Check for updates

Article

Hammill Institute on Disabilities

Learning Disability Quarterly
1–13
© Hammill Institute on Disabilities 2026

Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/07319487261490505
journals.sagepub.com/home/ldq

Teachers' and Parents' Evaluations of the Cognitive Abilities of Children With and Without a Dyslexia Diagnosis

Kim M. Lijbers, MSc[1,2], Sietske van Viersen, PhD[3], Elise H. de Bree, PhD[4], Kim Smeets, PhD[1,5], Anouke W. E. A. Bakx, PhD[1,5,6], and Sanne H. G. van der Ven, PhD[7]

Abstract

It is unclear whether a dyslexia label affects teachers' and parents' evaluations of children's cognitive abilities. In this study, we assessed whether such a labeling bias is present. To examine this, 1,036 primary school children (n = 941 without dyslexia; n = 95 with dyslexia) completed a cognitive ability test, covering crystallized intelligence (Gc), fluid intelligence (Gf), and visual processing (Gv). Teachers and parents also rated the cognitive abilities of their children. Findings aligned with the literature of lower Gc for children with dyslexia than their peers. They also showed lower Gf. Importantly, a labeling bias was found on Gf for teachers and on Gv for teachers and parents. Overall, children with dyslexia as a group have lower verbal abilities, but labeling bias was present on nonverbal abilities. The bias resulting from the diagnostic label thus extends to cognitive areas that are not directly affected by the diagnosis itself.

Keywords

cognitive ability, dyslexia, labeling bias, primary school children, teachers' evaluations, parents' evaluations

Introduction

Dyslexia is a specific learning disability characterized by severe and persistent difficulties in accurate or fluent decoding, word recognition, and/or word spelling, despite ample and appropriate instruction (American Psychiatric Association, 2013). These difficulties in word-level literacy are often underpinned by deficits in phonological processing (e.g., Snowling et al., 2020) and may also negatively affect text reading fluency and reading comprehension (Protopapas & Parrila, 2018; van Viersen et al., 2018). To address the challenges with word-level literacy, appropriate support is necessary, for example, specialized dyslexia treatment and educational accommodations (International Dyslexia Association (IDA), 2019).

Dyslexia occurs across intelligence outcomes, as intelligence quotient (IQ) is only set as an exclusionary criterion (American Psychiatric Association, 2013; Snowling & Hulme, 2024). Nevertheless, previous research has shown that groups of children with reading difficulties tend to exhibit lower verbal intelligence compared with groups of children without dyslexia (Torppa et al., 2010; van Bergen et al., 2014; van Viersen et al., 2017; see Snowling & Melby-Lervåg, 2016, for an overview). Findings regarding nonverbal intelligence and word reading are mixed (see, for example, the reviews of Peng et al., 2019, 2022). Importantly, little attention has been paid to how potential differences in intelligence are perceived by teachers and parents, and whether these perceptions may lead to labeling bias. In this study, we aim to gain insight into the impact dyslexia can have on the *evaluations* of children's cognitive abilities by significant others (teachers, parents). We did so by (a) comparing the outcomes of children with and without dyslexia on an intelligence test and (b) relating these actual cognitive ability scores to teachers' and parents' evaluations of the cognitive abilities (i.e., perceived cognitive abilities) of these children.

[1]Tilburg University, The Netherlands
[2]ATO-Scholenkring, 's-Hertogenbosch, The Netherlands
[3]Utrecht University, The Netherlands
[4]University of Amsterdam, The Netherlands
[5]Fontys University of Applied Sciences, Tilburg, The Netherlands
[6]PPF Centrum voor Hoog OntwikkelingsPotentieel, The Netherlands
[7]Radboud University, Nijmegen, The Netherlands

Corresponding Author:
Kim M. Lijbers, Department of Developmental Psychology, Tilburg School of Social and Behavioral Sciences, Tilburg University, Warandelaan 2, Tilburg 5037 AB, The Netherlands.
Email: K.M.Lijbers@tilburguniversity.edu

Word Reading and Intelligence

Substantial research has been devoted to identifying the underlying causes and/or risk factors of dyslexia. This research has shown that phonological abilities are proximal to word-level literacy outcomes. In particular, phonological awareness (PA; that is, detection and manipulation of speech sounds in spoken words) and rapid automatized naming (RAN; that is, rapid retrieval of phonological-orthographic information from long-term memory) constitute the core abilities underpinning word-level literacy (e.g., Hjetland et al., 2019; van Viersen et al., 2018; see Araújo & Faísca, 2019; Chen et al., 2021; Melby-Lervåg et al., 2012, for overviews). These skills can be seen as domain-specific skills underlying word-level literacy and are often impaired in children with dyslexia (e.g., Hulme et al., 2015; van Viersen et al., 2018).

In contrast, intelligence is typically considered to be a domain-general skill (Peng et al., 2022). Intelligence (general "g" or overall cognitive ability) refers to an individual's general ability to comprehend the world around them (Gottfredson, 1997) and is typically expressed as an IQ score. The Cattell–Horn–Carroll (CHC) theory of cognitive abilities provides insight into the cognitive abilities that constitute general intelligence (McGrew, 2009). The framework consists of three tiers: (a) general intelligence "g," (b) broad cognitive abilities (e.g., fluid reasoning/intelligence [Gf], comprehension-knowledge/crystallized intelligence [Gc]), and (c) narrowly defined cognitive abilities (e.g., spatial scanning, phonetic coding, etc.; McGrew, 2009).

Whereas findings regarding domain-specific skills underlying word-level literacy are fairly consistent, findings regarding the relationship between (word)reading/spelling and domain-general cognitive abilities are more mixed (McGrew & Wendling, 2010; Peng et al., 2022; van Viersen et al., 2018). One reason for this, as suggested by Peng et al. (2022), might be that the cognitive abilities that together constitute intelligence also vary in the degree to which they are more domain specific or more domain general. Depending on the modality in which they are assessed (i.e., using verbal instruction and responses vs. nonverbal), cognitive skills may show a different association with reading. Cognitive skills that are proposed as more domain-specific in relation to reading (when assessed with verbal materials) are working memory, short-term memory, switching, and processing speed (Peng et al., 2022). However, it is not clear how this translates to group differences between children with dyslexia and their peers on broader cognitive abilities, such as the abilities in Tier 2 of the CHC framework.

In the present study, we focused specifically on the broad cognitive abilities Gc, Gf, and visual processing [Gv]. Gc refers to "the knowledge of the culture that is incorporated by individuals through a process of acculturation" (i.e., verbal intelligence; see McGrew, 2009, p. 5), Gf to "the use of deliberate and controlled mental operations to solve novel problems that cannot be performed automatically" (i.e., nonverbal intelligence; see McGrew, 2009, p. 5), and Gv "the ability to generate, store, retrieve, and transform visual images and sensations" (see McGrew, 2009, p. 5). These three broad cognitive abilities were used to assess differences in actual performance between groups of children with and without dyslexia. This was needed as a first step to address the main question of our study: whether evaluations of these cognitive abilities of children by their teachers and parents are affected by the dyslexia label.

