Adult Responses to Children's Failure in Maths and English: The Impact of Gender and Perceived Effort

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Abstract

This study aims to find out which subjects (STEM/Language Arts) are recommended after failure is observed in both subjects in the first semesters of a child's formal education. Specifically, whether adults' recommendations are affected by the child's gender and level of effort, which may help us understand some of the psychological processes that steer women away from STEM. 189 adults (parents, in-service teachers and pre-service teachers) living in Australia (mean age 27.4, 6.3% male and 93.7%female) were exposed to a fictional failed school report where a child has failed in Maths and English. Reports were identical except for two variables that were manipulated: gender (the child is either a girl or a boy) and the child's effort in Maths (high or low). Participants provided ratings of that child's future academic performance, ability and interest in both subjects, and made recommendations for remedial classes. Results show that regardless of effort, boys were equally encouraged to develop their STEM and Language Arts skills by supporting students in additional subjects related to both domains. In comparison, girls were more frequently directed towards Language Arts subjects than STEM. Additionally, high-effort boys were perceived to have lower levels of Maths ability than low-effort boys.

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Girls have succeeded in closing the academic gap in Maths and science, and in some instances, female students have outperformed and enrolled in higher rates at tertiary educational institutions than male students in some areas of science like biology (Bursal, 2013; Hyde, 2008; Sax, Kanny, Riggers-Piehl, Whang, & Paulson, 2015). A longitudinal study of 1,303 higher education institutions in the United States revealed that undergraduate Mathematics enrolments have become more balanced. In 2011 there were 1,237 male and 1,220 female students enrolled in mathematics. Despite this gain in mathematics majors, computer science showed a gap of 3,278 male enrolments versus 618 female enrolments in the same year (Sax et al., 2015). Even more consequential are the findings that women who choose Science, Technology, Engineering and Maths (STEM) careers are more likely to leave them as they advance in their careers (Ceci, Williams, & Barnett, 2009), and as much as 52% of women working in STEM decide to leave their jobs, citing isolation, hostility and macho behaviour as reason for leaving (Hewlett, Buck Luce, & Servon, 2008). In Australia, only 16% of STEM qualifications are held by women (Australian Government Office of the Chief Scientist, 2016). At this low participation rate, disciplines like engineering and computer science lack the beneficial effect of diversity which women could bring into these domains by offering a different perspective and adding varied cognitive skills (Ioannides, 2010). Moreover, in the Australian workforce, career opportunities in a lucrative field are by passing women through lack of participation. STEM qualified individuals have the potential to earn in the top income bracket of $104,000 and over. However, only 12% of women currently working in STEM are found in this income bracket, whilst by comparison almost three times as many men in STEM (32%) belong to this bracket (Australian Government Office of the

Chief Scientist, 2016). These figures show that women have become more engaged in some STEM domains over the last four decades. However, the current statistics also suggest that there is still diminished engagement in Maths careers amongst girls and women. The following section is a review of possible explanations that may decrease girls’ interest in mathematics.

Biological theories: Innate abilities and/or lack of interest

Biological theorists have suggested that perhaps girls do not have a natural interest in Maths (Archer et al., 2012) or that they do not possess innate ability to succeed in the domain due to genetic, hormonal and cerebral differences (Baron-Cohen, 2003; Berenbaum, Korman Bryk, & Beltz, 2012; Valla & Ceci, 2011). This position suggests that these biological differences explain why men are better suited to understanding and building complex systems while women are more interested in understanding people and working with emotions (Baron-Cohen, 2003; Maccoby & Jackelin, 1974; Penner, 2008). This biological explanation makes an implicit assumption about intelligence as fixed due to gender differences. It also serves as a significant obstacle for women entering STEM as men are stereotypically perceived as having more of this brilliance or natural intelligence than women (Ankney, 1992; Cheryan, Master, & Meltzoff, 2015; Good, Rattan, & Dweck, 2012; Heyder, Steinmayr, & Kessels, 2019; Meyer, Cimpian, & Leslie, 2015). For example, in a study of over 14 million reviews, male professors from a range of disciplines were more frequently described as “brilliant” (1.81:1 male:female ratio) and “genius” (3.10:1 ratio) than female ones (Storage, Horne, Cimpian, & Leslie, 2016). In Western cultures, people tend to believe that males have higher mathematical skill and ability than female persons (Gunderson, Hamdan, Sorhagen, & D’Esterre, 2017; Hand, Rice, & Greenlee, 2017) and this belief can emerge as early as first and second grade (Cvencek, Meltzoff, & Greenwald, 2011;

Gunderson et al., 2017). Cvencek et al., (2011) found that by year 2, boys already tended to explicitly and implicitly associate their gender with Maths more than did girls. The authors stated that this difference in membership association is evidence of early maths-gender stereotype adoption. In 2005, then Harvard President Lawrence Summers stated that women could not succeed in STEM because there were gender differences at the elite level due to innate biological difference between males and females. He stated that although average Maths scores do not present gender differences, a clear gender divide can be seen at the extreme end due to divergent innate gender attributes (Fields, 2005; Lawler, 2005). Summer's perception of women' STEM ability is an example of the prevailing view that dominates people's implicit and explicit belief about mathematical intelligence. Studies of mathematical attribution from various countries show that students and parents subscribe to the notion that mathematical ability is innate or predetermined due to genetics and gender (Espinoza, Quezada, Rincones, Strobach, & Gutiérrez, 2012).

Biological theories would assume that gender differences in Maths would be maintained across cultures, nationalities, and across time. However, gender differences in Maths are not consistent across countries, cultures, or time (Penner, 2008; Prinsley, Beavis, & Clifford-hordacre, 2016). For example, a cross-cultural study of eleventh graders' Maths performance revealed that girls in Taiwan and Japan greatly outperformed both genders in the United States despite students reporting low interest in the domain (Evans, Schweingruber, & Stevenson, 2002). This shows that Maths performance varies across cultures. Moreover, the study also showed that, despite lack of interest, the gap in test scores between boys and girls is marginal in the US (boys: $M = 14.1$, $SD = 7.2$; girls: $M = 12.8$, $SD = 6.6$) while it is significant in Taiwan (boys: $M = 26.5$, $SD = 9.5$; girls: $M = 22.2$, $SD = 9.1$) and Japan (boys: $M = 23.9$, $SD = 7.1$; girls: $M = 18.3$, $SD = 5.1$). The researchers point to more traditional gender roles in Taiwanese and Japanese cultures to explain this performance gap in

Mathematics (Evans, Schweingruber, & Stevenson, 2002). Therefore, the evidence suggests little support for biological theories of STEM abilities (Australian Government Office of the Chief Scientist, 2016; Bussey & Bandura, 1999; Ceci et al., 2009) even though there is lay consensus regarding genetic differences when people evaluate Maths performance (Dar-Nimrod & Heine, 2006).

Beyond culture, gender differences in Maths also varies across time. Any historical gender gap that once existed in the United States is no longer evident among the grades 2 to 11 cohort as girls attain comparable Maths test scores to boys (Hyde, Lindberg, Linn, Ellis, & Williams, 2008). That is, contemporary studies demonstrate that boys and girls tend to achieve similar academic success on Maths test scores (Hyde, Lindberg, Linn, Ellis, & Williams, 2008; Hyde, 2014). Additionally, psychosocial studies indicate that when women are exposed to intervention programs that boost confidence, their Maths test scores increase (Good, Aronson, & Inzlicht, 2003). That is, young girls' motivation, enjoyment, value and Maths self-efficacy can be increased by exposing them to programs that promote positive attitudes towards Maths (Falco, Summers, & Bauman, 2010). Furthermore, women exhibit more self-efficacy and interest in STEM when they attain a higher sense of belonging in the domain (Good et al., 2012; Master, Cheryan, & Meltzoff, 2016; Master, Cheryan, Moscatelli, & Meltzoff, 2017). Finally, an international study on gender differences in extreme mathematical achievement points towards gender inequality in the labour market. Specifically, the status quo of men and women within different societies appears to drive gender differences in Maths accomplishment (Penner, 2008).This suggests that differences in Maths performance may be due to psychological factors and sociocultural influences that shape girls' beliefs, confidence and self-efficacy in mathematics (Bussey & Bandura, 1999; Cervoni & Ivinson, 2011) rather than innate differences.

Psychosocial theories: Confidence and self-efficacy

According to Bandura et al., (2001), self-efficacy determines how people feel, think and perform in response to obstacles and challenging experiences. Therefore, a strong sense of self-efficacy is able facilitate motivation to seek progress, but a low sense of self-efficacy can impede it due to anxiety, a sense of helplessness, and depression (Kurtz-Costes, McCall, Kinlaw, Wiesen, & Joyner, 2005). Importantly, it provides individuals with global confidence to face challenges (Pajares, 2002). However, despite both genders performing academic tasks at the same level of proficiency, boys tend to demonstrate higher self-esteem than girls (Aslam, Adefila, & Bagiya, 2018; Bandura et al., 2001; Degol, Wang, Zhang, & Allerton, 2018; Eccles, Wigfield, Harold, & Blumenfeld, 1993; Falco, Summers, & Bauman, 2010; Good et al., 2012; Sax, Kanny, Riggers-Piehl, Whang, & Paulson, 2015). In fact, boys hold such high levels of perceived mathematical ability that they overestimate their performance on Maths tests, while girls are more accurate with estimating their performance (Bench, Lench, Liew, Miner, & Flores, 2015). Even among gifted students, girls continue to rate their own mathematical ability as lower despite achieving comparable grades to boys (Preckel, Goetz, Pekrun, & Kleine, 2008; Siegle & Reis, 1998).

