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Gender stereotypes in the family

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Abstract
We study whether and why parents have gender-stereotyped beliefs when they assess their child's skills. Exploiting systematic differences in parental beliefs about a child's skills and blindly graded standardized test scores, we find that parents overestimate boys' skills more so than girls' in mathematics (a male-stereotyped subject), whereas there are no gender differences for reading. Consistent with an information friction hypothesis, we find that the parental gender bias disappears for parents who are interviewed after receiving information on their child's test scores. We further show that the parental gender bias in detriment of girls contributes to explain the widening of the gender gap in mathematical skills later in childhood, supporting the hypothesis that exposure to gender biases negatively influence girls' ability to achieve their full potential.

Key words: parental beliefs, gender bias, stereotypes, school performance, standardized scores
JEL codes: J13; D13; C23; C26

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1 Introduction

Gender stereotypes, such as the idea that boys are better than girls in mathematics, can be self-fulfilling prophecies. Exposure to gender stereotypes can negatively affect girls' self-confidence and aspirations, and ultimately explain the persistent gender gap in mathematics and the under-representation of women in math-intensive STEM fields[1] (Alan et al., 2018; Avitzour et al., 2020; Bertrand, 2020). Parents gender ideology can influence their children through recommendations, transmission of cultural traits, role modelling (Farré and Vella, 2013; Johnston et al., 2014) and investments (Doepke and Zilibotti, 2017). Assessing whether parents have gender-biased beliefs on their child's academic skills would help the design of effective policy tools to close the gender performance gap. Yet answering this question in real-world settings has remained elusive because of the lack of available datasets that combine parental beliefs on a child's skills with objective measures of a child's skills. In this paper we aim to close this gap by providing the first empirical evidence on whether and how parental beliefs about a child's skills depends on a child's gender.

To investigate whether parents perceive their child's skills differently depending on their child's gender, we use survey data on parent's self-reported beliefs about their child's skills from the Longitudinal Study of Australian Children and linked administrative records on children's performance in national standardized tests (NAPLAN, the National Assessment Program – Literacy and Numeracy) at age 8-9. Our empirical strategy relies on the fact that parental beliefs are not blind to gender considerations, whereas written standardized tests, consisting in close-ended questions, are blind and they can provide a counterfactual measure of a child's cognitive ability that is theoretically free of gender biases. We derive an estimate of parents' gender bias by computing the difference between boys and girls of the difference between their blind and non-blind assessments in the spirit of Lavy (2008), Breda and Ly (2015), Lavy and Sand (2018) and Terrier (2020). This difference-in-difference approach allows us to account for observed and unobserved factors associated to children's skills, including gender differences in innate and genetic predispositions. An important threat to identification comes from the fact that there can be gender differences in the performance of children in formal examination. If, for example, girls' performance is more negatively affected by lack of self-confidence than boys', then their standardized test scores would underestimate their true skills. To address this issue, we also estimate a triple difference specification that looks at the differential parental gender bias for mathematics relatively to reading (similar to approach adopted by Breda and Ly, 2015). Assuming gender differences in exams' performance are the same across subjects, this differential gender bias eliminates

[1]STEM fields are Science, Technology, Engineering and Mathematics fields.

any distortion caused by gender differences in performance and it reflects gender bias against (or in favour of) girls in mathematics.

Our results show that parents overrate their children's skills relative to actual test scores regardless of a child's gender (as found in recent studies, e.g. Dizon-Ross, 2019; Bergman, 2021, and Kinsler and Pavan, 2021). However, the magnitude of the parental over-estimation differs for boys and girls and across subjects. In particular, we find evidence of a parental gender bias in favour of boys in mathematics, a subject considered to be stereotypically "male". On the contrary, we do not observe a parental gender bias for reading skills. Our triple difference specification confirms a significantly higher parental premium for boys over girls in mathematics relative to reading of 15.7% of a standard deviation. These findings are consistent with the predictions of the social cognition approach in economics (e.g. Bordalo et al., 2016; Bordalo et al., 2019). In absence of perfect information, parents form their beliefs using cognitive heuristics relying on their stereotypes. While based on a kernel of truth, stereotypes tend to exaggerate true gender differences in skills or traits that are presumed to mostly differentiate the gender, such as mathematics (Eyal and Epley, 2017; Bertrand, 2020).

We provide evidence that lack of information results in parents using cognitive shortcuts based on stereotypes when assessing their children's skills. To do so we estimate the causal effect of an unexpected information shock generated by the exogenous nature of the release date of standardised test results to parents. In particular, we leverage linked survey and administrative data and use exogenous variation in the time when parents are interviewed with respect to the time when they receive information about a child's national standardized test-scores.[2]

Our results show that providing parents with ready and digestible information on their child's skills eliminates the gender bias in favour of boys in mathematics. We also document that parents continue to assign a premium to their child's skills in both reading and mathematics, even after new information on their child's skills is revealed. A comparison of parental beliefs with teachers' beliefs reveals that, unlike parents', teachers' beliefs are not systematically overestimating a child's skills. This result suggests that the observed parental premium of a child's skills can result from parents obtaining an intrinsic utility from maintaining positive beliefs about their child's skills (what the economics literature has termed "motivated

[2] A similar strategy is used by Greaves et al. (2021) to evaluate the effect of information about school quality on parental decisions on time investments in children and by Cobb-Clark et al. (2021) to evaluate the effect of information on standardised test performance on parental beliefs and investment decisions.

beliefs", see Bénabou and Tirole, 2002 and Bénabou and Tirole, 2016).

We show that the widening of the gender gap in mathematics during childhood that has been recently documented in the literature[3] can be in part explained by parental gender bias. To do so, we estimate the effect of parental gender bias in grade 3 (ages 8-9) on standardized test scores in grade 5 (ages 10-11) by adopting a value-added model which we estimate using a fixed effect estimation that exploits variation between subjects for a given child (see e.g. Del Boca et al., 2017 and Nicoletti and Rabe, 2018). Our empirical strategy allows us to relax the restrictive assumptions imposed by valued-added models, i.e. models where a child's skills are regressed on the lagged skills and current inputs (see Todd and Wolpin, 2003, for a definition of these restrictions). By using a within-child between-subject estimation, we are able to control for any unobserved past and current inputs and characteristics that are invariant across subjects. We find that an increase by 1 standard deviation in the parental premium when a child is in grade 3 leads to a statistically significant increase in the test scores in grade 5 by about 10% of a standard deviation. This translates into a widening of the gender gap in mathematics by an amount which is equivalent to girls lagging behind boys by over half a month of learning.

We contribute first and foremost to the recent literature in economics that highlights the role of stereotypes in explaining gender differences later in life (Guryan and Charles, 2013; Bertrand, 2020). Traditionally these studies have focused on teachers' blind versus open evaluations to analyse the impact of gender stereotypes on students' outcomes.[4] However, real-world evidence on parental gender bias is scant. A recent lab-in-the-field experiment looks at the role of parental stereotypes on children's choice of gender-stereotypical subjects (Carlana and Corno, 2021). This study shows that children tend to choose subjects that fit best with their gender based on stereotypical views when induced to think about the recommendation of same-gender parents. Here we provide the first evidence of a gender bias in parents' perception of their child's skills in a real-world setting. We also go a step further and test the effectiveness of remedial interventions, consisting in providing parents with information, to explore the origin of the documented parental bias.

This paper also adds to the literature on the role of information frictions on the beliefs formation process (Bernheim et al., 2019). Focusing on parents, Cunha (2015) discusses the

[3]See Ellison and Swanson (2010), Fryer and Levitt (2010), Bharadwaj et al. (2016), Contini et al. (2017), Borgonovi et al. (2021) and Borra et al. (2021).

[4]See Lavy (2008); Van Ewijk (2011); Hanna and Linden (2012); Burgess and Greaves (2013); Botelho et al. (2015); Breda and Ly (2015); Lavy and Sand (2018); Lavy and Megalokonomou (2019); Terrier (2020) among others.

concept of "subjective rationality model" of parenting, explaining that while parents are rational agents, namely they have a clear objective that they want to optimize, they often lack the information they need and rely on personal assessments in order to make choices. Empirical evidence based on behavioural interventions confirms that parents are not fully-informed agents and their investments change as a result of increasing their information set on the efficacy of their investments or on their children's skills and effort at school (Boneva and Rauh, 2018; Dizon-Ross, 2019; York et al., 2019; Barrera-Osorio et al., 2020; Bergman, 2021; Bergman and Chan, 2021). In this study, we show that lack of information does not only cause parents to have inaccurate beliefs and make inefficient investments, but it can also be linked to the formation of gender-stereotyped biases.

The rest of the paper is organised as follows. Section 2 provides details on the institutional context. Section 3 presents the data. Section 4 documents the existence of gender differences in parental beliefs and in Section 5 we test the hypothesis that such bias is driven by information frictions. Section 6 assesses the effect of gender differences in parent's overestimation on children's skills and its implications for the widening of the math gender gap in childhood. We conclude in Section 7.

2 Institutional Context

The main responsibility for school education in Australia falls on the six states and two internal territorial governments. School is compulsory for children by the time they turn six. Most children start when they are between four-and-a-half and five-and-a-half years, and attend primary school until they are 11 or 12 years of age. Additionally, most primary schools offer programs from kindergarten (foundation) to Years 6 or 7.

