Choosing to compete: How different are girls and boys?☆

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A B S T R A C T
Using a controlled experiment, we examine the role of nurture in explaining the stylized fact that women shy away from competition. We have two distinct research questions. First, does the gender composition of the group to which a student is randomly assigned affect competitive choices? Second, does the gender mix of the school a student attends affect competitive choices? Our subjects (students just under 15 years of age) attend publicly funded single-sex and coeducational schools. We find robust differences between the competitive choices of girls from single-sex and coed schools. Moreover, girls from single-sex schools behave more like boys even when randomly assigned to mixed-sex experimental groups. This suggests that it is untrue that the average female avoids competitive behavior more than the average male. It also suggests that observed gender differences might reflect social learning rather than inherent gender traits.

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1. Introduction

Women have been catching up to men in the workplace since the 1980s. The gender wage gap has not disappeared, though. Women still lag behind men in average pay and with regard to opportunities for advancement.1 Commonly cited reasons for these differences are discrimination or claims that women, more than men, are sensitive to work–family conflicts and more inclined to make career sacrifices.2 However, obtaining promotion and pay raises often involves competition, and it may be that women do not like to compete. If women dislike competition but men enjoy it, there will be two effects. First, fewer women will choose to enter a competitive environment, and second there will be fewer women succeeding in competitions. Recent experimental evidence has found that, when given the choice of whether or not to enter tournaments, women ‘shy away from competition’ while men may choose to compete too much (e.g. Datta Gupta et al., 2005; Niederle and

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1 A study by Bertrand and Hallock (2001) found that women in top corporate jobs earn about 5% less than their male counterparts and only represented 2.5% of high-level executives of large US firms from 1992 to 1997.

2 See for example Albrecht et al. (2003); Blau and Kahn (2006), and Arulampalam et al. (2005).
Vesterlund, 2007; Dohmen et al., 2006). Understanding why women seem less inclined than men to compete can provide insight into why a gender gap still exists in the workplace and what type of policies might address this gap.4

Innate differences are one obvious factor that might explain the gender competition-gap.5 While nature might well be important in shaping competitive behavior, the culture or environment in which an individual is raised might reduce or exacerbate gender disparities. For example, even if boys are more athletic than girls, hearing boys taunt one another with claims of ‘throwing like a girl’ may discourage athletically talented girls from participating in sports that involve throwing, increasing the participation gap that may have existed due to innate differences. Psychologists have shown that framing of tasks and cultural stereotypes do affect the performance of individuals.6 Therefore, even if innate differences do exist with regard to competition, the environment may still be a major factor contributing to observed differences. The role of nurture – environment, culture or upbringing – may therefore be central to explaining why men and women differ in their choices of whether or not to enter tournaments.7

Establishing if nurture plays a role in tournament entry is important in shaping the policy debate around gender differences in educational and labor market outcomes. First, it provides guidance as to whether or not gender differences in outcomes should be of concern. If nature is the primary reason for gender differences in tournament entry, then existing gender pay gaps may simply reflect economically important differences in preferences rather than underlying prejudice or discrimination in the workplace. However, if nurture is found to modify preferences for tournament entry, then we need to learn more about the various environmental factors shaping such preferences. Second, examining the role of nature provides insight into what policies might be implemented to address gender differences in outcomes. If nature is the primary reason for differences, a policy-maker aiming to decrease the gender gap may need to change the manner in which work is rewarded. However, if nurture is a primary reason, policies or curricula could be designed to address cultural or environmental factors affecting girls before they enter the workplace.

In this paper we examine the role that nurture might play in explaining the stylized fact that women shy away from competition. We do this by studying the choices made by girls when they are randomly assigned to two different settings: same-sex or mixed gender peer groups. Besides looking at the effect of a peer group randomly created in the lab, we also examine how girls from different educational environments – single-sex and coeducational schools – differ when they are given the opportunity to enter a tournament. While we use a different subject pool to that utilized in the literature, we follow a similar methodology by observing subjects’ behavior in response to different compensation schemes. But we also augment that approach in several crucial respects, as will be described below.

One of the strengths of our experiment is that we are able to look at an environment created in the lab – the experimental peer group – and one that is from the field – educational background. While the experimental peer-group is randomly assigned, students were not randomly sent to different schools. Therefore, to examine the effect of nurture from our second environment we will have to deal with issues of selection. Our experiment was carefully constructed to mitigate selection issues. First, we designed the experiment so we could obtain good measures of cognitive ability in the early stages of the experiment. These we then use as controls in the main part of the experiment. Second, we developed a post-experiment questionnaire, in order to gather information on where students lived and their family background. This facilitates construction of plausible instruments for school choice. Third, we asked our participating coeducational schools to provide students only from the higher-ability academic stream so that they would be more comparable to the grammar school students.8

Why might same gender peer groups cause girls to act differently? It is helpful to extend the approach of Akerlof and Kranton (2000) to examine this question. If behaving competitively is viewed as being a part of male gender identity but not of female, then adolescent girls in a mixed gender environment could be subject to more conflict in their gender identity since they have to compete with boys while at the same time they may feel pressured to behave in a ‘feminine manner’ to be attractive to boys. Why would boys not feel similarly pressured? First, competitive behavior and being attractive to girls are not such contradictory goals, owing to the prevalence of the male bread-winner model in our society. While adolescent

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4 Niederle et al. (2010) examine the effect of gender quotas when women do shy away from competitive environments.

5 Refer to Lawrence (2006) or Summers (2005) for discussions of the role innate differences may play. Barres (2006), on the other hand, aims to explain what is wrong with the nature hypothesis.

6 See Steele et al. (2002) for a summary of the stereotype threat literature and the role of stereotype threat in performance.

7 Gneezy et al. (2003), using a subject pool of engineering students from a coeducational school, find a significant gender gap in performance when compensation is tournament-based but not when it is piece-rate. This difference across groups might be due to stereotype threats (Steele, 1997), since being in a mixed group heightens subjects’ awareness of gender and prompts them to behave in accordance with their gender stereotype. That subjects’ behavior alters in response to such prompts also suggests that environment matters – even an environment in which the subjects have been placed for such a short time. One goal of the present paper is to see if environments in which individuals have been placed for far longer – typically 4–5 years – counteract this.

8 Grammar schools in the UK are selective state-funded schools for students between 12 and 18 years of age.

9 To compare students of roughly the same ability we recruited students from the top part of the distribution in the two coeducational schools in Essex: only students in the academic streams were asked to participate. Students from Suffolk do not have the option to take the 11+ exam and therefore higher ability students are unlikely to be selected out of Suffolk schools in the same way as in Essex. Nonetheless we only recruited students from the academic streams in the Suffolk as well.
boys in a mixed gender environment are also likely to be very aware of their gender identity, they may experience different conflicts to those of the girls. To the extent that the presence of girls pressures boys to develop their masculinity to increase their attractiveness, this might make them more assertive and competitive. The fact that they are also competing with other boys might reinforce this tendency. If this is true, we would expect girls in mixed gender groups to be less likely than girls in same gender groups to enter tournaments.

Why might single-sex schooling nurture girls to be more competitive? It is often argued that girls benefit academically from single-sex education, in part by achieving higher scores on standardized exams.\(^{10}\) Moreover, educational studies show that there may be more pressure for girls to maintain their gender identity in schools where boys are present than for boys when girls are present (Maccoby, 1990, 1998; Brutsaert, 1999). In a coeducational environment, adolescent girls are more explicitly confronted with adolescent subculture (such as personal attractiveness to members of the opposite sex) than they are in a single-sex environment (Coleman, 1961). This may lead them to conform to boys’ expectations of how girls should behave to avoid social rejection (American Association of University Women, 1992). If behaving competitively is viewed as being a part of male gender identity but not of female, then being in a coeducational school environment might lead girls to make less competitive choices than boys.