Interestingly, at a young age girls and boys posses the same levels of Maths self-efficacy (Amelink, 2009; Bursal, 2013). However, by the middle of primary school, girls start to lose confidence in their ability, which continues to decrease in high school (Bandura et al., 2001; Eccles et al., 1993; Prinsley, Beavis, & Clifford-hordacre, 2016). Importantly, it is self-*perceived* efficacy, and not actual academic achievement that influence the sense of competence in a specific domain which in turn can dictate careers choices (Bandura, et al., 2001; Espinoza, Quezada, Rincones, Strobach, & Gutiérrez, 2012). Self-efficacy is believed to be developed by four information sources: mastery of experience (interpretation of own performance), vicarious experience (observation of people’s reaction and performance), social persuasion (feedback from others) and physiological and emotional state (bodily reaction to an experience, for example, anxiety). Studies reveal that mastery experience and social persuasion are the main sources that build self-efficacy belief in early childhood. For example, research suggests that mastery experience and social persuasion predicted mathematical ability for both genders in third grade (Joët, Usher, & Bressoux, 2011). However, a more recent American primary school study showed that social persuasion was the strongest predictor of mathematical self-efficacy beliefs for boys and girls (Lau, Kitsantas, Miller, & Drogin Rodgers, 2018). Importantly girls are more vulnerable to others' opinions. By sixth grade, girls' primary source of self-efficacy belief tends to be mastery experience and social persuasion, while boys utilize mastery experience and vicarious experience as their main source of belief about self-efficacy (Usher & Pajares, 2006).

Stereotypes and gender bias

Gender stereotypes about men and women seem to influence people's perceptions of 'gender appropriate' behaviour for a career trajectory (Cheryan et al., 2015; Prinsley et al., 2016). Even women and men who consciously hold non-traditional gender beliefs make career choices based on their gendered self-conceptions. This may be due to gender being broadly perceived by the general population as dichotomous in terms of male and female characteristics and/or femininity-masculinity categories (Worell, 2002). Femininity is often associated with skills such as being artistic, creative and intuitive, while masculinity is associated with effective problem solving, analytics, and numeracy skills. These latter skills are generally associated with STEM (Williams & Tiedens, 2016; Worell, 2002). Thus, Maths has an association with masculinity. Therefore, entering a male-dominated field may be perceived as following a masculine path (Cervoni & Ivinson, 2011; Hand et al., 2017; Williams & Tiedens, 2016). Additionally, students of both genders seem to endorse this maths-male and humanities-female association from high school level which is then carried over into adulthood among educators (Hand et al., 2017; Martinot, Bagès, & Désert, 2012) and parents (Shin et al., 2015; Tenenbaum, 2009).

Gender bias associated with gender traits may influence how people evaluate individuals' abilities. For instance, women who possess feminine features are rated as being less likely to be a scientist (Banchefsky, Westfall, Park, & Judd, 2016). Researchers have also demonstrated that gender bias can serve as prohibitive barriers for entry into certain fields or elite levels of academia. For example, Steinpreis, Anders, and Ritzke (1999), asked 238 academics in the United States to review a CV for an assistant professor position and a tenure-path position. Two CVs were randomly assigned to participants. The CVs were identical except for gender manipulation where the CV depicted either a male or female applicant. Notably, the original CV was based on a real-life female scientist. Results showed that participants of both genders assessed the male CV more positively than the female CV. Moreover, the female CV was 'hired' less frequently than the male version. The experimental design of this study showed that the candidate's gender *influenced* hiring choices as well as perception of science ability.

In another study, gender bias was revealed when participants had to evaluate the teamwork of two employee profiles. Despite identical content aside from gender, results showed that male profiles were rated much higher in ability than the female profile. Males were also consistently rated as displaying more competence and leadership, as well as being more influential (Heilman & Haynes, 2005). Unfortunately, these gender biases may dictate opportunities from an early age. A large experimental study revealed that teachers (primary and high school) were less likely to nominate a girl to participate in a gifted program due to perceived domineering and arrogant personality, lack of social skills and 'bossiness' (Bianco, Harris, Garrison-Wade, & Leech, 2011). However, the identically described boy was nominated because he was perceived to be independent, self-directed, able to find unconventional solutions to problems and displaying leadership skills (Bianco et al., 2011). Clearly, gender stereotypes affect people's judgements and perceptions of individuals. Qualities that are perceived as valued in one gender (e.g., leadership skills in males) can be seen as a negative trait in another gender (e.g., 'bossiness' in females). Gender stereotype beliefs can be deeply ingrained and can be automatically activated even in those who profess to be aware and actively try to fight gender bias (Banaji & Hardin, 1996). Unlike previous studies, these aforementioned experimental studies controlled for gender as an independent (manipulated) variable, and therefore illustrate that perception of gender *causes* these biases. These experimental studies revealed that gender biases influence how adults perceive male and female ability, which had an impact on workplace hiring choices. However, these gender biases may also play a crucial role in early childhood education as primary caregivers may inadvertently transmit gender role expectations of STEM.

The role of the care givers

Given that parents and educators are the primary social transmitters of gender-related Maths attitudes when children are defining their own identity, significant adults play an integral role in the development of a child's academic values (Gunderson, Ramirez, Levine, & Beilock, 2012; Jacobs, Davis-Kean, Bleeker, Eccles, & Malanchuk, 2004; McKellar, Marchand, Diemer, Malanchuk, & Eccles, 2018; Nollenberger, Rodríguez-Planas, & Sevilla, 2016). They also transmit expectations and notions about the roles of males and females and who they should strive to be (Cech, 2013; Worell, 2002). For instance, Korean and USA parents expect their sons but not their daughters to pursue science-related careers (Shin et al., 2015; Tenenbaum, 2009) and discourage daughters from taking science subjects when selecting future courses (Tenenbaum, 2009). These expectations can dictate the caregiver's behaviour. Specifically, analysis of verbal interactions during science museum visits between parents and children demonstrated that adults were three times more likely to explain scientific concepts to boys than they were to girls, even though girls interacted with science exhibits as frequently as boys (96% and 99% respectively). In fact, 1-3 year old boys were four times more likely to hear scientific explanations than 6-8 year old girls (Crowley, Callanan, Tenenbaum, & Allen, 2001). Similarly, a longitudinal study by Alexander, Johnson, and Kelley, (2012) showed that opportunities for science learning were higher for males than females because parents of boys consistently provided science learning opportunities regardless of their son's interest, whereas these opportunities were only provided to girls if they showed interest in science.

Cheryan et al., (2015) suggested that girls' career choices were constrained by stereotypes conveyed either through direct or indirect messages that reinforce the specialty areas of interest or appropriateness for genders. This was illustrated by studies which indicate that daughters, but not sons, constructed career decision efficacy based on their parents' ability perceptions rather than their own ability perception (Bleeker & Jacobs, 2004; Lease & Dahlbeck, 2009). The reported studies support the observation that caregivers seem to tailor opportunities based on gendered stereotypes. As children grow, they enter the next phase of development - formal education - where teachers provide two main sources of self-efficacy building: academic achievement (mastery experience) and formal feedback on performance (social persuasion).

The role of the teachers

As illustrated above, caregivers can be an influential source of science and Maths gender stereotypes for children in an informal setting. In a formal setting, educators play a key role in children's development. Unfortunately, teachers are not impervious to gender biases. Riley (2014) observed three gender stereotypes teacher hold about male and female students: "girls are bad at Maths, boys are slow at reading", "boys are lazy, girls try hard" and "schools are better fit for girls than boys" (p.6). These gendered beliefs are significant for students because teacher make learning assessments and recommendations for learning assistance (Bianco et al., 2011; Riley, 2014). For instance, when educators performed the task of placing students into regular or advanced programs by observing grades on the report card, teachers' decisions were associated with factors such as gender, citing that girls enjoyed hard work and how it was remarkable for a male student to achieve A+ in Language Arts (Riley, 2014). Pedagogically, gender bias may inadvertently influence teaching methods/processes and provide different educational experiences for boys and girls. For example, during science class, middle school boys were asked to answer questions more frequently, were given more feedback, and generally received more attention from the teacher than girls (She, 2001). Furthermore, teachers also tended to ask girls factual questions. In contrast, would ask boys more analytical questions (Shepardson & Pizzini, 1992). Another example which illustrates how gender influence teaching behavior is Newall et al.,'s (2018) experimental study. Newall et al. asked educators to teach a science module online. Without revealing the gender of the child, educators video recorded their practice session. They were then provided with a student profile (male or female). However, they were deceived into believing that the Skype connections was disabled, and they recorded the lesson instead. Results revealed that adults' perception of children's ability and interest in science were influenced by the children's gender. Specifically, boys received higher ratings of predicted future academic performance in science. But most importantly, when educators thought they were teaching stereotypical girls, they provided significantly less science information compared to when they thought they were delivering scientific modules to boys.