Since 2008, Australian students enrolled in Years 3, 5, 7 and 9 take part in the National Assessment Program - Literacy And Numeracy (NAPLAN), a series of non high-stakes standardized tests in reading, writing, language (spelling, grammar and punctuation) and mathematics (numeracy) that generally take place on the second week of May each year. The NAPLAN tests are considered an important tool to measure students' progress and help schools, the government and parents to understand and improve students' outcomes. NAPLAN tests are conducted at schools and administered by classroom teachers, school deputies or principals. Each state and territory is responsible for marking the tests in accordance with strict guidelines and processes.

NAPLAN tests in reading and mathematics are written assessments. For the reading assessment, a child is asked to read a text and answer some close-ended questions. For mathematics, a child is asked to solve a set of numeracy problems by answering close-ended questions.[5] Questions are blindly marked by independent markers who are required to complete mandatory training developed in conjunction with the Australian Curriculum, Assessment and Reporting Authority. Test difficulty and scales are made consistent across school years and subjects, allowing results to be comparable across cohorts, successive years and learning subjects.[6]

As depicted in Figure A1, a preliminary summary report including information at national level and by state or territory on NAPLAN results for grade and subject is published by the Australian Department of Education and Training in August. Parents receive an individual student report between August and September. The information enclosed in the student report is identical for all students across the country and consists on their performance level and relative performance compared to the national average in each subject (see Figures B3 and B4 in Appendix B for an example of report).

3 Data

We link the Longitudinal Study of Australian Children (LSAC) to administrative records on children's performance in standardized tests (NAPLAN). The LSAC is an ongoing biannual survey which collects information on two nationally representative samples of Australian children aged 0-1 (B cohort) and 4-5 (K cohort) in the first wave of the study in 2004 (Soloff et al., 2005 and Gray and Smart, 2009). Table A3 describe the sample structure by age of the child, year of the interview and school grade.

In the majority of cases, the parent who answers the main questionnaire is the mother. For the purpose of this study, we focus on parents whose children are enrolled in grade 3, i.e. they are 8-9 years old. This is because, as explained in Section 2, children sit for standardised tests for the first time in grade 3, and therefore, it is also the first time that parents receive information on their child's performance in these tests.

From the original sample of children who took part in the study, we firstly removed those who did not sit for NAPLAN tests in grade 3 (5% of the sample), because they were withdrawn from the NAPLAN testing program by their parent/carer (0.3%), exempted (1%) or did not attend school on the days of the tests. Among those with a valid NAPLAN score, the majority (80%) took the grade 3 tests in 2008 and grade 5 tests in 2010 (2012 and 2014 for

[5] Examples of these open-ended questions are reported in Figures B1 and B2 in Appendix B

[6] A more detailed description of NAPLAN tests can be found at https://web.archive.org/web/20160713190329/http://www.nap.edu.au/naplan.

cohort B). Differences in the school year of enrollment (and therefore the calendar year when NAPLAN tests are taken) are due to (a) variation in school starting age regulations across States and Territories (Taylor and Fiorini, 2011), (b) parents' or preschool teachers' decision to delay starting school for children who are considered not ready (Hanly et al., 2019), and (c) children having to repeat the year (although this event is quite rare). After removing those observations with missing information on the key variables of interest, we are left with a sample of 2,916 children from cohorts B and K living in intact families and enrolled in Grade 3.

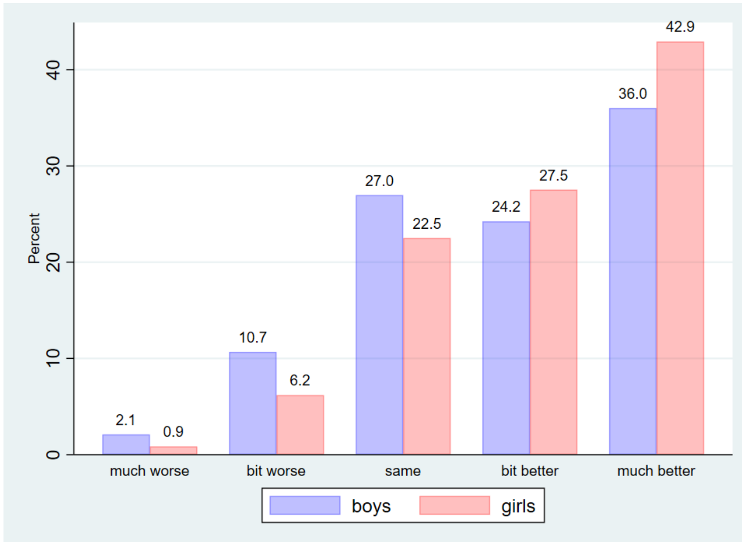
3.1 Parental Beliefs and Children's Skills

Parental beliefs about their child's reading and mathematics skills are measured using their answers to the following question: "Compared to other children in their class, how well do you think your (study) child is progressing in reading/mathematics?", which is asked separately for reading and mathematics. Parents can choose among a 5-point scale, ranging from much worse to much better. We re-scale this variable so that 0 corresponds to children who are as good as their classmates, according to parents. Positive values indicate that parents perceive a child's performance as better (1) or much better (2) than others', while negative values indicate that a child's performance is perceived as being worse (-1) or much worse (-2) than the performance of other children.

This parental beliefs variable measures how parents perceive their child's skills relative to the child's peers. In this context, a relative measure can be considered more appropriate than an absolute measure as previous studies found that parents are unable to correctly assess the absolute level of skills of their child, and instead, they have locally distorted beliefs that depends on the the skills of their child's peers (Kinsler and Pavan, 2021).

Figures 1 and 2 show that the majority of parents in our sample perceive their child's skills as better than those of other children in the same class, and this is true regardless of the child's gender and the subject (reading or mathematics). The measure of parental beliefs has a meaningful zero point, which indicates that a child's skills are as good as their classmates, and should be symmetric around zero if parents do not overestimate or underestimate their child's skills. Yet the distribution of parental beliefs is left-skewed. The proportion of parents who think their child's skills are "better" or "much better" than their peers is 60-70% (depending on the subject), whereas the proportion of parents who think that their child's performance is "worse" or "much worse" is 7-13%. This asymmetry in

Figure 1: **Parental beliefs about children's reading skills**



Notes: This figure shows the distribution of parental beliefs about their children's reading skills. Beliefs are measured using a 5-point scale answer to the following question: "Compared to other children in their class, how well do you think your (study) child is progressing in reading?". Sample includes parents who were interviewed before the release of the NAPLAN results, i.e. those interviewed before October and whose children are enrolled in grade 3.

Figure 2: **Parental beliefs about children's mathematics skills**

Notes: This figure shows the distribution of parental beliefs about their children's reading skills. Beliefs are measured using on a 5-point scale answer to the following question: "Compared to other children in their class, how well do you think your (study) child is progressing in mathematics?". Sample includes parents who were interviewed before the release of the NAPLAN results, i.e. those interviewed before October and whose children are enrolled in Grade 3.

parental beliefs is in line with evidence form other studies, which also find that parents tend to be over-confident when evaluating their children's skills (e.g. Kinsler and Pavan, 2021).

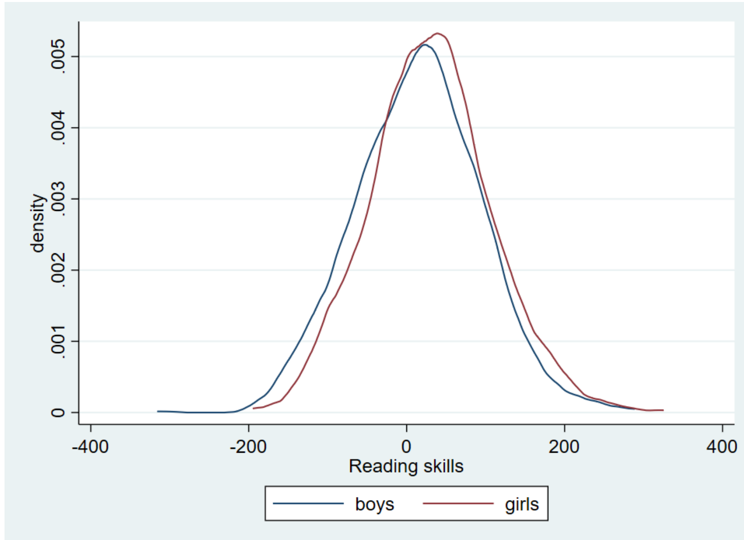
There are some striking differences when comparing parental beliefs about boys' and girls' skills, depending on the subject considered. 64.1% of parents think that boys are better than their peers in mathematics, whereas the figure is just 54.8% for girls. The reversal is true for reading skills, with parents being more likely to report better reading skills for girls than for boys. In particular, 70.4% of girls are considered better than other children, as opposed to 60.2% for boys. These gender differences are statistically significant.

We construct a measure of children's skills comparable to the parental beliefs measure by considering the difference between children's NAPLAN test scores in a given subject (reading or mathematics) and the average test score for all students enrolled in the same grade and school, who took the test in the same calendar year. We use school-level, rather than class-level data, due to lack of information about class composition. In Australia there are no systematic differences in class composition within school given that primary schools adopt the policy to form classes that are similar within schools, and balanced in terms of gender composition, children's skills, nationalities and cultures. When testing for differences in the average performance in math tests at school and class level using an alternative dataset, namely the TIMSS 2007 International Database (Olson et al., 2008), we find the variation in the average test score across classes is mainly explained by variation across schools (64%), hence the school average is a good proxy for the class average.