Gc, Gf, Gv, Word-Reading Ability, and Dyslexia

In terms of cognitive abilities and word-level literacy, a relation between Gc and word reading/spelling can be expected. In their review of the relationships between cognitive abilities (CHC) and academic achievement (word reading comprehension, basic math, and math reasoning), McGrew and Wendling (2010) showed the strongest correlation was found for word reading skills and Gc, with a moderate correlation for children aged 6 to 13 and a large correlation for children aged 14 to 19. In a meta-analysis on cognition and reading difficulties, Peng et al. (2022) established that the modality (i.e., verbal, nonverbal, or mixed) used to measure cognitive abilities influenced the strength of the relationship between reading ability (both word reading and reading comprehension) and cognition as well as individual differences between children with reading difficulties. For example, deficits in domain-specific skills (e.g., short-term memory) in children with reading difficulties were found to be more severe when measured in the verbal domain than with nonverbal or mixed materials. Furthermore, while verbal IQ was found to explain both domain-specific and domain-general variance in cognition between children with reading difficulties, nonverbal IQ only explained domain-general variance in cognition. These findings suggest that verbal IQ may, across the board, be more severely impaired in children with reading difficulties, while they show more variation in their nonverbal IQ. However, as stated by Peng et al. (2022), the relation between verbal IQ and reading difficulties may be dynamic over time, resulting from a vicious circle of insufficient language skills and limited development of verbal IQ feeding into each other, indirectly affecting reading development.

Longitudinal studies on children with reading difficulties or (family risk of) dyslexia have shown that oral language is foundational for literacy development (van Bergen et al., 2014) and generally contributes to word-level literacy indirectly through preliteracy skills (Hjetland et al., 2019; Hulme et al., 2015; Torppa et al., 2010; van Viersen et al., 2018). These oral language tasks are often measured by verbal IQ tasks. In addition, it has been found that these children have lower verbal IQ scores at various points

throughout development, but this trajectory is not necessarily stable (Torppa et al., 2010; van Bergen et al., 2014; van Viersen et al., 2017; see Snowling & Melby-Lervåg, 2016, for an overview). In their meta-analysis on the academic, cognitive, and behavioral performance of children with and without reading disabilities, Kudo et al. (2015) showed that the average effect size (Cohen's *d*) of differences on vocabulary and verbal IQ between children with and without a reading disability can range from small to moderate (−0.45 for vocabulary and −0.58 for verbal IQ). Taken together, these findings suggest that aspects of verbal IQ are necessary for the acquisition of reading skills, and that Gc is likely to be lower in children with dyslexia.

For Gf and Gv, relationships with word-level literacy are less clear, as findings of associations between nonverbal IQ and word reading, as well as group differences between children with and without dyslexia, are more mixed (see, for example, the reviews of Peng et al., 2019, 2022). McGrew and Wendling (2010) found in their review that Gf and Gv were not related to word reading. However, the meta-analysis on Gf and reading by Peng et al. (2019) did show a significant weak correlation between Gf and word reading. Moreover, the findings showed an increasing correlation between Gf and basic reading skills as children grow older, supporting the presence of reciprocal relations over time (Peng et al., 2019), despite initial assumptions that children would increasingly rely on long-term memory rather than *Gf* for word recognition during development (see also Peng et al., 2018). In addition, longitudinal studies have shown that, once controlled for verbal IQ, general IQ (including nonverbal IQ) (indirectly) contributes to word-level literacy in early grades (e.g., van Bergen et al., 2014; van Viersen et al., 2018). Nonverbal IQ could thus also contribute to early literacy. Group comparisons of children with and without (a risk of) dyslexia also point to a possible small-to-moderate difference between the groups on nonverbal IQ (e.g., Torppa et al., 2010; van Bergen et al., 2014). Taken together, the literature is inconclusive about the Gf outcomes of children with dyslexia compared with those without.

Regarding Gv, visual processing has been hypothesized to constitute an essential skill for developing visual representations of printed words and spelling patterns (Ramus, 2003). This skill could also support access to phonological and lexical representations (Castles & Coltheart, 1993; Seidenberg & Plaut, 1998). Indeed, children with reading difficulties show lower performance on visuospatial skills than their peers without reading difficulties, with an average effect size of −0.54, but there are significant individual differences (Peng et al., 2022). However, group comparisons between children with and without dyslexia on Gv are scarce.

In sum, based on the literature about (a) relationships between word-level literacy and cognitive abilities, and (b) comparisons between children with and without reading difficulties or dyslexia, it is likely that children with dyslexia will on average have lower Gc than children without this severe and persistent word-reading deficit. Although differences in Gf and Gv may also exist, current evidence is less conclusive and, if present, differences are likely smaller than for Gc.

Perceived Intelligence and Labeling Bias

In our study, the main focus is on teachers' and parents' evaluations of the cognitive abilities of children with dyslexia compared with those without. Previous research suggests that teachers and parents may underestimate the cognitive abilities of children with dyslexia compared with their ability-matched peers (Knight, 2021). In such cases, the label "dyslexia" might influence how others perceive the child. When this occurs, it is referred to as a *labeling bias* (Zee et al., 2020). As part of this labeling bias, stigmatization may occur, which can be defined as different treatment of a group of students (i.e., here those with a dyslexia label) as the result of a negative (implicit) attitude (Hornstra et al., 2010).

Regarding teachers, Hornstra et al. (2010) showed that they may hold negative implicit attitudes about the achievement of students with dyslexia. Students for whom teachers implicitly held negative attitudes regarding reading and spelling due to a dyslexia diagnosis indeed achieved lower outcomes in these domains compared with their peers without dyslexia, but not in mathematics, as indicated by both teacher ratings and standardized assessments. Explicit self-report measures of teacher attitudes did not relate to achievement outcomes of these students. The negative attitudes from teachers were thus implicit and attributable to their perceptions of labeled students, regardless of the students' actual intellectual potential.

The presence of a negative labeling bias is concerning because it may lead to treating children with such a label differently and not in line with their educational needs; it is essential that education, also for children with a label, is closely aligned with students' specific educational needs in order to reach their full learning potential (Herppich et al., 2018; Hornstra et al., 2010). Moreover, high teacher expectations are crucial for student achievement, richer learning opportunities, and the prevention of a self-fulfilling prophecy in which children (here with dyslexia) are going to behave in accordance with the lower (implicit or explicit) expectations placed upon them (Gentrup et al., 2020; Timmermans et al., 2018; see Jussim & Harber, 2005; Wang et al., 2018, for overviews). Accordingly, it is important to gain more insight into potential labeling bias in teachers' evaluations of the cognitive abilities of children with dyslexia and the areas in which it might occur.

With respect to parents or caregivers (henceforth parents), we know that their expectations also impact on the academic success of children. In a longitudinal study on parental involvement, parental expectations, and children's educational success, Froiland et al. (2013) showed that positive

parent expectations regarding their child in kindergarten constitute a strong predictor of parental expectations in Grade 8. This, in turn, leads to positive effects on the child's own expectations and positively influences children's academic achievement in Grade 8. Similar to teachers, a labeling bias might also exist for parents, which could impact on their perceptions and expectations of their children. For example, in a cross-sectional study on the relation between students' cognitive abilities and their teachers' and parents' evaluations of these abilities, Smeets et al. (2024) showed that both teachers and parents exhibit negative biases of children with special educational needs. However, targeted research on labeling bias in parents is much more limited, and there are currently, to the best of our knowledge, no studies on parents' labeling bias toward the cognitive abilities of children with dyslexia.

The Present Study

To meet the (educational) needs of children with dyslexia and allow them to reach their full potential, it is essential that teachers and parents have a realistic and unbiased perception of these children's cognitive abilities (Herppich et al., 2018; Hornstra et al., 2010; Wang et al., 2018). We aimed to assess whether teachers and/or parents may show a labeling bias on aspects of intelligence as a result of children's dyslexia label. Accordingly, we investigated teacher and parent evaluations of the intelligence (Gc, Gf, Gv) of children with and without dyslexia, while taking into account the actual abilities of the children.

