PERFORMANCE IN MIXED-SEX AND SINGLE-SEX COMPETITIONS: WHAT WE CAN LEARN FROM SPEEDBOAT RACES IN JAPAN

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Abstract—In speedboat racing in Japan, men and women compete under the same conditions and are randomly assigned to mixed-sex or single-sex groups for each race. We use a sample of over 140,000 individual-level records to examine how male-dominated circumstances affect women's racing performance. Our fixed-effects estimates reveal that women's race time is slower in mixed-sex than all-women races, whereas men's race time is faster in mixed-sex than men-only races. The same result is found for place in race. Moreover, in mixed-sex races, men are more aggressive, as proxied by lane changing, than women in spite of the risk of being penalized for rule infringement.

I. Introduction

A growing literature investigates whether gender gaps in economic outcomes might be due to differences in male and female attitudes to competition or to risk.[1] Some experimental studies have found the competitive choices men and women make differ according to whether they compete against men or women in competitive environments (see Gneezy, Niederle, & Rustichini, 2003; Gneezy & Rustichini, 2004; Niederle & Vesterlund, 2011; and Booth & Nolen, 2012). Moreover, the actual performance can vary, as in Gneezy et al., (2003), who used experimental data to show that women's performance in competitions differs depending on the gender of their competitors.

In this paper, we adopt a different but complementary approach to these experiments by analyzing unique performance data from a real-world activity that is by its very nature competitive and where potential payoffs from winning are high. Women have been competing in this activity since the early 1950s under exactly the same conditions as men, and all participants are randomly allocated to either single-sex or mixed-sex groups for the competition. The activity is speedboat racing. In this occupation, women represent approximately 13% of all racers, and they are treated as the equals of men. The rules of the race are strictly monitored, and any breaching of the rules results in disqualification. The potential payoffs are very high, but severe sanctions on disqualified racers mean they cannot participate, resulting in a fall in annual revenue. Consequently racers have a strong incentive to follow the rules in order to win the race. But they also face trade-offs because in order to win, they may have to engage in risky lane changing to improve their position.

Using data from these races, we explore how female and male performance and strategies in the mixed-sex races differ from the single-sex races. Our data are in panel form, where we have information for each racer's performance time and strategy across all the races in which they have competed. Thus, we have a total of over 15,000 women-race observations and over 127,000 men-race observations.

After controlling for unobservable individual-specific effects and other performance-relevant factors we describe subsequently, we find the following. (a) The performance of female racers is slower in the mixed-sex races than the all-female races, while men's time is faster in the mixed-sex races than in the all-male races. (b) Men adopt a more confident or aggressive strategy to obtain advantageous positions in the mixed-sex races than in the men-only races, whereas women adopt a less aggressive strategy in the mixed-sex races than in the women-only races. (c) There are no gender differences in disqualifications across the mixed-sex and the single-sex races.

The first above is of particular interest. It shows that female competitive performance, even for women who have chosen a competitive career and are very good at it, is enhanced by being in a single-sex environment rather than in a mixed-sex environment in which they are a minority. Our two other findings are also of great interest, since they follow from our investigation of the mechanisms through which our first finding operates.

The remainder of the paper is set out as follows. In section II, we describe the institutional background of the Japanese Professional Motor Boat Race, and in section III we provide an overview of the data and a brief discussion of strategies. In section IV, we explain the estimation approach. Section V presents the estimation results and interprets the major findings. Section VI summarizes our conclusions and draws out some implications for future research.