While our measures of parental beliefs and child's skills have different scales (the first being ordered, while the latter being continuous), this does not represent an issue for the interpretation of our results. First, both these measures are anchored to the average skills of the child's peers, i.e. they take value zero when a child's skills are equal to the skills of their school peers, while positive (negative) values are associated to children's skills that are better (worse) than the average skills. Furthermore, because we have standardized both measures to have variance 1, also the units of measurement are comparable, allowing us to use the difference between standardized beliefs and NAPLAN test scores as a measure of the potential distortions in parental beliefs.

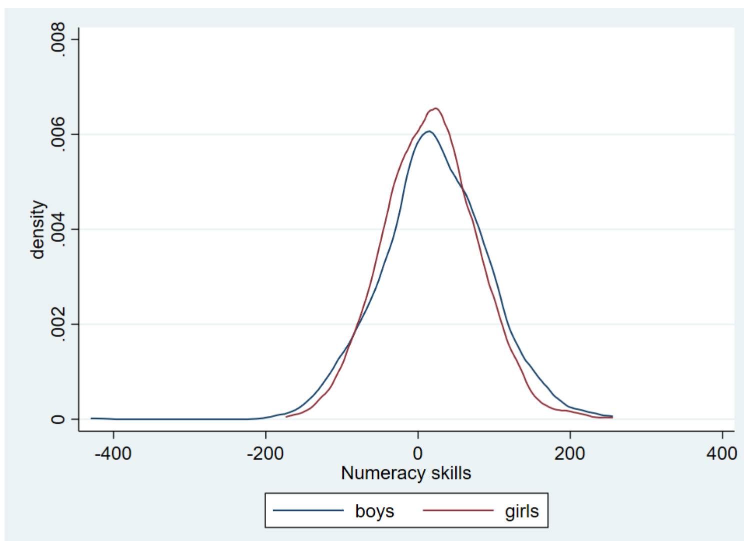
Figures 3 and 4 depict the distribution of of boys' and girls' reading and mathematics (relative) skills. In line with previous studies (e.g. Fryer and Levitt, 2010 and Breda and Napp, 2019), we find that girls outperform boys in reading, while the opposite is true for mathematics. However, girls' advantage in reading is larger than boys' advantage in mathematics. Indeed, girls outperform boys in reading by 18.1% of a standard deviation, as shown in Table A1. In contrast, boys outperform girls by 10.3% of a standard deviation. These observations suggest that girls have a comparative advantage in reading.

Figure 3: **Reading skills by child's gender**



Notes: This figure shows the distribution of children's reading skills, defined as the difference between individual NAPLAN scores and averages scores at school-year level in this subject. A positive (negative) value indicates that the child performs better (worse) than their school peers.

Figure 4: **Mathematics skills by child's gender**



Notes: This graph shows the distribution of children's mathematics skills, defined as the difference between individual NAPLAN scores and averages scores at school-year level in this subject. A positive (negative) value indicates that the child performs better (worse) than their school peers.

Taken together, this descriptive evidence shows that whereas parents over-estimate girls' reading scores and boys' math scores by a similar magnitude (Table A1), boys' advantage in mathematics over girls' is smaller than girls' advantage in reading over boys.

4 Parental Gender Bias

In order to identify whether parents' perception of their children's skills depends on their child's gender, we compare parents' beliefs, a non-blind assessment, which can be subject to gender biases, with a child's NAPLAN test scores, a blind assessment theoretically free of such gender bias.[7]

Following Lavy (2008), we allow these two types of assessment of a child i's skills in subject k to depend on a set of observed and unobserved characteristics (captured by an individual-by-subject fixed effect, $\tau_{i,k}$), on the gender of the child ($Girls_i$, taking value 1 for girls and zero for boys) and on the type of assessment ($\text{NB}_{i,k,b}$ taking value 1 for the non-blind parental assessment and 0 for the blind NAPLAN score):

$$\text{Assessment}_{i,k,b} = \lambda_0 + \lambda_1 \text{Girls}_i + \alpha_0^k \text{NB}_{i,k,b} + \alpha_1^k (\text{Girls}_i \cdot \text{NB}_{i,k,b}) + \tau_{i,k} + \omega_{i,k,b}, \quad (1)$$

The subscript for subject k is equal to 1 for reading and 2 for mathematics skills, while the subscript b takes value 1 for the non-blind assessment and 0 for the blind assessment. Parental beliefs and NAPLAN test scores are standardized to have variance 1. $\omega_{i,k,b}$ is an idiosyncratic error term and λ_0 is the intercept. λ_1 and α_0^k are parameters capturing the effect of the child's gender and the differences between parental beliefs and NAPLAN score respectively.

Our parameter of interest, α_1^k, measures the differential effect of the gender of the child on the non-blind assessment score with respect to the blind assessment, for subject k. Given that parents' beliefs can be affected by gender distortions, while NAPLAN test scores do not, α_1^k captures the *subject-specific gender bias* in parental beliefs. A coefficient of α_1^k equal to zero indicates that, on average, there is no gender bias in parental beliefs about their child's skills in subject k. A negative value of α_1^k indicates that parents tend to favor boys by "inflating" (overestimating) their skills more than for girls, while the opposite is true for positive values of α_1^k.

Equation 1 is equivalent to a difference in difference (DiD) estimation where the treatment is the child's gender, the control outcome is given by NAPLAN test score which is theoretically unaffected by gender biases, and the treatment outcome is the non-blind

[7]As explained in Section 2, these tests are written assessments, based on a set of close-ended questions. Therefore, it seems reasonable to assume that markers cannot identify students' gender. Breda and Napp (2019) provide evidence that it is difficult to guess correctly children's gender from their writing.

parental assessment, which is likely to be affected by such biases. The DiD can be implemented by adopting a child-by-subject fixed effect estimation of Equation 1 or, equivalently, by taking the difference between the non-blind and the blind assessments, $\text{Premium}_{i,k} = (\text{Assessment}_{i,k,1} - \text{Assessment}_{i,k,0})$, and estimating by ordinary least squares the following equation:

$$\text{Premium}_{i,k} = \alpha_0^k + \alpha_1^k \text{Girls}_i + \epsilon_{i,k}, \tag{2}$$

where $\text{Premium}_{i,k}$ measures the parental premium, i.e. how much parents' beliefs overestimate their child's skills relatively to the NAPLAN test scores, and $\epsilon_{i,k} = \omega_{i,k,1} - \omega_{i,k,0}$.

By controlling for $\tau_{i,k}$ and $\text{NB}_{i,k}$, the DiD estimation of α_1^k accounts for any unobservable and observable characteristics that differ between girls and boys, and for any distortion in the assessment measures, as long as the distortion is identical for boys and girls. For example, it accounts for the fact that NAPLAN tests overestimate students' skills if schools adopt a "teaching to the test" approach, focusing more on preparing students to pass the NAPLAN exams, rather than helping them to understand the subjects.

The DiD estimates would be inconsistent if there are factors whose effect on performance differs by gender. For example, NAPLAN test scores would overestimate boys' true skills if girls' performance in school exams is more negatively affected by lack of self-confidence than boys'. Alternatively, NAPLAN scores would underestimate boys' true skills if their performance in these tests is more negatively affected by attention and hyperactivity disorders than girls'. To address the possibility of inconsistent estimates, we compute the *differential gender bias for mathematics relatively to reading* (differential gender bias, hereafter), which is similar to the triple difference (DDD) approach adopted by Breda and Ly (2015). In practice, we consider the difference in the gender bias between mathematics and reading, $(\alpha_1^2 - \alpha_1^1)$.[8] Assuming gender differences in exam performance are the same across subjects, the DDD is theoretically free of any distortion. Furthermore, the DDD approach eliminates the co-founding effect of any variable that does not change across subjects, hence including subject-invariant controls in equation 2 does not alter the DDD estimation results.

The estimated parental gender bias and the differential parental gender bias in mathematics relatively to reading are reported in Table 1. The first two rows reveal a positive parental

[8]The DDD estimation is also equivalent to estimating the following equation, $\text{Premium}_{i,k} = \beta_0 + \beta_1 \text{Girls}_{i,k} + \beta_2 \text{Math}_{i,k} + \beta_3 \text{Girls}_{i,k} \cdot \text{Math}_{i,k} + \epsilon_{i,k}$, where $\text{Math}_{i,k}$ is a dummy variable taking value 1 for mathematics and 0 for reading, $\beta_0 = \alpha_0^1$, $\beta_1 = \alpha_1^1$, $\beta_0 + \beta_2 = \alpha_0^2$ and $\beta_1 + \beta_3 = \alpha_1^2$ so $\beta_3 = \alpha_1^2 - \alpha_1^1$.

premium in both subjects for boys and girls, indicating that parents tend to overestimate skills, regardless of the child gender and the subject. Large positive premiums in parental beliefs are consistent with recent papers showing that people overestimate their own skills and other people's skills (Moore and Healy, 2008), including their own children's (Dizon-Ross, 2019; Bergman, 2021 and Kinsler and Pavan, 2021). The difference between parental beliefs and test scores is large (50-60% of a standard deviation) and statistically significant at even 1% level. Given that a full year of education leads to about 30% of a standard deviation increase in test scores (Woessmann, 2016), our results suggest that parents overestimate the maturity of their child by almost two full school years.