The first research question (RQ1) was confirmatory in nature and asked to what extent children with and without dyslexia differ in Gc, Gf, and Gv. Based on the current literature, we expected lower performance of children with dyslexia on Gc compared with peers without dyslexia. On Gf and Gv, we hypothesized that differences between children with and without dyslexia might be present, but may be smaller than the Gc differences or even be absent. This information was needed to be able to address RQ2. This question was how teachers and parents evaluate the cognitive abilities of children with and without dyslexia, while controlling for children's actual cognitive abilities. We expected that, even when correcting for actual cognitive abilities, children with dyslexia would receive lower evaluations than children without dyslexia from both teachers and parents for all three cognitive abilities (i.e., consistent with a negative main effect of diagnosis). In addition, we explored whether this effect of a dyslexia diagnosis on the evaluations differed between teachers and parents.

Method

Participants

A total of 1,253 children in Grades 4 to 6 and their teachers and parents participated. They came from 16 Dutch primary schools. Only children with active consent participated: an estimated response rate of 70% (based on the average Dutch class size of 23 children). Data from 158 children were incomplete or missing (due to absence or missing birth date). In addition, 59 children were excluded based on self-reported low effort during testing. The final sample included 1,036 children from Grades 4 (37.5 %), 5 (33.0%), and 6 (29.5%) across 78 different classes from 16 different schools (49.7% girls, 49.9% boys, 0.4% other; $M_{age} = 10.79$ years, $SD_{age} = 0.96$). Ninety-five children (9.2%) had a dyslexia diagnosis. In the Netherlands, dyslexia is diagnosed by a certified psychologist. Criteria cover severity (lowest 10%) and persistence of the word-level literacy problems, excluding alternative explanations (poor quality of instruction, neurological conditions, and sensory impairments; Scheltinga et al., 2021; Tijms et al., 2021). Background information is presented in Table 1. Socio-economic status (SES) was based on highest completed education level of one of the parents (81.5% mother), divided into low, middle, and high. Home language was classified as Dutch or other. There were no significant group differences in distributions of sex, χ^2 (3, $N = 1{,}036$) = 0.84, $p = .84$, SES, χ^2 (2, $N = 1{,}025$) = 4.74, $p = .09$, and home language, χ^2 (1, $N = 1{,}035$) = 3.03, $p = .08$. Children with dyslexia were older than children without dyslexia, $t(1035, 118.78) = -5.62$, $p < .001$.

Table 1. Background Characteristics of Children With and Without Dyslexia.

Variable	*Dyslexia* (n=95)	*Control* (n=941)
Age *M (SD)*	11.16 (0.87)	10.75 (0.96)
Sex % girls/boys/other	50.5/49.5/0.0	49.6/49.9/0.39[b]
SES[a] % low/moderate/high	5.3/24.2/70.5	2.8/21.1/74.9[c]
Home language % Dutch/other	97.9/2.1	95.0/4.9[d]

Note. SES = socio-economic status.
[a]SES based on highest completed education level of one of the parents (low = primary education or lower secondary education; medium = upper secondary education or post-secondary education; high = bachelor or graduate degree). [b]Data "I do not want to say it" of two children with no dyslexia (0.1%). [c]Data missing of 11 children with no dyslexia (1.2%). [d]Data missing of two children without dyslexia (0.4%).

Instruments

Cognitive abilities of children were assessed using the Cognitive Ability Test, Third Edition (COVAT-3; Magez et al., in preparation). The COVAT-3 is a standardized digital cognitive ability test grounded in the CHC model of intelligence (Decaluwé et al., 2017; Magez & Bos, 2016; Tierens, 2017; Tierens & Magez, 2016). It was developed in Flanders, the Dutch-speaking region of Belgium. Previous versions of the COVAT received an A+ rating from the Belgian Test Committee (Belgian Federation of Psychologists, 2021).

Measures of Gc, Gf, and Gv were included in the present study. Standardized scores of the COVAT-3 are not yet available for the Netherlands. Therefore, composite scale scores were created by taking the mean *z*-score of the raw sum score per subtest. These were age-residualized to account for age differences, by regressing each score on age and taking the unstandardized residuals for further analysis (see also Smeets et al., 2024, for a similar approach).

Crystallized Intelligence. Gc was measured with the subtests Selections and Antonyms, both tapping into lexical knowledge. In the Selections subtest, participants had to identify which word out of a series of five written words did not fit (e.g., *chicken*, donkey, cow, cat, dog—all except the chicken are mammals). This subtest contained 40 items. In the Antonyms subtest, participants had to identify the antonym of a given written word from four options (e.g., black is the opposite of . . . dark, light, *white*, night). This subtest contained 45 items. Participants had a maximum of 7 min to complete each subtest. The score was the number of correct answers.

These tasks required reading under a time constraint, which may disadvantage children with dyslexia, who may struggle to reach the end of the test in time. We analyzed score patterns (i.e. number of missing scores, score distribution, variance) and excluded some of the last items to ensure equal opportunities for children with and without dyslexia. The Selections task was limited to the first 29 items and the Antonyms task to the first 34 items. Analyses were also conducted on the full item set. The pattern of findings was the same with the full versus limited set of items for both subtests; in the "Results" section we report our findings for Gc based on the shortened subtests. Internal consistency of the shortened tasks in the current sample was satisfactory for Selections ($\alpha = .71$) and Antonyms ($\alpha = .72$). The correlation between the subtests was .61.

Fluid Intelligence. Gf was measured with Dot Sequences. Participants had to extend 21 sequences of dots (in the form of dice pips). For the first 15 sequences, the child was shown five dice and asked to extend the sequence by filling in the correct number of dots in the two next empty dice (e.g., 1,1,2,2,3, ... (3), ... (4)). In the following sequences, the child could also choose a blank option when it was not possible to fill it in on a die (i.e., when the number was higher than six or lower than one). The time limit for the whole subtest was 10 min. The total score was the number of correct dice. Reliability in the current sample is good ($\alpha = .80$).

Visual Processing. For Gv, the Rotated Figures subtest was used, which measured spatial relations. For each item, the child had to indicate which of the five shapes were rotations of an example shape. Distractor items were rotated and mirrored. Participants had a maximum of 5 min to complete the 30 items. The number of correctly identified shapes was the total score, with one point deducted for each incorrectly selected shape. Reliability in the current sample is good ($\alpha = .87$).

Teachers' and Parents' Evaluations of Children's Cognitive Abilities. Teachers and parents were asked to rate the children with three statements. Each statement referred to a behavioral manifestation that reflects a cognitive ability (Gc, Gf, Gv). For Gc, it was *This child has a lot of general/common knowledge*. For Gf, the statement was *This child is good at solving problems in new situations*. For Gv, the statement was *This child is good at solving puzzles with pictures or figures.* Teachers and parents were asked to place a marker on a continuous line ranging from *totally disagree* (scored as 0) to *totally agree* (scored as 100). These and similar statements were also used in previous studies (e.g., Gnas et al., 2022; Mack et al., 2025).

Procedure

The full COVAT test battery was administered groupwise by trained graduate students and researchers during regular school hours between March and May 2021. The children completed the test independently and in silence on laptops, with testing lasting for 75 min. During the COVAT administration, teachers filled out the questionnaire about the perceived cognitive abilities of each child. Parents completed the online questionnaire at their own preferred time and place. The study was approved by the ethics committee of Fontys University of Applied Sciences. The design of the study and the analysis plan of the study were pre-registered via the Open Science Framework (https://osf.io/xcv2n/?view_only=ad9185abf2f5445c9cc05a3f3beaff3e). The pre-registration was done after data collection but before data analysis.