In a recent experimental contribution also addressing the role of nurture, Gneezy et al. (2009) compare subjects from a matrilineal and a patriarchal society. They find that women from the matrilineal society choose to compete as much as men from the patriarchal society.\(^ {11}\) We too use a controlled experiment to see if there are gender differences in the behavior of subjects from two distinct environments or ‘cultures.’ But our environments – publicly funded single-sex and coeducational schools – are closer to one another than those in Gneezy et al. (2009) and it seems unlikely that there is much evolutionary distance between our subjects. Any observed gender differences in behavior across these two distinct environments is more likely to be due to the nurturing received from parents, teachers or peers than to nature. Given this, we expect that girls from single-sex schools will choose to compete more than girls from coed schools.

The rest of this paper is set out as follows. In Section 2 we discuss the four conjectures we will test and how they can shed light on the nature and nurture debate with regard to competition. In Section 3 we describe the pool from which our sample was drawn, the design of the experiment and the sample means. The results are discussed in Section 4, while Section 5 concludes.

2. Conjectures

While the subject pool in our experiment differs in age and educational background from those used in previous studies, we nonetheless hypothesize that we too will find gender differences in tournament entry. This is summarized in the first conjecture.

Conjecture 1. Men choose to enter the tournament more than women.

If it is the case that men, on average, prefer to compete more than women, then our experimental data will support this conjecture. However, while any such evidence would show that the gender gap in tournament entry is robust to a change in subject pool, it would not identify if the gender gap is due to nature or nurture. Preference differences for competition could arise from innate differences between men and women or in how they are raised. If evidence supporting Conjecture 1 is due primarily to nature, we would expect to find that gender differences in tournament entry are not sensitive to a subject’s schooling or to the gender make-up of the experimental peer-group to which one was assigned. But if nurture plays a role, we would expect to find that tournament entry varies across our categories of interest. This leads us to our next three conjectures.

Conjecture 2. Girls in same gender experimental peer-groups choose to enter the tournament more than girls in mixed gender experimental peer-groups.

Psychologists have shown that cultural stereotypes and the framing of tasks affect the performance of individuals (see inter alia Steele et al., 2002). Being in a same gender group for the experiment might trigger subjects in particular ways that relate to their gender identity. For example, schoolgirls assigned to mixed gender groups may feel their gender identity is threatened when they are confronted with boys, leading them to be less competitive. Should the same girl be assigned instead to an all-girl group, such reactions would not be triggered.\(^ {12}\) In short, the cue of the gender composition of the experimental group is likely to affect female behavior. This hypothesis is summarized in Conjecture 2, which suggests that assignment to a same-sex group can modify, in an economically important way, female preferences for making competitive choices.

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\(^{10}\) See Campbell and Sanders (2002) for an overview of the empirical studies on single-sex education and its effect on girls.

\(^{11}\) Gneezy et al. investigated two distinct societies – the Maasai tribe of Tanzania and the Khasi tribe in India. The former are patriarchal while the latter are matrilineal. In the patriarchal society, women are less competitive than men, a result that is consistent with the findings of studies using data from Western cultures. But in the matrilineal society, women are more competitive. Indeed, the Khasi women were as competitive as Maasai men.

\(^{12}\) If girls do feel more pressured to maintain their gender identity when boys are present than boys feel when girls are present, then we should expect to observe a gender gap in competitive behavior for girls and boys attending single-sex schools who are assigned to mixed-sex groups. We discuss this in a later section.
To test this, we randomly assign students to same or mixed gender groups in the experiment. This allows us to examine how the gender composition of a group affects the choice of girls to enter a tournament. Since subjects are randomly assigned to groups, unobservables should not be driving the effects.

Two other studies have looked at competition and the effect of the gender make-up of the experimental peer-group. However, they looked at the effect on tournament performance and not the choice to enter a tournament. Gneezy et al. (2003) found that girls performed better in tournaments when boys were not present but Gneezy and Rustichini (2004) found no improvement when subjects were in single-sex groups. We expect that girls in an all-girls group will choose to enter the tournament more than girls in a mixed gender group.

Conjecture 3. Girls from single-sex schools choose to enter the tournament more than girls from coed schools.

This conjecture suggests that single-sex schooling can modify, in an economically important way, female preferences for making competitive choices. If we find evidence that girls from single-sex schools choose to enter the tournament more than girls from coeducational schools, this could suggest that nurture can affect a girl’s choice. Given that subjects are not randomly assigned to their school, we will also control for factors that could potentially be correlated with attendance, as will be explained later.

Suppose we find that, conditional on observable factors, girls from single-sex schools choose to enter the tournament more than girls from coed schools. This would provide more support for the case that nurture plays a role than if the controls explained all the difference in tournament entry decisions.

Next we consider how girls will behave relative to boys.

Conjecture 4. Girls from single-sex schools choose to enter the tournament at the same rate as boys.

As noted in the introduction, studies show that there may be more pressure for girls to maintain their gender identity in schools where boys are present than for boys when girls are present. If behaving competitively is viewed as a part of male gender identity but not of female, then being educated in a coeducational school environment might lead girls to make less competitive choices than boys.

3. Experimental design

Our experiment was designed to test the four conjectures listed above. To examine the role of nurturing, we recruited students from coeducational and single-sex schools to be subjects. We also designed an ‘exit’ survey to elicit information about family background characteristics. At no stage were the schools we selected, or the subjects who volunteered, told why they were chosen. Our subject pool is relatively large for a controlled, laboratory-type experiment. We wished to have a large number of subjects from a variety of educational backgrounds in order to investigate the conjectures outlined above.

Below we first discuss the educational environment from which our subjects were drawn, and then the experiment itself.

3.1. Subjects and educational environment

In September 2007, students from eight publicly funded schools in the counties of Essex and Suffolk in the UK were bused to the Colchester campus of the University of Essex to participate in the experiment. Four of the schools were single-sex.13 The students were from years 10 or 11, and their average age was just under 15 years. On arrival, students from each school were randomly assigned into 65 groups of four. Groups were of three types: all-girls; all-boys; or mixed. Mixed groups had at least one student of each gender and the modal group comprised two boys and two girls. The composition of each group – the appropriate mix of single-sex schools, coeducational schools and gender – was determined beforehand. Thus only the assignment of the 260 girls and boys from a particular school to a group was random. The school mix was two coeducational schools from Suffolk (103 students), two coeducational schools from Essex (45 students), two all-girl schools from Essex (66 students), and two all-boy schools from Essex (46 students).

In Suffolk county there are no single-sex publicly funded schools. In Essex county the old “grammar” schools remain, owing to a quirk of political history.14 These grammar schools are single-sex and, like the coeducational schools, are publicly funded. It is highly unlikely that students themselves actually choose to go to the single-sex schools. Instead Essex primary-school teachers, with parental consent, choose the more able children to sit for the Essex-wide exam for entry into grammar

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13 A pilot was conducted several months earlier, in June at the end of the previous school year. The point of the pilot was to determine the appropriate level of difficulty and duration of the actual experiment. The pilot used a different subject pool to that used in the real experiment. It comprised students from two schools (one single-sex in Essex and one coeducational in Suffolk) who had recently completed year 11. The actual experiment conducted some months later, at the start of the new school year, used, as subjects, students who had just started years 10 or 11.