A study by Shumow & Schmidt, (2013) revealed that even if science teachers explicitly expressed the belief that boys and girls possessed the same potential for the domain, science teachers still spent 39% more time interacting with boys than with girls. Importantly, studies show that despite attaining similar scores and exhibiting similar learning behaviours, teachers consistently underestimate girls' Maths academic achievement compared to boys from grade one onwards (Cimpian, Lubienski, Timmer, Makowski, & Miller, 2016). Moreover, girls perceive that their teachers have lower expectations of their mathematical performance and ability, which may explain the reduction in motivation and decreased career plans in the maths-related fields (Lazarides & Watt, 2014). The above studies suggest that differential classroom treatment and expectations may be associated with girls' failure to develop their full STEM potential post-secondary education (Shepardson & Pizzini, 1992). However, in addition to these social factors, students' personal beliefs about success and failure attribution are likely to influence their STEM development and career choices in this domain.

Success and failure attribution

There are several factors that explain success and failure, but students seem to generally attribute their academic performance to effort and ability (Good & Brophy, 1990). Belief patterns about effort and ability differ in different cultures. For example, parents, teachers and children from the United States and Germany believe that children succeed because of their ability. In contrast, Asian cultures tend to believe that success can be attained through hard work (Kurtz-Costes, McCall, Kinlaw, Wiesen, & Joyner, 2005). This means that there are two different ideas about the effort-ability interplay. The first idea is the 'negative rule', where effort and ability is inversely related. For example, high levels of effort must mean low levels of ability. The second idea is the 'positive rule' in which high effort equals high ability (Dweck, 2000; Lam, Yim, & Ng, 2008). How this interplay is perceived by adults becomes crucial to intelligence attribution as a negative rule between effort and ability tends to predict a fixed mindset (viewing intelligence is static), while a positive rule embraces a growth mindset (viewing intelligence as malleable) (Lam et al., 2008). Furthermore, parents who view intelligence as malleable tend to perceive failure as an opportunity to learn, whereas parents who hold an ‘entity’ theory of intelligence may see a temporary setback as evidence of low ability (Haimovitz & Dweck, 2016; Lam et al., 2008). According to this research, parents’ intelligence mindset is not visible to their children. However, children are able to accurately perceive their parents’ mindset about intelligence through parental reactions to failure. This is especially important as parents’ reactions shape the children's own beliefs about their abilities (Haimovitz & Dweck, 2016).

Unfortunately, individuals seem to view effort and ability as contradictory (Siegle, Rubenstein, Pollard, & Romey, 2009). In other words, the dominant perception is that if a domain requires effort, it implies low ability, but if it requires low effort it implies high ability (Heider, 2005; Siegle et al., 2009). This concept does not apply to all tasks and domains. Miele, Browman and Vasilyeva (2019) explain that effort can be perceived as *task-elicited* (amount of effort due to task difficulty) and as *self-initiated* (amount of effort due to motivation and engagement). In domains like mathematics where competition and comparison allows for task-elicited effort, more effort is perceived as possessing less ability while subjects like English, where the focus is on growth, high effort is perceived as self-initiated, thereby, a display of high ability (Muenks & Miele, 2017). This effort attribution theory has also been researched by Koriat, Ackerman, Adiv, Lockl, and Schneider (2014), who refer to task-elicited effort as *data-driven* effort and self-initiated effort as *goal-driven*. Their work is important because they point out that how students think about their learning (data-driven or goal-driven), influences their effort/ability attribution. Young children seem to hold a positive rule between effort and ability, therefore intelligence equals high effort, but as children get older, they begin to associate the concept of high effort expenditure as an indication of lower ability (Folmer et al., 2008; Kurtz-Costes et al., 2005;) and this dichotomous belief seems to be carried into adulthood. Interestingly, adult studies suggest that women generally interpret greater effort as an indication that they do not belong in that field while men are less likely to make this interpretation (Smith, Lewis, Hawthorne, & Hodges, 2013; Cheryan, Ziegler, Montoya, & Jiang, 2017). Additionally, people tend to associate natural intelligence with performing tasks easily and quickly (Veronikas & Shaughnessy, 2004). When it comes to failure, male students tended to attribute failure to lack of effort, which encourages them to succeed in the future. In contrast, female students attributed failure to lack of ability which may result in a lower sense of self-efficacy (Siegle et al., 2009).

Usher's (2009) study showed that parents and teachers attributed girls' mathematical success to high effort rather than ability. Even though it is unknown whether the effort-ability interaction is inversely related or positive related, it seems that a negative rule is implied with the success due to effort. This could explain why despite the absence of gender differences in general ability and Maths performance, teachers evaluate girls' Maths ability as lower than that of boys (Dickhäuser & Meyer, 2006). Teachers believe that boys succeed due to their natural abilities whereas girls succeed due to their efforts (Fennema, Peterson, Carpenter, & Lubinski, 1990; Georgiou, Christou, Stavrinides, & Panaoura, 2002; Lazarides & Watt, 2014; Siegle & Reis, 1998; Smith, Lewis, Hawthorne, & Hodges, 2013; Tiedemann, 2002; Usher, 2009). Tiedemann's (2002) study of gender bias found that teachers' perceptions of student's mathematical abilities can be distorted if they uphold strong gender-role stereotype beliefs. Specifically, the study showed that the more frequently that teachers subscribe to traditional gender roles, the more they perceived males' success as being due to natural abilities and females' success as being due to effort. Even among gifted students, teachers consistently rated female students' success in science, Maths and social studies as due to effort rather than ability (Siegle & Reis, 1998).

Considering these findings, researchers are interested in discovering the best way to support students when they encounter failure. Research on failure attribution paints a complex picture of educators' responses to failing students, and failure attribution seems to dictate teacher reaction towards failing student. For example, if low ability is attributed, the teacher is more likely to respond with pity, but if low effort is attributed, teachers respond with anger (Georgiou et al., 2002). Well-meaning teachers who try to console failing Maths students by expressing sympathy inadvertently promote low expectation in future tasks and lock students into resigning themselves to poor performance (Rattan, Good, & Dweck, 2012). Teacher feedback and perceived ability is important for female students to build a strong sense of self-efficacy in mathematics since girls are inclined to rely on their teachers' evaluation to build confidence. In comparison, boys rely on feedback and their Maths achievement (Dickhäuser & Meyer, 2006). For example, a primary school study showed that the more positive messages the children received, the higher their Maths self-efficacy became (Joët et al., 2011). However, compared to boys, girls in the study received fewer encouraging social messages about their Maths achievements. Bandura (1997) theorises that young children rely on social persuasion to construct evaluations of their performance as they do not yet possess experience to rely on self-appraisal. Unfortunately, teacher's feedback may be associated with assumptions about gender stereotypes and therefore, an inaccurate appraisal of the student's potential in Mathematics.

Assumptions about gender as cause for differences

In mathematics, extant research suggests that gender is associated with the observed differences in interest and performance. However, without experimental studies it is not possible to determine whether gender plays a causal role or, whether the effects observed are driven by other variables which have not been considered in natural settings. For instance, in observational studies such as She's (2001) paper, teachers may direct more questions to boys as teachers may perceive girls' quiet behaviour as evidence of disinterest. As a result, teacher's behaviour might be modified and is diverted towards seemingly more interested males. However, it is not the students' gender but their perceived interest that could explain the results of that study. This behaviour has already been observed with parents who present opportunities for science learning if they perceive that their daughters are already interested in the subject (Alexander et al., 2012). Many studies claim that gender drives result differences, when in fact gender was not manipulated in the studies (Worell, 2002). Therefore, experimental research in this area that manipulates gender perception holding other variables constant (e.g., perceived interest, hobbies) can help clarify assumptions about mathematical ability, student failure, self-efficacy beliefs and teacher judgment as caused by gender perception rather than other variables such as students' disinterest or other classroom behaviours.

The current study

It is important to establish if gender is the underlying reason for differential treatments because it impacts on how educators are going to help girls who are at risk of performing sub optimally in Mathematics and/or to support girls who exhibit high effort in Maths but do not perform well academically. Current studies indicate that even when boys fail, teachers persist in supporting boys in STEM because of assumed ability (Alexander et al., 2012), whereas girls fail quietly and unnoticed (Lahelma, 2005).