Deviations From Preregistration. We also preregistered to analyze twice-exceptional children: the 10% highest-scoring children per cognitive ability (with and without dyslexia). Unfortunately, there were only 14 children with dyslexia among the 10% highest-scoring students, yielding insufficient statistical power. Accordingly, it was not possible to conduct these analyses. Moreover, the literature review was updated and extended, resulting in more specified hypotheses. In the preregistration, we hypothesized lower cognitive ability outcomes for children with dyslexia across measures. In the present study, this hypothesis was further refined: we expected lower Gc scores, without strong hypotheses regarding Gv and Gf. Finally, two small changes are the use of the shortened tests for crystallized intelligence (see Instruments) and the use of R instead of IBM SPSS Statistics 29.0.

Analyses

Given the nested data structure, in which informants (i.e., parents/teachers; Level 1) were nested within children (Level 2),

who were nested within classes (Level 3), which were nested within schools (Level 4), we applied mixed-effects modeling. As there was minimal variance at the school level, this level was dropped from the analyses. We used the *lme4* package (Bates et al., 2015) in R version 4.3.1 (R core team, 2023). Maximal models were employed, incorporating random intercepts and slopes at each level whenever possible. Sum-to-zero contrasts were used for dichotomous variables.

To compare the children with and without dyslexia on the intelligence measures (RQ1), three linear mixed-effects models were conducted: one with each cognitive ability (Gc, Gf, and Gv) as dependent variable. The independent variable was Dyslexia diagnosis (−0.5 = no diagnosis, 0.5 = diagnosis). To investigate differences in teachers' and parents' evaluations of the intellectual abilities of children with and without dyslexia (RQ2), three sets of linear mixed-effects models were conducted, with the evaluations of the cognitive abilities (Gc, Gf, and Gv) as respective dependent variables. The independent variables included the child's corresponding COVAT score, Informant (teacher = −0.5, parent = 0.5), dyslexia diagnosis (no diagnosis = −0.5, diagnosis = 0.5), and the interaction term (Informant × Diagnosis). The interaction term indicates how the effect of a dyslexia diagnosis on the cognitive ability evaluations differs between teachers and parents. If this interaction effect was significant, a simple slopes analysis was performed to assess the effect of a dyslexia diagnosis on the evaluation of children's cognitive abilities for each informant group (teachers and parents) separately.

To evaluate effects, an alpha of .05 with Bonferroni correction (0.05/3 analyses = 0.0167) was used. *P*-values of the effects were determined with conditional *F*-tests using Kenward–Roger degrees of freedom, using the *afex* package (Singmann et al., 2023). Furthermore, for each linear mixed-effects model, Nakagawa marginal R^2 values were calculated with the *performance* package (Lüdecke et al., 2021). Marginal R^2 measures the variance explained by the fixed effects (individual level), using the following rule of thumb: $R^2 \geq .01$ for a small effect, $R^2 \geq .09$ for a medium effect, and $R^2 \geq .25$ for a large effect (Cohen, 1988). Correlations between children's COVAT scores and teachers' and parents' evaluations were also calculated and interpreted, with the rules of thumb of $r > .10$ for a weak correlation, $r > .30$ for a moderate correlation, and $r > .50$ for a strong correlation (Cohen, 1988).

Results

Data Screening

An outlier analysis using *z*-scores (values < −3.00 or > 3.00) identified several univariate outliers across the study variables. To evaluate the potential impact of these outliers on the results, winsorization was applied. As a sensitivity check, all analyses were conducted both with and without the winsorized data. The results were highly similar across both sets of analyses, indicating that the outliers had a negligible influence on the findings. Therefore, the results reported in this study were based on the original, non-winsorized data. In addition, the assumptions of multicollinearity, normality, linearity, and homoscedasticity were examined and found to be satisfactorily met.

Descriptive Statistics

Descriptive statistics of children's cognitive abilities and teachers' and parents' evaluations are provided in Table 2. To provide a general impression of the sample statistics, the correlations are presented in Table 3.

The correlations between children's *assessed* cognitive abilities (COVAT-score) are small to moderate (.30–.39), while the correlations between *evaluations* of children's cognitive abilities are stronger: strong for teachers (.70–.81) and moderate for parents (.44–.51). This indicates that children can show considerable intraindividual variability in COVAT scores, while parents and especially teachers show less intraindividual variation in their evaluations. In addition, correlations between children's COVAT scores and evaluations by their teachers and parents were moderate for Gc, $r_P = .41$, $r_T = .52$, but small for Gf, $r_P = .14$, $r_T = .28$, and Gv, $r_P = .16$, $r_T = .21$.

Cognitive Abilities of Children With and Without Dyslexia

The results of three mixed-effects models with COVAT score (Gc, Gf, Gv) as dependent variable and dyslexia diagnosis as independent variable are shown in Table 4. Children with dyslexia had significantly lower Gc and Gf scores, but did not differ significantly from their peers in Gv. Effects were small: the presence of a dyslexia diagnosis accounted for 6.6% of the variance in Gc, 1.2% in Gf, and 0.1% in Gv.

Teachers' and Parents' Evaluations of Children's Cognitive Abilities

The results of three series of linear mixed-effects models with teachers' and parents' cognitive ability evaluation as respective dependent variables and COVAT score, dyslexia diagnosis, informant, and informant × diagnosis as independent variables are displayed in Table 5. In each analysis, Model 0 contained only the control variable (the COVAT score), and Model 1 contained all other variables.

For all cognitive areas, Model 0 shows that children's COVAT scores contributed significantly and positively to teachers' and parents' evaluations, explaining a small to moderate part of the variance: 20.2% of the variance in teacher and parent evaluations in Gc, 4.8% in Gf, and 3.4% in Gv.

Table 2. Descriptive Statistics of Children COVAT Scores and Teachers' and Parent's Evaluations of Chi ldren's Cognitive Abilities.

	Dyslexia					*No Dyslexia*				
Variable	*n*	*M*	*SD*	Min	Max	*n*	*M*	*SD*	Min	Max
Child scores[a]										
Gc	95	−0.67	0.99	−3.02	1.28	938	0.07	0.97	−3.43	2.48
Gf	95	−0.28	0.97	−2.47	2.56	930	0.04	1.00	−3.15	3.01
Gv	93	−0.09	0.91	−2.28	2.43	912	0.01	1.00	−2.37	3.59
Teacher evaluations[b]										
Gc	89	56.19	24.51	10.00	100	896	67.86	24.39	0.00	100
Gf	89	50.22	23.57	3.00	100	896	62.75	24.69	0.00	100
Gv	89	55.36	24.45	6.00	100	896	66.46	25.31	0.00	100
Parent evaluations[b]										
Gc	95	65.19	22.90	13.00	100	937	72.45	20.89	0.00	100
Gf	95	61.63	22.49	5.00	100	937	64.28	22.87	0.00	100
Gv	95	68.80	23.32	8.00	100	937	74.01	21.59	0.00	100

Note. Gc = crystallized intelligence, Gf = fluid intelligence, Gv = visual processing.
[a]Age-residualized *z*-score on cognitive abilities. [b]Rating 0 to 100.

Table 3. Correlations Between Children's COVAT scores and Teachers' and Parents' Evaluations (N = 985–1,033).