14 In the UK, schools are controlled by local area authorities but frequently “directed” by central government. Following the 1944 Education Act, grammar schools became part of the central government’s tripartite system of grammar, secondary modern and technical schools (the latter never got off the ground). By the mid-1960s, the central Labour government put pressure on local authorities to establish “comprehensive” schools in their place. Across England and Wales, grammar schools survived in some areas (typically those with long-standing Conservative boroughs: such as Essex and Suffolk) but were abolished in most others. In some counties the grammar schools left the state system altogether and became independent schools; these are not part of our study. However, in parts of Essex, single-sex grammar schools survive as publicly funded entities, while in Suffolk they no longer exist. Nonetheless, residential mobility across regions is low in Britain (see Boheim and Taylor, 2002).
schools.\textsuperscript{15} Parents must be resident in Essex for their children to be eligible to sit the entrance exam (the 11+exam). It is possible that more informed or more competitive Essex parents may persuade their children to sit for the 11+ and indeed may coach their children for the 11+. Sitting for the 11+ is more likely to reflect the ambition or achievement-orientation of the parents and teachers rather than that of the children. Therefore students at the single-sex schools are not a random subset of the students in Essex, since they are selected based on measurable ability at age 11 as well as parental achievement-orientation.\textsuperscript{16} Our controls for parental education – obtained from the exit questionnaire – may pick up unobservable parental achievement-orientation, which is part of the nurturing environment. We also control for ability in our analysis, as will be described below. Moreover, we asked our participating coeducational schools from both Essex and Suffolk to provide students only from the higher-ability academic stream so that they would be more comparable to the grammar school students.\textsuperscript{17} There are no grammar schools in Suffolk. We will perform a series of robustness checks to control for possible differences between students from co-ed and single-sex schools after we examine different choices made by students.\textsuperscript{18}

The experiment took place in a very large auditorium with 1000 seats arranged in tiers. Students in the same group were seated in the same row with an empty seat between each person. There was also an empty row in front of and behind each group. While subjects were told which other students were in the same group, they were sitting far enough apart for their work to be private information. If two students from the same school were assigned to a group, they were forced to sit as far apart as possible; for example, in a group of four, two other students would sit between the students from the same school. There was one supervisor, a graduate student, assigned to supervise every five groups. Once the experiment began, students were told not to talk. Each supervisor enforced this rule and also answered individual questions. Consequently, during the experiment there was very little talking within or between groups.

3.2. Experiment

At the start of the experiment, students were told that they would be performing a number of tasks, and that one of these would be randomly chosen for payment at the end of the experiment.\textsuperscript{19} In each round students had 5 min to solve as many of 15 mazes as possible. The instructions are given in the Appendix.\textsuperscript{20} Before the first task was explained, students were shown a practice maze, given instructions on how to solve it, and allowed to ask any questions. Immediately before each round, students were told the nature of the task to be carried out and the payment for that round. At this stage, students were permitted to ask questions of clarification about that round. At no stage were students told how they performed relative to others in their group. The specific payment mechanisms are explained below, in the order in which the rounds occurred. No student was able to solve all 15 mazes in the time allotted. All mazes were double-blind marked as is the standard in UK universities.

The three rounds of the experiment closely follow those of Niederle and Vesterlund (2007). We wished to use a well-tested experimental strategy to investigate a new conjecture – that nurturing, in either single-sex or coeducational environments, may affect women’s propensity to compete. In contrast, Niederle and Vesterlund (2007) used the coeducational subject pool of the Pittsburgh Experimental Economics Laboratory at the University of Pittsburgh. Their tasks involved the addition of numbers whereas ours involve completing paper mazes.\textsuperscript{21}

The incentive structure of each round is laid out below. We also conducted an exit questionnaire at the end of the experiment.

Round 1: Piece rate. Students were asked to solve as many mazes as possible in 5 min. They would receive £0.50 for each maze solved correctly if this round was randomly selected for payment.

\textsuperscript{15} If a student achieves a high enough score on the exam, s/he can attend one of the 12 schools in the Consortium of Selective Schools in Essex (CSSE). The vast majority of these are single-sex. The four single-sex schools in our experiment are part of the CSSE.

\textsuperscript{16} Examples of parental unobservables likely to determine whether or not children are encouraged to sit for the 11+ include parental ambition, parental heterogeneity in discount rates, social custom factors, or lack of information about potential benefits of education.

\textsuperscript{17} To compare students of roughly the same ability we recruited students from the top part of the distribution in the two coeducational schools in Essex: only students in the academic streams were asked to participate. Students from Suffolk do not have the option to take the 11+ exam and therefore higher ability students are unlikely to be selected out of Suffolk schools in the same way as in Essex. Nonetheless we only recruited students from the academic streams in Suffolk as well.

\textsuperscript{18} The 11+ exam scores of students are unfortunately not available from the CSSE, the body that administers the 11+ exam. Therefore regression discontinuity analysis is not a feasible option for us.

\textsuperscript{19} Payment was randomized in the same manner as in Datta Gupta et al. (2005) and Niederle and Vesterlund (2007). Since the round students are paid for is randomly selected at the end of the experiment, they should maximize their payoff in each round in order to maximize their payment overall. Moreover, as only one round was selected for payment, students did not have the opportunity to hedge across tasks.

\textsuperscript{20} Mazes were of the type that can be found at http://games.yahoo.com/games/maze.html. These mazes have been used in several economic experiments before: Gneezy et al. (2003), Datta Gupta et al. (2005), and Hoff and Pandey (2005). For this experiment the difficulty used was the easiest of the “Easy to Hard” scale found at the bottom right hand side on the webpage.

