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Understanding mental health in developmental dyslexia through a neurodiversity lens: The mediating effect of school-connectedness on anxiety, depression and conduct problems

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Dyslexia, a neurocognitive difference characterised by poor word-reading, is associated with elevated risk for internalising (e.g., anxiety) and externalising (e.g., aggression) mental health concerns, the reasons are largely unknown. We took a neurodiversity perspective and explored whether school-connectedness mediated these associations. A total of 283 primary school children (87 with dyslexia) and their caregivers (95.4% mothers) completed a battery of well-validated connectedness and mental health measures. Two mediation models (one for child-report and one for caregiver-report) tested direct and indirect effects of dyslexia on anxiety, depression and conduct problems via several domains of school-connectedness. After controlling for gender and neurodevelopmental conditions other than dyslexia, there were no direct effects of dyslexia on child- or caregiver-reported internalising symptoms or child-reported conduct problems. Dyslexia was associated with child and caregiver reported anxiety, depression and conduct problems via low levels of school (but not teacher, friend or peer)

connectedness. Findings highlight school-connectedness as an important intervention target for the mental health of children with dyslexia. Future research is needed to test associations between dyslexia, school-connectedness and mental health over time.

KEYWORDS
dyslexia, externalising, internalising, mental health, neurodiversity, school-connectedness

Practitioner Points

- Whole school initiatives to promote school-connectedness are needed to support the mental health of children with dyslexia
- Researchers and clinicians can work with school communities to better understand how to promote school-connectedness among children with dyslexia

1 | INTRODUCTION

Reading difficulties characterised by poor phonetic decoding, spelling and reading fluency affect up to 10% of children (Brimo et al., 2021; Castles et al., 2010), a figure that equates to approximately 2–4 children in an average sized classroom. When reading difficulties persist without an alternative explanation a child can be diagnosed with a Specific Learning Disorder (SLD) with impairment in reading, otherwise known as developmental dyslexia (APA; American Psychiatric Association, 2013). Dyslexia is known to be highly heritable, neurocognitive in origin, persistent across the lifespan and frequently co-occurring with other neurodevelopmental conditions (or traits thereof; Brimo et al., 2021; Castles et al., 2010; Frith, 2013; Maughan et al., 2020). Furthermore, dyslexia is associated with a range of psychosocial difficulties, including elevated internalising (e.g., anxiety, depression) and externalising (e.g., conduct problems) mental health concerns which may (in terms of internalising symptoms) persist into adulthood (Donolato et al., 2021; Francis et al., 2019; Maughan & Carroll, 2006; Nalavany et al., 2011), and worsen educational outcomes such as secondary school completion (Smart et al., 2017). Whilst the evidence for associations between dyslexia and mental health concerns is robust, the reasons *why* are largely unknown (Boyes et al., 2016; Francis et al., 2019). Severity of reading difficulty, age and IQ do not appear to moderate associations with internalising/externalising mental health concerns (Donolato et al., 2021). Research to explore risk/protective factors and mechanisms underlying associations between dyslexia and mental health concerns is needed to: (a) support teachers, parents and others to identify children who are more or less at risk for mental health concerns, and (b) provide evidence-based targets for mental health programmes to support children with dyslexia[1] (Boyes et al., 2016).

1.1 | Dyslexia through a neurodiversity lens

Dyslexia research is predominantly situated within a 'medical model' which conceptualises neurodevelopmental conditions as 'disorders' characterised by developmental 'delays' or 'deficits' (APA, 2013). Some researchers posit that

[1]Whilst identity-first language has been confirmed as the preference of most autistic people (Kenny et al., 2016) and is consistent with a neurodiversity perspective, the conversation of preferred language has not yet been undertaken with the dyslexic community as far as we are aware. We use person first language (i.e., person with dyslexia) in this article, consistent with the International Dyslexia Association. We would always recommend asking an individual about their preferred language.

a medical model of dyslexia may narrow the focus of research and constrain best practices and argue for practitioners and researchers to consider a neurodiversity perspective as an alternative (Rappolt-Schlichtmann et al., 2018). Neurodiversity advocates reject the pathologising of brain-based differences such as dyslexia and autism. Instead, they argue that neurocognitive differences reflect natural human variation (akin to the term biodiversity as it relates to the natural world), to be accepted and respected rather than pathology to be cured (see, e.g., Baron-Cohen, 2017; Blume, 1998; den Houting, 2019; Pellicano & den Houting, 2021; Singer, 1998). If one conceptualises dyslexia as 'just' reading difficulties, then it may be difficult to see how the neurodiversity paradigm applies. However, for many with lived experience, dyslexia extends beyond difficulties with reading (Wilmot, Pizzey, et al., 2023b) and is an accepted and integrated aspect of their identity (see, e.g., Johnson, 2023; Wilmot, Pizzey, et al., 2023a).