Variable per informant	1.	2.	3.	4.	5.	6.	7.	8.	9.
Children's cognitive abilities									
1. Crystallized intelligence	—								
2. Fluid intelligence	.39***	—							
3. Visual processing	.31***	.30***	—						
Teacher's evaluations									
4. Crystallized intelligence	.52***	.33***	.21***	—					
5. Fluid intelligence	.40**	.28***	.16***	.73***	—				
6. Visual processing	.45***	.35***	.21***	.81***	.70***	—			
Parents' evaluations									
7. Crystallized intelligence	.41***	.23***	.09	.42***	.22***	.26***	—		
8. Fluid intelligence	.19***	.14***	.03	.31***	.30***	.28***	.47***	—	
9. Visual processing	.24***	.24***	.16***	.37***	.23***	.28***	.51***	.44***	—

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

Table 4. Parameter Estimates of Linear Mixed-effects Models for Children's Cognitive Abilities.

	Gc (N = 1,033)			Gf (N = 1,025)			Gv (N = 1,005)		
Effect	*b*	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*
Fixed effects									
Intercept	−0.32	0.06		−0.14	0.06		−0.05	0.06	
Dyslexia[a]	−0.88	0.10	<.001**	−0.38	0.11	<.001**	−0.12	0.11	.285
Random effects									
Class variance	0.08			0.05			0.05		
Residual	0.82			0.94			0.93		
R^2 marginal	.066			.012			.001		

Note. Gc= crystallized intelligence, Gf = fluid intelligence, Gv= visual processing.
[a]No dyslexia = −0.5, Dyslexia = 0.5.
*$p < .0167$. **$p < .001$.

Table 5. Parameter Estimates of Linear Mixed-effects Models for Teachers' and Parents' Evaluations.

	Model 0			Model 1		
Effect	*b*	*SE*	*p*	*b*	*SE*	*p*
Crystallized intelligence (N = 1,033)						
Fixed effects						
Intercept	69.13	0.66		68.26	1.01	
Cognitive ability score	10.66	0.53	<.001**	10.51	0.55	<.001**
Informant*				6.80	1.36	<.001**
Dyslexia[b]				−1.94	1.84	.29
Informant × Dyslexia				4.71	2.71	.08
Random effects						
Class variance	13.63			14.32		
Child variance	95.69			101.60		
Residuals	317.37			305.07		
R^2 marginal	.202			.213		
Fluid intelligence (N = 1,025)						
Fixed effects						
Intercept	62.68	0.77		60.10	1.13	
Cognitive ability score	5.24	0.58	<.001**	5.06	0.58	<.001**
Informant*				6.45	1.55	<.001**
Dyslexia[b]				−6.20	2.01	.002*
Informant × Dyslexia				10.01	3.10	.001**
Random effects						
Class variance	19.83			20.6		
Child variance	121.60			120.81		
Residuals	403.12			397.59		
R^2 marginal	.048			.059		
Visual processing (N= 1,005)						
Fixed effects						
Intercept	69.91	0.71		66.18	1.11	
Cognitive ability score	4.45	0.60	<.001**	4.35	0.59	<.001**
Informant*				10.06	1.57	<.001**
Dyslexia[b]				−8.84	2.02	<.001**
Informant × Dyslexia				5.46	3.15	.08
Random effects						
Class variance	12.11			15.57		
Child variance	111.07			118.69		
Residuals	431.61			400.55		
R^2 marginal	.034			.072		

Note. COVAT-3 scores are z-scores.
[a]Teacher = −0.5, Parent = 0.5. [b]No dyslexia = −0.5, Dyslexia = 0.5.
*$p < .0167$. **$p < .001$.

In Model 1, the effects of dyslexia diagnosis, informant, and informant × diagnosis were added. When controlling for actual abilities (COVAT score), informant showed a significant positive effect, meaning that in all three cognitive areas parents' evaluations were significantly higher than teachers' evaluations. Dyslexia diagnosis had a significant negative effect on Gf and Gv but not Gc. The interaction of Informant × Diagnosis showed that this effect differed between teachers and parents for Gf but not Gc and Gv. A simple slopes analysis (see Table 6) shows that only teachers, and not parents, evaluated the fluid intelligence of children with dyslexia significantly lower than their peers without dyslexia. This analysis also shows that the effect of COVAT score on Gf was smaller for parents than for teachers. Model 1 explained only a small degree of extra variance: $\Delta R^2 = .01$ for both Gc and Gf, and $\Delta R^2 = .04$ for Gv.

Table 6. Simple Slopes Analysis for Interaction Between Informant and Dyslexia Status on Teachers' and Parents' Evaluation of Children's Fluid Intelligence.

	Teacher			Parent		
Variable	*B*	*SE*	*p*	*B*	*SE*	*p*
Intercept	57.14	1.64		63.24	1.23	
Cognitive ability score[a]	7.06	0.74	<.001**	3.22	0.71	<.001**
Dyslexia[b]	−10.74	2.56	<.001**	−1.46	2.45	.55

[a]Cognitive ability scores are age-residualized *z*-scores. [b]No dyslexia = −0.5, Dyslexia = 0.5.
*$p < .0167$. **$p < .001$.

Discussion

The aim of this study was to assess whether teachers' and parents' evaluations of children's cognitive abilities are biased when a dyslexia label is present. To answer this question, children's cognitive abilities (i.e., crystallized intelligence [Gc], fluid intelligence [Gf], and visual processing [Gv]) were first measured and compared between children with and without dyslexia. Teachers' and parents' evaluations of these cognitive abilities were then related to the actual cognitive abilities of these children. Findings for measured cognitive abilities point to group differences on both Gc and Gf. Furthermore, findings regarding teachers' and parents' evaluations of the cognitive abilities of children with and without dyslexia indicate some labeling bias. While children with dyslexia had lower verbal abilities, labeling bias was mostly present on nonverbal abilities.

Cognitive Abilities of Children With and Without Dyslexia

A comparison on actual intelligence outcomes showed that average Gc outcomes were lower for the children with dyslexia. These differences in Gc align with our expectations based on studies indicating that verbal intelligence is lower in children with dyslexia (Torppa et al., 2010; van Bergen et al., 2014; van Viersen et al., 2017; see Snowling & Melby-Lervåg, 2016, for an overview). In addition, other prior studies have shown that verbal intelligence generally contributes to word-level literacy indirectly through preliteracy skills (Hjetland et al., 2019; Hulme et al., 2015; van Viersen et al., 2018). Our finding that children with dyslexia, who struggle with word-level literacy, exhibit weaker verbal abilities (Gc) supports the foundational role of verbal abilities for literacy development.

Regarding Gf, prior studies provided mixed findings on the relationship between nonverbal intelligence and dyslexia or word reading difficulties (see McGrew & Wendling, 2010; Peng et al., 2018, 2019, 2022; Torppa et al., 2010; van Bergen et al., 2014). We, therefore, did not have clear expectations. Our findings showed small differences in Gf, with children with dyslexia scoring lower than their peers without dyslexia. This finding is in line with the meta-analysis of Peng et al. (2018) which showed a weak significant correlation between Gf and word reading and longitudinal studies (e.g., van Bergen et al., 2014; van Viersen et al., 2018), which showed that nonverbal IQ (indirectly) contributes to early literacy.

For Gv, the findings showed no group differences. The absence of group differences was expected given the lack of consistent (empirical) evidence. Although some studies suggest that visuospatial skills may be slightly lower in children with reading difficulties (Peng et al., 2022), there is limited support for a robust relationship between visual processing and word-level literacy, including deficits associated with dyslexia (see also Caemmerer et al., 2024; McGrew & Wendling, 2010). Previous studies showed that visual processing constitutes an essential skill for developing visual representations of printed words and spelling patterns (Ramus, 2003), and Gv could support access to phonological and lexical representations (Castles & Coltheart, 1993; Seidenberg & Plaut, 1998). However, this assumption did not lead to group differences between children with and without a dyslexia diagnosis in our study. An explanation may be that our measure of Gv (the subtest rotated figures) is not associated with domain-specific factors underlying word-level literacy such as RAN and PA (see Araújo & Faísca, 2019; Chen et al., 2021; Melby-Lervåg et al., 2012, for overviews).

