor readers differed on four comprehension	Fluency	Reading accuracy	The Neale Analysis of Reading Ability-Revised (Neale, 1989).	N/A

		words both in and out of context, but who differ in comprehension skill. They did not provide the exact cutting off value.	skills: inferencing, deriving the structure and main point of a story, monitoring comprehension, tests of short-term memory.	Oral Language	Vocabulary	The Gates-MacGinitie Primary Two Vocabulary Test (Gates & MacGinitie, 1965)	N/A
				Reading comprehension	Reading comprehension	The Neale Analysis of Reading Ability-Revised (Neale, 1989).	N/A
Oakhill Hartt, & Samols, 2005	9-10-year-old, English	This study did not provide very clear definition of poor compehenders. In the table, it shows their Reading comprehension scores: Less skilled comprehenders: M=8.3Y, SD= 11.44 M; skilled comprehenders: M=10.10, SD= 14.17	Twelve good and 12 poor comprehenders were selected to take part in the study, who were matched for chronological age and accuracy age but had significantly different comprehension ages.	Fluency	Accuracy	The Neale Analysis of Reading Ability-Revised (1989, Form 1)	N/A
				Oral Language	Vocabulary	The Gates Mac-Ginitie Vocabulary Test (1965, Survey D, Form 1)	N/A
				Reading comprehension	Reading comprehension	The Neale Analysis of Reading Ability–Revised (1989, Form 1)	N/A
Potocki, Ecalle, & Magnan, 2017	2nd grade, French	For the specific poor comprehender group, the cut-off criterion of a z-score lower than 1.3 was considered deviant from the norm and corresponded to the 10th percentile. The differences between z scores in the listening comprehension and the word reading task were also calculated for the groups of poor decoders and poor comprehenders to ensure they indeed presented a specific deficit in only one reading component.	A smaller subset of the 79 good readers (n = 15) was then randomly selected to form the final control group.	Decoding	word reading	The French Screening Battery for Dyslexia (ODEDYS; Jacquier-Roux, Valdoix & Zorman, 2005)	N/A
				Oral Language	Listening comprehension	A researcher-designed test	Reliability for this task, assessed by calculating the Cronbach alpha over items, was adequate at α=.71.
				Reading comprehension	Reading comprehension	A researcher-designed test	Reliability for the reading comprehension task was adequate at α = .71.
Ricketts, Nation, & Bishop, 2007 (time	8-10-year-old, English	Scoring at least 1 SD below the population norm (i.e., standard score < 85) on the reading	Fifteen children with more skilled comprehension (reading	Decoding	Nonword reading efficiency	The Phonemic Decoding Component of the Test of Word Reading Efficiency (Torgesen et al., 1999).	N/A

1 table 2)		comprehension subtest of the Neale Analysis of Reading Ability–II (Neale, 1997) were classified as poor comprehenders.	comprehension scores > 95) were matched to poor comprehenders for age, nonverbal ability, and decoding level (Test of Word Reading Efficiency).	Decoding	Regular word, nonword reading, exceptional word reading	30 regular words, and 30 nonwords from Coltheart and Leahy (1996). The three lists were matched on number of letters and number of syllables. The regular and exception words were also matched for word frequency.	The reliability ratings (Chronbach's α) for nonword, regular word, and exception word lists were 0.88, 0.76, and 0.80 respectively.1 A proportion correct score was calculated for each child.
				Fluency	Text reading accuracy	The Neale Analysis of Reading Ability-II (Neale, 1997).	N/A
				Oral language	Vocabulary	The Vocabulary Subtest of the Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999).	N/A
				Reading comprehension	Reading comprehension	The Neale Analysis of Reading Ability-II (Neale, 1997).	N/A
Ricketts Sperring, & Nation, 2014	8-10-year-old, English	Poor comprehenders obtained reading comprehension standard scores of at least one standard deviation below the test mean (≤85). PC and controls were identified at Time 1 using the standardized measures of nonverbal reasoning, decoding, and reading comprehension.	Controls' scores were well into the average range or above (>95).	Decoding	Nonword reading	The phonemic decoding efficiency subtest of the Test of Word Reading Efficiency (TOWRE; Torgesen et al., 1999).	The test provides norms for individuals aged 6–24 years, and its manual indicates a high level of test/re-test reliability (r = 0.89–0.91, depending on age group)
				Oral language	Vocabulary	The vocabulary usbtest of the WASI (Wechsler, 1999).	The split half reliability is reported in the manual (r = 0.86–0.96, depending on age group).
				Reading comprehension	Reading comprehension	The Neale Analysis of Reading Ability-II (NARA-II; Neale, 1997).	The test provides norms for children aged 6–12 years, and shows high internal consistency (Cronbach's α = 0.93–0.95, depending on age group).
Spooner Sperring,	7-8-year-old,	Less-skilled comprehenders have (a)	Skilled comprehenders have	Fluency	Accuracy	The Neale Analysis of Reading Ability (Neale, 1997)	N/A