II. Speedboat Racing in Japan

Speedboat racing in Japan takes the form of tournaments that are tightly controlled by a central federation, the Japanese

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[1] Studies investigating gender differences in performance in competitive environments include Gneezy et al. (2003), Niederle and Vesterlund (2007, 2011), Booth (2009), Dreber, von Essen, and Ranehill, (2011), Cárdenas et al. (2012), and Niederle (2014). Studies exploring gender differences in preference to enter a competition include Gneezy, Leonard, and List (2009), Booth and Nolen (2012), Apicella and Dreber (2015), and Buser, Dreber, and Möllerström (2017), while studies analyzing attitudes toward, risk include Booth, Sosa, and Nolen (2014), Dreber, van Essen, and Ranehill (2014), and Khachatryan et al. (2015), and Buser, Niederle, and Oosterbeek (2014) explore how preference for competition across genders affects academic task choice. In a study that is closest to ours, Backus et al. (2016) find that the gender composition of chess tournaments affects the behavior of men and women in ways that are detrimental to female performance.

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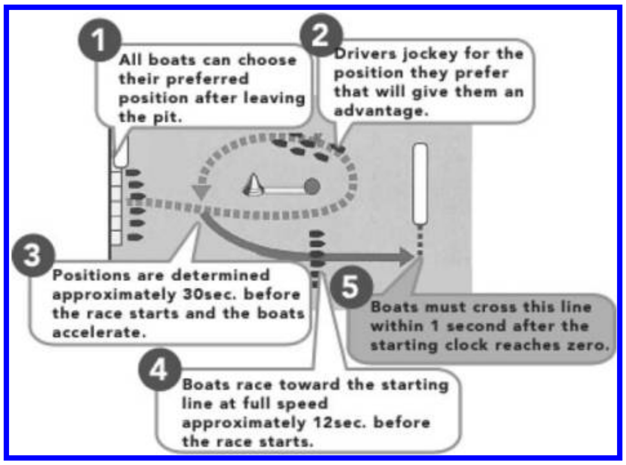
Speedboat Racing Association. Male and female racers receive exactly the same intensive training, and there is only one training school, the Yamato Boat School. Not only do women train with the men under the same conditions, they also participate and compete with men in the races under the same conditions. Well before a race day, individuals are randomly assigned to mixed-sex or single-sex races.

To qualify as a professional speedboat racer, individuals between the ages of 15 and 29 years must train for one year and pass a final examination at Yamato Kyotei Gakko (Yamato Boat School). [2] Because of this wide age window, individuals who gain entry are from a variety of backgrounds, ranging from individuals who have completed only junior high school, up to individuals whose highest educational qualification is from a university. Moreover, some of the entrants have also had a subsequent career after completing their education. Thus, time since graduation from the boat school is not just picking up age.

In this section, we describe the institution of speedboat racing in some detail, since an understanding of this is important for interpreting the data and estimates. Unless otherwise noted, our principal source of information is Himura (2015). In speedboat racing in Japan, there are about 1,600 racers, aged between 18 and 70 years,[3] of whom around 1,400 are men and 200 women. There are twenty-four speedboat racing stadiums throughout Japan, and boat races are randomly held about four days a week in each stadium. Racers go to many different stadiums to compete. The racing circuit is a large artificial pond or sectioned-off body of water that is 600 meters in length. Competitors race around it three times, leading to a total race distance of 1,800 meters. In each racing meet, there are twelve races, and six racers compete in any given race. The prizes offered are considerable.

On race meeting day and before each race, each racer's name is announced. That individual then drives the boat (randomly allocated to him or her for that day) a distance of 150 meters along a straight section of the circuit. His or her performance time is immediately reported, and this provides a public measure of the racer's condition. A short exhibition time is held to indicate good condition, since the time depends not only on physical and mental factors (that may or may not vary across days) but also on the boat and its engine randomly allocated to the racer for that day.[4] Racers are obliged to inspect and mechanically maintain the boat and engine allocated to them and have no assistance in this task. They cannot reject either the boat or the engine that has been randomly assigned to them. Thus, racers are motivated to aim for a good exhibition time in order to understand the boat's condition and its match to their talents, and then to adopt a racing strategy dependent on that. Thus, racers use performance times in the exhibition run to obtain information not only about competitors but about their own performance. This information is also used by bettors.

