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Learning outcomes in primary school children with emotional problems: a prospective cohort study

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Background: Academic difficulties are common in adolescents with mental health problems. Although earlier childhood emotional problems, characterised by heightened anxiety and depressive symptoms are common forerunners to adolescent mental health problems, the degree to which mental health problems in childhood may contribute independently to academic difficulties has been little explored. **Methods:** Data were drawn from a prospective cohort study of students in Melbourne, Australia ($N = 1239$). Data were linked with a standardised national assessment of academic performance at baseline (9 years) and wave three (11 years). Depressive and anxiety symptoms were assessed at baseline and wave two (10 years). Regression analyses estimated the association between emotional problems (9 and/or 10 years) and academic performance at 11 years, adjusting for baseline academic performance, sex, age and socioeconomic status, and hyperactivity/inattention symptoms. **Results:** Students with depressive symptoms at 9 years of age had lost nearly 4 months of numeracy learning two years later after controlling for baseline academic performance and confounders. Results were similar for anxiety symptoms. Regardless of when depressive symptoms occurred there were consistent associations with poorer numeracy performance at 11 years. The association of depressive symptoms with reading performance was weaker than for numeracy if they were present at wave two. Persistent anxiety symptoms across two waves led to nearly a 4 month loss of numeracy learning at 11 years, but the difference was not meaningful for reading. Findings were similar when including hyperactivity/inattention symptoms. **Conclusions:** Childhood anxiety and depression are not only forerunners of later mental health problems but predict academic achievement. Partnerships between education and health systems have the potential to not only improve childhood emotional problems but also improve learning.

Key practitioner message

- Mental health problems, particularly behavioural problems, in adolescents are associated with poor academic performance. Yet little is known about the extent to which childhood emotional problems contribute to academic performance.
- This population study found that children with depressive and anxiety symptoms had poorer academic performance, particularly in numeracy.
- These findings provide a strong rationale for mental health practitioners to work with their education partners to support students with emotional problems that emerge during primary school.

Keywords: Academic performance; anxiety; CATS study; depression; emotional problems

Introduction

In recent years, rates of child and adolescent mental health problems seem to be increasing (Twenge, Cooper, Joiner, Duffy, & Binau, 2019), and the COVID-19 pandemic appears to have led to a further increase (Ma et al., 2021). These problems often persist into adult life (Mulraney et al., 2021; Rutter, Kim-Cohen, & Maughan, 2006), with consequences across multiple domains, including economic, peer and family relationships, and additional mental and physical health problems (Fergusson & Woodward, 2002; Morales-Muñoz, Palmer, Marwaha, Mallikarjun, & Upthegrove, 2021). Such adverse life outcomes are likely to arise from continuity of mental health problems into adulthood (Fergusson & Woodward, 2002), comorbidity with other disorders (Fombonne, Wostear, Cooper, Harrington, & Rutter, 2001), and effects on social role transitions including successful completion of education (Dupéré et al., 2018; Riglin, Petrides, Frederickson, & Rice, 2014).

Indeed, academic failure is a clear antecedent of later adult social, emotional, and physical health problems (Winkleby, Jatulis, Frank, & Fortmann, 1992).

Educational policies to promote school engagement and improve academic performance have focused on pedagogy and resourcing for schools, but connections between health and school achievement are attracting policymakers' interest (Michael, Merlo, Basch, Wentzel, & Wechsler, 2015). There is growing recognition that a student's emotional style affects school engagement and learning (Agnafors, Barmark, & Sydsjö, 2021; Deighton et al., 2018; Fergusson & Woodward, 2002; Mundy et al., 2017; Zins, Bloodworth, Weissberg, & Walberg, 2007). Consistent associations have been demonstrated between behavioural problems and learning (Hinshaw, 1992). In particular, children with attention deficit hyperactivity disorder have poorer educational outcomes than their peers (Hinshaw, 1992). There is also evidence of links between broader psychopathology and learning (Riglin et al., 2014).