Table 1: **Gender Bias in Parental Beliefs**

	Reading	Maths	Reading	Maths
Average premium for boys, α_0^k	0.584***	0.612***	0.635***	0.627***
	(0.027)	(0.028)	(0.159)	(0.158)
Average premium for girls, $(\alpha_0^k + \alpha_1^k)$	0.613***	0.484***	0.651***	0.476***
	(0.026)	(0.026)	(0.159)	(0.154)
Subject-specific gender bias (DiD), α_1^k	0.029	-0.128***	0.016	-0.151***
	(0.038)	(0.038)	(0.040)	(0.040)
Differential gender bias (DDD), $(\alpha_1^2 - \alpha_1^1)$	-0.157***		-0.157***	
	(0.044)		(0.044)	
No. Observations	2,576	2,576	2,415	2,415
Controls			✓	✓

Notes: The dependent variable measures the premium in parental beliefs, i.e. the gap between parental beliefs about their child's skills and the NAPLAN test scores, both measured in standard deviations. Results are obtained estimating Equation 2 by OLS, for reading and mathematics separately. The sample includes parents who have not yet received information regarding their child's NAPLAN scores. In Column (3) and (4) we control additionally for the set of parents' and child's characteristics listed in Table A2. Data Source: Grade 3, Cohorts K and B. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The results show also a gender bias in favour of boys in mathematics, but not in reading. Indeed, the average premium is not statistically different across genders in reading, whereas α_1^k is negative and equal to 12.8% of a standard deviation (15.1% when adding control variables) for mathematics. Using a DDD approach, we find a differential gender bias of -15.7% of a standard deviation, i.e. a higher parental premium for boys over girls in mathematics relative to reading. As explained above, the DDD estimation accounts for any observed and unobserved factors that affect differently the blind and non-blind assessments even if these factors have a different impact for boys and girls, therefore we can exclude that the differential gender bias is caused by gender differences in performance in formal assessments or parental misreporting.

Our results that parental beliefs are biased in favour of boys, particularly in mathematics, a subject considered to be stereotypically "male", seem to suggest that parents may rely on stereotypes when they assess their child's skills. The stereotype that boys are better in mathematics than girls is based on real gender differences in mathematics. When asked to evaluate their child's skills parents may adopt cognitive shortcuts that rely on such stereotype. This seems to lead parents to associate mathematical skills to boys much more frequently than to girls when forming their expectations and to an exaggeration of the true gender difference in mathematical skills (Bordalo et al., 2016; Eyal and Epley (2017); Bordalo et al., 2019; Bertrand, 2020).

5 Exploring the Origin of Parental Gender Bias: the Role of Imperfect Information

In this section we explore imperfect information as a potential reason for parents to use cognitive shortcuts that rely on gender stereotypes when assessing their child's skills. There exists extensive evidence showing that parents lack information on their children's school skills, and that when provided with new information on those skills they update their beliefs.[9] For example, Dizon-Ross (2019) and Barrera-Osorio et al. (2020) show in experimental settings that new information on children's reading and maths achievements helps closing the gap between parental beliefs and child skills. If the parental bias is the result of cognitive heuristics (based on stereotypes), providing parents with new information on their child's skills should reduce, even eliminate, such bias (Hilton and Fein, 1989; Reuben et al., 2014). If, instead, parents do not update their bias upon the arrival of new information, it may suggest that they either hold gender stereotypes or other beliefs which exist regardless of the information they have.[10]

[9] There is also a large literature in economics that looks at imperfect information and parental expectations about the return of parental investments (Attanasio, 2015; Fitzsimons et al., 2016; Boneva and Rauh, 2018; Attanasio et al., 2022; Biroli et al., 2020; Cunha et al., 2020) and school quality (Greaves et al., 2021). Other studies use behavioral tools to document that parents also have incomplete information on their offspring's school effort (Rogers and Feller, 2018; Bergman, 2021 and De Walque and Valente, 2023).

[10] One possibility is that parents may hold motivated beliefs (Bénabou and Tirole, 2002; Bénabou and Tirole, 2016). In particular, they may perceive that there is a cost in deviating from what gender role norms suggest is standard and acceptable behaviour (social desirability bias) and intentionally inflate the skills of boys in subjects which are male-dominated (Akerlof and Kranton, 2002 and

5.1 The Effect of New Information on Parental Gender Bias using a Quasi-Experimental Design

In order to explore the impact of information frictions on parental gender bias, we adopt a quasi-experimental approach which allows us to document how parental gender bias changes when they receive new information on their child's skills.

Our quasi-experimental methodology exploits an exogenous difference in parents' interview date with respect to when NAPLAN scores were revealed to parents (an approach similar to those implemented in Greaves et al., 2021). As shown in Figure A1, parents taking part in the LSAC are interviewed throughout the year, but they receive individual reports with information on their child's performance in NAPLAN tests between the end of August and September. This allows us to compare the beliefs of parents who are interviewed before they receive information on their child's NAPLAN scores (control group) with those of parents who are interviewed after the new information is provided (treated group).

While in the previous section we estimated Equation 2 for the parental premium by considering only parents interviewed before the release of NAPLAN results, we now enlarge our sample to include also parents interviewed after they receive their NAPLAN results and extend Equation 2 to

$$\text{Premium}_{i,k} = \alpha_0^k + \alpha_1^k \text{Girls}_i + \gamma_0^k \text{After}_i + \gamma_1^k \text{After}_i \cdot \text{Girls}_i + \epsilon_{i,k}, \quad (3)$$

where After_i is a dummy variable that takes value 1 if parents of child i are interviewed after the release of the NAPLAN tests scores (treated group) and 0 otherwise (control group). γ_0^k captures how the new information about the child's skills changes the premium in parental beliefs for boys, whereas $(\gamma_0^k + \gamma_1^k)$ indicates the corresponding change for girls. α_1^k denotes the gender bias for parents in the control group, whereas $(\alpha_1^k + \gamma_1^k)$ is the gender bias for parents in the treatment group.

Because we can only observe the month of the interview, a parent is assigned to the treated group if the interview took place in October or afterwards, and to the control group if they were interviewed before October. Classifying parents as "treated" if interviewed in October is a conservative choice, as it makes sure our treated group does not include any parents who have not received the information by the time they are interviewed. However, since some parents interviewed in September might have already received their child's NAPLAN report, our estimation strategy might underestimate the effect of the NAPLAN information received

Akerlof and Kranton, 2010).

by parents. To check if this is the case, we also consider a "donut" sample, where we drop from the estimation sample all parents who were interviewed in August and September.

Our identification strategy relies on the assumption that the interview timing is exogenous, namely uncorrelated with observed parents' and children's characteristics. We provide evidence that the treatment assignment is as good as random by testing that the treatment and control group do not differ across a range of the household, child, and parental characteristics. Table 2 shows that there are no statistically significant differences between the two groups. The only exception is the probability of having a child with hyperactivity-inattention problems, which is higher for children of parents in the treatment group. When we control for this variable in our regression models, the results do not change.

Table 2: **Balancing Test**

	Controls	Treated	Difference
Household Income	2,398.046	2,573.707	-175.661
No. Siblings	1.595	1.612	-0.017
High School (m)	0.217	0.182	0.034
Employed (m)	0.799	0.818	-0.018
Employed (f)	0.971	0.968	0.004
Egalitarian Gender Norms	0.376	0.367	0.009
Financial hardship	0.109	0.13	-0.021
Hyperactivity Problems	0.23	0.31	-0.080**
Peer Problems	0.156	0.188	-0.033
Emotional Problems	0.221	0.264	-0.044
Conduct Problems	0.131	0.17	-0.039
Boy	0.498	0.521	-0.023
Public School	0.618	0.644	-0.026
No. Observations	2,576	340	2,916

Notes: Comparison of sample means by treatment group. Treated (control) parents are defined as those whose beliefs about their children's skills have been measured after (before) they receive information about their child's performance in standardized tests (NAPLAN). The last column reports the difference in each measure between the treated and control group, with stars indicating the p-value obtained from a two-side t-test (where *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). Data Source: Grade 3, Cohorts K and B.