\textsuperscript{21} In experimental settings, students can perform tasks using computer-based technology or simply pencil and paper. In both types, there are potential issues to do with the noise associated with completing mazes that might cue other participants as to performance. In the case of computer-based tasks, there are associated noises of mouse clicks as the task is performed, which potentially provide information to other participants. For paper mazes, there is the turning of the page. To address this issue, we control for group-peers baseline performance by using a variable giving the average performance of peers in one’s group, as will be seen below. For a further discussion of peer group effects refer to Mas and Moretti (2009).
Table 1  
Descriptive statistics by gender, experimental peer-group, and school background.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Girls</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mixed</td>
<td>All boys</td>
<td>Dif</td>
<td>Coed</td>
<td>Single sex</td>
<td>Dif</td>
<td>Coed</td>
<td>Single sex</td>
<td>Dif</td>
</tr>
<tr>
<td>Chose risky option (before R3)</td>
<td>0.20</td>
<td>0.30</td>
<td>0.09</td>
<td>0.15</td>
<td>0.41</td>
<td>0.26**</td>
<td>0.55</td>
<td>0.47</td>
<td>0.08</td>
</tr>
<tr>
<td>Piece-rate score (R1)</td>
<td>2.38</td>
<td>2.32</td>
<td>−0.06</td>
<td>2.16</td>
<td>2.62</td>
<td>0.47***</td>
<td>2.90</td>
<td>3.17</td>
<td>0.26</td>
</tr>
<tr>
<td>Tournament score (R2)</td>
<td>3.92</td>
<td>3.93</td>
<td>0.01</td>
<td>3.78</td>
<td>4.14</td>
<td>0.35</td>
<td>4.90</td>
<td>4.97</td>
<td>0.07</td>
</tr>
<tr>
<td>Mean difference (R2 − R1)</td>
<td>1.54</td>
<td>1.61</td>
<td>0.07</td>
<td>1.63</td>
<td>1.52</td>
<td>−0.11</td>
<td>2.00</td>
<td>1.81</td>
<td>−0.19</td>
</tr>
<tr>
<td>Number of siblings</td>
<td>0.84</td>
<td>1.04</td>
<td>0.20</td>
<td>0.88</td>
<td>1.05</td>
<td>0.17</td>
<td>0.60</td>
<td>0.97</td>
<td>0.38**</td>
</tr>
<tr>
<td>Number of female siblings</td>
<td>0.70</td>
<td>0.71</td>
<td>0.02</td>
<td>0.80</td>
<td>0.57</td>
<td>−0.23*</td>
<td>0.77</td>
<td>0.78</td>
<td>0.00</td>
</tr>
<tr>
<td>Age</td>
<td>14.73</td>
<td>14.98</td>
<td>0.25***</td>
<td>14.80</td>
<td>14.95</td>
<td>0.15</td>
<td>14.71</td>
<td>14.56</td>
<td>−0.15</td>
</tr>
<tr>
<td>Mother went to University</td>
<td>0.28</td>
<td>0.26</td>
<td>−0.02</td>
<td>0.13</td>
<td>0.49</td>
<td>0.36***</td>
<td>0.34</td>
<td>0.20</td>
<td>−0.14</td>
</tr>
<tr>
<td>Father went to University</td>
<td>0.28</td>
<td>0.32</td>
<td>0.03</td>
<td>0.16</td>
<td>0.52</td>
<td>0.36***</td>
<td>0.44</td>
<td>0.33</td>
<td>−0.10</td>
</tr>
<tr>
<td>Coed school travel time (min)</td>
<td>7.92</td>
<td>6.89</td>
<td>−1.03</td>
<td>6.21</td>
<td>8.06</td>
<td>1.85*</td>
<td>11.74</td>
<td>8.71</td>
<td>−3.04</td>
</tr>
<tr>
<td>Single-sex school travel time (min)</td>
<td>18.80</td>
<td>17.47</td>
<td>−1.33</td>
<td>23.09</td>
<td>15.32</td>
<td>−7.77***</td>
<td>18.57</td>
<td>20.69</td>
<td>2.11</td>
</tr>
<tr>
<td>Average risk score (scale = 0–10)</td>
<td>6.73</td>
<td>6.54</td>
<td>−0.19</td>
<td>6.40</td>
<td>6.95</td>
<td>0.55*</td>
<td>6.86</td>
<td>6.71</td>
<td>−0.14</td>
</tr>
</tbody>
</table>

Significant differences are denoted:  
* Significant at a 10% level;  
** Significant at a 5% level;  
*** Significant at a 1% level.

Round 2: Tournament.  Students were asked to solve as many mazes as possible in 5 min. If this round was randomly selected for payment, the group-winner would receive £2 for each maze solved correctly and the other members zero.

Round 3: Choice of tournament or piece rate.  Students were asked to choose either Option One or Option Two and then solve as many mazes as possible in 5 min. Payment would depend on which option they chose if this round was randomly selected for payment. If a student were to choose Option One, she would get £0.50 per maze solved correctly. If she chose Option Two, she would get £2 per maze solved correctly if she solved more mazes correctly than anyone else in her group did, the previous round and zero otherwise.

Exit questionnaire.  At the end, students were asked to complete an exit questionnaire. This questionnaire asked about family background, parents, any siblings, residential postcode and risk-attitudes. Risk attitudes were captured using the same general risk question asked in the 2004 wave of the German Socioeconomic Panel (GSOEP): “On a scale from 0 to 10 how prepared are you to take risks” where 0 was labelled ‘not at all prepared to take risks’ and 10 was labelled ‘fully prepared to take risks’.

The payments (both the show-up fee of £5 plus any payment from performance in the randomly selected round) were in cash and were hand-delivered in sealed envelopes (clearly labeled with each student’s name) to the schools a few days after the experiment. The average payment was £7. In addition, immediately after completing the exit questionnaire, each student was given a bag containing a soft drink, packet of crisps and a bar of chocolate.

3.3. Descriptive statistics

When examining the tournament entry choice, we wish to control for ability, learning and any family or other background attributes that could be driving the results. Therefore we next compare girls’ and boys’ summary statistics by experimental peer-group and school-type, to check if there are any statistically significant differences across environments. Table 1 shows the summary statistics.

A comparison of the same gender experimental groups (all-girls and all-boys) with the mixed gender groups suggests that the randomization was implemented successfully. There are no statistically significant differences between the same and mixed gender groups with regard to the number of female siblings, mother went to university, father went to university, travel time to either a single-sex or coed school, and the average risk score from the exit questionnaire. For girls, the subjects assigned to mixed gender groups were slightly younger than those assigned to all-girl groups. For boys, the subjects assigned to all-boys were likely to have more siblings than those assigned to mixed gender groups. Given these two differences we will control for age and number of siblings when estimating the choice of whether or not to enter the tournament.

A comparison of the means for students from coeducational and single-sex schools, however, shows that there are some observable differences between the two groups. For both boys and girls, attendance at single-sex schools is associated with
having a mother or father who has attended university and also with living closer to a single-sex school. Moreover, on average girls from single-sex schools have fewer female siblings, live further from a coed school, report being more risk-taking and perform better in the piece-rate round than their coed counterparts, while boys from single-sex schools are, on average, slightly younger than their coed counterparts. Since we are aiming to compare girls and boys from single-sex and coeducational schools who are roughly the same, we need to control for these observed differences. Therefore in all of our regressions we control for age, parental education, the number of siblings, and the number of female siblings. Furthermore, we allow these effects to vary by gender and school-type, and interact the controls by gender and schooling in all regressions reported in the next section.

The average piece-rate and tournament performances reported in Table 1 show a gender gap in maze-completion: girls in mixed gender or all-girl groups and those at coed or single-sex schools all perform worse than boys assigned to either group or attending either school type for both the piece-rate and tournament. Therefore, on average, girls do worse than boys in both the piece-rate and tournament setting. However, when moving from a piece-rate to a tournament setting, the mean difference in performance does not differ by gender.22

The first two rounds of our experiment are used to control for ability. In particular the tournament score, and the increase in performance from the piece-rate to tournament setting, proxy ability and learning when estimating a student’s choice about whether or not to enter a tournament in Round 3. However, the tournament score (Round 2) is important for another reason: it provides students with information about how they perform in a tournament setting. Therefore, when choosing to compete in Round 3, the student knows her ability, how she performs under pressure, and has had experience in the competitive environment. Hence she should be able to make an informed decision on whether or not to enter the tournament.

4. Choosing to compete

In this section we will discuss the decision of whether or not to enter a tournament and the probability of winning, and will relate choices to the four conjectures set out in Section 2.

4.1. The probability of winning Round 2

As shown in Table 1, girls solve fewer mazes correctly than boys in the four settings we are examining. Because of these gender differences in performance, one might expect girls and boys to make different competitive choices. Moreover, the probability of winning will differ depending on the group to which the student was assigned. In this subsection we therefore consider what level of competition might be optimal for the individual. Of course subjects do not know how they compare with others in their group because they are never told this. But they will have beliefs about this, beliefs that are likely to be shaped by their performance in the piece-rate and mandatory tournament rounds as well as by their backgrounds. Hence it is important to control for background factors and for previous performance when estimating the tournament choice in Round 3 – which we do below.