In contrast, childhood emotional problems have largely been overlooked in terms of their effects on learning (Riglin et al., 2014). Emotional problems might affect learning by reducing concentration, attention, and memory (Curcio, Ferrara, & De Gennaro, 2006; Maddox & Prinz, 2003). Emotional problems commonly affect engagement with school and learning, with a loss of connection predicting learning loss and educational failure (Bond et al., 2007). Equally, poor academic achievement diminishes self-confidence, in turn triggering emotional problems (Hinshaw, 1992). If emotional problems are related to later academic outcomes, then they are a potential target for interventions aimed at improving academic performance.

Research on the association between mental health problems and academic performance has produced inconclusive and sometimes contradictory findings (Ansary, McMahon, & Luthar, 2012; Kremer, Flower, Huang, & Vaughn, 2016; Riglin et al., 2014). For example, a study of adolescents from low- and high-income families found that amongst adolescents from low-income backgrounds, emotional problems, and substance use were associated with poor academic performance (Ansary et al., 2012). However, for adolescents with an affluent background, only social anxiety was related with poor performance (Ansary et al., 2012). Further, most research has not controlled for comorbidity of behavioural problems, such as attention-deficit/hyperactivity disorder, as a potential confounder (e.g., Hinshaw, 1992; Mundy et al., 2017).

Previous studies have also been limited in their measures of learning. They have largely relied on subjective measures (brief teacher reports, student self-report) of academic performance rather than objective measures (national achievement tests; Brière, Janosz, Fallu, & Morizot, 2015; Kantomaa, Tammelin, Demakakos, Ebeling, & Taanila, 2010; Riglin, Frederickson, Shelton, & Rice, 2013; van der Ende, Verhulst, & Tiemeier, 2016). When objective measures have been used, data loss has often been extensive with poor linkage rates (e.g., Downs et al., 2019; Murphy et al., 2015; Rothon et al., 2009). A meta-analysis highlighted that most studies have failed to control for prior academic performance (Riglin et al., 2014). Furthermore, many existing studies focus on global measures of academic performance rather than examining performance across individual domains such as literacy and numeracy (e.g., Riglin et al., 2013; Rothon et al., 2009). The existing literature typically focuses on adolescence, well after many mental health and learning problems have already begun, and many studies include participants spanning wide age ranges (e.g., Fergusson & Woodward, 2002; Kantomaa et al., 2010; Rothon et al., 2009). There is, therefore, a need for population cohort studies starting earlier in life with a prospective design.

This article examines whether emotional problems (symptoms of depression and anxiety) at 9 and 10 years predict academic performance at 11 years (measured using a standardised national test), independently of baseline academic performance. We hypothesise that there will be a meaningful relationship between emotional problems and later academic performance. The design addresses many limitations of existing studies by controlling for baseline academic performance and comorbid behavioural symptoms, as well as focusing on a limited age-range of participants in mid-primary school, using an objective measure of academic performance and examining individual domains of academic performance.

Methods

Study population and design

This study uses data from the first three waves of the Childhood to Adolescence Transition Study (CATS; Mundy et al., 2013). All grade three children from a stratified random sample of 43 primary schools in Melbourne, Australia were invited to participate. Of the 2289 invited children, 1239 (54%) were recruited through active, informed parent consent. Wave one occurred in 2012 (grade three; 9 years), wave two in 2013 (grade four; 10 years) and wave three in 2014 (grade five; 11 years). Retention was high; 1190 students participated in wave two (96.0%) and 1201 in wave three (96.9%).

The sample contained a slightly smaller proportion of males than females (46% males; 54% females) compared with census data for 8–9 year old enrolled in grade three across Victoria, Australia (51% males; 49% females; Australian Bureau of Statistics, 2013). The sample scored slightly higher on a measure of socioeconomic status (SES; Australian Bureau of Statistics Socio-Economic Index for Areas, SEIFA) compared with the Australian population (M (SD)) = 1012 (67) vs. 1000 (100).

Procedure

Research assistants visited schools to conduct the assessment. Ethics approval was granted by the Royal Children's Hospital Human Research Ethics Committee (#31089).