The present experimental study investigates mathematical failure in a child's first year of formal education. Gender and effort are manipulated to determine whether gender or effort alone, or a combination of gender *and* effort affects adults' responses to children's failure in mathematics. Specifically, the study measures if failing students were encouraged or discouraged from pursuing Maths through extracurricular activities. Participants are also asked to complete a mathematics mindset and the Maths self-efficacy questionnaire. Research consistently indicates that self-efficacy beliefs seem to be drive outcomes which are then carried into adulthood (Stoehr, 2017), therefore a mathematics self-efficacy scale was used to measure participant's self-concepts as mathematicians. This was measured in order to observe whether the participants' mathematics self-efficacy was a significant predictor of their placement decisions for failing students in remedial Maths and Language Arts domain subjects.

It is predicted that boys will be encouraged to persevere with mathematics regardless of effort (low or high). Girls who demonstrate high-effort and failed may also be supported with extra Maths experience as previous research suggests that adults of ten believe that if girls try hard enough, they will succeed (Fennema et al., 1990; Georgiou et al., 2002; Lazarides & Watt, 2014; Smith et al., 2013). However, it is also possible that girls with high-effort in Maths may not be encouraged to persevere in Maths as frequently as boys with high-effort and may be steered towards English related subjects because girls who display low-effort and fail may be assumed to have no interest and ability in the subject and will probably not be encouraged to pursue mathematics.

Method

Participants

Participants were limited to people living in Australia at the time of research to avoid heterogeneity of responses (e.g., cultural differences in STEM attitudes). 234 participants agreed to take part in the survey, but 36 participants stopped taking part in the survey before any subject recommendations were made. 198 (83.5%) participants completed the study and submitted their answers when the experimental nature and purpose of the study was revealed. However, 9 participants (4.5%) were excluded as they failed the experimental manipulation check. These participants could not recall the correct gender or effort in the report card that they viewed in the study. Therefore, the final sample size was N=189. There were twelve male (6.3%) and 177 female (93.7%). Of these, 131 (69.3%) were preservice primary school teachers, 15 (7.9%) were in-service primary school teachers, and 43 (22.8%) were parents of primary school aged children. Of the total participants, preservice teachers (6) and in-service teachers (11) were also parents (17 total). Participants were recruited from two sources: social media sites (Facebook, LinkedIn and Reddit) and groups of pre-service teachers enrolled in undergraduate units at Macquarie University (See table 1 for all demographic information). Student participants (pre-service teachers) were offered credit points for participating in the study. Participation in this project was entirely voluntary and they were free to withdraw at any time without having to give a reason and without consequences. Participants recruited on social media had the option to take part in a gift card draw to the value of $200. This study was approved by the Faculty of Human Science, Macquarie University research ethics committee (ethics reference: 5201927957614).

Material and Measures

Student profile.

The student profile, which included the student's residential area, hobbies, and family structure, was designed to depict an average family in the median income range. The names John and Annie where chosen for their high association with male and female names (Battig & Montague, 1969). John/Annie is six years old and just completed the first semester of year one at a local primary school. The profile also points out that the student has adjusted well to school life (see appendix A).

Child's report card.

See appendix B for the report card content which illustrates the four experimental conditions. All four reports depicted failure in Maths and English. Report cards however, varied on gender (male or female) and effort (high or low). This led to four types of report card: (1) boy who failed with low effort, (2) boy who failed with high effort, (3) girl who failed with low effort, and (4) girl who failed with high effort. To design the content of the report card, real primary school report cards were examined, and comments were based on performance objectives from the New South Wales Education Standards Authority (NESA; New South Wales Government, 2018). Maths and English were chosen as key subjects in this study as the literature indicates that they are core subjects with established gender biases (del Río & Strasser, 2013; Eccles et al., 1993; Gunderson et al., 2012; Siegle & Reis, 1998). Additionally, English was included to show that any gender effects observed are not general to all subjects but are specific to Maths.

Mathematics Oriented Implicit Theory of Intelligence Scale (MOITIS)

(Appendix C) Ilhan and Çetin (2013), developed the Mathematic Oriented Implicit Theory of Intelligence Scale (MOITIS) to measure beliefs about entity and incremental theory of intelligence. The 11-item questionnaire is based on Dweck's (2000) theories of intelligence scale. However, the items in the MOITIS were reworded to present a first-person statement, for example, "I have a certain level of mathematical intelligence . . ." Participants answered by using a 4-point scale from 0 = *I definitely disagree*, 4 = *I definitely agree*. This was done in order to measure the participants' own beliefs about their mathematical intelligence rather than a general belief about people (De Castella & Byrne, 2015). In Ilhand and Cetin's (2013) analysis, the MOITIS was found to be a valid and reliable measuring instrument (Ilhand & Cetin, 2013). The Cronbach's co-efficient for the current sample was 0.78 growth mindset and 0.79 for fixed mindset.

PISA Maths Self-efficacy Scale.

The Maths self-efficacy scale (see appendix D) is an 8-item questionnaire based on the Program for International Student Assessment (PISA) (OECD, 2018) mathematic tasks. It was chosen because it aims to measure real world Maths tasks (for example, 'how confident do you feel about understanding graphs represented in newspapers') which makes it more relevant to the general population. Items are measured on a 4-point Likert scale from 0= *not at all confident* to 4= *very confident.* The Cronbach's alpha for the current sample was 0.82.

Outcome measures.

Future academic performance, interest, and ability

Participants were asked to rate the child's future academics performance by giving a score from a scale to "*How well do you think the child will perform academically in Mathematics/English?*" with values ranging from 0 = very poorly, to 4= very well. Participants were also asked to rate the reason for failure in mathematics and English by using a 5-point scale slider bar, for example "Do you think the student failed in Mathematics/English due to lack of interest?" (0= *strongly agree* to 4= *strongly disagree*). Finally, participants were invited to describe other reasons (apart from interest and ability) for failure.

Subject recommendation rating

Six remedial subjects were presented in the survey and participants were asked to rate these as options for consolidating the child's achievements in Maths and English. Three of the activities are STEM related (Cool Computer Codes, Maths Madness and Lego Robotics) and 3 are associated with Language Arts (Reading Race, Writing Ready and Art Advantage). Based on the student report card, participants were asked to rate how likely they were to recommend each of the extra-curricular choices by using a 5-point scale slider bar (0= *unlikely* to 4= *extremely likely*).

Gender and effort manipulation check

After being exposed to the experimental condition participants were asked an effort manipulation check question. Specifically, we ask participants whether students showed high or low effort in their report card for Mathematics and for English. (e.g, “What the student’s effort in Maths?”). Participants who incorrectly perceived effort in Maths and English were either excluded or reclassified. Where participants provided consistent answers across English and Mathematics even when they were incorrect, they were reclassified to the perceived effort group in order to be retained. For example, if participants perceived that a child had put in low effort in Maths and English (but the exposed condition was high effort), that participant was reassigned into the low effort group. See table 2 for how participants were treated. Twelve participants had to be reassigned to the low-effort group. No participants had to be reassigned to the high-effort group. Four participants were removed from the final sample. After making subject recommendations and rating reasons for failure, participants were asked a gender manipulation check (e.g., “What was the students’ gender?). Five participants did not pass the gender manipulation check and were therefore excluded from the final sample.

Design and procedure

Participants who met criteria for the online survey were directed to a detailed consent form, which explained that the study was an evaluation of a student's report card. Upon consent, participants proceeded to answer demographic questions. They were then randomised to read one of four report cards: boy low-effort, boy high-effort, girl low-effort or girl high-effort. Participants read the student profile for Semester 1-Year 1, followed by the school report. Participants were then asked to rate the child’s future academic performance, and rate how likely they were to enroll the child in each of the offered remedial subjects. Next, they rated the reason for failure in mathematics and English (lack of interest and lack of ability). This was followed by an experimental manipulation check. Finally, participants completed the Mathematics Implicit Theory of Intelligence Scale and Maths Self-Efficacy Scale.

At the end of the survey participants were informed that the main focus of the study is whether the child's gender and effort affect people's perception of the child's ability and interest in Maths and English. They are also given the chance to submit or withdraw from the study, but no participants chose to withdraw at this stage.

Statistical Analyses

To examine the data, General Linear Model (GLM) analyses were performed for perceived future academic achievement, interest, ability and subject recommendations ratings. Between-subject factors were Experimental Gender (male or female student depicted in report card) and effort (high or low for both English and Math in the report card). Within-subject factors were subjects (STEM /Math or English/Language Arts subjects). Based on this design, the study had a 95% chance of detecting a moderate effect size for a between-within interactions predicted in this study. SPSS 26 was used to conduct reported analyses.

Results

Preliminary results

In order to detect any demographic differences between participants and the four experimental groups, Chi-square tests of independence were performed on demographic variables. Results revealed that participants in the four experimental conditions did not differ by age, gender, participant kind (preservice teacher, in-service teacher or parent), cultural background or income (all $ps > .05$).

The distribution scores for dependent variables (STEM + Language Arts subject recommendations, Maths + English Interest, Maths + English ability) were within the normal distribution levels with skewness between −.512 and .766, and kurtosis between −.918 and .395. Therefore, no adjustments were made to the data. For all result means and standard deviations across the four groups see table 4.