Figure 1.—The Premature Start System



Source: Japan Boat Race Association, http://www.boatrace.jp/en.html (accessed October 7, 2016).

Speedboat racing uses the premature start system, in which boats must pass the starting line within 1 second after the starting clock reaches 0. "Standby warm-up" refers to the period from the time racers receive the signal to leave the docks (pit) to the moment they cross the starting line. Racers' initial pits—and therefore lanes—are determined prior to the race by the committee of the association. However, racers can strategically change their lane during the initial period of turnaround as illustrated in figure 1 and may thus end up in a different position for the start of the race. Following in a position behind another boat is judged as a violation.

A. *Racers and Gender*

Japanese speedboat racing is characterized by an openness to age and gender. Hence, a woman can compete with men and win if her performance time is the fastest of the racers in the mixed-sex race. For female racers, the difference between the women-only race and mixed-sex race is as follows; all five competitors are the same sex (female) in the women-only race, whereas in the mixed-sex race, almost all five competitors are the opposite sex. Consequently, we are able to examine how the gender of competitors influences women's performance. However, mixed-sex races are very different for men and women, since men always outnumber women in the mixed races.

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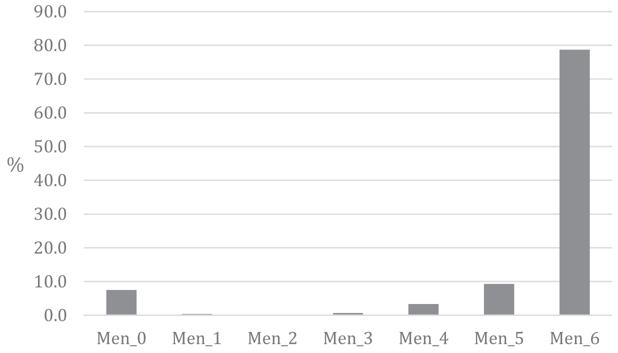
[2] There were 1,435 applicants for the 2015 entrance exam to the Yamato Boat School. Of these, only 35 were admitted (27 men and 8 women) and 25 graduated. Training covers driving techniques and inspection and maintenance of the engine and boat.

[3] The youngest racer is 16 years old. There is no compulsory retirement age. While students can enter the Yamato Kyotei Gakko (Yamato Boat School) from 15 years of age, it takes a year to graduate and become a racer, and hence the rule is that the age of the youngest racer is 16 years. However, this is the exceptional case. In the dataset used in this paper, the youngest racer is 18 years old.

[4] Speedboat racing is financed from betting. The sport is run by local governments (the principal), that deputize tasks to the Japanese Motorboat Association (the agent). Local governments also own the boats, but the Japanese Motorboat Association is in charge of them. The boats used for racing at a particular stadium are always kept at that stadium.

FIGURE 2.—COMPOSITION OF RACES ACCORDING TO NUMBER OF MEN RACERS



Reflecting the gender ratio, there are only one or two women racers among six racers in most cases of mixed-sex races. Figure 2 breaks down races according to the number of men participating. In slightly fewer than 80% of races, all six racers are men, while in 7% percent of races, all six racers are women. The remainder—about 15%—are mixed-sex races. Almost half of the mixed-sex races have only one woman competing with men racers. However, among different types of races, rules and condition are equivalent.[5] Therefore, even in the mixed-sex races, women racers are treated like men racers on an equal basis[6]. There is no difference in prize money between genders in the mixed-sex races or the all-male and all-female races.