Measures

Academic performance. National Assessment Programme – Literacy and Numeracy (NAPLAN) test was included at waves one (age 9) and three (age 11). This article focuses on reading and numeracy as they are important drivers of future economic productivity (Geiger, Goos, & Forgasz, 2015; Piacentini & Pacileo, 2019). The reading test measures literacy proficiency and focuses on the reading of written English (ACARA, 2022b). The numeracy tests assess the proficiency strands of understanding, fluency, problem-solving and reasoning across three content strands of mathematics: number and algebra; measurement and geometry and statistics and probability (ACARA, 2022a). Students were graded on each domain out of 1000, with one year of learning equating to 40 NAPLAN points, allowing estimates of months/years of learning lost (Australian Curriculum Assessment and Reporting Authority, 2012). NAPLAN data were sourced from the Victorian Curriculum and

Assessment Authority for children whose parents provided optional consent for data linkage (93% of sample).

Emotional problems. At waves one and two depressive symptoms were measured using two items adapted from the Short Mood and Feelings Questionnaire (SMFQ; 'I felt miserable and unhappy', 'I didn't enjoy anything at all'), which have validity as markers of depressive symptoms in similar age population-based samples and reduced respondent burden in this young sample (Angold, Costello, Pickles, Winder, & Silver, 1995; Rhew et al., 2010). The time frame was 'in the past 2 weeks'. Items were scored on a 5-point Likert scale (0 = never to 4 = almost always) and were recoded to a 3-point scale (0 = not true; 1 = sometimes true; 2 = true) to match original SMFQ scoring. The total score was dichotomised to define the presence of depressive symptoms using a cut-point of 2 or more (a child scoring ≥2 answered at least 'sometimes true' on both items; Rhew et al., 2010).

At waves one and two, anxiety symptoms were measured using two items selected by expert-opinion from the Spence Children's Anxiety Scale (SCAS; 'I worry about things', 'I feel afraid') to reduce respondent burden (Reardon, Spence, Hesse, Shakir, & Creswell, 2018; Spence, Barrett, & Turner, 2003). The time frame was 'in the past 2 weeks'. These items used a 5-point Likert scale (0 = never to 4 = almost always), and were recoded to a 4-point scale (0 = never to 3 = always) to match the original scoring. The total score was dichotomised to define anxiety symptoms using a cut-point of 3 or more (a child scoring ≥3 answered at least 'often' on at least one of the two items).

Summary measures of depressive and anxiety were derived to indicate symptoms at wave one only (resolved), wave two only (incident), both waves (persistent), or at neither waves (none).

Confounders. In addition to adjusting for baseline academic performance, we controlled for the following potentially confounding variables: child's age, sex and family SES. SES was calculated from home postcode using the SEIFA Index of Relative Socio-economic Advantage and Disadvantage (IRSAD). SEIFA values were used as categories determined by the quintiles of the distribution in the Australian population.

In additional analyses, we controlled for hyperactivity/inattention symptoms by parent-report on the Strengths and Difficulties Questionnaire (SDQ) at 9 years (Goodman, 2001). This questionnaire has five items for hyperactivity/inattention rated on a 3-point scale. The total score ranges from 0 to 10, with higher scores indicating greater hyperactivity/inattention.

Auxiliary variables. Additional variables were included in the multiple imputation model to handle missing data. These auxiliary variables were selected as they had moderate/high correlation with those to be imputed. Teachers provided an overall rating of children's abilities in English and mathematics on items adapted from the Longitudinal Study of Australian Children. Teachers were asked to provide a rating of the child's ability in these areas compared with other children of the same grade level on a 5-point scale ranging from 'far below average' to 'far above average'. Hyperactivity/inattention symptoms by parent-report on the SDQ at wave two were included.

Data analysis

Analyses were implemented using Stata 15.0 (Stata Corp, College Station, TX). Descriptive statistics were calculated for child sex, age and SES. Continuous measures were summarised using means and standard deviations and categorical variables using percentages.

The dataset consisted of n = 1239 participant records, of which 33.2% had missing data on at least one of the analysis variables. Missing data were handled using multiple imputation by chained equations, which consisted of imputing the incomplete dataset to produce multiple (in this case 50) completed versions of the dataset (Royston & White, 2011). Linear regression was used to impute the continuous variables, logistic regression to impute the binary variables and ordinal logistic regression to impute the ordinal variables. Further details can be found in the Supporting Information. Estimates were obtained by averaging results across the 50 imputed datasets using Rubin's rules (Rubin, 1987).