It is important to note that our results provide no information about the nature of the observed differences between children with and without dyslexia for various reasons. First, our study relied solely on raw scores because standardized norm scores were not available. Hence, we cannot determine the level of performance children showed, nor whether children with dyslexia scored objectively poor(er). Second, we cannot make causal inferences regarding the directionality of the relationship between cognitive ability and word-level reading. It thus remains unclear whether (a) reduced cognitive ability contributes to the development of dyslexia, (b) reduced cognitive ability is a consequence of dyslexia, or (c) reduced cognitive ability and dyslexia are independently associated, potentially through a bidirectional relationship. Future longitudinal research is needed

to gain more insight into these relationships. As part of such future research, it would be valuable to include a measure of children's actual reading and spelling ability instead of dichotomous information about the presence of a diagnosis. Continuous measures would allow for a confirmation of the diagnosis and assessing individual differences, as well as enable testing various statistical models that represent relations between reading and spelling abilities (domain-specific) and cognitive abilities (domain-general).

Teachers' and Parents' Evaluations of Children's Cognitive Abilities

The main question focused on teachers' and parents' evaluation of the cognitive abilities of children with and without dyslexia. The hypothesis that children with dyslexia would receive lower evaluations was confirmed for Gf and Gv, indicating labeling bias in these areas. For Gc, no lower evaluations were found after controlling for actual cognitive abilities.

The labeling bias in Gf and Gv could stem from the formulation of the statements: Gf and Gv referred to specific, context-dependent skills that are less observable in everyday interactions, whereas verbal ability (Gc) was assessed through general knowledge, making it easier to judge accurately. This aligns with the Realistic Accuracy Model (Funder, 2012), which states that there must be a chance to detect and utilize relevant and observable information in order to make accurate judgments about student characteristics (Urhahne & Wijnia, 2021). Observable characteristics, such as academic achievement, are easier to assess whereas non-directly observable aspects (such as cognitive abilities) are inferred from observable aspects (i.e., academic achievement; Machts et al., 2016). While this study provides an initial indication of labeling bias among teachers and parents due to the dyslexia label, further research is needed to deepen our understanding of this phenomenon. To achieve this, future studies should use more elaborate and fine-grained instruments to capture teachers' and parents' evaluations about children's cognitive abilities.

We also explored if the effect of a dyslexia diagnosis on the evaluations of teachers and parents differed between teachers and parents. Our findings showed that both teachers and parents demonstrated labeling bias for Gv, while teachers also showed labeling bias for Gf. A possible explanation may lie in the different contexts in which teachers and parents see and observe children. While parents' evaluations are likely informed by individualized observations and expectations of their children (Geiser et al., 2016), teachers' evaluations may depend more on their classroom-specific reference frameworks. As teachers interact with many children, they should be able to make informed comparisons and recognize variations in cognitive abilities with sufficient accuracy (Bracken & Brown, 2008; Geiser et al., 2016). In classroom contexts, the challenges of dyslexia might thus reinforce teachers' negative expectations, increasing the risk of labeling bias (Hornstra et al., 2010).

Limitations

The findings should be viewed in light of some methodological constraints. The selection of COVAT-3 subtests and the reliance on single-item evaluations by teachers and parents has limited the precision of measurement; using multiple subtests (see full COVAT-3; Magez et al., in preparation) and more statements per domain would have allowed for greater accuracy (e.g., Gnas et al., 2022; Mack et al., 2025). Future research should take into account the validity of multiple measures assessing similar constructs, for instance through the use of latent variables. Furthermore, the Gc subtests required adjustments to the task, as children had to read words, which is more challenging for the children with dyslexia. To prevent amplification of group differences, item cut-offs were adjusted to mitigate effects. Ideally, when studying children with dyslexia, verbal intelligence is measured with oral tasks that do not require reading or a written response.

Implications for Practice

The current study yields two practical implications. First, cognitive ability scores can provide more insight into children's strengths and weaknesses. When verbal weaknesses are present, investing in high-quality instruction and enriched learning environments is essential, as strong language skills, especially vocabulary, can protect against long-term literacy difficulties and promote resilience (Appels et al., 2024; Slomowitz et al., 2021). If nonverbal weaknesses are evident, both instructional remediation and compensatory strategies are recommended, such as visual supports, memory aids, and approaches that reduce cognitive load (Peng et al., 2022). When weaknesses are present in both domains, support should be combined and tailored to the child's individual needs. However, it is important to stress that cognitive ability outcomes may be informative but not decisive; the focus must remain on understanding and addressing each child's educational needs.

Second, labeling bias should be addressed among teachers and parents, as it can lead to stigmatization, inequitable treatment, and negatively affect children's well-being and academic performance (Haft et al., 2023; Hornstra et al., 2010). Raising awareness of implicit attitudes and fostering high expectations are key to creating inclusive learning environments where all students can thrive (Gentrup et al., 2020; Timmermans et al., 2018). Professional development programs that address bias and emphasize high expectations have proven effective in promoting educational equity (Bijl et al., 2025).

Conclusion

In sum, the present study identified group differences between children with and without dyslexia on both crystallized intelligence (Gc) and fluid intelligence (Gf), with children with dyslexia scoring lower than their peers. Evidence of labeling bias was found for Gf and visual processing (Gv), but not for Gc, and occurred particularly in teachers. These findings underscore the importance of educational practices, as well as targeted interventions and support for children with dyslexia, focusing on providing high-quality instruction and rich learning environments that support the development of verbal abilities while also considering individual differences in nonverbal abilities. Furthermore, increasing teachers' awareness of potential labeling bias in evaluations of children's cognitive abilities, combined with strategies that promote high expectations, are crucial for fostering educational equity and supporting the development of children with dyslexia.

Acknowledgments

We would like to thank Dr. M. Tierens and her team from the Center of Expertise Health and Care of Thomas More, for allowing us to use the COVAT-3 and for training the junior researchers and graduate students to administer this test. We would also like to thank the children who participated, their parents, and teachers of the POINT schools for their involvement in this study.

ORCID iDs

Kim M. Lijbers https://orcid.org/0000-0002-1408-1193
Sietske van Viersen https://orcid.org/0000-0002-4912-6822
Elise H. de Bree https://orcid.org/0000-0001-5258-7518
Kim Smeets https://orcid.org/0000-0003-1875-4460
Anouke W. E. A. Bakx https://orcid.org/0000-0003-2983-2962
Sanne H. G. van der Ven https://orcid.org/0000-0002-4761-0741

Author Contributions

Kim M. Lijbers: Conceptualization; Methodology; Formal analysis; Writing – Original Draft.
Sietske van Viersen: Conceptualization; Methodology; Writing – Review & Editing; Supervision.
Elise H. de Bree: Conceptualization; Writing – Review & Editing.
Kim Smeets: Methodology; Formal analysis; Writing – Review & Editing.
Anouke W. E. A. Bakx: Conceptualization; Data Curation; Writing – Review & Editing; Supervision; Funding acquisition.
Sanne H. G. van der Ven: Conceptualization; Methodology; Formal analysis; Writing – Review & Editing.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Supplemental Material

Supplemental material for this article is available online.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.).