B. *Race Grade, Racer's Grade, Prizes, and Penalties*

Race participants win prize money according to whether they finish first, second, or third in each race. Moreover, all racers receive a fee for racing on race day even if they are not placed. We define the order in which participants cross the finishing line as their place in that race. Races are also classified into five grades: super grade (SG), grade I (GI), grade II (GII), grade III (GIII), and "usual" races. In the higher-grade races, the number of points that winners earn is greater (see Himura 2015). Any racers can participate in the "usual" race, which is the bottom rank. In GIII races, racers under 30 years old with high winning rates are selected to participate. The criteria for being selected to participate in GII and GI races are stricter. In SG, racers are selected from top-ranked racers on the basis of prior performance. Within a year, the number of races is eight in the SG; around 40 in the GI eight in the GII around fifty in the GIII and almost every day for the "usual" races.

Prize money for race winners is considerable: $300,000 (SG), $100,000 (GI), $40,000 (GII), $10,000 (GIII), and under $10,000 ("usual" racers). There are also other monetary prizes. In SG, for example, prize winnings are around $150,000 (second place), $50,000 (third), $20,000 (fourth), $10,000 (the fifth), and under $10,000 (the sixth).

The Japanese Motorboat Association selects race participants. Various status racers, from the top to the bottom levels, are evenly and randomly assigned to participate in the "usual races". As a result, the top-class racers participate not only in the high-grade races such as SG and GI but also in the "usual" races.

As noted, a racer obtains points according to his or her order in the race. For example, in the bottom-grade race ("usual" race) and the next-to-bottom race (GIII), points accumulated in first, second, third, fourth, fifth, and sixth places are 10, 8, 6, 4, 2, and 1, respectively (Himura, 2015). In the case of GI and GII (SG), 1 point (2 points) is added to each of the points listed above. But penalties are also possible. For instance, participants navigating poorly and breaking rules in the race or the turnaround period lose 7 points.

Individuals' aggregated points in a season are subsequently used to select participants in the top-grade (SG) race. Racers disqualified for interrupting other racers are automatically excluded from SG races. There is an extra element to point accumulation: each individual's points are aggregated for three years, and the total then determines racers' grades, known as A1, A2, B1, and B2. (We use this as a measure of ability.) Participants disqualified for interrupting others during a race lose 15 points. If they break the rules—for the actual race or in the turnaround period—they lose 2 points. Hence, racers have a considerable incentive not only to win the race but also to avoid rule breaking and potentially losing their grade classification.

For the four grades of racer, average annual earnings associated with each grade are as follows: A1 grade (top grade): $330,000 $; A2 grade: $190,000 $; B1 grade: $80,000 $; and B2 grade: $50,000 $. Higher-grade racers are allowed to participate in more races. Even on a day when there are no high-grade races, A1 racers can take part in the "usual" race and so can earn something. Furthermore, higher-grade racers can also participate in higher-grade races with greater rewards. Percentages of women racers for A1, A2, B1, and B2 are about 11%, 19%, 46%, and 23%, respectively, while for men, they are around 21%, 20%, 43%, and 14%, respectively. Therefore, as a whole, composition of ranks of racers for women is lower than men.

Racing in an inner lane confers an advantage. While racers are allowed to change lane during the race, they are disqualified and face severe penalties if they interrupt other racers' runs. Thus, changing to an inner lane requires a highly skilled technique in order not to interrupt others. In the case of disqualification, apart from losing points, racers are penalized by being prohibited from racing for one month and banned from participating in GI and SG races for a year. Disqualification thus reduces aggregated points and lowers the chance of shifting to a higher grade, inevitably reducing annual revenue. All in all, top-class racers are

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[5] An exception is minimum weight: men have to weigh more than 50 kg, and women have to be over 47.5 kg.

[6] For all races, boats and motors are the same model and make and are used for only one year. However, individual performance may vary across boats and motors due to differences in deterioration and maintenance. To avoid unfairness across racers, allocation of machines is decided by drawing lots.

skilled enough to change to a better lane while not interupting other racers to avoid disqualification.