Table 3 shows that providing parents with new information about a child's test scores eliminates their gender bias in mathematics. When comparing the parental premium for girls' mathematics skills with respect to boys, we find that the gender bias becomes smaller in size (one third, with respect to the control group) and no longer statistically significant. Similarly, the gender bias in mathematics with respect to reading is -0.157 (-0.128-0.029) in the control group, but drops to -0.043 (-0.042-0.001) in the treatment group. The gender

Table 3: **Response of Parental Beliefs to Information**

	Parental Premium = Beliefs - Skills	
	Reading	Maths
Panel A: No Information (Control Group)		
Average premium for boys, α_0^k	0.584***	0.612***
	(0.027)	(0.028)
Average premium for girls, $(\alpha_0^k + \alpha_1^k)$	0.613**	0.484***
	(0.026)	(0.026)
Subject-specific gender bias, α_1^k	0.029	-0.128***
	(0.038)	(0.039)
Panel B: With Information (Treated Group)		
Average premium for boys, $(\alpha_0^k + \gamma_0^k)$	0.639***	0.643***
	(0.072)	(0.071)
Average premium for girls, $(\alpha_0^k + \gamma_0^k + \alpha_1^k + \gamma_1^k)$	0.640***	0.601***
	(0.076)	(0.074)
Subject-specific gender bias, $(\alpha_1^k + \gamma_1^k)$	0.001	-0.042
	(0.105)	(0.102)
No. Observations	2,916	2,916

Notes: The dependent variable measures is the premium in parental beliefs, i.e. the difference between parental beliefs about their child's skills and their child's NAPLAN test scores in the same subject, reading or mathematics (both measured in standard deviations). Results are obtained estimating Equation 3 by OLS, for reading and mathematics separately. Panel A shows the results for parents in the control group, namely those who have not received new information on their children's NAPLAN scores at the time of the interview. Panel B, instead, shows the results for parents who received information on their children's skills before the interview (treated group). Data Source: Grade 3, Cohorts K and B. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

bias in reading is not statistically significantly different from zero both before and after the release of the NAPLAN results, as parents over-estimate reading skills equally, regardless of their child's gender and regardless of whether they have accurate information on their child's skills.

All in all, our results are consistent with the hypothesis that the parental gender bias in mathematics is driven by cognitive heuristics, and that parents rely on stereotypes not because they necessarily think that boys are better than girls in mathematics, but because they lack accurate information on their child's skills.

5.2 Why Do Parents Overestimate their Child's Skills?

Our results show that whereas the gender bias in parental beliefs disappears after new information on a child's skills is received, parents continue to overestimate their child's skills in both reading and mathematics. In this section we reconcile these seemingly contradictory findings by providing some evidence that the parental gender bias and the parental premium are likely driven by different cognitive processes.

First we exclude that parents continue to overestimate children's skills because they are skeptical about using NAPLAN results to measure pupils' school skills and decide not to rely on this information when forming their beliefs. If this was the case, we would find that providing parents with information does not change the accuracy of their beliefs (Dizon-Ross, 2019). To test whether parents adapt their beliefs to new information we show how the accuracy of parental beliefs, namely its correlation with the NAPLAN measure of child's skills, increases after the information shock.

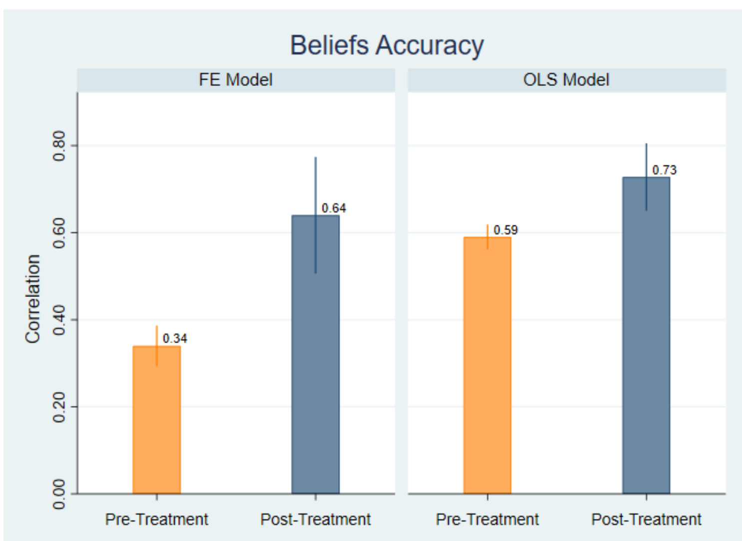
We estimate the correlation between the parents' beliefs and the NAPLAN test scores before and after the NAPLAN release by simply regressing $\text{Assessment}_{i,k,1}$ on $\text{Assessment}_{i,k,0}$,

$$\text{Assessment}_{i,k,1} = \pi_0 + \pi_1 \text{Assessment}_{i,k,0} + \pi_2 \text{Assessment}_{i,k,0} \cdot \text{After}_i + \upsilon_i + \nu_{i,k}, \qquad (4)$$

where as before $\text{Assessment}_{i,k,1}$ is the parental assessment (belief) on the child i skill in subject k, $\text{Assessment}_{i,k,0}$ is the corresponding NAPLAN test score, After_i takes value 1 if parents of child i are interviewed after the release of the NAPLAN tests scores and 0 if interviewed before the release, υ_i is an individual effect capturing any observable and unobservable child, household and school characteristics that are relevant to the parental formation of beliefs and do not vary across subjects (mathematics and reading), and $\nu_{i,k}$ is the idiosyncratic error term. Because both assessments, $\text{Assessment}_{i,k,1}$ and $\text{Assessment}_{i,k,0}$, are standardized to have variance 1, π_1 measures the correlation (namely, the accuracy) between the blind and non-blind assessments for the control group, while $(\pi_1 + \pi_2)$ measures the accuracy for parents who have received the NAPLAN results by the time of the interview (treated group). Notice that the NAPLAN scores, $\text{Assessment}_{i,k,0}$, is likely to be endogenous because correlated with $\nu_{i,k}$, i.e. with unobservables (e.g. parents' genetic ability) that can explain both parental beliefs and children's NAPLAN scores. To correct for the bias caused by such endogeneity we adopt a fixed effect estimation that exploits variation within child across subject.[11]

Figure 5 shows the results from Equation 4. The correlation between parental beliefs and children's skills before the release of NAPLAN test scores is well below 1, at 34%, indicating that beliefs are only somehow aligned with true skills. Instead, once parents are informed about their children's performance in NAPLAN, the correlation almost doubles, becoming 64%. The fact that the correlation is higher for those in the treatment group supports the hypothesis that the accuracy of parental beliefs, namely the correlation between parental beliefs and children's skills, improves as a result of the additional information provided to parents and that parents use the information provided through the NAPLAN reports to update their beliefs.

Figure 5: **Changes in the Accuracy of Parental Beliefs**



Notes: This graph shows changes in the correlation between parental beliefs about children's reading and mathematics skills and their child's true skills after parents received information on their children's performance in NAPLAN tests. Results obtained from a fixed effect estimation of Equation 4. Data Source: Grade 3, Cohorts K and B.

[11]This type of estimation method has been used in previous empirical papers on education (e.g. Dee, 2005 and Dee, 2007).

Another reason why parents overestimate their child's skills could be an intrinsic utility in maintaining positive beliefs about their child. Consistently with a motivated beliefs explanation, as defined by Bénabou and Tirole (2002) and Bénabou and Tirole (2016), parents may feel better when they believe their child's skills are good, so they self-deceive themselves to avoid stress and fear (affective motives), or they may hope that being over-confident about their child's skills will help the child to be more self-confident and perform better (instrumental motives).

We provide suggestive evidence in support of this hypothesis by comparing parental beliefs about a child's skills with teachers' beliefs. Because teachers are unlikely to be affected by motivational reasons, their beliefs should not be systematically higher than a child's skills.[12]

In line with our hypothesis, Table 4 shows that, unlike parents, teachers do not overestimate child's skills. Interestingly, teachers display a statistically significant gender bias for both reading and mathematics skills, with a bias in mathematics against girls and in reading against boys. Undoubtedly, teachers have more accurate information on children's skills and indeed we find that the magnitude of teachers' gender bias in both subjects is much smaller in absolute terms than the parental gender bias.

This result seems to suggest that the parents' overestimation is not caused by cognitive biases, as is the case for the parental gender bias, but rather by motivated beliefs. As such, when new information arises, parents adjust their gender biased beliefs, but do not correct the premium on child's skills.

[12]Our data include a measure of teachers' beliefs about children's skills, defined in the same way as parental beliefs. However, because of lack of information on when teachers do receive information on NAPLAN test scores, we cannot adopt the same quasi-experimental design as in Section 5.1.

Table 4: **Gender Bias in Teachers' Beliefs**

	(1) Reading	(2) Maths
Average premium for boys, α_0^k	-0.255*	-0.182
	(0.142)	(0.149)
Average premium for girls, $(\alpha_0^k + \alpha_1^k)$	-0.156	-0.261*
	(0.142)	(0.146)
Subject-specific gender bias, α_1^k	0.099**	-0.079**
	(0.039)	(0.040)
Differential gender bias, $(\alpha_1^2 - \alpha_1^1)$	-0.178***	
	(0.056)	
No. Observations	2,001	1,991

Notes: The dependent variable is the teachers' premium i.e. the difference between teachers' beliefs and children's skills measured as the difference between each child's individual score and the average at school level (both standardized to have variance 1). Results are obtained estimating Equation 2 by OLS replacing parental beliefs with corresponding teachers' beliefs. We restrict the sample to teachers interviewed in July or earlier when information on NAPLAN scores is not yet available to teachers. Data Source: Grade 3, Cohorts K and B. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

6 The Effect of Parental Gender Bias on the Maths Gender Gap

This section explores the implications of the gender bias in parental beliefs for children's skills development and the gender gap in mathematics. Exposure to teachers' traditional gender views has been shown to negatively affect girls' performance in school because of a decrease in girls' self-confidence (Alan et al., 2018), a higher probability of choosing a less demanding high school track (Carlana, 2019), and a lower probability of choosing maths courses (Lavy and Sand, 2018).