Prevalence of depression and anxiety were estimated to describe the patterns of emotional problems. To investigate the effect of symptoms of emotional problems on NAPLAN scores, the following analyses were conducted.

Primary analyses. Linear regression fit using generalised estimating equations was used to account for clustering by school to estimate the association between each emotional problem and each NAPLAN domain, using separate models. Unadjusted estimates were obtained using models including only emotional problem as predictor in the regression. Partially adjusted estimates were obtained by additionally including child sex, child age at wave one, SES and relevant NAPLAN domain score at wave one as predictors in the regression. Fully adjusted estimates additionally included SDQ hyperactivity/inattention in the regression.

Secondary analyses. All analyses were repeated on the complete case data as well as using the longitudinal profiles of depressive and anxiety symptoms as exposures.

Results

Study characteristics

Table 1 summarises the demographic characteristics of the 1239 children recruited into the study at wave one. Some data were missing in all variables except child sex, age and SES (see Supporting Information).

Prevalence and patterns of emotional problems

In wave one, an estimated 28.6% of children reported depressive symptoms (95% CI: 26.0 to 31.2) and 15.6% anxiety symptoms (95% CI: 13.5 to 17.8). In wave two, this fell to 17.8% for depressive symptoms (95% CI: 15.6 to 20.1) and 13.6% for anxiety symptoms (95% CI: 11.6 to 15.6). For depressive symptoms, this translated to an estimated 8.4% persistent (95% CI: 6.8 to 10.1), 20.2% resolved (95% CI: 17.8 to 22.6) and 9.4% incident (95% CI: 7.7 to 11.1). For anxiety symptoms, the rates were 5.6% persistent (95% CI: 4.2 to 7.0), 10.0% resolved (95% CI: 8.3 to 11.8) and 8.0% incident (95% CI: 6.4 to 9.6).

Emotional problems and academic performance

Table 2 shows the adjusted estimates of the association between emotional problem symptoms (at wave one) and

Table 1. Demographic characteristics of the n = 1239 children

Measure[a]	*n*	Statistic
Children's characteristic		
Male (%)	572	46.2
Female (%)	667	53.8
Age in years (*M* (*SD*))	—	9.0 (0.4)
Socioeconomic status (SEIFA), %		
1st quintile (most disadvantaged)	167	13.5
2nd quintile	109	8.8
3rd quintile	194	15.7
4th quintile	346	27.9
5th quintile (most advantaged)	423	34.1

SEIFA, Socio-Economic Index for Areas.
[a]Measured at wave one.

Table 2. Effect (mean difference) of symptoms of emotional problems at wave one on NAPLAN scores at wave 3 amongst $n = 1239$ primary school children[a]

	Depressive symptoms			Anxiety symptoms		
	Absent ($n = 885$)[b]	Present ($n = 354$)[b]		Absent ($n = 1046$)[b]	Present ($n = 193$)[b]	
NAPLAN domain	Mean score (95% CI)	Mean score (95% CI)	Mean difference (95% CI)	Mean score (95% CI)	Mean score (95% CI)	Mean difference (95% CI)
Numeracy						
Unadjusted	504.9 (497.0 to 512.9)	476.4 (468.3 to 484.5)	−28.5 (−38.2 to −18.9)	500.2 (492.6 to 507.7)	476.4 (465.6 to 487.2)	−23.8 (−35.6 to −11.9)
Partially adjusted[c]	504.5 (499.8 to 509.3)	492.1 (485.6 to 498.5)	−12.5 (−19.4 to −5.5)	502.6 (498.1 to 507.1)	492.0 (484.2 to 499.9)	−10.6 (−18.7 to −2.5)
Fully adjusted[d]	504.8 (500.0 to 509.6)	492.2 (485.8 to 498.5)	−12.6 (−19.5 to −5.7)	502.6 (498.1 to 507.1)	493.3 (485.5 to 501.1)	−9.3 (−17.2 to −1.4)
Reading						
Unadjusted	518.3 (509.8 to 526.8)	498.3 (487.4 to 509.1)	−20.0 (−30.2 to −9.8)	513.9 (505.2 to 522.5)	503.7 (489.7 to 517.7)	−10.2 (−24.2 to 3.8)
Partially adjusted[c]	516.6 (511.5 to 521.7)	515.4 (507.3 to 523.4)	−1.2 (−9.6 to 7.1)	516.6 (511.9 to 521.4)	514.3 (504.1 to 524.5)	−2.3 (−12.2 to 7.5)
Fully adjusted[d]	517.0 (511.9 to 522.1)	515.6 (507.6 to 523.5)	−1.4 (−9.7 to 6.8)	516.7 (511.9 to 521.4)	516.1 (506.1 to 526.1)	−0.6 (−10.2 to 9.1)