& Nation, 2006 (Exp.1)	English	at least age-appropriate reading accuracy and (b) reading comprehension age at least 6 months below accuracy age.	at least age-appropriate reading accuracy and comprehension.	Reading comprehension	Reading comprehension	The Neale Analysis of Reading Ability (Neale, 1997)	N/A
Spooner Sperring, & Nation, 2006 (Exp. 2)	8-10-year-old, English	Less-skilled comprehenders have (a) at least age-appropriate reading accuracy and (b) reading comprehension age at least 6 months below accuracy age.	Skilled comprehenders have at least age-appropriate reading accuracy and comprehension.	Fluency	Accuracy	The Neale Analysis of Reading Ability (Neale, 1997)	N/A
				Reading comprehension	Reading comprehension	The Neale Analysis of Reading Ability (Neale, 1997)	N/A
Spooner Sperring, & Nation, 2006 (Ex3)	English	Less-skilled comprehenders exhibited (a) at least age-appropriate reading accuracy and (b) reading comprehension age at least 12 months below chronological age.	Skilled comprehenders have (a) at least age-appropriate reading accuracy and comprehension, (b) reading accuracy and comprehension ages no more than 2 years above chronological age and (c) reading accuracy and comprehension ages within 12 months of each other.	Fluency	Accuracy	The Neale Analysis of Reading Ability (Neale, 1997)	N/A
				Reading comprehension	Reading comprehension	The Neale Analysis of Reading Ability (Neale, 1997)	N/A
				Oral language	Vocabulary	The British Picture Vocabulary Scale (Dunn, Dunn, Whetton & Burley, 1997)	N/A
Tong et al., 2011	5th grade, English	They identified children below the lower 80% confidence interval of the regression line as unexpected poor comprehenders.	Those above the 80% upper confidence interval as unexpected good comprehenders.	Fluency	Word reading accuracy	The Test of Word Reading Efficiency (Torgesen, Wagner, & Rashotte, 1999)	The split-half reliability is .93.
				Fluency	Word reading speed	The Test of Word Reading Efficiency (Torgesen, Wagner, & Rashotte, 1999)	The split-half reliability is .93.
				Reading comprehension	Reading comprehension	The passage comprehension subtest of the Woodcock Reading Mastery Tests–Revised (Woodcock, 1998)	The split-half reliability of this task is .73 for Grade 5 children (Woodcock, 1998).
Yuill & Joscelyne, 1988 (Exp.1)	7-8-year-old, English	Less skilled comprehenders' reading accuracy ages were above or equal to their	The skilled comprehenders were matched with the less skilled ones on	Fluency	Accuracy	The Neale Accuracy Test (Neale, 1966)	The Neale test has high test-retest reliability (.96) and evidence of

		chronological ages, but their comprehension ages were below their chronological ages, and were at least half a year below their reading accuracy ages.	chronological age and regressed Neale accuracy age, but had a significantly higher comprehension age, The skilled group was also selected so that their scores on the Gates- MacGinitie vocabulary test did not differ significantly from those of the less skilled group.				construct validity (Neale, 1966).
				Fluency	Vocabulary	The Gates-MacGinitie Vocabulary Test (Gates & MacGinitie, 1965)	N/A
				Reading comprehension	Reading comprehension	The Neale Test (Neale, 1966)	The Neale test has high test-retest reliability (.96) and evidence of construct validity (Neale, 1966).
Yuill & Joscelyne, 1988 (Exp.2)	7-8-year-old, English	Less skilled comprehenders' reading accuracy ages were above or equal to their chronological ages, but their comprehension ages were below their chronological ages, and were at least half a year below their reading accuracy ages.	The skilled comprehenders were matched with the less skilled ones on chronological age and regressed Neale accuracy age, but had a significantly higher comprehension age, The skilled group was also selected so that their scores on the Gates- MacGinitie vocabulary test did not differ significantly from those of the less skilled group.	Fluency	Accuracy	The Neale Accuracy Test (Neale, 1966)	The Neale test has high test-retest reliability (.96) and evidence of construct validity (Neale, 1966).
				Fluency	Vocabulary	The Gates- MacGinitie Vocabulary Test (Gates & MacGinitie, 1965)	N/A
				Reading comprehension	Reading comprehension	The Neale Test (Neale, 1966)	The Neale test has high test-retest reliability (.96) and evidence of construct validity (Neale, 1966).

Appendix B

Sample List

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