Taking a neurodiversity approach to dyslexia does not imply that children should not be provided with the opportunity to develop their reading skills (Rappolt-Schlichtmann et al., 2018) nor that research should not continue into the cognitive underpinnings of dyslexia to inform evidence-based reading intervention. Rather, research and intervention should *also* focus on: (a) recognising and building children's capacity (e.g., strengths), (b) understanding dyslexia as identity and (c) modifying children's environment to support learning and mental health (see, e.g., Hogan, 2018; Johnson, 2023; Rappolt-Schlichtmann et al., 2018; Wilmot, Pizzey, et al., 2023a). From a medical perspective, 'within child' factors are investigated as the cause of mental health concerns (Mandy, 2022). Conversely, from a neurodiversity perspective, mental health concerns can occur when there is a poor 'fit' (Mandy, 2022) between the neurodivergent[2] child and their environment, a notion which can be explored by investigating links between dyslexia, school-connectedness and mental health.

1.2 | School-connectedness

School-connectedness, sometimes referred to as school belonging, is variously defined, but in this study, refers to the quality of a child's attachment to their learning and the people (e.g., teachers, peers) within their school environment (García-Moya et al., 2019; Karcher, 2011; Raniti et al., 2022). School-connectedness has historically been investigated in the context of school dropout and academic outcomes (see, e.g., Bond et al., 2007) but there is increasing evidence of its importance to child and adolescent mental health. Importantly, poor school-connectedness predicts the onset of anxiety and depression (Gunnarsdóttir et al., 2021; Raniti et al., 2022; Shochet et al., 2006), meaning that it can be an early warning sign to identify children at risk. Furthermore, school-connectedness is malleable; promising results have been reported from interventions which target school-connectedness amongst autistic students and their peers (Hodges et al., 2022; Shochet et al., 2022) which may also improve mental health (Shochet et al., 2022). School-connectedness is usually studied as a multifactor construct, and, often by a measure which taps a child's sense of being valued and supported at school rather than their attachment to school (García-Moya et al., 2019). Nevertheless, researchers who study particular domains of school-connectedness such as perceived support from teachers and classmates (Wit et al., 2011), teacher discrimination (Jiang & Dong, 2020), classroom environment (Shochet & Smith, 2014) and whole school ethos (Dimitrellou & Hurry, 2019) find consistent results in regard to children's mental health. The consistency of these findings underscores the importance of children's school experience to their mental health.

1.3 | Dyslexia, school-connectedness and mental health

To the best of our knowledge no previous study has investigated links between school-connectedness and mental health in the context of developmental dyslexia. This is surprising given cumulative evidence from longitudinal

[2]We use the definition provided by Pellicano and Den Houting (2021), which defines neurodivergent as referring to 'a person or people whose neurodevelopment falls outside of (or "diverges" from) the range usually considered to constitute "typical" development' (p. 6; Pellicano & Den Houting, 2021).

studies that mental health concerns among childen with dyslexia typically start when children start school and may worsen during the primary school years (see, e.g., Jordan & Dyer, 2017; McArthur et al., 2022; Morgan, 2012; Morgan et al., 2008). Furthermore, aspects of poor school-connectedness such as peer relationship difficulties (Boyes et al., 2019; Singer, 2005) and concepts related to school-connectedness, such as poor reading/academic self-concept (beliefs about oneself as a reader/learner; McArthur, 2022; Terras et al., 2009) are (a) associated with mental health concerns in developmental dyslexia, and (b) posited to be causal mechanisms linking poor reading to anxiety (McArthur, 2022) When interviewed, some children with dyslexia, and their parents, report feeling misunderstood by teachers and/or discriminated in their learning environments (Learned, 2016; Leitão et al., 2017; Wilmot, Pizzey, et al., 2023a). These findings suggest poor awareness or application of inclusivity policies at school may undermine school-connectedness. Consistent with this notion, there is evidence that children with learning difficulties and other neurodevelopmental differences such as autism are at elevated risk of experiencing poor school-connectedness both in Australia and elsewhere in the world (see for example, Benassi et al., 2022; Dimitrellou & Hurry, 2019; Hebron, 2018).

Drawing from recent interviews with children and their mothers (Wilmot, Pizzey, et al., 2023a; Wilmot, Pizzey, et al., 2023b) and research into school-connectedness among children with learning difficulties broadly (using definitions that include dyslexia; Benassi et al., 2022; Chiappedi & Baschenis, 2016; Dimitrellou & Hurry, 2019; Kopelman-Rubin et al., 2020), we posited that children with dyslexia may be at elevated risk of experiencing poor school-connectedness (peer, teacher and school as a whole), which in turn, may negatively affect their mental health (both internalising and externalising symptoms). Prior research investigating children's friendships in the context of dyslexia is limited so our investigation of friend-connectedness and links to mental health was explorative.