To analyse the impact of gender bias in parental beliefs about their child's skills on the child's future skills, we estimate the impact of parental premium (over-estimation) in grade 3 on children's skills in grade 5, while allowing for self-productivity of skills (Cunha and Heckman, 2007) and controlling for inputs and characteristics as follows

$$\begin{aligned}\text{Assessment}_{i,k,0}^{grade5} =& \eta_0^k + \eta_1^k \text{Premium}_{i,k} + \eta_2^k \text{Girls}_i + \eta_3^k \text{Girls}_i \cdot \text{Premium}_{i,k} + \\ &+ \rho \text{Assessment}_{i,k,0} + \mu_i + u_{i,k},\end{aligned} \tag{5}$$

where dependent variable, $\text{Assessment}_{i,k,0}^{grade5}$, is child's i NAPLAN standardized test scores in grade 5 in subject k. As in Section 4, $\text{Premium}_{i,k}$ is the difference between parental beliefs in grade 3, $\text{Assessment}_{i,k,1}$, and the standardized test scores in grade 3, $\text{Assessment}_{i,k,0}$. Girls is a dummy that takes value one if a child is a girl, μ_i is a child individual effect capturing child and parents' and family specific inputs and characteristics which are relevant to explain the NAPLAN test scores in grade 5 but do not vary across subjects, and $u_{i,k}$ is an idiosyncratic error.

We adopt a child fixed effect estimation of Equation 5 which exploits variation between subjects within a child, similar to the within-pupil between-subject estimation in the education literature.[13] The results of this fixed effect estimation are reported in column 1 of Table 5 and show that an increase in the parental premium by 1 standard deviation at the time a child is in grade 3 leads to a statistically significant increase in the standardized test scores in grade 5 by about 10% of a standard deviation for boys and girls.[14]

This positive effect of the parental premium on test scores in grade 5, combined with the fact that parents tend to overestimate boys' skills in mathematics more than girls', leads to a widening of the gender gap in mathematics later on in children's life. In particular, a difference in the average parental premium in mathematics between boys and girls in grade 3 of 0.15 standard deviation (Table 1) corresponds to a 1.5% ($0.15 \cdot 10\%$) increase in the gender gap in scores in mathematics in Grade 5. To interpret these findings, it is helpful to think of one third of a standard deviation in test scores as equivalent to a year in learning gains (Woessmann, 2016). Thus, a 1.5% increase in the gender gap in test scores in mathematics in grade 5 is equivalent to a gender gap of over half a month of learning ($0.015 \cdot 12/0.3$).

Our results are consistent with a recent literature showing increased gender gaps in mathematics in families with more gender stereotypical roles. In particular, Doss et al. (2019) find that girls growing up in a 'boy-biased' family score worse on maths exams than girls raised in other types of family. Similarly, a recent paper by Brenøe (2022) shows that the transmission of stereotypes about gender roles appears particularly strong in families with mixed-sex children, leading to a lower likelihood for girls of completing a STEM degree, and a higher likelihood of working in female-dominated occupations and marrying a more

[13]See Dee (2005); Dee (2007); Clotfelter et al. (2010); Slater et al. (2012); Altinok and Kingdon (2012);and Nicoletti and Rabe (2018).

[14]The consistency of the fixed effect estimation relies on the assumption that Equation 5 holds identical for mathematics and reading. We provide some evidence on this by considering an OLS estimation of Equation 5 separately for reading and mathematics in columns 2 and 3 of Table 5, which seems to suggest that the parental premium in mathematics and reading have a statistically significant effect of similar magnitude on grade 5 test results.

Table 5: **The effect of parental gender bias on future children's skills**

	Skills in Grade 5		
	FE estimation	OLS Reading	OLS Mathematics
	(1)	(2)	(3)
Premium in Grade 3	0.098***	0.114***	0.066***
	(0.018)	(0.019)	(0.018)
(Premium in Grade 3) x Girls	-0.022	-0.034	-0.010
No. Observations	5,080	2,540	2,540
R-squared	0.407	0.729	0.732

Notes: The dependent variable, namely children's skills in grade 5, is defined as the different between child i NAPLAN test score in Grade 5 and the school average (in standard deviation). Premium is the difference between parental beliefs and child's skills in Grade 3. Control variables include also the dummy for girls and the lagged test score, the NAPLAN in Grade 3. The sample includes parents who have not received information on the NAPLAN test scores. In columns (1) we report results from the fixed effect estimation. In columns (2) and (3) we use OLS estimation separately for reading and mathematics and control for the set of parents' and child's characteristics listed in Table A2. Data Source: Grade 3 and 5, Cohorts K and B. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

traditional partner. This empirical evidence is consistent with children internalizing parental expectations on their skills and adjusting their educational effort in response (Dhar et al., 2019). The effect of parental gender biases and stereotypes in mathematics can also operate thorough a decrease in girls' self-confidence and through a reduction in investments in mathematics, making girls less likely to choose mathematics as their specialty subject (Giuliano, 2020).

7 Conclusions

This study investigates how the gender of a child affects parents' perception about the child's reading and mathematical skills. It shows that parents over-estimate girls' mathematics skills less than boys' skills, while there are no gender differences for reading skills. Exploiting exogenous variation in parents' interview dates, we compare beliefs of parents who receive additional information on their child's skills (nationally standardised test scores in mathematics and reading), with those who are interviewed before this information is released. We find that the gender bias disappears for those parents with additional information, suggesting that parents may rely on stereotypes when they assess their child's skills because of information frictions.

We also show that parents' overestimation of children's skills has a positive impact on child's skills two years later. This result, combined with the evidence of a gender bias in favor of boys for mathematics, can contribute to explain the increase in the gender gap in maths performance documented in recent studies. It can also ultimately prove that gender stereotypes, according to which mathematics is a male-subject, can be self-fulfilling prophecies, given that the observed gender bias in parental beliefs in mathematics against girls in grade 3 can enlarge the gap in mathematical skills between boys and girls in grade 5.

Admittedly, while our results are compatible with the hypothesis of gender stereotypes affecting parental beliefs, we cannot exclude that the bias in the way parents perceive their girls' mathematics skills is the reflection of gender differences in children's confidence in mathematics skills. For example, if girls display less math self-efficacy (self-confidence in solving math related problems) and math self-concept (beliefs in their own skills) or if girls are more anxious and stressed when involved in math-related activities (Twenge and Campbell, 2001; Heckman and Kautz, 2012; Lubienski et al., 2013; OECD, 2015; Burgess et al., 2022) and transmit this information to their parents, then the fact that parents do over-estimate girls' skills less than boys' skills would not depend on their own stereotypes, but instead on the way that girls behave. Unfortunately, our data do not allow to explore this channel. Future research is needed to understand this aspect.

Our results highlight the importance of providing parents with reliable and ready to use information on their children's skills, especially in light of the impact that their beliefs have on future school achievements of their child. Information about school achievements of students has been increasingly used by policy makers for school accountability (Hanushek and Raymond, 2004; Figlio and Loeb, 2011; Hanushek, 2019) and by parents to choose the school in which enrolling their child (Figlio and Lucas, 2004; Hastings and Weinstein, 2008; Burgess et al., 2015). Given the worldwide diffusion of school standardized tests (e.g. England, Norway, Italy, Japan, China, Australia, South Africa, Brazil, Mexico and India), they are likely to provide an easy to adopt policy tool to support parents and shaping unbiased parenting strategies.

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Appendix A

Figure A1: **Timeline**

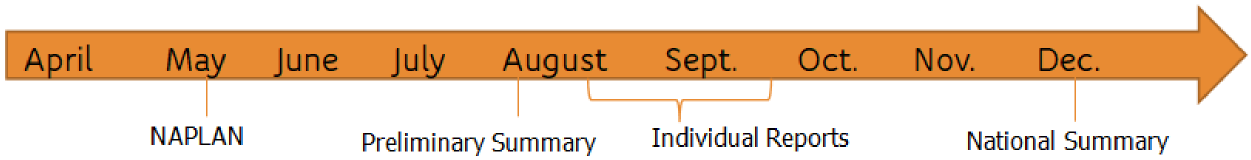


Table A1: **Parental beliefs, children's skills and parental premium: summary statistics by child's gender**

	BOYS		GIRLS	
	Mean	Std. Dev.	Mean	Std. Dev.
Panel A: Parental beliefs				
Reading	0.778	1.038	0.984	0.950
Mathematics	0.935	1.002	0.713	0.986
Panel B: Children's skills (NAPLAN results)				
Reading	0.187	1.014	0.368	0.978
Mathematics	0.319	1.062	0.216	0.931
Panel C: Parental Premium (Beliefs-Skills)				
Reading	0.590	1.038	0.616	0.950
Mathematics	0.616	1.002	0.497	0.986

Notes: Descriptive statistics computed using the full sample (grade 3), separately by gender. Beliefs are defined using a 5-point scale answer to the following question:"Compared to other children in their class, how well do you think your (study) child is progressing in reading/mathematics?" with the scale going from "much worse" (-2) to "much better" (+2). Children skills are defined as the difference between individual NAPLAN scores and averages scores at school-year level in each subject. Both beliefs and skills are standardized, i.e. defined as the raw beliefs (skills) measure divided by their standard deviation (and without demeaning). Data Source: Grade 3, Cohorts K and B.