Perceived future academic performance.

There was a main effect of subject, F (1, 185) = 21.62, p = .001, η_p^2 = .10. Participants gave higher predicted academic ratings for Maths (M= 1.14, SD = .79) than English (M= .94, SD = .82) regardless of children's gender or effort. There were no other significant main effects or interactions (p range: .00 - .716).

STEM and Language Arts subject recommendations.

ANOVA results indicate a significant Subject x Experimental Gender interaction effect; F (1, 185) = 5.42, p = .021, η_p^2 = .02. As can be seen in Figure 1, differences in subject recommendations occurred for girls but not for boys. Girls were less likely to be recommended to STEM subjects compared to Art subjects whereas boys were equally likely to be recommended to STEM and Art subjects. Paired t-test analyses confirmed this observation. Specifically, there were no differences in subject recommendations for boys, t (90) = 0.71, p >.05. However, there was a significant difference between STEM and English recommendations for girls regardless of effort exerted, t (97) = -2.61, p = .010. There were no other significant main effects or interactions (p range: .184 - .762).

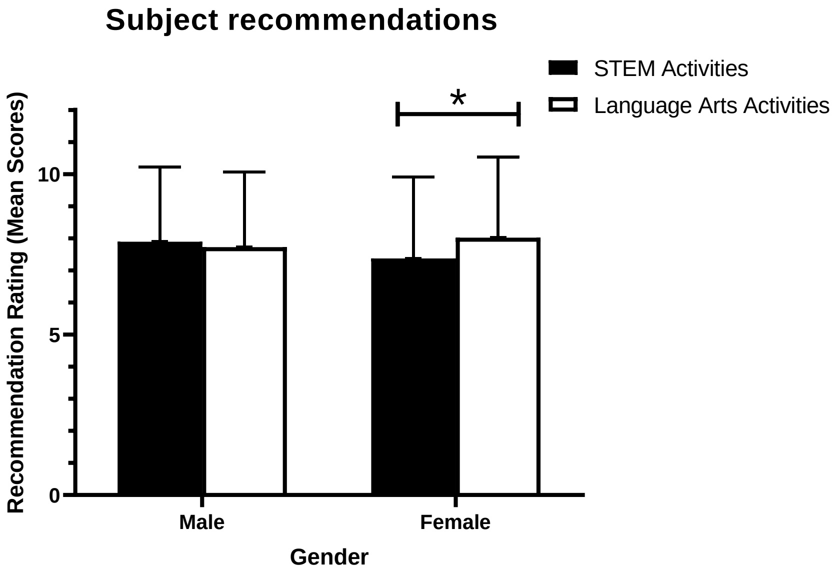

Fig. 1. Estimated marginal means for subject recommendations. Error bars represent standard errors. An asterisk indicates a significant difference between groups.

Table 4

Means and standard deviations for subject recommendation, perceived failure due to low interest and perceived failure due to low ability

	Boy Low Effort (n = 47)		Girl Low Effort (n = 52)		Boy High Effort (n = 44)		Girl High Effort (n = 46)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Maths future academic performance	1.06	.81	1.13	.81	1.11	.78	1.28	.75
English future academic performance	.76	.72	.84	.77	.97	.82	1.21	.86
STEM Subject Recommendations	8.10	2.31	7.51	2.45	7.63	2.39	7.30	2.59
Art Subject Recommendation	7.93	2.35	8.23	2.43	7.47	2.37	7.80	2.60
Maths Failure due to Low Interest	1.21	1.04	1.51	1.26	2.31	1.19	2.43	1.02
English Failure due to Low Interest	1.23	0.98	1.67	1.09	2.27	1.12	2.52	1.06
Maths Failure due to Low Ability	2.00	1.04	1.82	1.02	1.47	1.08	1.63	1.04
English Failure due to Low Ability	1.68	1.04	1.76	1.04	1.70	1.15	1.69	1.07

Failure due to low interest

There were no main or interaction effects for failure attribution due to lack of interest in a subject, p range = .216 - .999. See table 4 for mean ratings.

Failure due to low ability

Results revealed a significant interaction for discipline subject x effort; F (1, 185) = 10.20, p = .002, η_p^2 = .05. However, there was also a three-way interaction effect of Subject x Effort x Experimental gender, F (1, 185) = 4.08, p =.045, η_p^2 = .02. Four follow-up t-tests revealed the basis for this interaction. Among girls, effort did not affect participants' ratings of ability in Maths, t (96) = .941, p>.05, or English, t (96) = .341, p>.05. That is, girls were seen as having similar abilities regardless of the effort they exerted in both discipline subjects. However, among boys, there was a different pattern of results based on discipline subject and effort. As can be seen in Figure 2, when boys exerted high effort in Maths, they were perceived as having *less* ability than boys who exerted low effort. This difference in ability ratings based on effort was not observed in English for boys. That is, boys were seen as having similar abilities regardless of effort exerted in English. This interpretation of the results is supported by follow-up t-tests showing that ability ratings for boys differed significantly based on effort exerted *only* in Maths, t(89) = -2.33, p=.022 but not in English, t(89) = -.10, p>.05.

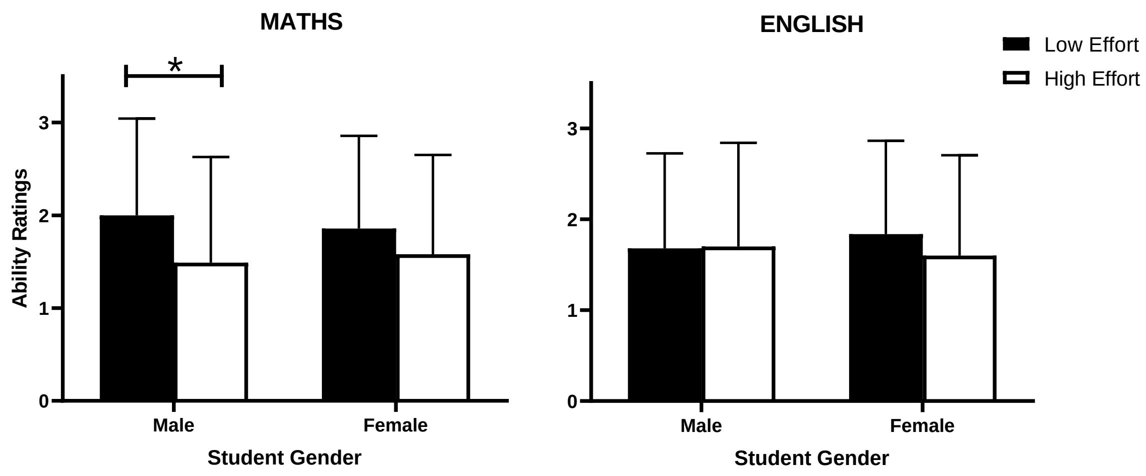

Fig. 2. Estimated marginal means for perceived Maths and English ability. Error bars represent standard errors. An asterisk indicates a significant difference between groups.

Other reasons for failure

As an additional exploratory approach, participants had the option to provide an explanation to why they thought the child may have failed in Maths and English. The work of Jaksic and Malinic, (2019) was used to guide the analysis of the themes in this qualitative data. These are: the student's *personal factors* such as motivation and ability, *educational support* which includes teachers and parents, and *social aspects* which encompass family and the social environment. Interestingly, an additional theme emerged in this study: undiagnosed learning difficulty was also a commonly cited reason for failure. Finally, *other reasons* was added as a category for reason which did not fit the other themes. These five themes were individually judged by (1) chief student investigator, (2) another PhD candidate (reliability coder) from Educational Studies in an unrelated topic (3) and a practicing English language teacher (reliability coder).

Twenty-eight percent of participants ($N = 53$) provided comments about other reasons for failure (apart from lack of interest and lack of ability) for Maths, and 25% of participants

($N = 48$) also provided hypothesized explanations for for failure in English. Three judges coded those explanations for each of the two subjects using five themes. These were (1) lack of ability or motivation, (2) lack of educational support, (3) lack of family support, (4) undiagnosed learning disability and (0) other reasons. The interclass correlation (ICC) for the three judges was .981 in Maths and .911 in English. Given the high ICC, the mean percentages for each reason was calculated across the three judges. Based on this it was found that for both Maths and English, failure was mainly attributed to lack of educational support, at 33.3% and 38.9% respectively. However, the second most cited reason for failure in Maths was undiagnosed learning difficulty (24.5%), while the second reason for English failure was equally ascribed to lack of family support and other reasons, at 25.5%. For the complete table of analysis see table 3. It's interesting that the second reason for Maths failure is undiagnosed learning difficulties. This may suggest a more entity approach to mathematics as participants more frequently associate what may be a temporary failure as a fixed factor (Haimovitz & Dweck, 2017; Lam et al., 2008)

Mathematical mind-set and Maths self-efficacy

Despite research pointing towards mathematics mindset and a Maths self-efficacy as key factors that may affect adult's perception of children's mathematical ability, these two variables did not contribute to our results. Specifically, mathematical mind-set and Maths self-efficacy were included in the above analysis as covariates in supplementary analysis. Neither factor was a significant contributor as results did not vary when these two factors were included in the above analyses for subject recommendations and failure attribution (lack of ability and lack of interest), p range = .557 - .899.