1.4 | The current study

Previous studies of school-connectedness have been limited by measures which conflate different domains of school-connectedness (i.e., connection with teachers or peers) within their total scores (García-Moya et al., 2019). Similarly, much past research in the dyslexia field investigates *global* psychosocial functioning rather than *specific* mental health concerns such as anxiety (Wilmot, Hasking, et al., 2023). In order to design evidence-based intervention it is important to identify the *particular* domain of school-connectedness associated with the *particular* domain of mental health. Futhermore, research which differentiates the relative importance of various domains of school-connectedness helps to determine priorities for mental health programmes. We posited that *both* child and caregiver perspectives were needed to provide insight into internalising symptoms and some aspects of peer relations (e.g., bullying) which may be difficult for an outsider to accurately assess and/or may vary by context (e.g., school/home; Wilmot, Hasking, et al., 2023). Given these factors, the aim of the current study was to investigate school-connectedness as a mechanism underlying links between dyslexia and specific mental health concerns, namely, anxiety, depression and conduct problems using a tool that differentiated different domains of children's connectedness to school (teacher, school-based peers and school as a whole). Based on previous literature, and informed by a neurodiversity perspective, we expected both direct and indirect links (via low levels of teacher, peer and whole school-connectedness) between dyslexia and anxiety, depression and conduct problems from the perspectives of children and their caregivers. Our exploration of friend-connectedness was explorative, so no a priori predictions were made.

2 | MATERIALS AND METHODS

This research was approved by Curtin University Human Research Ethics Committee (HRE-2020-0168) and recruitment via schools was approved by the Department of Education Western Australia. Data were obtained from a larger study on the mental health of children with and without reading difficulties. Informed by a socioecological

model (Bronfenbrenner, 1996), this larger study included a battery of measures to assess individual, family and community-level risk and protective factors for mental health. Inclusion criteria were that children must be in year 6 (approximately 11 years old; the final year of primary school in Australia and a caregiver willing to participate. No other inclusion/exclusion criteria were applied. Families of children with dyslexia were primarily recruited via the Dyslexia SPELD Foundation (DSF) a leading provider of assessment and support services for children with learning difficulties. Families of children without dyslexia were primarily recruited through social media, schools and word of mouth. Advertisement through schools occurred at the school principal's discretion.

2.1 | Participants

In total 283 children (*Mage* = 139.26 months) (11 years 6 months); 87 (30.7% of total sample) with dyslexia and a corresponding parent/carer (95.4% mothers) participated in this study. According to Fritz and MacKinnon (2007) with a sample of 283 we were powered to find the proposed indirect effects. A total of 149 children (52.7%) identified as female; 133 children (47%) identified as male; and one child (0.4%) responded 'other'. Sixty-seven (23.7%) parents reported that their child had at least one neurodevelopmental difference (e.g., ADHD) other than (37; 18.9% of subsample) or in addition to (30; 34.5% of subsample) dyslexia. This level of co-occurrence between dyslexia and other neurodevelopmental conditions is to be expected (see, e.g., Brimo et al., 2021). A total of 197 schools were represented in the sample. Most participants (91.5%) attended schools in the Perth metropolitan area.

2.2 | Measures

2.2.1 | Dyslexia

At the point of recruitment caregivers reported whether their child had a confirmed diagnosis of dyslexia, or not. In Australia, diagnosis is undertaken according to the Diagnostic and Statistical Manual for Mental Disorders (DSM-5) which stipulates that children must be: (a) school-aged, (b) achieving substantially below same-aged peers on standardised literacy tests despite having had at least 6 months of targeted and explicit literacy intervention and (c) not have another condition or adversity that can better explain the reading difficulties (APA; 2013). Furthermore, as part of the assessment all children completed the Test of Word Reading Efficiency-Second edition (TOWRE-2; Torgesen et al., 2012). The TOWRE-2 consists of two sub-tests, the test of Sight Word Reading Efficiency (SWE) which measures children's ability to read and pronounce printed words and the test of Phonemic Decoding Efficiency (PDE) which measures children's ability to sound out irregular printed words. For both tests, children are asked to read aloud as many words as possible in 45 s and are scored based on the number of words correctly read. Raw scores are standardised according to age-based norms to produce a Total Word Reading Efficiency score per child. Sub-test and total scores between 90 and 110 are regarded as average. The TOWRE-2 is widely used for clinical and research purposes as a diagnostic screener for dyslexia. Importantly, the TOWRE-2 has been validated for online assessment in samples of Australian school children (Hodges et al., 2019).

Child anxiety and depression were measured by both child and caregiver report with the 15-item anxiety sub-scale and the 10-item depression sub-scale of the 25-item Revised Child Anxiety and Depression Scale (RCADS-Short version and RCADS-25-Parent Version; Ebesutani et al., 2017, 2012). Respondents are asked to rate how often each statement applies to themselves or their child (e.g., item from child anxiety sub-scale 'I worry about things') using a 4-point Likert scale (0 = never, 1 = sometimes, 2 = often, and 3 = always) with higher scores indicating higher levels of anxiety or depression. The various versions of the RCAD have demonstrated sound psychometric properties in community and clinical samples of children and adolescents (see, e.g., Becker et al., 2017; Lisøy et al., 2022; Piqueras et al., 2017). In our sample, reliability of the sub-scales ranged from $\alpha = 0.82$ (depression-parent report) to $\alpha = 0.85$ (anxiety-child report).