95% CI, 95% confidence interval; NAPLAN, National Assessment Program – Literacy and Numeracy; SDQ, Strengths and Difficulties Questionnaire; SEIFA, Socio-Economic Indexes for Areas.
[a]Multiple imputation was used for these analyses.
[b]Frequency estimates were calculated using imputed percentage estimates and total number of students ($N = 1239$).
[c]Adjusted for child sex, child age in years (at wave one), SEIFA Advantage/Disadvantage Index quintile (at wave one), and corresponding NAPLAN domain score at wave one.
[d]Adjusted for child sex, child age in years (at wave one), SEIFA Advantage/Disadvantage Index quintile (at wave one), corresponding NAPLAN domain score at wave one, and SDQ hyperactivity subscale score (at wave one).

NAPLAN numeracy and reading performance at wave three. Evidence emerged that children with depressive symptoms in wave one scored lower on the numeracy NAPLAN domain in wave three compared with children without depressive symptoms (partially adjusted mean difference in NAPLAN score: $\beta = -12.5$; 95% CI: −19.4 to −5.5 (a delay of nearly 4 months, given one year of learning equates to approximately 40 NAPLAN points)). A similar difference was found for anxiety (partially adjusted $\beta = -10.6$; 95% CI: −18.7 to −2.5 (a delay of nearly 3 months)). No evidence of an association between children's depressive or anxiety symptoms and reading NAPLAN scores emerged (partially adjusted $\beta = -1.2$ (95% CI: −9.6 to 7.1), $\beta = -2.3$ (95% CI: −12.2 to 7.5), respectively). Additional adjustment by SDQ hyperactivity in the models led to similar results. Findings were similar when models were fitted with data from complete cases (results available upon request). Results for participants with both depressive and anxiety symptoms are presented and summarised in the Supporting Information.

Tables 3 and 4 show progressively adjusted estimates of the association between longitudinal profiles of depression and anxiety, respectively, over waves one and two, and NAPLAN numeracy and reading scores at wave three. Regardless of when depressive symptoms occurred there were consistent associations with poorer numeracy performance at wave three (Table 3). There was some evidence that depressive symptoms were associated with reading performance if they were present at wave two, especially when incident (partially adjusted $\beta = -16.0$ (95% CI: −27.4 to −4.7) a delay of nearly 5 months; Table 3).

There was some evidence that persistent, but not single-episode, anxiety symptoms were associated with poorer numeracy at wave three (Table 4 partially adjusted $\beta = -12.4$ (95% CI: −24.0 to −0.7; a delay of nearly 4 months)), although this relationship was weakened when adjusted by SDQ hyperactivity ($\beta = -11.0$ (95% CI: −22.6 to 0.7; a delay of over 3 months)). There was little evidence of an association between the longitudinal profile of anxiety symptoms and reading performance at wave three (Table 4). Findings were similar in fully adjusted models and when models were fitted with data from complete cases (results available upon request).

Discussion

Mid-primary school emerges from these findings as an important point for intervention not only in the prevention of mental health problems but also preventing learning loss. Students with emotional problems at 9 years of age had poorer numeracy at 11 years after controlling for baseline academic performance. In grade five (11 years), these students were nearly 30 NAPLAN points behind their peers (three-quarters of a year's learning). When adjusting for key confounders including learning at baseline, students were over 10 NAPLAN points further behind their peers in numeracy in grade five (equating to a quarter of a year's learning). Regardless of when depressive symptoms occurred (age 9 or 10 years) there were consistent associations with poorer numeracy at 11 years. Depressive symptoms were meaningfully associated with poor reading if they were