Discussion

There were three major findings in the present study. Firstly, participants perceived both genders, regardless of the fictional child's effort, as having greater potential of performing better Maths than in English. The second finding reflects a bias for recommending girls to remedial Language Arts subjects rather than STEM subjects regardless of effort exerted in English and Maths. In comparison, boys were recommended to remedial subjects equally across Language Arts and STEM. Finally, even though it was a relatively small effect size, we found a punitive effect for boys who showed high effort and failed in mathematics. Boys who tried and failed were seen as having less ability than boys who put in low effort and failed. Interestingly, this effect is not observed in English for boys or girls. Despite Maths self-efficacy and Maths mindset playing a key role in various studies (Dweck, 2000; Haimovitz & Dweck, 2016; Lam et al., 2008), these two factors did not contribute significantly to any of the results presented here.

In Newall et al.,'s (2018) study, knowledge of the child's gender affected ratings for future academic success. In their study, participants rated girls' potential for academic performance in STEM subjects as lower than boys. The current finding revealed a surprising subject effect for perceived future academic performance where children were predicted to perform better in Maths than in English *regardless* of gender. The results may be dissimilar due to variations in the student profiles. The mentioned study included stereotypical girls (girly girls), whereas the present study represented gender neutral girls. This might explain why Newall et al., (2018) observed a gender affect that is absent in this study. These results could reflect people's conscious belief that both boys and girls can perform academically well in STEM (Shumow & Schmidt, 2013). In the Australian context this is a positive cultural change. Even though boys outnumber girls in STEM, subject enrolment in high school level (Commonwealth of Australia, 2017) as well as the number of participants studying STEM in higher education has continued to decrease over the past 20 years (Commonwealth of Australia, 2017; Timms, Moyle, Weldon, & Mitchell, 2018). Researchers state that while STEM participation numbers decrease the demand for STEM literacy increases. If this trend continues researchers predict that Australia will not be able to meet future demand for STEM positions. Therefore, it is crucial to encourage boys and girls to pursue STEM related field.

It was expected that boys who failed would be encouraged to pursue STEM subjects regardless of effort. This was neither confirmed nor contradicted as boys were equally encouraged to further explore STEM and Language Arts subjects. It was also predicted that girls who exhibited high-effort and failed in Maths would not be encouraged to further develop their mathematical ability. However, the results revealed that all girls- regardless of effort - were more frequently nominated to participate in Language Arts than STEM domain subjects. This finding is consistent with the prevailing stereotype that girls/women are more suited to the Arts/languages than STEM (Martinot et al., 2012). Moreover it is also consistent with Tenenbaum's (2009) study, which showed that parents and daughters chose to take part in Language Arts courses more frequently than Maths. The findings of the present study add to the growing body of work which shows the prevalence of the gendered belief that girls succeed in the humanities and boys in STEM (Hand et al., 2017; Martinot et al., 2012; Shin et al., 2015; Tenenbaum, 2009). Even though parents and teachers may not explicitly state that girls lack capacity for Maths, girls can often infer beliefs from adults' behaviours such as being asked less challenging questions in science classes (Shepardson & Pizzini, 1992) being provided with less scientific information in the classroom (Newall et al., 2018) and receiving less encouraging comments in Maths (Joët et al., 2011).

Experimental studies such as Newall et al.,' (2018) and the one presented here are significant because they depict real-world application and outcomes. These studies do not only rely on self-reported measures such as rating and ranking. They require participants to perform a classroom-based behaviour. Specifically, the significant finding that girls are most often recommended to Language/Arts remedial courses are relevant to real-world behaviours. For example, teachers are routinely asked to make recommendations for gateway classes, Maths competitions and STEM camps. According to the presented studies and the current findings, teachers and parents may be making gender-stereotyped decisions. Similarly, when girls are being taught, learning content may be modified to contain less scientific information in a social learning environment such as museum visits (Crowley et al., 2001) as well as in the formal teaching (Newall et al., 2018). Consequently, girls are provided with less scientific information and according to this study's results, with less opportunities to develop their STEM skills.

It has been well documented that boys are provided with support towards STEM subject as they are perceived to possess field specific ability (Alexander et al., 2012; Espinoza, Quezada, Rincones, Strobach, & Gutiérrez, 2012). Nonetheless, the ability analysis conducted in this study revealed that boys who put in high-effort and failed were perceived to have much less ability than boys who failed and did not exert effort. This finding about Maths competence perception is in line with effort attribution theory which explains that levels of effort exerted in a task is conversely related to ability (Heider, 2005). That is, more effort is needed to make up lack of ability. This assumption especially applies to Maths due to its task-elicited characteristics (amount of effort due to task difficulty) (Miele et al., 2019) which may explain low ability rating in Maths (for high-effort) and the absence of low ability rating in English (for high-effort). Because of its focus on mastery, high effort in English tends to imply high ability. The current finding shows that boys who exert a lot of effort but still fail are judged to possess less mathematical ability after just 6 months of formal mathematical education. Surprisingly, for girls, there was no difference in ability rating in Math and English regardless of effort. Therefore, effort attribution theory is not consistent for both genders.

Girls were judged to have comparable levels of ability in both English and Maths. This may be linked to the unexpected finding in the present study. Unlike previous research (Dweck, 2000; Haimovitz & Dweck, 2016; Lam et al., 2008), a self-efficacy or mind-set effect was not detected for any of the mentioned results. Evidence of fixed mindset in mathematics would have explained why only boys who exerted high effort were perceived as having less ability in Math but not girls. The lack of effect may be due to lack of good internal consistency for the Maths mindset and self-efficacy scales. The internal consistency is moderate to low (Maths mindset 0.78 growth mindset and 0.79 for fixed mindset. Self-efficacy 0.82). Nevertheless, there is another theory which could help explain the current finding. With boys, a *punishing* effect can be observed if they fail despite high-effort expenditure. The ‘backlash’ theory punishes boys for breaking gendered expectations (Sullivan, Moss-Racusin, Lopez, & Williams, 2018), and this may explain the negative ability rating for high-effort boys in Maths.

As previously mentioned in the introduction, STEM is seen as a masculine subject where boys are expected to do well (Alexander et al., 2012; Espinoza et al., 2012; Riley, 2014). The backlash theory predicts that when individuals violate stereotypical assumptions, society pushes back by punishing them for their infringement (Sullivan et al., 2018). The backlash theory applies to both genders but when boys break away from expected behaviour, they are more severely punished than girls (Feinman, 1981; Sullivan et al., 2018; Yu et al., 2017). Specifically, adult males as well as boys are shunned by their peers if they violate gender rules (Coyle, Fulcher, & Trübutschek, 2016; Rudman & Mescher, 2013; Sullivan et al., 2018; Yu et al., 2017). For example boys who wear nail varnish are ostracised by their own friends (Yu et al., 2017) and men who request parental leave from their work place are more likely to be demoted due to being perceived as weak and feminine (Rudman & Mescher, 2013). However, if girls adopt stereotypically masculine behaviours such as wearing trousers or playing football (Yu et al., 2017), this behaviour is approved and seen as desirable (Coyle et al., 2016; Feinman, 1981). Conversely, boys experience disproval of cross-gender like behaviour (Coyle et al., 2016; Feinman, 1981; Yu et al., 2017). Importantly, adults also reject stereotype-violating children by perceiving them to be less likeable when they adopt behaviours associated with the opposite sex, and boys are more severely punished by adults when the boys adopt feminine like traits (Coyle et al., 2016; Sullivan et al., 2018). This leads into the precarious masculinity theory were any violation of masculinity is perceived as much worse than violation of femininity. There is extensive research which shows that males are much more restricted in the behaviours they are allowed to perform without backlash (Coyle et al., 2016; Feinman, 1981; Moss-Racusin & Johnson, 2016; Rudman, Moss-Racusin, Glick, & Phelan, 2012; Yu et al., 2017). For example, male primary school teachers are perceived as posing a safety threat, more likely to be gay, and less likeable that female primary school teachers (Moss-Racusin & Johnson, 2016). Consistent with the three-way interaction found in the present study, boys are more likely to be punished when they exert effort in a stereotypical masculine subject and then fail. Additionally, this does not occur for English *and* not for girls. However, future studies could explore this effect in more detail by presenting gender atypical student profiles where a boy academically succeeded in Language Arts and failed in Maths versus a girl who attained high Maths scores but performed poorly in Language arts. It would be interesting to find out if the girl would be supported but the boys would be punished. It would also be important to find out the thought process behind these decisions. Perhaps qualitative data could provide information about the rationale participants use when referring students to remedial classes.