Child externalising symptoms were measured by both child and caregiver report with the 5-item (e.g., 'I am often accused of lying or cheating') conduct problems sub-scale of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). Respondents are asked to respond based on how things have been 'over the last six months' on a 3-point Likert scale, 'not true', 'somewhat true' and 'certainly true'. Higher total scores represent higher levels of conduct problems. The SDQ is a widely used measure of children's psychosocial well-being which has been applied in prior research with samples of children with language difficulties (see, e.g., Kilpatrick et al., 2019) and reading difficulties (see, e.g., Boyes et al., 2017). The self-report version of the SDQ is validated for children aged 11–17 years (Goodman, 1997). Reliability in our sample was $\alpha = 0.61$ for child report and $\alpha = 0.73$ for caregiver report.

Teacher, school-based peers, friend and school-connectedness were measured by the relevant sub-scales of the child and caregiver versions of the Hemingway Measure of Adolescent Connectedness (HMAC; Adolescent version 5.5; Karcher, 2011). The HMAC purports to assess a child's ability to satisfy their need for connection with both people (e.g., teachers) and places (e.g., school). All sub-scales of the HMAC have items which tap children's involvement and caring within that relationship/context. Both versions contain sub-scales to measure connectedness to: teachers (e.g., item 'I care what my teachers think of me'); school-based peers (e.g., item 'I like working with my classmates'; hereafter referred to as 'peers'); and, school as a whole (e.g., item 'I feel good about myself when I am at school'). The child, but not caregiver, version of the HMAC has a sub-scale to measure connectedness to friends (e.g., item 'I have friends I'm really close to and trust completely') but does not refer to friendships specifically in the school context. Respondents answer how true each item is of them/their child on a 5-point Likert scale, from 1 = not at all true to 5 = very true. Higher sub-scale scores indicate higher levels of connectedness in that domain/context. The HMAC has demonstrated sound psychometric properties in cross-cultural populations of adolescents (Karcher & Sass, 2010; Sass et al., 2011), and is one of the few tools that measures the various aspects of school-connectedness independently (García-Moya et al., 2019). Reliability for the sub-scales in this sample ranged from $\alpha = 0.76$ (peers-child report) to $\alpha = 0.87$ (peers-caregiver report).

2.3 | Procedure

Data were collected between May 2021 and January 2023 by a team of trained research assistants including the first and fourth author. All assessments during 2021 took place in-person but from 2022 onwards, participants could opt for an in-person or online assessment to provide more options for participation and to adhere to coronavirus guidelines. There were no school shutdowns during our data collection period, however, children were required to remain home when they were infectious. Written caregiver and child consent was required before commencing the assessment. The child assessment took approximately one hour (and included administering the TOWRE) and the caregiver assessment took approximately 20–40 min. Research assistants remained with the children to read the survey (if needed), answer questions and/or monitor for signs of distress. Children were told they could take a break or stop the assessment if desired. Furthermore, as per the ethical approval guidelines, when clinical levels of emotional difficulties were reported by either caregiver or child then a registered psychologist on the team contacted the caregiver to discuss avenues for support. Child participants received a $15 gift voucher to thank them for their participation.

2.4 | Analysis strategy

All preliminary analyses were conducted via SPSS v. 28 (IBM Corp., 2021). After a missing values analysis was conducted, descriptive statistics and bivariate correlations between variables of interest were calculated (see Table 1). This was followed by two tests (one for child report and one for caregiver report) of direct and indirect effects using JASP v. 0.17.1.0 (JASP team, 2023). In each test, child anxiety, child depression and child conduct problems were entered simultaneously as outcome variables; dyslexia (*0* = no dyslexia, *1* = dyslexia) was entered as the predictor

TABLE 1 Descriptive statistics disaggregated by group (dyslexia and no-dyslexia) and correlations by child (C) and caregiver (CG) report on variables of interest.