Table 3. Effect (mean difference) of combined wave one/wave two depressive symptoms on NAPLAN scores at wave three amongst primary school children ($n = 1239$)[a]

	None ($n = 769$)[b]	Resolved ($n = 250$)[b]		Incident ($n = 116$)[b]		Persistent ($n = 104$)[b]	
NAPLAN domain	Mean score (95% CI)	Mean score (95% CI)	Mean difference (95% CI)	Mean score (95% CI)	Mean difference (95% CI)	Mean score (95% CI)	Mean difference (95% CI)
Numeracy							
Unadjusted	509.0 (500.8 to 517.1)	478.7 (469.4 to 488.0)	−30.3 (−41.6 to −19.0)	480.8 (465.7 to 495.8)	−28.2 (−43.7 to −12.7)	471.6 (457.7 to 485.4)	−37.4 (−51.2 to −23.6)
Partially adjusted[c]	506.7 (501.6 to 511.7)	491.7 (484.5 to 499.0)	−14.9 (−22.8 to −7.0)	490.9 (481.7 to 500.0)	−15.8 (−25.8 to −5.8)	492.6 (481.4 to 503.7)	−14.1 (−25.6 to −2.7)
Fully adjusted[d]	506.7 (501.6 to 511.9)	491.5 (484.3 to 498.7)	−15.2 (−23.1 to −7.4)	492.2 (483.2 to 501.2)	−14.6 (−24.5 to −4.7)	493.5 (482.6 to 504.4)	−13.2 (−24.4 to −2.1)
Reading							
Unadjusted	522.8 (514.0 to 531.7)	500.7 (487.2 to 514.2)	−22.2 (−36.0 to −8.4)	491.2 (476.3 to 506.1)	−31.6 (−47.3 to −15.9)	493.3 (477.1 to 509.5)	−29.5 (−44.4 to −14.6)
Partially adjusted[c]	518.8 (513.6 to 524.1)	516.9 (506.9 to 527.0)	−1.9 (−12.6 to 8.8)	502.8 (491.6 to 514.0)	−16.0 (−27.4 to −4.7)	511.4 (500.5 to 522.3)	−7.5 (−18.5 to 3.6)
Fully adjusted[d]	519.0 (513.8 to 524.2)	516.7 (506.7 to 526.7)	−2.3 (−13.0 to 8.3)	504.4 (493.5 to 515.4)	−14.6 (−25.7 to −3.5)	512.7 (501.7 to 523.7)	−6.3 (−17.3 to 4.7)

95% CI, 95% confidence interval; NAPLAN, National Assessment Program – Literacy and Numeracy; SDQ, Strengths and Difficulties Questionnaire; SEIFA, Socio-Economic Indexes for Areas.
[a]Multiple imputation was used for these analyses.
[b]Frequency estimates were calculated using imputed percentage estimates and total number of students ($N = 1239$).
[c]Adjusted for child sex, child age in years (at wave one), SEIFA Advantage/Disadvantage Index quintile (at wave one), and corresponding NAPLAN domain score at wave one.
[d]Adjusted for child sex, child age in years (at wave one), SEIFA Advantage/Disadvantage Index quintile (at wave one), corresponding NAPLAN domain score at wave one, and SDQ hyperactivity subscale score (at wave one).

Table 4. Effect (mean difference) of combined wave one/wave two anxiety symptoms on NAPLAN scores at wave three amongst primary school children ($n = 1239$)[a]