To assess the probability of winning Round 2, we randomly created four-person groups from the observed performance distribution for Round 2. Conditioning on gender and group (same-gender or mixed), the win probability is 25% for girls and boys assigned to same-gender groups but in mixed groups it is 36% for boys and 14% for girls.23 Therefore, if girls and boys know the performance distribution of the mandatory tournament (and they do not), they should choose to enter the tournament in Round 3 at the same rate if they are in same-gender groups. However, in mixed gender groups boys should choose the tournament more than girls.

Now consider the win probability conditional on performance in the mandatory tournament. For boys solving 5 mazes in same-gender groups, the probability of winning is 12% while for girls it is 43%. For those who solved 6 mazes, it increases to 47% for boys and 79% for girls. Next we calculated the probability of winning conditional on performance for the mixed gender groups. For boys solving 5 mazes in Round 2 it is 28% while it is 20% for girls. But for people solving 6 mazes the probability of winning jumps to 65% for boys and 56% for girls. Therefore, if students have correct beliefs regarding the probability of winning, girls in single-sex groups should choose to enter the tournament more than girls in mixed gender groups, producing evidence in line with the second conjecture above. But let us compare the actual choices made by the students to these predicted probabilities to examine the extent to which beliefs can explain the predicted choices.

When looking at the decision to enter the tournament or not in Round 3, a risk-neutral student should choose to enter the tournament if her probability of winning, \( p(\text{win}) \), is greater than 25%. That is \( 0.5 \cdot x < 2 \cdot x \cdot p(\text{win}) \Rightarrow 0.25 < p(\text{win}) \) where \( x \) is the number of mazes solved correctly. Given the probabilities of winning in a mixed gender group, both girls and boys who correctly solved 5 mazes or less should take the piece-rate option (assuming that there is some risk aversion for boys) and

\[22\] Regression results for performance in the piece-rate and tournament rounds can be found in Table A of the Appendix. The results show that females do worse in the piece-rate round and that consistent with other studies of this type – when controlling for performance in the piece-rate round there is no gender gap in how a subject improves when going from piece-rate to a tournament setting. This suggests that girls and boys are, on average, equally motivated to perform well in the tournament setting.

\[23\] For each group type (all girls, all boys, or half each) we randomly drew 10,000 groups comprising that mix, where we sampled with replacement. The frequency of winning is computed from this. The whole procedure was repeated 100 times. The average of these win frequencies is reported for each group in the text. For the win probabilities conditional on number of mazes solved correctly, to be discussed below, the same procedure was followed.
Table 2

Dependent variable (+1) if girl chooses to enter the tournament in Round 3.

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Columns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tournament score in Round 2</td>
<td>0.062$^*$</td>
</tr>
<tr>
<td></td>
<td>[0.033]</td>
</tr>
<tr>
<td>Tournament – piece rate score</td>
<td>0.014</td>
</tr>
<tr>
<td></td>
<td>[0.035]</td>
</tr>
<tr>
<td>Single-sex school (+1)</td>
<td>0.422$^*$</td>
</tr>
<tr>
<td></td>
<td>[0.119]</td>
</tr>
<tr>
<td>All-girls group (+1)</td>
<td>0.161$^*$</td>
</tr>
<tr>
<td></td>
<td>[0.067]</td>
</tr>
<tr>
<td>Two or three boys in experimental group (+1)</td>
<td>0.020</td>
</tr>
<tr>
<td></td>
<td>[0.117]</td>
</tr>
<tr>
<td>Controls</td>
<td>No</td>
</tr>
<tr>
<td>Controls + single-sex</td>
<td>No</td>
</tr>
<tr>
<td>Observations</td>
<td>162</td>
</tr>
</tbody>
</table>

Marginal effects for the probit regressions are shown in each column. The marginal effects are calculated at the mean value for each variable. Columns [1]–[4] use all observations in the sample. Column [5] uses just girls at single-sex schools and those who took the 11+ exam. Column [6] uses just girls at single-sex schools and those from Suffolk. Controls used are: mother went to University (+1); father went to University (+1); number of brothers; number of sisters; student is 14 years old (+1). Robust standard errors are in brackets and:

- $^*$ p < 0.1
- $^*$ p < 0.05
- $^{**}$ p < 0.01

both boys and girls should chose to enter the tournament if they solved six or more mazes correctly. However, 23% of girls and 51% of boys who solved 5 or less mazes correctly chose to enter the tournament. Therefore a large percent of students are either risk-loving, have incorrect beliefs, or other factors are affecting a student’s choice to enter the tournament.

4.2. Tournament choices in Round 3

We now focus on the decision a student makes in Round 3 – the choice of whether or not to compete by entering the tournament. As noted above, having the subjects compete against predetermined scores, as in Niederle and Vesterlund (2007), helps to isolate their choice and minimize the chance that strategic games are being played. A student should choose option two, to enter the tournament, if she thinks she can do better than everyone else in her group did last time. Her choice should therefore be unaffected by concerns about other students’ choices in the current round; for instance she should not worry about causing someone else to lose if she chooses the tournament.

We initially examine females alone, in order to focus more clearly on differences in behavior across girls from different educational backgrounds. To address our second and third conjectures we estimated probit models for the subsample of females. The dependent variable takes the value one if the student chooses option two and zero otherwise. The columns of Table 2 present the marginal effects calculated at the variable averages. Column [1] shows how much of the decision can be explained by a girl’s performance in the Round 2 mandatory tournament and the increase in her performance from the piece-rate to the tournament setting. A girl who solved more mazes correctly in the Round 2 tournament is 6 percentage points more likely to enter the tournament in Round 3. How one functioned in a tournament relative to a piece-rate setting, as represented by the tournament score minus the piece rate score, is insignificant. Column [2] adds controls for family background and age, as described in the note under the table.

Column [3] includes our main variables of interest: attendance at a single-sex school and whether or not the girl was randomly assigned to an all-girl group. To look at the role of nurture, we first examine our second conjecture: that girls in same gender experimental peer-groups choose to enter the tournament more than girls in mixed gender peer-groups. With the random assignment of student to experimental groups we are able to see if the environment a girl has been in for fewer than 20 min affects her decision. As the all-girls group coefficient shows, a girl assigned to an all-female group is 16 percentage points more likely to choose to enter the tournament, roughly 40% of the difference that exists between girls at single-sex and coed schools. This striking result shows that environment matters and we will show how robust the result is in the sensitivity analysis below.

Column [3] of Table 2 also shows that, ceteris paribus, a girl who attends a single-sex school is 42 percentage points more likely to choose to enter the tournament than a girl from a coed school. This is after controlling for ability, learning, family-background, and age. Given that the gender gap in choosing whether or not to compete was roughly of that magnitude in Niederle and Vesterlund (2007) and Gneezy et al. (2009), it would seem that a single-sex educational background has the potential to change the way women view tournaments. However, we cannot immediately interpret the point estimate as causal, given that schooling is not randomly assigned, unlike the experimental peer group.