		Mean (SD)	Mean (SD)																
Variable		Dyslexia	No-dyslexia	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Dyslexia[a]	-	-	-	0.30‡	0.07	−0.06‡	0.28‡	0.13*	0.13*	0.02	0.10	0.11	0.11	0.38‡	0.01	−0.08	0.10	0.16†	−0.01
2	Other neurodevelopmental conditions[a]	-	-		-	0.12*	−0.29‡	0.20‡	0.13*	0.13*	−0.06	0.11	0.18†	0.19‡	0.31‡	−0.10	0.12*	0.19‡	0.30‡	0.17†
3	Gender[a]					-	−0.08	0.21‡	0.23‡	−0.06	0.17†	0.17†	−0.05	0.21‡	0.26‡	0.23‡	0.01	0.21‡	−0.02	0.07
4	Word reading (TOWRE)	81.27 (11.53)	102.81 (13.53)				-	0.37‡	0.15†	0.17†	0.10	−0.20‡	−0.19‡	−0.18†	0.47‡	0.11	0.14*	−0.18†	−0.16†	−0.01
5	School-connectedness (C)	19.78 (4.00)	22.37 (4.09)‡					-	0.61‡	0.55‡	0.32‡	0.40‡	0.52‡	0.50‡	0.62‡	0.37‡	0.27‡	0.23‡	0.33‡	0.28‡
6	Teacher connectedness (C)	22.41 (4.49)	23.62 (4.21)*						-	0.42‡	0.31‡	−0.11	0.26‡	0.45‡	0.33‡	0.39‡	0.15*	−0.07	0.14*	0.23‡
7	Peer connectedness (C)	20.86 (4.57)	22.03 (4.12)*							-	0.52‡	0.36‡	0.44‡	0.38‡	0.28‡	0.09	0.44‡	0.23‡	0.31‡	0.23‡
8	Friend connectedness (C)	24.30 (4.18)	24.14 (4.78)								-	0.13*	0.18†	0.22‡	0.15*	0.09	0.24‡	−0.11	0.14*	0.13*
9	Anxiety (C)	12.28 (7.49)	10.76 (6.41)									-	0.73‡	0.34‡	0.25‡	0.13*	0.29‡	0.43‡	0.30‡	0.18†
10	Depression (C)	8.51 (4.83)	7.39 (4.48)										-	0.47‡	0.32‡	0.21‡	0.32‡	0.33‡	0.43‡	0.27‡
11	Conduct problems (C)	2.23 (1.83)	1.82 (1.64)											-	0.39‡	0.36‡	0.23‡	0.17†	0.26‡	0.43‡
12	School-connectedness (CG)	19.70 (4.20)	23.41 (4.27)‡				0.47								-	0.51‡	0.49‡	0.32‡	0.49‡	0.38‡
13	Teacher connectedness (CG)	25.33 (3.78)	25.25 (3.84)				0.11									-	0.30‡	−0.05	0.17†	0.29‡
14	Peer connectedness (CG)	19.17 (3.86)	19.83 (3.54)				0.14										-	0.49‡	0.53‡	0.42‡
15	Anxiety (CG)	7.85 (5.76)	6.79 (4.55)				−0.18†											-	0.33‡	0.31‡
16	Depression (CG)	6.15 (3.98)	4.77 (3.97)†				−0.19												-	0.50‡
17	Conduct problems (CG)	1.66 (1.77)	1.67 (1.85)				−0.01													-

Note: (C) = child report (CG) = caregiver report.

[a]Point-biserial correlations; independent samples *t*-tests used to assess the significance of mean group differences.

*$p \leq 0.05$; †$p \leq 0.01$; ‡$p \leq 0.001$.

variable, gender and other neurodevelopmental conditions were entered as covariates and the relevant connectedness variables were added simultaneously as mediators. Friend-connectedness was only added to the child test as caregivers did not report on children's friendships. A bootstrapping procedure (5000 resamples) produced coefficients and bias-corrected confidence intervals for all direct and indirect effects. JASP computes confidence intervals using the bias-corrected percentile method suggested by Biesanz et al. (2010). Significance of direct and indirect effects was indicated if bias-corrected 95% confidence intervals did not overlap zero.

3 | RESULTS

3.1 | Preliminary analysis

Little's MCAR test indicated that data was not missing completely at random (X^2 (5413) = 5876.47, $p < 0.001$). However, given the low level of missing data across variables (≤1.4% on any item), missing values were imputed using expectation maximisation (Tabachnick & Fidell, 2013). Descriptive statistics and correlations between variables of interest are reported in Table 1. Correlations were generally in the expected direction.

In contrast to expectations, dyslexia did not correlate with any of the child-reported mental health outcomes. However, there was a significant correlation between dyslexia and symptoms of depression according to caregivers. Dyslexia was also negatively correlated with school, teacher and peer (but not friend) connectedness according to children, and school (but not teacher or peer) connectedness according to caregivers. Furthermore, there were negative correlations between many of the connectedness and mental health concerns among children with and without dyslexia. No correlations were strong enough to suggest multicollinearity. However, gender as well as having any other neurodevelopmental conditions (e.g., ADHD) correlated with mental health outcomes, as expected, were therefore controlled in the tests of direct and indirect effects. In our sample, boys reported significantly higher levels of conduct problems ($M = 2.35$, SD = 1.81) than girls ($M = 1.60$, SD = 1.54, $p < 0.001$), whereas girls had significantly higher levels of anxiety by both child and caregiver report ($M = 12.30$, SD = 7.49; $M = 8.10$, SD = 5.52, respectively) than boys ($M = 10.06$, SD = 5.71 $p = 0.005$; $M = 6.02$, SD = 4.02, $p < 0.001$ respectively).

3.2 | Word reading

In our sample, the mean TOWRE score for children with dyslexia ($n = 87$, $M = 81.27$, SD = 11.53) was below the average range (90–110), and significantly lower than that of children without dyslexia ($M = 102.81$, SD = 13.53, $p < 0.001$, $d = 12.9$).