	None ($n = 947$)[b]	Resolved ($n = 124$)[b]		Incident ($n = 99$)[b]		Persistent ($n = 69$)[b]	
NAPLAN domain	Mean score (95% CI)	Mean score (95% CI)	Mean difference (95% CI)	Mean score (95% CI)	Mean difference (95% CI)	Mean score (95% CI)	Mean difference (95% CI)
Numeracy							
Unadjusted	500.6 (493.6 to 507.6)	481.5 (467.8 to 495.1)	−19.2 (−32.7 to −5.7)	496.8 (481.5 to 512.1)	−3.8 (−19.2 to 11.6)	467.7 (450.3 to 485.0)	−32.9 (−50.2 to −15.7)
Partially adjusted[c]	501.9 (497.4 to 506.4)	493.4 (483.5 to 503.3)	−8.5 (−18.3 to 1.2)	508.6 (497.0 to 520.2)	6.7 (−4.5 to 17.8)	489.6 (478.3 to 500.9)	−12.4 (−24.0 to −0.7)
Fully adjusted[d]	501.9 (497.5 to 506.4)	494.6 (484.7 to 504.6)	−7.3 (−17.1 to 2.4)	508.4 (496.9 to 519.9)	6.4 (−4.6 to 17.5)	491.0 (479.6 to 502.4)	−11.0 (−22.6 to 0.7)
Reading							
Unadjusted	514.8 (506.6 to 522.9)	507.1 (491.0 to 523.2)	−7.7 (−23.4 to 8.0)	506.6 (488.5 to 524.7)	−8.2 (−25.9 to 9.6)	497.9 (477.2 to 518.5)	−16.9 (−37.1 to 3.3)
Partially adjusted[c]	516.2 (511.4 to 521.1)	516.2 (503.8 to 528.7)	0.02 (−12.6 to 12.6)	520.4 (509.7 to 531.0)	4.2 (−6.2 to 14.6)	510.8 (496.3 to 525.3)	−5.4 (−19.0 to 8.2)
Fully adjusted[d]	516.3 (511.5 to 521.1)	517.9 (505.7 to 530.1)	1.6 (−10.7 to 13.9)	520.1 (509.6 to 530.6)	3.8 (−6.5 to 14.1)	512.9 (498.1 to 527.7)	−3.4 (−17.1 to 10.3)

95% CI, 95% confidence interval; NAPLAN, National Assessment Program – Literacy and Numeracy; SDQ, Strengths and Difficulties Questionnaire; SEIFA, Socio-Economic Indexes for Areas.
[a]Multiple imputation was used for these analyses.
[b]Frequency estimates were calculated using imputed percentage estimates and total number of students ($N = 1239$).
[c]Adjusted for child sex, child age in years (at wave one), SEIFA Advantage/Disadvantage Index quintile (at wave one), and corresponding NAPLAN domain score at wave one.
[d]Adjusted for child sex, child age in years (at wave one), SEIFA Advantage/Disadvantage Index quintile (at wave one), corresponding NAPLAN domain score at wave one, and SDQ hyperactivity subscale score (at wave one).

present at 10 years, especially if they were incident. In our study, there was some evidence that persistent anxiety was meaningfully associated with poorer numeracy at 11 years. There was a negligible association between the longitudinal profile of anxiety symptoms and reading at 11 years. These findings were robust to adjustment for hyperactivity/inattention symptoms.

We have found that mid-childhood emotional problems predict later academic performance in numeracy, which supports findings from the socioemotional learning (SEL) literature of the importance of social and emotional development for academic success (Panayiotou, Humphrey, & Wigelsworth, 2019; Zins et al., 2007). It is important to note, however, that we cannot rule out underlying factors, such as child temperament, life adversity or parent mental health problems, which might explain the association between children's emotional problems and poor academic performance (Trzesniewski, Moffitt, Caspi, Taylor, & Maughan, 2006). For example, a child growing up in a home where violence or neglect occur is likely to experience both mental health problems and difficulty with learning (Eckenrode, Laird, & Doris, 1993). Our analyses included adjustment for one index of socioeconomic disadvantage, but the possibility of residual confounding cannot be excluded. It is also possible that students with poorer cognitive skills are more likely to report emotional problems, although this seems unlikely given our adjustment for baseline academic performance (Buelow et al., 2003).

There are various ways emotional problems might contribute to poor academic performance including through indirect effects on concentration, poor sleep quality, attention and school engagement (Curcio et al., 2006; Dewald, Meijer, Oort, Kerkhof, & Bögels, 2010; Maddox & Prinz, 2003). Children with emotional problems also more commonly report persistent pain and are more likely to miss school than their peers (Campo, Jansen-McWilliams, Comer, & Kelleher, 1999; Finning, Ford, Moore, & Ukoumunne, 2020). Absence from school could be a mechanism for the association between emotional problems and academic performance. Few previous studies have explored specific domains of academic performance, possibly explaining some inconsistency in findings to date (e.g., see Riglin et al., 2014). In the current analysis, the association with emotional problems was clearer for numeracy than reading, with a weaker link between incident depressive symptoms and reading. A key feature of depression is an inability to concentrate and there is some evidence from cognitive neuroscience that suggests stronger links between early attention and mathematical skills compared with early attention and reading skills (Blair & Razza, 2007).