The present study is important because it shows that gender alone predicts opportunities for girls' STEM development. The student profile for this study showed the academic results of a 6-year-old child who just completed their first six months of formal education. Nonetheless, adults in this study determined that girls needed more English skills than STEM skills development. The subtle messages adults transmit to girls through socio cultural practices such as the one observed here may communicate gender appropriate domains and restrict girls' future STEM explorations (Bussey & Bandura, 1999; Cervoni & Ivinson, 2011; Cheryan et al., 2015). Most studies to date have focused on how teachers rate ability or support girls in Maths. However, this study has examined how adults react to failure in discipline specific subjects (Maths and English). The results show that educational choices are affected from grade one, and after their first failure. Parent and teachers restrict STEM educational choices for girls as young as six, when they are just starting their educational journey. This may explain why girls start to doubt their Maths skills and ability by middle primary school (Bandura et al., 2001; Eccles et al., 1993; Prinsley et al., 2016). Previous studies show that parents typically provide more STEM learning opportunities to sons rather than daughters (Alexander et al., 2012). This study shows that daughters are provided with more opportunities to further develop their Language Arts abilities, which also means leading them away from STEM, but boys are given equal opportunity across the two domains. Regardless of girls' effort in Maths and English (high or low), they keep being directed toward the arts.

Educational implications

The current findings add to previous research which indicates that students' gender may inadvertently influence teacher behaviour (Lazarides & Watt, 2014; Newall et al., 2018; Riley, 2014; She, 2001; Shepardson & Pizzini, 1992; Shumow & Schmidt, 2013). Our results have significant educational implications as this study mirrors what occurs in the real world. Previous research indicates that gendered beliefs are so intricately woven in our subconscious that even when people consciously fight gender bias, they are still influenced by gender

(Banaji & Hardin, 1996; Shumow & Schmidt, 2013). In this study, teachers believe that students have the same interest and the same potential for mathematical academic achievement but may have implicitly made choices based on gender stereotype beliefs about males and females. In order to make a difference in dispersing gender stereotypes, educators and parents need to become aware that their perceptions of boys and girls can influence gender gap in Maths achievement (del Río & Strasser, 2013; Robinson-Cimpian, Lubienski, Ganley, & Copur-Gencturk, 2014). The present study shows that adult participants recognise that boys and girls have similar interest in Maths and English as well as ability. However, their decision-making in the context of remedial classes recommendation revealed an underlying bias for girls to pursue the Language Arts domain.

Another key educational observation is performance feedback. Because children are susceptible to the value attribution of effort and ability (Muenks & Miele, 2017), the way teachers and parents give feedback about performance in a domain determines how students think about the value of effort and the value of ability within a specific context. Within the context of the current study, adults attributed low ability to only high-effort boys. This may suggest an entity mindset which indicates that educators need to avoid highlighting brilliance and natural ability as a key to success in Maths for boys. In order to make this shift, teachers should emphasise the role of effort, persistence and hard-work instead of talent, in all domains (Smith et al., 2013; Wang & Degol, 2017). Importantly, because mindsets about effort seem to emerge late in primary school, the importance of hard-work, effort and perseverance needs to be highlighted as early as possible in formal education (Wang & Degol, 2017). Additionally, growth mindset language and communicating the value of effort in increasing mastery in a domain can help shift students' perception from a negative relationship to a positive relationship

Despite high-effort boys being perceived as having less ability, they were still provided with equal remedial support in Maths and Language Arts, whereas girls receive more educational opportunities for Language Arts. Studies could exclusively explore teachers (rather than parents and teachers) to see if remedial class recommendation would differ to the current findings. Alternatively, a comparison study between single-sex schools and co-educational teachers could be explored. It would be interesting to find out if there is a variation in ability perception and subject recommendation, especially from single-sex educational institutions as these teachers interact only with girls in the classroom.

Limitations

The first limitation is the fact that the highest number of participating cohort were pre-service teachers. Results may have been affected by the fact that pre-service teachers may not yet have enough teaching experience to evaluate students' needs when they fail. Nevertheless, the findings still apply to teachers early in their career. Though the current sample included parents and in-service teachers, both samples were too small (parents N = 43, 22.8 %, and in-service teachers N = 15, 7.9% of overall sample), which precluded comparisons across different participant groups (e.g., parents versus pre-service teachers verses in-service teachers). Further studies may exclusively look at teachers or parents. Research about teachers and parents' attitude to failure is important because it reflects classroom behaviours and home behaviours. Establishing how influential each of those factors are in students' educational choices could lead to better designed interventions and affect greater change. For example, in a situation where a student is interested in Language Arts, but parents endorse gender-bias, could a growth mindset teacher offset this influence? Research indicates that parental perception influences educational choices (Bleeker & Jacobs, 2004; Cheryan et al., 2015; Lease & Dahlbeck, 2009) and girls are more susceptible to parents perceptions than boys. Therefore, it would be beneficial to find out if encouraging teachers could impact educational paths for girls and boys who struggle with mathematics.

Another limitation is the report design. To minimise design complexity, all students were consistently low-effort or high-effort in both mathematics and English. Therefore, we couldn't find out what happened to students who were high-effort in mathematics and low-effort in English and vice versa, and whether that would have made the effects more pronounced in terms of recommendations. Specifically, it is unclear how participants would have perceived a girl who exerted high effort and achievement in math but failed in English because of low effort in that subject. These may lead to a more nuanced picture of effort-ability. Results found in this study indicate that girls are perceived to have the same ability in English and Maths regardless of effort, therefore a study looking at the scenario of differential effort and achievement across English and Math may reveal that effort does influence performance for girls. However, the present study is unable to predict result for this context. Future studies could explore this concept.

Conclusion

To the author's knowledge, this is the first study to experimentally control gender and effort to explore adults' response to Math and English failure. A surprising finding is the perception that boys who exert high effort and fail in Maths are seen as possessing less ability than boys who put in low effort. This could be due to backlash from violating a gender stereotype, where boys are expected to excel at Maths. By rating them with lower ability, adults may be punishing these boys by depriving them of the Math-male status. A more consistent finding with previous research is girls being directed towards Language Arts. This finding adds to the language-female gendered assumptions (Hand et al., 2017; Martinot et al., 2012; Tenenbaum, 2009). However, these results have not been able to clarify how equity for boys and girls can be achieved across disciplines, or how to change the culture that directs girls away from STEM and punishes boys for not excelling in the domain. There is a need for more well controlled studies which clarify the main contributors of bias as well as interventions that minimise the impact of these biases. This study set out to investigate whether failing student would be supported or discouraged from further developing STEM skills through supplementary classes. Despite high-effort boys being perceived as having less ability that low-effort boys, they were equally recommended to improve their STEM and Language Art skills. This indicates that at this young age, parents and teachers seem to perceive both domains as equally important for boys. Results indicate that Language Arts related subjects seem to be significantly more important than STEM related subject for girls. However, adults also perceive that girls have the potential perform academically well in Maths and possess the same level of ability in Maths and English. This may be evidence of a shifting culture and the beginning of social progress regarding stereotypes about girl and ability.

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Tables

Table 1

Participant Demographic Information

Characteristics	Total N	% of respondents
Gender		
Male	12	6.30%
Female	177	93.70%
Participants mean age		
	27.4	100%
Kind of participant		
Pre-service teacher	131	69.30%
In-service teacher	15	7.90%
Parents	43	22.80%
Cultural Background		
Australian	121	64%
Chinese	17	9%
British	6	3.20%
New Zealander	4	2.10%
Indian	3	1.60%
Other	38	20.10%
Annual Household Income		
Less than $20,000	109	57,7%
$20,000 to $34,99	18	9.50%
$35,000 to $49,999	15	7.90%
$50,000 to $74,999	14	7.40%
$75,000 to $99,999	13	6.90%
Over $100,000	20	10.60%

Table 2

Effort Check

	Manipulation check **Maths effort**	Manipulation check **English effort**	Randomization **Exposed effort**	Outcome
Participant 1	Low	Low	High	Reassign to Low Effort group
Participant 2	High	High	Low	Reassign to High Effort group
Participant 3	Low	High	Low	Excluded
Participant 4	High	Low	Low	Excluded
Participant 5	Low	High	High	Excluded
Participant 6	High	Low	High	Excluded

Table 3

Comments provided by participants as reasons for failure in Maths and English

Theme		N (53) Mean count	N (48) Mean count
Lack of ability or motivation	1	8.2%	5.6%
Lack of educational support	2	33.3%	38.9%
Lack of family support	3	18.2%	21.5%
Undiagnosed learning difficulty	4	24.5%	12.5%
Other reasons	0	15.7%	21.5%

Appendix

Appendix A: Student Profile: Male and female

John R. **Semester 1-YEAR 1**

John is 6 years old and is enrolled in year 1 at a local primary school. He lives in Hornsby Shire with his parents and one other sibling. The family owns their 3-bedroom residential home. They do not report any current stress or family conflict. Overall, his teachers and parents report that John is well-adjusted, friendly, happy at school, and shows good social skills with peers and teachers. John has just finished his first semester of year one. The following is John's report card. Please look over it carefully before providing responses.