3.3 | Test of direct and indirect effects: Child report

After controlling for gender and children having a neurodevelopmental condition other than dyslexia, there were no significant direct effects of dyslexia on anxiety, depression or conduct problems reported by children. Further, there were no significant indirect effects of dyslexia on anxiety, depression or conduct problems operating via teacher, peer or friend connectedness. However, there were significant indirect effects of dyslexia on all mental health outcomes operating via school-connectedness (see Figure 1): anxiety ($\beta = 0.11$, 95% CI = [0.06, 0.19], $p < 0.001$), depression ($\beta = 0.12$, 95% CI [0.06, 0.20], $p < 0.001$) and conduct problems ($\beta = 0.07$, 95% CI [0.03, 0.13], $p = 0.004$).

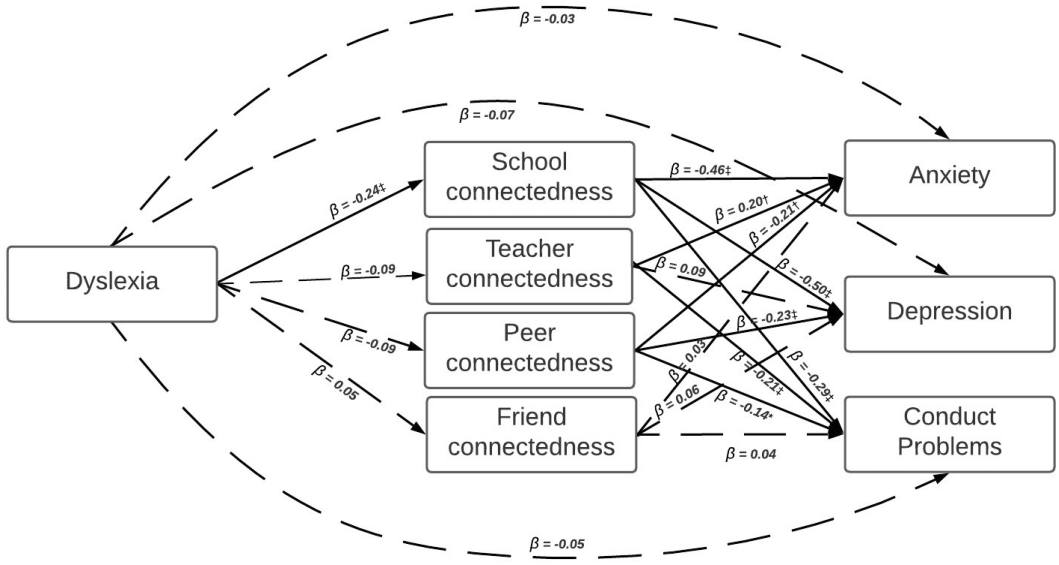

FIGURE 1 Direct and indirect effects: child report. *$p \leq 0.05$; †$p \leq 0.01$; ‡$p \leq 0.001$; dotted line = non-significant effect; solid line = significant effect; effect sizes = $\beta = 0.1$–0.29, small; $\beta = 0.3$–0.49, medium; $\beta \geq 0.5$, large.

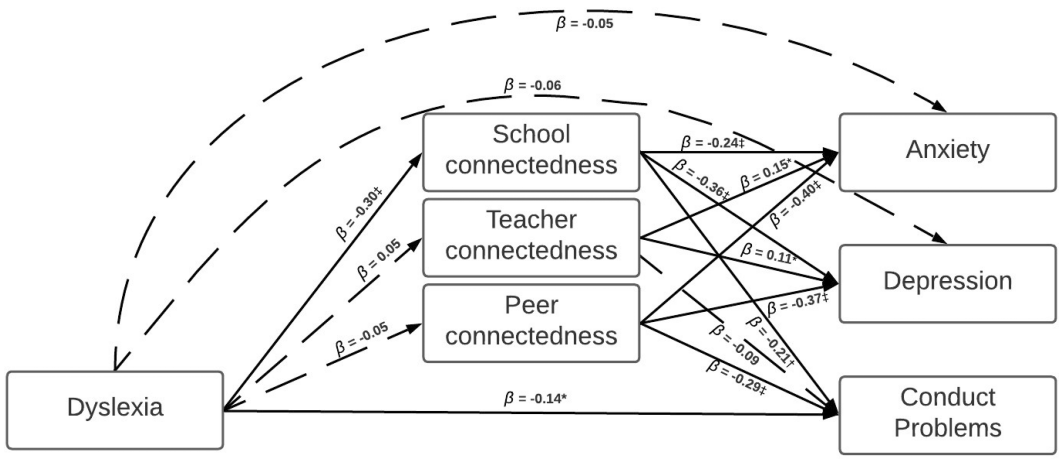

FIGURE 2 Direct and indirect effects: caregiver report. *$p \leq 0.05$; †$p \leq 0.01$; ‡$p \leq 0.001$; dotted line = non-significant effect; solid line = significant effect; effect sizes, $\beta = 0.1$–0.29, small; $\beta = 0.3$–0.49, medium; $\beta \geq 0.5$, large.