Table A2: **Descriptive Statistics: Control Variables**

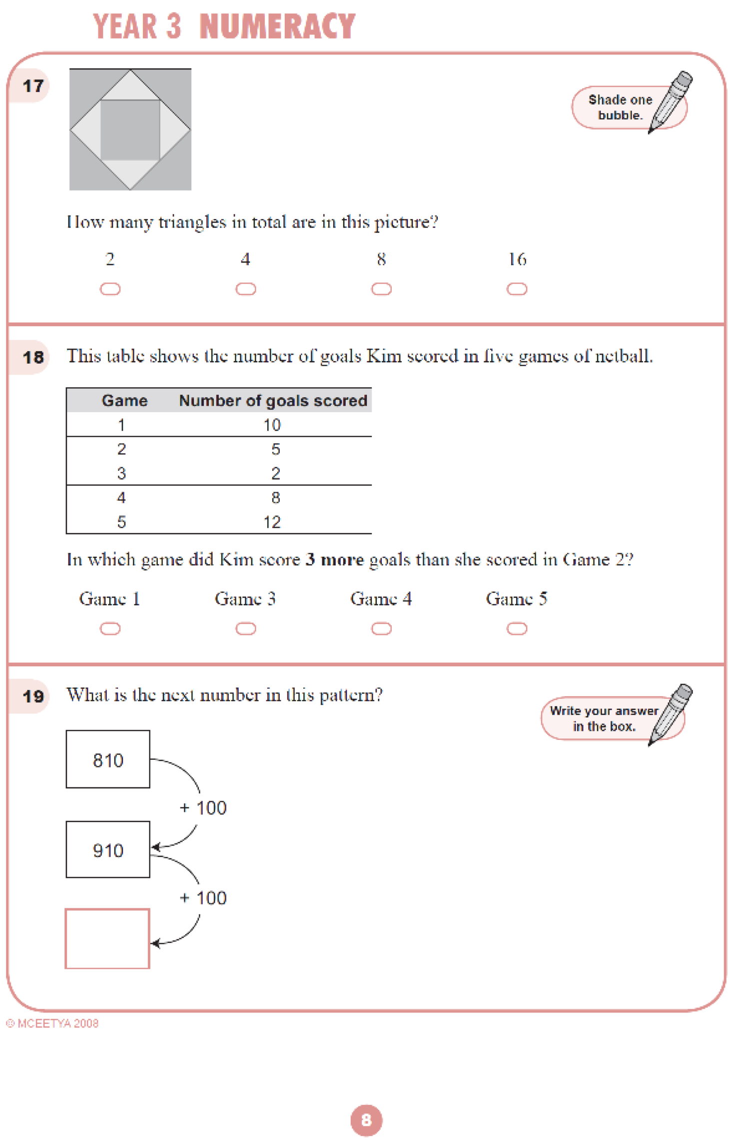
	Mean	Std. Dev.	Min	Max
Income	2418.528	1519.808	0	16746.41
Hardship	0.112		0	1
N. siblings	1.597	0.920	0	9
No degree (m)	0.213		0	1
Public School	0.621		0	1
Employed (m)	0.801		0	1
Employed (f)	0.971		0	1
New South Wales	0.343		0	1
Victoria	0.253		0	1
Queensland	0.149		0	1
South Australia	0.072		0	1
Western Australia	0.102		0	1
Tasmania	0.038		0	1
Northern Territory	0.010		0	1
Australian Capital Territory	0.034		0	1
Hyperactive	0.239		0	1
Peer Problems	0.160		0	1
Emotional Problems	0.226		0	1
Conduct Problems	0.136		0	1
Boy	0.501		0	1
Cohort K	0.521		0	1

Table A3: **Cohorts B and K: child's age, interview years and school grades**

	2004	**2006**	**2008**	**2010**	**2012**	**2014**
Cohort B						
Child age	0-1	2-3	4-5	6-7	8-9	10-11
School Grade					3	5
Cohort K						
Child age	4-5	6-7	8-9	10-11	12-13	14-15
School Grade			3	5	7	9

Appendix B

Figure B1: **Example of questions for mathematics NAPLAN tests in 2008**



YEAR 3 NUMERACY

17

Shade one bubble.

How many triangles in total are in this picture?

2 ⬭ 4 ⬭ 8 ⬭ 16 ⬭

18 This table shows the number of goals Kim scored in five games of netball.

Game	Number of goals scored
1	10
2	5
3	2
4	8
5	12

In which game did Kim score **3 more** goals than she scored in Game 2?

Game 1 ⬭ Game 3 ⬭ Game 4 ⬭ Game 5 ⬭

19 What is the next number in this pattern?

Write your answer in the box.

810

+ 100

910

+ 100

© MCEETYA 2008

8

Notes: These are the tests taken by children in Cohort K when enrolled in Grade 3. Cohort B children took Grade 3 NAPLAN tests in 2012. Full list of test papers is available at: https://www.acara.edu.au/assessment/naplan/naplan-2008-2011-test-papers (2008) and https://www.acara.edu.au/assessment/naplan/naplan-2012-2016-test-papers (2012).

Figure B2: **Example of questions for reading NAPLAN tests in 2008**

YEAR 3 READING

5 When did the children go fishing?

Shade one bubble.

- ⬭ last week
- ⬭ yesterday
- ⬭ this morning
- ⬭ a long time ago

6 From reading the story, what do we know about the children?

- ⬭ They fight a lot.
- ⬭ They are all brothers.
- ⬭ They live in the same house.
- ⬭ They do lots of things together.

Read *Chimpanzees* on page 3 of the magazine and answer questions 7 to 12.

7 The text tells us that chimpanzees eat

- ⬭ tools.
- ⬭ sticks.
- ⬭ leaves.
- ⬭ termites.

8 The text tells us *This chimp is hooking termites out of the ground with a stick.* Which word could you use instead of *hooking*?

- ⬭ hitting
- ⬭ getting
- ⬭ cooking
- ⬭ drinking

3

Notes: These are the tests taken by children in Cohort K when enrolled in Grade 3. Cohort B children took Grade 3 NAPLAN tests in 2012. Full list of test papers is available at: https://www.acara.edu.au/assessment/naplan/naplan-2008-2011-test-papers (2008) and https://www.acara.edu.au/assessment/naplan/naplan-2012-2016-test-papers (2012).

Figure B3: **Example of Individual Report (Page 1-2)**

Year 3

Student report 2019

Summary of skills assessed

The skills described in the following table represent those typically assessed in NAPLAN tests for Year 3 students. These skills increase in difficulty from the lowest to the highest band. A student achieving a result in a particular band is likely to have correctly answered questions involving skills in that band and in each band below it.