The significance of the coefficients on all-girls group and single-sex schooling provides evidence in support of the second and third conjectures, and initially suggests that the environment in which a girl is placed affects whether or not she chooses to compete. However, before pushing this interpretation further, we next examine the robustness of the results.
4.2.1. Sensitivity analysis

We begin by examining the all-girls group coefficient. When choosing whether or not to compete, a girl’s decision could be influenced by the composition of her group, as found in Gneezy et al. (2003). For example, if a female chooses to compete more in an all-girls group, perhaps it is because she believes she has a better chance of beating a girl’s score rather than a boy’s score. If that is the case, the all-girls group dummy may be picking up this effect. To examine this, we add an extra control to the column [4] in Table 2. This is a dummy variable that equals one if the experimental group has two or three boys in it; this makes groups with one boy in them the base group for the regression. If girls are choosing to compete more in the all-girls group because there are no boys present, we would expect the new coefficient on two or three boys in the peer group to be negative and the significance of the coefficient on the all-girl dummy variable to decrease. This does not happen. Given that peer groups were randomly assigned, that we control for observed differences between the two groups, and that the coefficient is robust to different specifications, there is strong evidence that being in a same-gender experimental peer group for only 20 min causes a girl to enter the tournament more than a girl in a mixed gender experimental peer group. This is strong evidence that nurture matters with regards to choosing to compete.24

We now examine the sensitivity of the single-sex schooling coefficient. The regression results in columns [5] and [6] of Table 2 compare single-sex girls to different control groups from our sample. In column [5], we report marginal effects from a specification estimated on a subsample comprising only female students at single-sex schools in Essex and those in Essex that took the 11+exam but did not attend a single-sex school. In 2008, of all the students offered admission to a CSSE school, less than 10% of parents declined admission on behalf of their children.25 Therefore, conditional on having sat the exam, it is highly likely that the student will attend if she gains admission. The group of students taking the 11+exam are a more homogenous subgroup of our sample and selection is less likely to be an issue conditional on having taken the exam. In column [5] the single-sex school coefficient is still significant but the point estimate is much smaller. This suggests that, even though we are controlling for observables and ability, unexplained heterogeneity could be why the coefficient is significant. However, the sample size in column [5] has also fallen by nearly 50%; this could also be affecting the estimate as well. Therefore, in column [6] we compare the girls at single-sex schools to those who have taken the 11+exam and girls from Suffolk – where there are no selective grammar schools. In column [6] the sample size is larger and the point estimate is roughly what it was in column [3] and statistically significant.

Are these results found for girls also found for boys? To answer this, we investigate the role of experimental group composition and school type for the subsample of boys. The estimated coefficients are reported in columns [2] and [3] of Table 3. Column [1] of Table 3 repeats estimates from our preferred regression for girls, for ease of comparison with the same regression for boys reported in column [2].

Column [2] of Table 3 shows that, for boys, neither single-sex schooling nor the gender make-up of a boy’s experimental peer group affect the probability of choosing the tournament. Moreover, as shown in column [3] when we further restrict the boys-only sample to boys from Suffolk and boys who took the 11+exam from Essex, there is again no statistically significant effect for either of the variables of interest.

That single-sex environments affect girls but not boys is a striking result. If unobserved heterogeneity inducing selection were alone driving the results, that heterogeneity would have to be present only for girls. A reasonable assumption is that the equally prestigious state-funded, single-sex schools are as beneficial for both boys and girls. Given this, it is unlikely that unobserved heterogeneity explains the difference between boys and girls. In fact, to explain this difference, selectivity of girls into single-sex schools would have to be correlated with girls’ preferences for competition but not with boys’ preferences for competition. Given that boys and girls take the same exam for admission into the CSSE schools, this seems unlikely. However, if parents of competitive girls believed that single-sex schooling could benefit their daughter and pushed their children to go to a single-sex school, then this could be an explanation for our results. In 2009, there were 536 places available for girls and 542 places available for boys in the six single-sex CSSE schools. On exam day 3628 students, of whom 1861 were girls and 1767 were boys, took the 11+exam, making the average probability of admission for a girl 29% and 31% for a boy. Given the similarity in chances of being admitted and the number of boys and girls who took the exam, it is unlikely that single-sex schools admit more competitive girls but not more competitive boys.

For girls we undertake some further robustness checks. First, for girls we report estimates of the linear probability model (LPM) in column [4] of Table 3. The LPM coefficients on single-sex education and being in an all-girls (same-gender experimental) group are roughly the same as the marginal effects in the probit regressions.26 Secondly, we further investigate the role that unexplained heterogeneity might play. Suppose that – in spite of our estimates and observations above – there is positive selection of competitive girls into single-sex schools, but no such selectivity for boys. If this were the case, the

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24 We also considered an extension to Conjecture 2 that involved an interaction between single-sex schooling and experimental-group assignment. Since students from single-sex schools are not used to competing against the other sex, the gender composition of the group could affect students at single-sex schools differently. To investigate this, we tried including an interaction between single-sex schooling and experimental-group assignment. Since this interaction was always statistically insignificant, we have not reported that in the tables (the full set of estimates is available from the authors on request).

25 These numbers were obtained from Shamsun Noor at the local authority council for Essex.

26 To examine further the role of experimental group to which one was assigned and its composition, we estimated a LPM specification with a fixed-effect for each group. It is interesting that the single-sex coefficient stayed roughly the same, suggesting that group compositional effects are not affecting the single-sex coefficient much. Moreover the fixed-effects are not statistically significant, either individually or jointly, suggesting that the experiment was appropriately controlled.
Table 3
Dependent variable (+1) if a student chooses to enter the tournament in Round 3.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Columns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample gender</td>
<td>Girls</td>
</tr>
<tr>
<td>Model type</td>
<td>Probit</td>
</tr>
<tr>
<td>Tournament score in Round 2</td>
<td>0.056</td>
</tr>
<tr>
<td>[0.034]</td>
<td>[0.053]</td>
</tr>
<tr>
<td>Tournament – piece rate score</td>
<td>0.020</td>
</tr>
<tr>
<td>[0.035]</td>
<td>[0.063]</td>
</tr>
<tr>
<td>Single-sex schooling (+1)</td>
<td>0.422 **</td>
</tr>
<tr>
<td>[0.139]</td>
<td>[0.238]</td>
</tr>
<tr>
<td>Same-gender experimental group (+1)</td>
<td>0.161 **</td>
</tr>
<tr>
<td>[0.067]</td>
<td>[0.121]</td>
</tr>
<tr>
<td>Controls</td>
<td>Yes</td>
</tr>
<tr>
<td>Controls + single-sex</td>
<td>Yes</td>
</tr>
<tr>
<td>Constant</td>
<td>– 0.274 **</td>
</tr>
<tr>
<td>Observations</td>
<td>161</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.304</td>
</tr>
<tr>
<td>F-stat for IV variables</td>
<td>28.92</td>
</tr>
</tbody>
</table>

Column [1] uses all girls; column [2] uses all boys; column [3] uses only boys at single-sex schools, those who took the 11+ exam, and those from Suffolk. Columns [4] and [5] use all girls for whom a travel time to the nearest single-sex and coeducational school can be calculated. The first stage regression for the IV estimate in columns [5] is listed in Table B of the Appendix; the F-stat for the instrumental variables are reported at the bottom of the column. Please note that the standard error for the single-sex coefficient in column [5] was calculated using a bootstrap. Marginal effects are reported for the probit regressions and are calculated for the mean value of each variable. Controls used are: mother went to University (+1); father went to University (+1); number of brothers; number of sisters; student is 14 years old (+1). Robust standard errors are in brackets.

\[ p < 0.1, \quad \ldots p < 0.05, \quad \ldots p < 0.01, \]

estimated coefficient to single-sex schooling for girls would be upward biased. To investigate this, we next instrument girls’ single-sex schooling. Columns [5] of Table 3 report the results. Given potential self-selectivity, we want an instrument that is correlated with single-sex schooling but uncorrelated with the probability that a student will choose to enter the tournament. We utilize instruments based on the student’s residential postcode. Travel-to-school time is a good measure of the cost to a family of attending a particular school. The further away a student lives, the earlier she has to get up in the morning and the more parental traveling is involved in ferrying children to extra-curricular activities. There are far fewer single-sex schools in Essex than there are coed schools, and hence on average children attending Essex single-sex schools live further away. (Suffolk-based children cannot attend state-funded single-sex schools at all.) Living further away from a school is likely to be associated with a greater cost of attendance.