3.4 | Test of direct and indirect effects: Caregiver report

After controlling for gender and children having other neurodevelopmental conditions, there were no significant direct effects of dyslexia on anxiety or depression nor were there any significant indirect effects operating via teacher or peer connectedness on anxiety, depression or conduct problems. However, dyslexia had a significant direct negative effect on conduct problems ($\beta = -0.14$, 95% CI [−0.28, −0.01], $p = 0.018$) by caregiver report and a significant indirect effect via school-connectedness (see Figure 2) on anxiety ($\beta = 0.07$, 95% CI [0.03, 0.13],

$p = 0.004$), depression ($\beta = 0.11$, 95% CI [0.06, 0.18], $p < 0.001$) and conduct problems ($\beta = 0.06$, 95% CI [0.01, 0.14], $p = 0.014$).

We ran the analysis with reading scores, rather than dyslexia, as the predictor variable. The pattern of effects between reading and anxiety, depression and conduct problems was broadly similar (see Figure S.1 and S.2). However, we encourage future researchers to replicate these findings.

4 | DISCUSSION

Children with dyslexia are at elevated risk of internalising (e.g., anxiety) and externalising (e.g., conduct problems) mental health concerns; the reasons *why* are largely unknown (Boyes et al., 2016). The aim of the current study was to explore school-connectedness as a mechanism underlying links between dyslexia and mental health concerns. Based on previous literature, and informed by a neurodiversity perspective, we expected both direct and indirect links (via low levels of peer, teacher and whole school-connectedness) between dyslexia and anxiety, depression and conduct problems from the perspectives of children and their caregivers. Our investigation of friend-connectedness was explorative and so no a priori predictions were made. We took a neurodiversity lens to our analysis which considered mental health in terms of a balance of strengths and challenges, development of a positive dyslexic identity and the 'fit' of school for children with dyslexia.

After controlling for gender and children having other neurodevelopmental conditions, there were no direct effects of dyslexia on internalising symptoms or child reported conduct problems nor were there any dyslexia-related differences in teacher, peer or friend connectedness. Furthermore, contrary to expectations, caregivers of children with dyslexia reported fewer, rather than more, conduct problems. However, as predicted, dyslexia was associated with symptoms of anxiety, depression and conduct problems via poor connectedness to school as a whole, by both child and caregiver report. These findings contrast with research which finds a direct link between dyslexia and internalising symptoms (see, e.g., Maughan et al., 2003), but are in keeping with those reporting mental health concerns as a *secondary consequence* of reading difficulties and/or the school struggles that often co-occur (Jordan & Dyer, 2017; McArthur et al., 2022; Morgan et al., 2008; Wilmot, Pizzey, et al., 2023a). Struggles such as poor academic performance (Singer, 2007), elevated school stress (Undheim et al., 2008; Xiao et al., 2022) and poor academic self-concept (belief about oneself as a learner; McArthur et al., 2020) are highlighted in the literature. Indeed, Australian children with dyslexia, and their parents, describe a poor match between the school curriculum and their strengths and challenges (Wilmot, Pizzey, et al., 2023a) and may feel stigmatised in a culture that 'privileges perceived ability' (p. 331; Leitão et al., 2017).

The unexpected inverse effect of dyslexia on caregiver reported conduct problems suggests that externalising behaviour in dyslexia may be accounted for by overlaps with other aspects of neurodevelopment. This interpretation is consistent with Maughan and Carroll's (2006) conclusion that attentional difficulties may mediate the association between reading difficulties and conduct problems. An alternative explanation, given that over 90% of our caregivers were mothers, is that this result may reflect strong mother–child bonds and cooperative relationships forged in the context of dyslexia (see, e.g., Leitão et al., 2017; Singer, 2007; Wilmot, Pizzey, et al., 2023b). When interviewed, mothers contextualise children's externalising behaviour as an emotional release of the stress and frustration that builds through the school day (Wilmot, Pizzey, et al., 2023a; Wilmot, Pizzey, et al., 2023b), consistent with a neurodiversity perspective.

Our findings regarding school-based relationships are also unexpected given previous literature implicating peer problems (see, e.g., Boyes et al., 2019) and poor student–teacher relationships (Alexander-Passe, 2008; Chiappedi & Baschenis, 2016), in the mental health of children with dyslexia. This finding may signpost an improvement in dyslexia awareness amongst teachers and students and/or highlight interpersonal strengths among some children with dyslexia. It is worth noting that much previous research in the dyslexia field has assessed children's peer relationships from parent/teacher perspectives using measures such as the Strengths and Difficulties Questionnaire, which

conflate children's experiences with friends and school-based peers within their total scores (see, e.g., Jordan & Dyer, 2017; Nathan & Rucklidge, 2011). We would encourage future research to further explore the social strengths *and* challenges of children with dyslexia across school and non-school contexts from multiple (i.e., child, parent, teacher) perspectives. This would inform the design of peer relationship components of future and current mental health interventions for children with dyslexia.

Whilst differentiating friend and peer connectedness is a strength of the Hemingway Measure of Adolescent Connectedness (HMAC) used in this study, it is also important to note the measure's limitations. Specifically, the HMAC does not assess children's perceptions of social support within their relationships. We therefore encourage future researchers to assess the role of friend, peer and teacher support/understanding (rather than connectedness) on the association between dyslexia and mental health. There is burgeoning evidence that emotional support from these sources may be particularly salient for the mental health of children with learning challenges including dyslexia (Al-Yagon, 2016; Chiappedi & Baschenis, 2016; Wilmot, Pizzey, et al., 2023a), perhaps because parents are not available during the school day to support children with school struggles.