Appels, S., van Viersen, S., van Erp, S., Hornstra, L., & de Bree, E. (2024). A scoping review on word-reading resilience in literacy: Evaluating empirical evidence for protective factors. *Learning and Instruction*, *93*, 101969. https://doi.org/10.1016/j.learninstruc.2024.101969

Araújo, S., & Faísca, L. (2019). A meta-analytic review of naming-speed deficits in developmental dyslexia. *Scientific Studies of Reading*, *23*(5), 349–368. https://doi.org/10.1080/10888438.2019.1572758

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, *67*(1), 1–48. https://doi.org/10.18637/jss.v067.i01

Belgian Federation of Psychologists. (2021). *Kwalificatie cognitive vaardigheidstests* [Qualification cognitive ability tests]. https://www.bfp-fbp.be/testbeoordelingen

Bijl, R. A., van den Bergh, L., & Bakx, A. W. (2025). Professional development targeting teacher expectations and behavior to impact (un) equal opportunities: A systematic review. *International Journal of Educational Research Open*, *9*, 100483. https://doi.org/10.1016/j.ijedro.2025.100483

Bracken, B. A., & Brown, E. F. (2008). Early identification of high-ability students: Clinical assessment of behavior. *Journal for the Education of the Gifted*, *31*(4), 403–426. https://doi.org/10.4219/jeg-2008-794

Caemmerer, J. M., Scudder, A. M., Keith, T. Z., & Reynolds, M. R. (2024). Beyond individual tests: Youths' cognitive abilities, basic reading, and writing. *Journal of Intelligence*, *12*(11), 120. https://doi.org/10.3390/jintelligence12110120

Castles, A., & Coltheart, M. (1993). Varieties of developmental dyslexia. *Cognition*, *47*(2), 149–180. https://doi.org/10.1016/0010-0277(93)90003-E

Chen, Y. J. I., Thompson, C. G., Xu, Z., Irey, R. C., & Georgiou, G. K. (2021). Rapid automatized naming and spelling performance in alphabetic languages: A meta-analysis. *Reading and Writing*, *34*(10), 2559–2580. https://doi.org/10.1007/s11145-021-10160-7

Cohen, J. E. (1988). *Statistical power analysis for the behavioral sciences*. Lawrence Erlbaum Associates, Inc.

Decaluwé, V., Tierens, M., & Magez, W. (2017). *Test-hertest-betrouwbaarheid* [Test-retest reliability]. Psychodiagnostisch Centrum Thomas More. https://expertisetoegepastepsychologie.be/subpages/covat-chc-basisversie/

Froiland, J. M., Peterson, A., & Davison, M. L. (2013). The long-term effects of early parent involvement and parent expectation in the USA. *School Psychology International*, *34*(1), 33–50. https://doi.org/10.1177/0143034312454361

Funder, D. C. (2012). Accurate personality judgment. *Current Directions in Psychological Science*, *21*(3), 177–182. https://doi.org/10.1177/0963721412445309

Geiser, C., Mandelman, S. D., Tan, M., & Grigorenko, E. L. (2016). Multitrait-multimethod assessment of giftedness: An application of the correlated traits-correlated (methods-1) model. *Structural Equation Modeling*, *23*(1), 76–90. https://doi.org/10.1080/10705511.2014.937792

Gentrup, S., Lorenz, G., Kristen, C., & Kogan, I. (2020). Self-fulfilling prophecies in the classroom: Teacher expectations, teacher feedback and student achievement. *Learning and Instruction*, *66*, 101296. https://doi.org/10.1016/j.learninstruc.2019.101296

Gnas, J., Mack, E., & Preckel, F. (2022). When classmates influence teacher judgment accuracy of children' cognitive ability: Studying frame-of-reference effects in primary school. *Contemporary Educational Psychology*, *69*, 102070. https://doi.org/10.1016/j.cedpsych.2022.102070

Gottfredson, L. S. (1997). Mainstream science on intelligence: An editorial with 52 signatories, history, and bibliography. *Intelligence*, *24*(1), 13–23.

Haft, S. L., Greiner de Magalhães, C., & Hoeft, F. (2023). A systematic review of the consequences of stigma and stereotype threat for individuals with specific learning disabilities. *Journal of Learning Disabilities*, *56*(3), 193–209. https://doi.org/10.1177/00222194221087383

Herppich, S., Praetorius, A. K., Förster, N., Glogger-Frey, I., Karst, K., Leutner, D., Behrmann, L., Böhmer, M., Ufer, S., Klug, J., Hetmanek, A., Ohle, A., Böhmer, I., Karing, C., Kaiser., & Südkamp, A. (2018). Teachers' assessment competence: Integrating knowledge-, process-, and product-oriented approaches into a competence-oriented conceptual model. *Teaching and Teacher Education*, *76*, 181–193. https://doi.org/10.1016/j.tate.2017.12.001

Hjetland, H. N., Lervåg, A., Lyster, S. A. H., Hagtvet, B. E., Hulme, C., & Melby-Lervåg, M. (2019). Pathways to reading comprehension: A longitudinal study from 4 to 9 years of age. *Journal of Educational Psychology*, *111*(5), 751–763. http://dx.doi.org/10.1037/edu0000321

Hornstra, L., Denessen, E., Bakker, J., van den Bergh, L., & Voeten, M. (2010). Teacher attitudes toward dyslexia: Effects on teacher expectations and the academic achievement of students with dyslexia. *Journal of Learning Disabilities*, *43*(6), 515–529. https://doi.org/10.1177/0022219409355479

Hulme, C., Nash, H. M., Gooch, D., Lervåg, A., & Snowling, M. J. (2015). The foundations of literacy development in children at familial risk of dyslexia. *Psychological Science*, *26*(12), 1877–1886. https://doi.org/10.1177/0956797615603702

International Dyslexia Association (IDA). (2019). *Dyslexia basics*. https://dyslexiaida.org/dyslexia-basics-2/

Jussim, L., & Harber, K. D. (2005). Teacher expectations and self-fulfilling prophecies: Knowns and unknowns, resolved and unresolved controversies. *Personality and Social Psychology Review*, *9*(2), 131–155. https://doi.org/10.1207/s15327957pspr0902_3

Knight, C. (2021). The impact of the dyslexia label on academic outlook and aspirations: An analysis using propensity score matching. *British Journal of Educational Psychology*, *91*(4), 1110–1126. https://doi.org/10.1111/bjep.12408

Kudo, M. F., Lussier, C. M., & Swanson, H. L. (2015). Reading disabilities in children: A selective meta-analysis of the cognitive literature. *Research in Developmental Disabilities*, *40*, 51–62. https://doi.org/10.1016/j.ridd.2015.01.002

Lüdecke, D., Ben-Shachar, M. S., Patil, I., Waggoner, P., & Makowski, D. (2021). performance: An R package for assessment, comparison and testing of statistical models. *Journal of Open Source Software*, *6*(60), 3139. https://doi.org/10.21105/joss.03139

Machts, N., Kaiser, J., Schmidt, F. T., & Moeller, J. (2016). Accuracy of teachers' judgments of students' cognitive abilities: A meta-analysis. *Educational Research Review*, *19*, 85–103. https://doi.org/10.1016/j.edurev.2016.06.003

Mack, E., Scherrer, V., & Preckel, F. (2025). How smart is my child? The judgment accuracy of parents regarding their children's cognitive ability. *Child Development*, *96*(1), 122–140. https://doi.org/10.1111/cdev.14156

Magez, W., & Bos, A. (2016). *Wederzijdse relaties schoolse criteria en testresultaten* [Mutual relationships scholastic criteria and test results]. Psychodiagnostisch Centrum Thomas More. https://expertisetoegepastepsychologie.be/subpages/covat-chc-basisversie/