With this in mind, we used the six-digit residential postcode for each student to calculate the distances to the nearest single-sex school and to the nearest coed school. (Our sample size shrinks slightly, as some postcode responses were unreadable.) From this, we imputed the minimum traveling time to the closest coeducational school and to the closest single-sex school; the means of these minimum travel time variables are reported in Table 1.27 With these two variables we calculated how much longer it took a student to get to a single-sex school than the closest coed school. This difference in travel time is used to create our instruments.

We use three instrumental variables to predict the probability of attending a single-sex school. The first is a dummy variable that is equal to one if a student lives in Essex and zero otherwise. The second instrument is the how much longer it takes a student to travel to a single-sex school than a coed school if the difference in travel time is below the mean difference, multiplied by the Essex dummy. The third instrument is how much longer it takes a student to travel to a single-sex school than a coed school if the difference in travel time is above the mean difference, multiplied by the Essex dummy.28

With these three instrumental variables we estimated the probability of a student attending a single-sex school. The F-Statistic for the instruments is 28.92. (Regression results for the first-stage are presented in Table B of the Appendix.) We then estimated the regression reported in column [5] where we use predicted single-sex school attendance in place of the original single-sex school dummy. Since the equation uses predicted values, we bootstrapped the standard errors

27 To calculate this, we used the postcode of each school and the postcode in which a student resides. We then entered the student’s postcode in the “start” category in MapQuest.co.uk (http://www.mapquest.co.uk/mq/directions/mapbydirection.do) and the school’s postcode in the “ending address.” Mapquest then gave us a “total estimated time” for driving from one location to the other. It is this value that we used. Thus the “average time” is based on the speed limit of roads and the road’s classification (i.e. as a motorway or route).

28 The Essex dummy is multiplied by the two travel time variables because only students who live in Essex are able to attend a single-sex school. We did not enter the difference in travel time linearly because there is evidence of a non-linear relationship between travel time and probability of attending a single-sex school.
Table 4
Dependent variable (1) if student chooses to enter the tournament in Round 3.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Female (1)</td>
<td>0.267***</td>
<td>0.390***</td>
<td>0.710***</td>
<td>0.728***</td>
<td>0.675***</td>
<td>0.601***</td>
<td></td>
</tr>
<tr>
<td>(0.061)</td>
<td>(0.132)</td>
<td>(0.123)</td>
<td>(0.147)</td>
<td>(0.132)</td>
<td>(0.278)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tournament score in Round 2</td>
<td>0.089*</td>
<td>0.071*</td>
<td>0.092**</td>
<td>0.063*</td>
<td>0.065*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.032)</td>
<td>(0.032)</td>
<td>(0.037)</td>
<td>(0.032)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tournament – piece rate score</td>
<td>– 0.007</td>
<td>0.003</td>
<td>– 0.007</td>
<td>0.022</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.034)</td>
<td>(0.034)</td>
<td>(0.037)</td>
<td>(0.033)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single-sex school (1)</td>
<td>0.042</td>
<td>– 0.084</td>
<td>0.046</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.212)</td>
<td>(0.237)</td>
<td>(0.212)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female + single-sex</td>
<td>0.487</td>
<td>0.541**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.256)</td>
<td>(0.265)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All-girls group (1)</td>
<td>0.219**</td>
<td>0.209**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.094)</td>
<td>(0.105)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All-boys group (1)</td>
<td>– 0.095</td>
<td>– 0.034</td>
<td>– 0.071</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.095)</td>
<td>(0.121)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Readiness to take risk (0–10)</td>
<td>0.046*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female + readiness to take risk</td>
<td></td>
<td></td>
<td></td>
<td>0.054*</td>
<td>0.028</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marginal effect when female =</td>
<td>– 0.284</td>
<td>– 0.371</td>
<td>– 0.216</td>
<td>– 0.107</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>single-sex female + single-sex = 1</td>
<td>(0.179)</td>
<td>(0.245)</td>
<td>(0.156)</td>
<td>(0.078)</td>
<td></td>
<td></td>
<td></td>
</tr>
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Marginal effects for the probit regressions are shown in each column. The marginal effects are calculated at the mean value for each variable. Columns [1],[3] use all observations in the sample. Column [4] uses just students at single-sex schools, those who took the 11+ exam, and those from Suffolk. Columns [5] and [6] use all observations for whom a risk questionnaire was answered. Controls used are: mother went to University (1); father went to University (1); number of brothers; number of sisters; student is 14 years old (1). Robust standard errors are in brackets.  

- \( p < 0.1 \)
- \( p < 0.05 \)
- \( p < 0.01 \)

for attending a single-sex school.\(^29\) Again, the coefficient to single-sex schooling is statistically significant, though, the standard error is slightly larger.\(^30\) Given the strength of the instruments, the lack of evidence that single-sex schooling has an effect on boys, and the continued significance of the single-sex coefficient when looking at sample sub-groups, there is strong evidence that schooling environment – like the experimental peer-group – has an effect on individuals’ propensity to choose a tournament.\(^31\) This provides strong evidence for Conjectures 2 and 3. We next compare girls and boys in order to examine our first and fourth conjectures.

4.3. Differences between girls and boys

The regression results reported in Table 4 are obtained from the sample of boys and girls, and from different subsets of the full sample, as described in the note under the table. This table will allow us to examine the first and fourth conjectures.

Our first conjecture was that males choose to enter the tournament more than females. Column [1] of Table 4 reports a specification including only the gender dummy. It shows that girls choose to enter the tournament less than boys. This result is similar in size and significance to the results obtained by Niederle and Vesterlund (2007) and Gneezy et al. (2009), and supports the first conjecture. Column [2] reports estimates from a specification in which we also control for tournament performance, the change from piece-rate to tournament setting, and the standard controls and their interactions. The inclusion of these variables does not diminish the statistical significance of the marginal gender effect, which becomes larger in absolute terms. In column [3] the school and group controls are added to the regression. The absolute value of the marginal gender effect again increases. Thus in our preferred specification – after controlling for ability, observables, learning, and environment – we find that girls from coed schools are 71 percentage points less likely to enter the tournament than boys

\(^{29}\) We randomly drew 1000 different samples from our experimental data to calculate the bootstrap results.

\(^{30}\) We also experimented with using a different instrument – a set of dummy variables for students’ residential postcode. The results were no different to those reported above, so in the interests of brevity we do not report this in the table. The estimates are available from the authors on request.

\(^{31}\) In addition, we replicated these specifications for the boys’ subsample. The estimates do not differ from those reported in columns [2] and [3] of Table 3; the point estimates and statistical significance for the single-sex coefficient do not change and hence we do not report the estimates here. They are available from the authors on request.
from coed schools. This effect is larger in absolute terms than that found in other work but we are using school students and not the college-aged students who are the usual subjects. The results from columns [1]–[3] provide strong support for Conjecture 1, that men chose to enter the tournament more than women.