Band	Reading	Writing	Language Conventions	Numeracy
6	Makes meaning from a range of text types and understands how they are structured. Recognises the purpose of general text features such as titles and headings. Makes inferences by connecting ideas across different parts of texts. Draws conclusions about the feelings and motivations of characters, and sequences events and information.	Organises a text using paragraphs with related ideas. Uses some effective text features and accurate words or groups of words when developing ideas. Punctuates nearly all sentences correctly with capitals, full stops, exclamation marks and question marks. Correctly uses more complex punctuation markers some of the time.	Identifies errors and correctly spells most words with common spelling patterns (*gloves, collect, hungry, comfortable*). Demonstrates knowledge of grammar and punctuation conventions in longer sentences and speech, such as the correct use of commas to separate phrases and apostrophes for contractions (*we'll*).	Applies appropriate strategies to solve multi-step problems, simple multiplication and division and patterning. Converts between familiar units of measure. Calculates durations of events. Interprets and uses data from a variety of displays. Recognises nets of familiar 3D objects and symmetry in irregular shapes. Uses simple legends and coordinate systems to interpret maps and grids.
5	Applies some knowledge of texts, makes inferences and processes information to understand the main idea in texts. Draws conclusions about a character in narrative texts. Connects and sequences ideas in short informative texts.	Structures a text with a beginning, complication and resolution; or with an introduction, body and conclusion. Includes enough supporting detail for the text to be easily understood by the reader, although the conclusion or resolution may be weak or simple. Correctly structures most simple and compound sentences and some complex sentences.	Identifies errors and correctly spells one- and two-syllable words with common spelling patterns (*spill, looked, pleasing, benches*). Recognises grammar and punctuation conventions in standard sentences and speech, such as the correct use of adjectives, compound verbs (*could have*), capital letters for compound proper nouns and commas in lists.	Solves routine problems using a range of strategies. Demonstrates knowledge of simple fractions and decimals. Continues number and spatial patterns. Uses familiar measures to estimate, calculate and compare area or volume. Reads graduated scales. Compares likelihood of outcomes in chance events. Recognises the effect of transformations on 2D shapes. Uses major compass points and follows directions to locate positions.
4	Connects events and interprets the behaviour of characters in stories. Identifies the meaning of some unfamiliar words from their context and finds specific information in short informative texts and diagrams.	Writes a text in which characters or setting are briefly described; or in which ideas on topics are briefly elaborated. Correctly punctuates some sentences with both capital letters and full stops. May demonstrate correct use of capitals for names and some other punctuation. Correctly spells most common words.	Identifies errors and correctly spells most one- and two-syllable words with common spelling patterns (*clear, melt, brick, won*). Recognises grammar and punctuation conventions in short sentences and speech, such as the correct use of groups of adjectives, referring pronouns (*those*) and capital letters for simple proper nouns.	Solves problems involving unit fractions, combinations of addition and subtraction of two-digit numbers and number facts to 10 x 10. Identifies repeating parts of patterns. Interprets timetables and calendars and reads time on clocks to the quarter hour. Locates information in tables and graphs. Recognises familiar 2D shapes after a transformation and identifies a line of symmetry. Visualises 3D objects from different viewpoints.
3	Makes meaning from simple texts with familiar content and themes. Makes some connections between ideas that are not clearly stated. Identifies simple cause and effect. Makes some simple inferences and draws conclusions, such as identifying the main idea of a text.	Attempts to write a text containing a few related events or ideas on topics, although these are usually not elaborated. Correctly orders the words in most simple sentences. May experiment with using compound and complex sentences but with little success. Orders and joins ideas using a few connecting words but the links are not always clear or correct.	Identifies errors and correctly spells one-syllable words with simple spelling patterns (*out, feet, rain, hose, would*). Recognises grammar and punctuation conventions in short sentences, such as the correct use of linking and coordinating words (*that, but*), describing words, capital letters to begin a sentence, full stops and question marks.	Solves single-step problems involving addition, subtraction or simple multiplication. Recognises representations of unit fractions and completes simple number sentences. Compares length and mass using familiar units of measure. Describes outcomes of simple chance events. Uses common features and properties to classify families of shapes and objects, and recognises symmetrical 2D shapes. Locates positions using grid references.
2	Makes some meaning from short texts, such as simple reports and stories, that have some visual support. Makes connections between pieces of clearly stated information.	Shows audience awareness by using common text elements, for example, begins writing with *Once upon a time*; or *I think … because …* Uses some capital letters and full stops correctly. Correctly spells most simple words used in the writing. Some other one- and two-syllable words may also be correct.	Identifies errors and correctly spells some words with simple spelling patterns. Recognises grammar and punctuation conventions in short sentences, such as the correct use of pronouns (*herself*).	Compares and orders different representations of three-digit numbers. Applies addition and subtraction facts up to 20 to solve problems. Identifies equal groups of collections. Uses language of time and chance in familiar contexts. Visually compares area and locates information in simple tables. Recognises common features of 2D shapes and 3D objects. Locates positions on simple maps and plans by following directions.
1	Makes some meaning from simple texts with familiar content. Texts have short sentences, common words and pictures to support the reader. Finds clearly stated information.	Writes a small amount of simple content that can be read. May name characters or a setting; or write a few content words on a topic. May write some simple sentences with correct word order but full stops and capital letters are usually missing or incorrect. Correctly spells a few simple words used in the writing.	Identifies errors and correctly spells a few words with simple spelling patterns. Recognises a small range of grammar and punctuation conventions in short sentences, such as the correct use of simple conjunctions (*because*) and common verbs (*will go*).	Uses counting strategies to solve problems and demonstrates knowledge of place value of three-digit numbers. Identifies the next term in a simple pattern. Interprets tally marks. Recognises and compares length and mass of familiar objects. Names common 2D shapes and familiar 3D objects and shows some understanding of spatial positioning.

acara AUSTRALIAN CURRICULUM, ASSESSMENT AND REPORTING AUTHORITY

Student report 2019

National Assessment Program — Literacy and Numeracy

Year 3

This report shows the results for

In May 2019, national literacy and numeracy assessments were administered to students in Years 3, 5, 7 and 9 throughout Australia. This report shows your child's achievement in those assessments.

These assessments provide a snapshot of your child's achievement at a point in time. The information contained in this report should be considered together with school-based assessments and reports.

NAPLAN is moving from a paper test to an online test to provide more accurate and precise information about what students know and can do. This means that during this period some students take NAPLAN on paper, while others sit the tests online.

For the 2019 transition year, the online test results were equated with the pen-and-paper tests. Results for both the tests are reported on the same NAPLAN assessment scale.

NAPLAN results, however, should always be interpreted with care. This is particularly the case this year for some students who experienced disruptions due to connectivity issues. Your child's teacher will have the best insight into your child's educational progress.

Literacy assessment

The literacy assessments measured student achievement in reading, writing and language conventions.

Reading

Students were required to read a range of texts similar to those used in Year 3 classrooms and answer questions of varying difficulty to show their understanding of the material.

Writing

Students were instructed to respond to a writing prompt. This writing task required students to generate and organise ideas and demonstrate their skills in vocabulary use, sentence structure, spelling and punctuation.

Language Conventions

Students were required to identify and correct spelling errors and answer questions on aspects of grammar and punctuation.

Numeracy assessment

The numeracy assessment measured student achievement across number and algebra; measurement and geometry; and statistics and probability. Questions required students to apply mathematical knowledge, skills and understanding in a variety of contexts.

How to read the student report

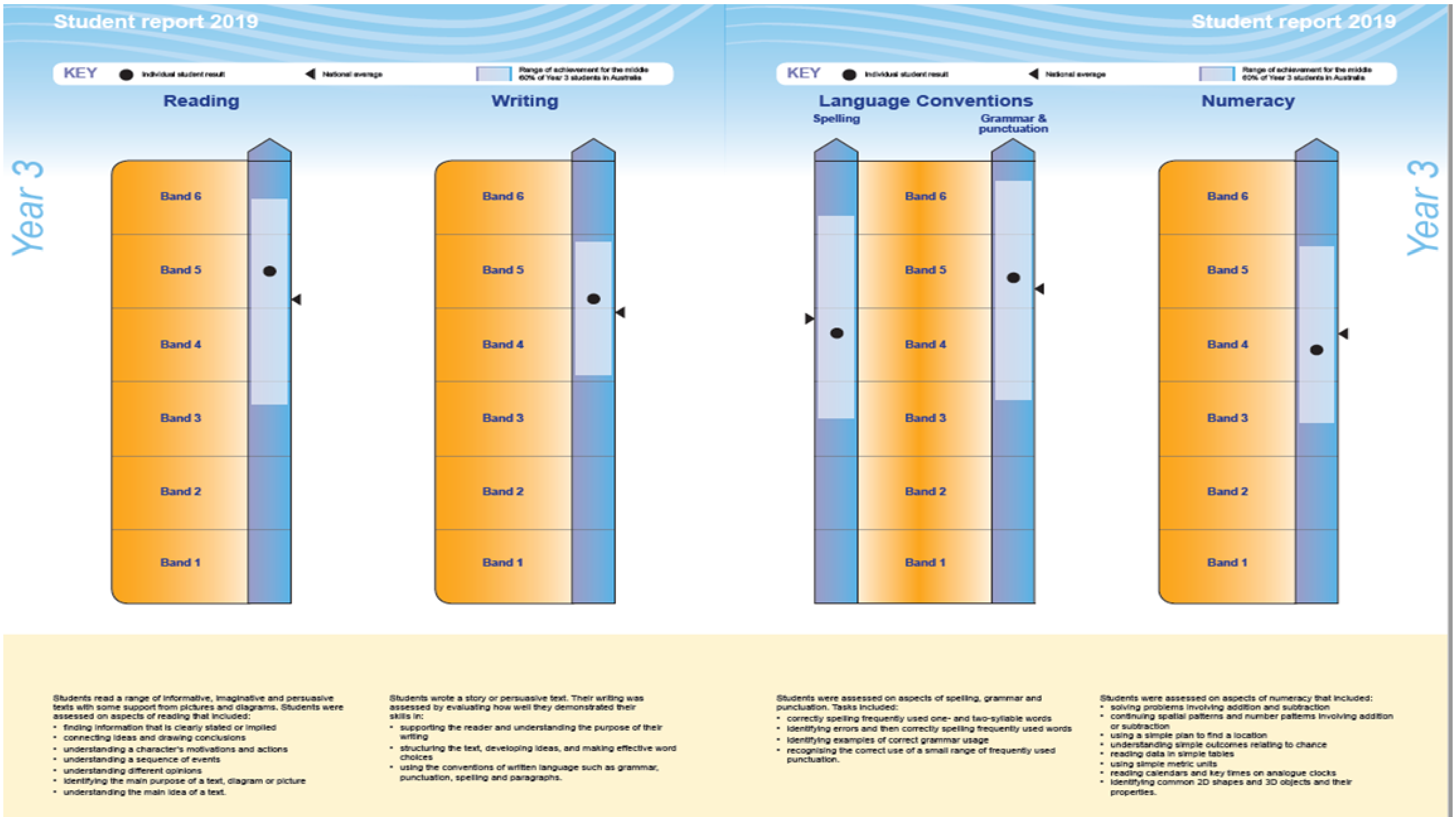
A student's result is shown on an achievement scale for each assessment area. Results across the Years 3, 5, 7 and 9 literacy and numeracy assessments are reported on a scale from Band 1 to Band 10.

The achievement scale represents increasing levels of knowledge, understanding and skills demonstrated in the assessments. Results for Year 3 are reported across the range of Band 1 to Band 6, with Band 2 representing the national minimum standard for this year level.

The national average and the range of achievement for Year 3 students are also shown on the scale.

Your child's results are shown on the inside pages of this report.

Figure B4: **Example of Individual Report (Page 3-4)**



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