Magez, W., Van Parijs, K., Joris, S., & Tierens, M. (in preparation) *COVAT-3: Digitale cognitieve vaardigheidstest volgens het CHC-model* [COVAT-3: Cognitive ability test based on the CHC-model]. Psychodiagnostisch Centrum Thomas More and CAPvzw. https://expertisetoegepastepsychologie.be/subpages/covat-chc-basisversie

McGrew, K. S. (2009). CHC theory and the human cognitive abilities project: Standing on the shoulders of the giants of psychometric intelligence research. *Intelligence*, *37*(1), 1–10. https://doi.org/10.1016/j.intell.2008.08.004

McGrew, K. S., & Wendling, B. J. (2010). Cattell–Horn–Carroll cognitive-achievement relations: What we have learned from the past 20 years of research. *Psychology in the Schools*, *47*, 651–675. https://doi.org/10.1002/pits.20497

Melby-Lervåg, M., Lyster, S. A. H., & Hulme, C. (2012). Phonological skills and their role in learning to read: A meta-analytic review. *Psychological Bulletin*, *138*(2), 322–352. https://doi.org/10.1037/a0026744

Peng, P., Barnes, M., Wang, C., Wang, W., Li, S., Swanson, H. L., & Tao, S. (2018). A meta-analysis on the relation between reading and working memory. *Psychological Bulletin*, *144*(1), 48–76. http://dx.doi.org/10.1037/bul0000124

Peng, P., Wang, T., Wang, C., & Lin, X. (2019). A meta-analysis on the relation between fluid intelligence and reading/mathematics: Effects of tasks, age, and social economics status. *Psychological Bulletin*, *145*(2), 189–236. https://doi.org/10.1037/bul0000182

Peng, P., Zhang, Z., Wang, W., Lee, K., Wang, T., Wang, C., Luo, J., & Lin, J. (2022). A meta-analytic review of cognition and reading difficulties: Individual differences, moderation, and language mediation mechanisms. *Psychological Bulletin*, *148*(3-4), 227–272. https://doi.org/10.1037/bul0000361

Protopapas, A., & Parrila, R. (2018). Is dyslexia a brain disorder? *Brain Sciences*, *8*(4), 611–618. https://doi.org/10.3390/brainsci8040061

Ramus, F. (2003). Developmental dyslexia: Specific phonological deficit or general sensorimotor dysfunction? *Current Opinion*

in Neurobiology, *13*(2), 212–218. https://doi.org/10.1016/S0959-4388(03)00035-7

R Core Team. (2023). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.R-project.org/

Scheltinga, F., Tijms, J., Zeguers, M., Rolak, M., & de Bree, E. (2021). *Brede inhoudelijke richtlijn dyslexie* [Broad Content Guideline for Dyslexia]. NIP, NVO, NKD en LBRT.

Seidenberg, M. S., & Plaut, D. C. (1998). Evaluating word-reading models at the item level: Matching the grain of theory and data. *Psychological Science*, *9*(3), 234–237. https://doi.org/10.1111/1467-9280.00046

Singmann, H., Bolker, K., Westfall, J., Aust, F., & Ben-Shachar, M. (2023). afex: Analysis of factorial experiments [R Package, version 1.3-0]. http://cran.rproject.org/package=afex)

Slomowitz, R. F., Narayan, A. J., Pennington, B. F., Olson, R. K., DeFries, J. C., Willcutt, E. G., & McGrath, L. M. (2021). In search of cognitive promotive and protective factors for word reading. *Scientific Studies of Reading*, *25*(5), 397–416. https://doi.org/10.1080/10888438.2020.1821035

Smeets, K., Rohaan, E., van der Ven, S., & Bakx, A. (2024). The effects of special educational needs and socioeconomic status on teachers' and parents' judgements of pupils' cognitive abilities. *British Journal of Educational Psychology*, *95*(2), 321–345. https://doi.org/10.1111/bjep.12719

Snowling, M., & Hulme, C. (2024). Do we really need a new definition of dyslexia? A commentary. *Annals of Dyslexia*, *74*, 355–362. https://doi.org/10.1007/s11881-024-00305-y

Snowling, M. J., Hulme, C., & Nation, K. (2020). Defining and understanding dyslexia: Past, present and future. *Oxford Review of Education*, *46*(4), 501–513. https://doi.org/10.1080/03054985.2020.1765756

Snowling, M. J., & Melby-Lervåg, M. (2016). Oral language deficits in familial dyslexia: A meta-analysis and review. *Psychological Bulletin*, *142*(5), 498–545. https://doi.org/10.1037/bul0000037

Tierens, M. (2017). *Onderzoeksrapport constructvaliditeit* [Research report construct validity]. Psychodiagnostisch Centrum Thomas More. https://expertisetoegepastepsychologie.be/subpages/covat-chc-basisversie/

Tierens, M., & Magez, W. (2016). *Onderzoeksrapport normering* [Research report on standards]. Psychodiagnostisch Centrum Thomas More. https://expertisetoegepastepsychologie.be/subpages/covat-chc-basisversie/

Tijms, J., De Bree, E. H., Bonte, M., De Jong, P. F., Loykens, E., & Reij, R. (2021). *Protocol Dyslexie Diagnostiek en Behandeling-versie 3.0* [Protocol Dyslexia Diagnosis and Treatment—Version 3.0]. Nederlands Kwaliteitsinstituut Dyslexie (NKD).

Timmermans, A. C., Rubie-Davies, C. M., & Rjosk, C. (2018). Pygmalion's 50th anniversary: The state of the art in teacher expectation research. *Educational Research and Evaluation*, *24*(3-5), 91–98. https://doi.org/10.1080/13803611.2018.1548785

Torppa, M., Lyytinen, P., Erskine, J., Eklund, K., & Lyytinen, H. (2010). Language development, literacy skills, and predictive connections to reading in Finnish children with and without familial risk for dyslexia. *Journal of Learning Disabilities*, *43*(4), 308–321. https://doi.org/10.1177/0022219410369096

Urhahne, D., & Wijnia, L. (2021). A review on the accuracy of teacher judgments. *Educational Research Review*, *32*, 100374. https://doi.org/10.1016/j.edurev.2020.100374

van Bergen, E., de Jong, P. F., Maassen, B., Krikhaar, E., Plakas, A., & van der Leij, A. (2014). IQ of four-year-olds who go on to develop dyslexia. *Journal of Learning Disabilities*, *47*(5), 475–484. https://doi.org/10.1177/0022219413479673

van Viersen, S., de Bree, E. H., Verdam, M., Maassen, B., Krikhaar, E., van der Leij, A., & de Jong, P. F. (2017). Delayed early vocabulary development in children at family risk of dyslexia. *Journal of Speech, Language, and Hearing Research*, *60*(4), 937–949. https://doi.org/10.1044/2016_JSLHR-L-16-0031

van Viersen, S., de Bree, E. H., Zee, M., Maassen, B., van der Leij, A., & de Jong, P. F. (2018). Pathways into literacy: The role of early oral language abilities and family risk for dyslexia. *Psychological Science*, *29*(3), 418–428. https://doi.org/10.1177/0956797617736886

Wang, S., Rubie-Davies, C. M., & Meissel, K. (2018). A systematic review of the teacher expectation literature over the past 30 years. *Educational Research and Evaluation*, *24*(3-5), 124–179. https://doi.org/10.1080/13803611.2018.1548798

Zee, M., de Bree, E., Hakvoort, B., & Koomen, H. M. (2020). Exploring relationships between teachers and students with diagnosed disabilities: A multi-informant approach. *Journal of Applied Developmental Psychology*, *66*, 101101. https://doi.org/10.1016/j.appdev.2019.101101