The significant gender gap only exists for students in coed schools. In column [3] the coefficient on the interaction of female and single-sex is significant, whereas the coefficient on single-sex is not. Thus boys from single-sex and coed schools are statistically just as likely to enter the tournament. How do single-sex girls compare to boys? To answer this we report the marginal effect for a single-sex female at the bottom of column [3]. This shows that the estimated difference between a single-sex female and a coed male is negative but it is insignificant. Therefore, according to the results in column [3], single-sex girls are choosing to enter the tournament just as much as boys from coed and single-sex schools. However, the robustness of that result needs to be examined. The point estimate of the marginal coefficient is roughly one-third of the gender gap column [3]. Therefore, taking the point estimate seriously, single-sex schooling decreases the gender gap in choosing to compete by over 60%. Given the large decrease in the gender gap due to single-sex schooling for girls, and the fact that the significance on the interaction of female and single-sex shows that the benefit from single-sex education is going primarily to girls (as suggested by much of the education literature), there is strong evidence in favor of Conjecture 4.

4.3.1. Sensitivity analysis

As before, we begin by comparing single-sex students to a more homogeneous subgroup: students from Essex who took the 11+ and students from Suffolk. The results for this comparison are shown in column [4] of Table 4. The size of the female dummy and the interaction of female and single-sex schooling stay roughly the same. However, the significance of the interaction between female and single-sex schooling increases. At the bottom of column [4], the marginal effect of being a single-sex female is shown. Here the estimate is significant and it shows that single-sex girls are slightly less likely than coed boys to enter the tournament. But given the significance of the interaction of female and single-sex schooling, the gap between boys and girls in coed schools is larger than the gap between coed boys and single-sex girls. Thus single-sex schoolgirls are still entering the tournament with a higher probability but that they are not behaving exactly like coed boys. This evidence does not support hypothesis four.

Experimental evidence has shown that women tend to be more risk averse than boys. Entering the tournament introduces more uncertainty into the payoff that the subject will receive. Thus, gender differences in risk aversion may be driving the gender differences in tournament entry. To get at this, we asked students a series of questions regarding risk in the exit questionnaire. The main question was ‘On a scale from 0 to 10 how prepared are you to take risks’ where 0 was labeled ‘not at all prepared to take risks’ and 10 was labeled ‘fully prepared to take risks’. As shown in Table 1, on average there were no gender differences in response to the question in either the coed or single-sex-school samples. However, girls from single-sex schools were more likely to take risks than their coed counterparts. In columns [5] and [6] of Table 4, each subject’s answer to this question was included in the estimation of the model. In column [6] we allowed the effect of the student’s risk attitude to vary by gender. In both cases the gender gap, as represented by the female coefficient, decreased, suggesting that risk attitudes can explain part of the gender difference in tournament entry. However, the female coefficient remained negative and significant. The size and significance of the interaction between female and single-sex stayed almost exactly the same, at around 0.50. Furthermore, as in column [3], there is no significant difference in the probability of a single-sex girl and a coed boy choosing to enter the tournament.

The results in Table 4 present mixed evidence for our fourth conjecture. What can be taken away from the table, however, is that the benefit of single-sex education – in terms of increasing competitive behavior – is being realized primarily by females, and that the gap in tournament entry between single-sex girls and coed boys is smaller than the gap between boys and girls from coed schools. Therefore, while we cannot conclude that single-sex girls are behaving like coed boys, there is evidence that the single-sex environment is making girls more competitive than girls at coed schools.

5. Conclusions

Our experimental evidence suggests that women seem to be shying away from competition, as also shown by other studies. However, the bulk of our evidence suggests that a girl’s environment plays an important role in explaining why she chooses not to compete. We have looked at the choices made by girls from single-sex and co-ed schools and found that there are robust differences in their behavior: girls from single-sex schools behave more competitively than do coeducational girls. We have also examined the effect of a randomly assigned environment – being assigned to an all-girls group. Being in an all-girls group for only 20 min affects the decision a girl makes, even when controlling for composition of the group to which she is randomly assigned for the experiment. This finding has implications for the single-sex versus coed educational debate.

32 Our sample has fewer boys than girls. When we consider the subsample comprising only single-sex students and students from Essex who took the 11+, we only have 12 boys from a coed school and therefore cannot estimate the model. For the subsample comprising only students from Suffolk and single-sex students, we only have 20 coed boys and again cannot estimate the model. Therefore, unlike in the girls section, the smallest sub-group for whom we can estimate the model is single-sex and Suffolk students and students who took the 11+. In this sub-group we have 32 coed boys as our base sample.

33 See Booth and Nolen (2009) for a detailed exploration of risk aversion using these data.

34 This general risk question is exactly the same as that asked in the 2004 wave of the German Socioeconomic Panel (GSOEP).
especially with regard to classes. Single-sex classes in subjects where behaving competitively is desirable could produce better outcomes. Such an arrangement could, of course, occur within coeducational schools.

In our experiment we also compared girls’ behavior with that of boys from single-sex and coeducational schools, and found that girls from single-sex schools behaved more like boys. Our findings are consistent with the gender identity theory outlined at the start of the paper and with the education literature that suggest that there is greater pressure for girls to maintain their gender identity in schools where boys are present than for boys when girls are present (Maccoby, 1990, 1998).

The experimental evidence supports the first three conjectures: that boys choose to enter the tournament more than girls; that girls from single-sex schools choose to enter the tournament more than girls from coed schools; and that girls in single-sex experimental peer-groups choose to enter the tournament more than girls in coed experimental peer-groups. The evidence for the fourth conjecture – that girls from single-sex schools choose to enter the tournament at the same rate as boys – was rather more mixed. However, our evidence did suggest that the tournament-entry gap between single-sex girls and coed boys is at least smaller than the gap between boys and girls from coed schools, if not non-existent.

Are there any other ‘nature’ arguments that might explain our results rather than the ‘nurture’ argument we have put forward? The only other hypothesis we can think of that is consistent with our findings is that girls who happen to be genetically more competitive gain admission to single-sex schools, whereas boys who are genetically more competitive do not. This seems deeply implausible.

In summary, we have discovered at least one setting – in addition to the Kasai tribe of India studied by Gneezy et al. (2008) – in which it is untrue that the average female avoids competitive behavior more than the average male. On average girls from single-sex schools are found in our experiment to be as likely as coed boys to choose competitive behavior. This suggests that the observed gender differences in competitive choices found in previous studies might reflect social learning rather than inherent gender traits.

What are the other implications of our study? Our major finding is that an environment such as single-sex schooling can affect economically important preferences. We have shown that selection alone cannot explain our results in this regard. Moreover, the gender composition of groups to which adolescent children are randomly assigned also affects competitive choices. This last finding is relevant to the policy debate on whether or not single-sex classes within coed schools could be an useful way forward.

To conclude, we would not wish to suggest that concerned parents should at once enroll their daughters in single-sex schools during those sensitive adolescent years. This is because there might be other advantages to coeducational secondary education, not least in terms of socializing boys and girls and preparing them for mixed-gender tertiary colleges and workplaces, that might outweigh the effects isolated in our experiment. But our analysis does serve to illustrate the importance of the school – and class – environment in affecting real economic outcomes through behavioral responses.34 For example, the differences in competitive behavior that we have observed across school type could well have effects on future pay-negotiation and remuneration. Indeed, a testable hypothesis for future survey-based studies is that there are wage gaps between women of the same ability educated at single-sex and coeducational schools. Finally our research, and that of related studies before us, point to an important topic – whether or not for a society there is an optimal level of competitive behavior. While this is beyond the reach of experiments like ours, further investigation of this difficult question could well prove fruitful in the future.

Appendix A. Supplementary data


References


34 If nurture matters, as we have shown, educational curricula could address environmental issues that would allow students to develop to their full potential without being cued or pressured to follow gender identity.