A strength of our study was the inclusion of both child and caregiver perspectives and multiple aspects of school-connectedness and mental health. Much previous research in the field has investigated mental health using global measures of psychosocial functioning such as the Strengths and Difficulties Questionnaire, which conflate externalising, internalising and social difficulties within their total scores (see, e.g., Kopelman-Rubin et al., 2020). In contrast, our analysis was able to examine the differential effects of subdomains of school-connectedness on anxiety, depression and conduct problems independently. As such, we found that children reported greater effects of poor school-connectedness on internalising symptoms (medium to large effect sizes) than caregivers (small to medium effect sizes), and that school-connectedness had a greater effect on internalising (small to large effect sizes) than externalising symptoms (small effect sizes) by both child and caregiver report (Nieminen, 2022). Furthermore, we were able to demonstrate that it is connection at the whole school level specifically that is implicated in the mental health of children with dyslexia. From a neurodiversity perspective, this is consistent with the notion of school as a poor 'fit' for children with dyslexia.

Future research is needed to investigate the reasons *why* children with dyslexia are at elevated risk for poor school-connectedness at the whole school level. From a neurodiversity perspective, poor school-connectedness may occur when approaches to learning highlight children's challenges and minimise their strengths (Wilmot, Pizzey, et al., 2023a). Interviews with educators reveal that they are aware of the importance of recognising the strengths of children with dyslexia to support their self-esteem (Claessen et al., 2020). However, the balance between targeting children's difficulties and supporting strengths (i.e., capacity building) may not be optimal (Rappolt-Schlichtmann et al., 2018; Wilmot, Pizzey, et al., 2023a). Furthermore, whole school approaches which focus on supporting inclusivity, in addition to neurodiversity-affirming teacher practices, may be needed to address school-connectedness (see, e.g., Carrington et al., 2021; Shochet et al., 2022). Future research to promote school-connectedness in collaboration with school communities is needed, so that all children including those with dyslexia can feel supported and successful at school. We are aware of projects which aim to promote school-connectedness among students with autism by working at multiple levels (i.e., child, parent, whole school; see, e.g., Hodges et al., 2022; Shochet et al., 2022). We are also aware of a strengths-based programme which aims to develop the self-understanding and self-advocacy skills of children with developmental language disorder to empower them to negotiate accommodations to their learning (Sowerbutts & Finer, 2020). These programmes may be suited to (or be adapted to suit) children with developmental dyslexia.

In terms of limitations of our study, it is important to consider the relatively low internal reliability we gleaned from the child-report conduct problems scale. Furthermore, being cross-sectional by design, we were unable to make conclusions regarding the direction of effects between school-connectedness and mental health. Our analysis cannot rule out reverse causation. Additionally, we assessed only one type of reading difficulty, developmental dyslexia. There is burgeoning evidence that different subtypes of reading difficulty may be differentially associated with mental health concerns (see, e.g., Francis et al., 2022). Future research which replicates our findings among children with

different types of reading difficulty and/or when reading difficulties have not yet been formally identified would prove fruitful. Importantly, we would encourage longitudinal research to clarify the direction of effects and fluctuations between children's school-connectedness and mental health over time. This is needed to build theory regarding causal mechanisms for mental health in developmental dyslexia and elucidate the most efficacious timing and focus of dyslexia-specific mental health interventions. Despite these limitations, our research identified poor school-connectedness as a factor to be considered when designing mental health intervention for children with dyslexia and highlighted children's interpersonal strengths (e.g., friend-connectedness) which could be leveraged in mental health support.

5 | CONCLUSION

Our findings suggest that children with dyslexia may be at elevated risk for poor school-connectedness even when school-based relationships are sound. Poor school-connectedness, rather than dyslexia per se, was associated with children's internalising/externalising symptoms. From a neurodiversity perspective, this finding implies a poor 'fit' between the child with dyslexia and their school environment especially in terms of recognising their strengths and supporting the development of a positive dyslexic identity. Our findings extend previous research regarding links between children's school struggles and mental health (see, e.g., Benassi et al., 2022) and that which highlights school-connectedness as a protective factor for parent and child well-being in the context of developmental dyslexia (Wilmot, Pizzey, et al., 2023a; Wilmot, Pizzey, et al., 2023b). Our findings underscore the need to complement individualised mental health support with whole school initiatives designed to promote the school-connectedness of all children, including those with dyslexia and other neurodevelopmental differences.

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CONFLICT OF INTEREST STATEMENT

Mark Boyes is a member of the *Dyslexia* Editorial Board. Suze Leitão is a Board member with the Dyslexia SPELD Foundation. None of the other authors declare any conflict of interests.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

Curtin University Human Research Ethics Committee (HREC) has approved this study (HRE2020-0168) and the Department of Education Western Australia.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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