Strengths of this study include the use of a nationally standardised assessment of education outcomes in contrast with previous studies that have typically relied on subjective measures of academic performance (Brière et al., 2015; Kantomaa et al., 2010; Riglin et al., 2013; van der Ende et al., 2016). Where more objective measures were used, data loss was extensive through poor data linkage rates (Downs et al., 2019; Murphy et al., 2015; Rothon et al., 2009). Our study included control for baseline academic performance and hyperactivity/inattention symptoms, which have not been adjusted for in most previous studies (Hinshaw, 1992; Mundy et al., 2017; Riglin et al., 2014; Trzesniewski et al., 2006). Students self-reported on depressive and anxiety symptoms separately, which is another strength of the current study (Riglin et al., 2014). Finally, prior literature has focused on adolescence when school difficulties and mental health problems are often well established, and many studies spanned wide age range (Fergusson & Woodward, 2002; Kantomaa et al., 2010; Rothon et al., 2009). Hence the pressing need for our population cohort study starting earlier in life with a truly prospective design.

However, the following limitations should be noted. We were not able to adjust for all potential confounders such as child temperament and family adversity. Active written consent by parents was required to engage participants in the CATS study. Parents of 54% of eligible children consented, raising the possibility of selection bias. Even so, the sample was close to the Australian population mean on SES and NAPLAN scores at baseline. Also, we used a two-item screener to assess depressive and anxiety symptoms with the possibility of measurement error. However, the creation of the 'never' and 'persistent' groups across two waves helps to increase the possibility of capturing presence/absence of emotional problems over this period. The two-item anxiety measure does not capture trait and state anxiety separately and thus we were not able to control for trait anxiety separately. Finally, we have not been able to include all variables which may impact academic performance in late childhood, such as relationships with teachers and school engagement, but including adjustment for prior academic performance allows us to disentangle the direction of the relationship between emotional problems and academic performance.

These findings provide evidence of the links between mental health and academic success, in terms of cognitive outcomes. This provides support for education systems to consider SEL as a way of both promoting educational outcomes and reducing the likelihood of mental health problems (Panayiotou et al., 2019). In turn, these findings provide an evidence for mental health practitioners to work with their education partners to identify childhood with emotional problems and support the emotional wellbeing of students. Future research should examine the extent to which SEL might be useful in promoting better cognitive outcomes, even in the absence of mental health problems (Zins et al., 2007). Positive Action is an example of a universally delivered SEL program for use in primary schools, which aims to improve mental health and school engagement (Bavarian et al., 2013). Partnerships across health and education systems will be essential in responding to the emotional needs of students. Recognition of shared goals and continuing to build the evidence-base for the links between health and education, as well as identifying the ways in which schools themselves affect mental health, will be imperative for establishing and maintaining health promoting activities in schools (Herlitz, MacIntyre, Osborn, & Bonell, 2020).

Conclusions

Emotional problems in mid-primary school were associated with poorer academic performance, particularly in numeracy. This finding was independent of

socioeconomic status, prior academic performance and attention/hyperactivity symptoms. Thus, our results indicate that it is not just behavioural problems (such as Attention-Deficit/Hyperactivity Disorder) that lead to poorer academic performance. From both health and education perspectives, these findings provide a strong rationale to focus on emotional problems that emerge during primary school. Combined with early interventions for mental health difficulties, this approach has the potential to improve longer-term outcomes of many children and adolescents.

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Ethical information

Ethics approval was granted by the Royal Children's Hospital Human Research Ethics Committee (#31089). Permission was granted from the Victorian Department of Education and Training and Catholic Education Melbourne.

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Supporting information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Supplementary Material
Table S1. Details of MI for analyses in the main text.
Table S2. Details of MI for the sensitivity analyses.
Table S3. Effect (mean difference) of symptoms of emotional problems at wave one on NAPLAN scores at wave three amongst $n = 1239$ primary school children*

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