Annie R. **Semester 1-YEAR 1**

Annie is 6 years old and is enrolled in year 1 at a local primary school. She lives in Hornsby Shire with her parents and one other sibling. The family owns their 3-bedroom residential home. They do not report any current stress or family conflict. Overall, her teachers and parents report that Annie is well-adjusted, friendly, happy at school, and shows good social skills with peers and teachers. Annie has just finished her first semester of year one. The following is Annie's report card. Please look over it carefully before providing responses.

Appendix B: School Report-Female High Effort

Annie R. **Semester 1-YEAR 1**

MATHEMATICS	Class Teacher: K. Robins				
OVERALL ACHIEVEMENT	Limited	Basic	Sound	High	Outstanding
Working Mathematically: Develop an understanding of maths concepts and applying problem-solving skills	✓				
Measurement and Geometry: Identify and quantify shapes and objects	✓				
Numbers: Recognise numbers and do simple calculations		✓			

EFFORT	LOW	CONSISTENT	**HIGH**

TEACHER COMMENT

Annie is having difficulty associating number symbols accurately with actual numbers, and she needs to memorise and apply basic addition and subtraction facts. Annie finds geometric puzzles challenging. Also, her homework is generally not finished.

ENGLISH	Class Teacher: A. Langley				
OVERALL ACHIEVEMENT	Limited	Basic	Sound	High	Outstanding
Speaking and Listening: Communicate with peers and adults in informal and guided activities	✓				
Writing, Spelling and Presenting: Compose simple texts to explain an idea or message. Spell unknown words phonetically with closer approximations	✓				
Reading and Viewing 1: Develop skills and strategies to read and comprehend short, predictable texts	✓				

EFFORT	LOW	CONSISTENT	**HIGH**

TEACHER COMMENT

Annie has made slow progress over the last 4 months in her communication strategies with other students. She is also having a lot of difficulty sounding words out. Annie is struggling to complete homework and her handwriting is difficult to read.

ADDITIONAL PROGRAMS	INVOLVED
Public Speaking	
Spelling Bee	
Choir	✓
Sports	✓

School Report-Female Low Effort

Annie R. Semester 1-YEAR 1

MATHEMATICS	Class Teacher: K. Robins				
OVERALL ACHIEVEMENT	Limited	Basic	Sound	High	Outstanding
Working Mathematically: Develop an understanding of maths concepts and applying problem-solving skills	✓				
Measurement and Geometry: Identify and quantify shapes and objects	✓				
Numbers: Recognise numbers and do simple calculations		✓			

EFFORT	LOW	CONSISTENT	HIGH
	■		

TEACHER COMMENT

Annie is having difficulty associating number symbols accurately with actual numbers, and she needs to memorise and apply basic addition and subtraction facts. Annie finds geometric puzzles challenging. Also, her homework is generally not finished.

ENGLISH	Class Teacher: A. Langley				
OVERALL ACHIEVEMENT	Limited	Basic	Sound	High	Outstanding
Speaking and Listening: Communicate with peers and adults in informal and guided activities	✓				
Writing, Spelling and Presenting: Compose simple texts to explain an idea or message. Spell unknown words phonetically with closer approximations	✓				
Reading and Viewing 1: Develop skills and strategies to read and comprehend short, predictable texts	✓				

EFFORT	LOW	CONSISTENT	HIGH
	■		

TEACHER COMMENT

Annie has made slow progress over the last 4 months in her communication strategies with other students. She is also having a lot of difficulty sounding words out. Annie is struggling to complete homework and her handwriting is difficult to read.

ADDITIONAL PROGRAMS	INVOLVED
Public Speaking	
Spelling Bee	
Choir	✓
Sports	✓

School Report-Male High Effort

John R. Semester 1-YEAR 1

MATHEMATICS	Class Teacher: K. Robins				
OVERALL ACHIEVEMENT	Limited	Basic	Sound	High	Outstanding
Working Mathematically: Develop an understanding of maths concepts and applying problem-solving skills	✓				
Measurement and Geometry: Identify and quantify shapes and objects	✓				
Numbers: Recognise numbers and do simple calculations		✓			
EFFORT	LOW	CONSISTENT	**HIGH**		

TEACHER COMMENT

John is having difficulty associating number symbols accurately with actual numbers, and he needs to memorise and apply basic addition and subtraction facts. John finds geometric puzzles challenging. Also, his homework is generally not finished.

ENGLISH	Class Teacher: A. Langley				
OVERALL ACHIEVEMENT	Limited	Basic	Sound	High	Outstanding
Speaking and Listening: Communicate with peers and adults in informal and guided activities	✓				
Writing, Spelling and Presenting: Compose simple texts to explain an idea or message. Spell unknown words phonetically with closer approximations	✓				
Reading and Viewing 1: Develop skills and strategies to read and comprehend short, predictable texts	✓				
EFFORT	LOW	CONSISTENT	**HIGH**		

TEACHER COMMENT

John has made slow progress over the last 4 months in his communication strategies with other students. He is also having a lot of difficulty sounding words out. John is struggling to complete homework and his handwriting is difficult to read.

ADDITIONAL PROGRAMS	INVOLVED
Public Speaking	
Spelling Bee	
Choir	✓
Sports	✓

School Report-Male Low Effort

John R. **Semester 1-YEAR 1**

MATHEMATICS	Class Teacher: K. Robins				
OVERALL ACHIEVEMENT	Limited	Basic	Sound	High	Outstanding
Working Mathematically: Develop an understanding of maths concepts and applying problem-solving skills	✓				
Measurement and Geometry: Identify and quantify shapes and objects	✓				
Numbers: Recognise numbers and do simple calculations		✓			
EFFORT	**LOW**	CONSISTENT	HIGH		
TEACHER COMMENT					
John is having difficulty associating number symbols accurately with actual numbers, and he needs to memorise and apply basic addition and subtraction facts. John finds geometric puzzles challenging. Also, his homework is generally not finished.					

ENGLISH	Class Teacher: A. Langley				
OVERALL ACHIEVEMENT	Limited	Basic	Sound	High	Outstanding
Speaking and Listening: Communicate with peers and adults in informal and guided activities	✓				
Writing, Spelling and Presenting: Compose simple texts to explain an idea or message. Spell unknown words phonetically with closer approximations	✓				
Reading and Viewing 1: Develop skills and strategies to read and comprehend short, predictable texts	✓				
EFFORT	**LOW**	CONSISTENT	HIGH		
TEACHER COMMENT					
John has made slow progress over the last 4 months in his communication strategies with other students. He is also having a lot of difficulty sounding words out. John is struggling to complete homework and his handwriting is difficult to read.					

ADDITIONAL PROGRAMS	INVOLVED
Public Speaking	
Spelling Bee	
Choir	✓
Sports	✓

Appendix C: Mathematics Oriented Implicit Theory of Intelligence Scale (MOITIS)

I think that:	I definitely disagree	I do not agree	I am undecided	I agree	I definitely agree
1. I have a certain level of mathematical intelligence and there is no way to change this.	○	○	○	○	○
2. I can learn new things in mathematics but cannot change my mathematical intelligence.	○	○	○	○	○
3. People are born with fixed mathematical intelligence and cannot change this intelligence level throughout their lives.	○	○	○	○	○
4. My mathematical intelligence determines my achievement in maths.	○	○	○	○	○
5. The fact that I make a lot of effort for solving a mathematics problem indicates that my mathematical intelligence is unsatisfactory.	○	○	○	○	○
6. An individual who is unsuccessful in mathematics should question his/her mathematical intelligence.	○	○	○	○	○
7. I can improve my mathematical intelligence by studying.	○	○	○	○	○
8. Novel knowledge that I learn in mathematics can contribute to the development of my mathematical intelligence.	○	○	○	○	○
9. Completing a mathematics assignment with success may contribute to developing my mathematical intelligence.	○	○	○	○	○
10. Making good preparation before making a mathematics assignment is a way of improving my intelligence.	○	○	○	○	○
11. One who is unsuccessful when solving a mathematics problem should continue believing in his/her mathematical intelligence.	○	○	○	○	○

Appendix D: PISA Maths self-efficacy scale.

How confident do you feel about doing the following tasks?	Not at all confident	Not very confident	Neither	Fairly confident	Very confident
1. Using a train timetable to work out how long it would take to get from one place to another.	○	○	○	○	○
2. Calculating how much cheaper a TV would be after a 30% discount.	○	○	○	○	○
3. Calculating how many square metres of tiles you need to cover a floor.	○	○	○	○	○
4. Understanding graphs presented in newspapers.	○	○	○	○	○
5. Solving an equation like 3x+5=17.	○	○	○	○	○
6. Finding the actual distance between two places on a map with a 1: 10,000 scale.	○	○	○	○	○
7. Solving an equation like 2(x+3) = (x + 3)(x-3).	○	○	○	○	○
8. Calculating the petrol consumption rate of a car.	○	○	○	○	○

Appendix E of this thesis has been removed as it may contain sensitive/confidential content