C. *Strategies*

In speedboat racing, contestants can choose a number of ways to boost their performance as well as adversely affect the performance of their immediate competitors. These activities involve costs, and contestants therefore face simple trade-offs when making decisions. By increasing effort and other performance-enhancing activities, a racer increases her probability of winning, but this extra effort is costly. The bigger the prize spread, the greater the expected gain from winning, and hence the more worthwhile it may be to boost ones's own performance.

Strategies to improve own performance include not only effort in the actual race but also fine-tuning the engine of the randomly allocated boat and dieting before race day to be at optimal weight. Strategies that adversely affect the performance of immediate competitors include seizing command of an inner lane as well as insulting or otherwise intimidating competitors (known in cricket as “sledging”). While lane changing is easily observable, sledging is not. And yet it is a potent way to weaken opponents’ concentration, causing them to underperform.

Psychological factors affect own performance and responses to the activities of other contestants. In our data, we have mixed-sex and single-sex races, so we can explore how the performance of men and women differs across these environments. The literature shows that women prefer not to compete against men (see Apicella & Dreber 2015; Cárdenas et al., 2012; Khachatryan et al., 2015). But in speedboat racing, women are sometimes compelled to through their random allocation to boat race groups. This allocation is known several months before the actual races.

Racing a speedboat against others involves skill not only at maneuvering the boat but also at jockeying for a desirable position, since the inner lanes confer an advantage. However, while lane changing can bring benefits, it can also bring costs, because the rules are strict and breaking them leads to serious penalties. Owing to male characteristics of “over confidence” or a greater tendency to take risk (found, for example, in Dreber et al., 2014; Almenberg & Dreber 2015), male speedboat racers may be more likely than women to adopt an aggressive strategy—or to be successful at it, for it is possible that women are less confident in mixed races, and as a result, aggressive male behavior is more successful. Within our data set, this is proxied by lane changing. Our prediction is that women racers follow a less aggressive or confident strategy than men and are less successful at lane changing. (Unfortunately, we do not have information on the number of attempted infractions relative to the number a person is actually charged with. Hence, we cannot test the hypothesis that even if women racers are found to be less aggressive, that they are less likely to be penalized than men in the mixed-sex race.)

We now consider individual performance in the solo exhibition race. It is hard to separate out strategic and psychological factors within our data. However, both affect performance in the actual race, in which peer effects as well as own decisions play a part. In contrast, strategy plays a much smaller role in the exhibition run. This is because, in the exhibition run, participants run solo and do not compete directly with the other race participants. Thus jockeying for position is not relevant. But there are other ways in which competitors can sabotage performance in an exhibition run. Chowdhury and Gurtler (2015) extensively surveyed studies investigating sabotage in competitions. They report widespread evidence of sabotage, defined as an activity conducted to damage others and driven by material benefits for the saboteur. In the context of speedboat racing, it would be easy for a participant to take a subtly menacing attitude toward a competitor. One example might be glaring, which may so unnerve the recipient that his or her performance is affected, in both the exhibition run and the actual race. Such behavior is likely to be very hard to observe by the race organizers. There is also a possibility that a subset of racers might collude to slow down another racer. Again we have no data on this and simply mention it as a possibility.

III. Data and Descriptive Statistics

Our data are individual records for the period April 2014 to October 2015 from Boat Advisor, the database of Japanese speedboat racing.[7] Of the 24 boat race stadiums in Japan, only seven provide all racers’ records, and we used these to construct a panel data set for the number of racers and the races in which they participated. The seven stadiums cover a wide variety of locations and statuses.[8] In a racing meet, racers participate in two or three races. For the period studied, there are 202 female and 1,430 male racers. The average number of races in which each of these individuals participated was 250, resulting in 400,000 person-race observations. Our estimating subsample comprises all those races with complete information about racers’ records, which yields approximately 140,000 person-race observations. This is a far larger sample than other data sets used to consider gender differences in preferences and behavior that are obtained from experiments (Dreber et al., 2011 2014; Cárdenas et al., 2014) and from survey data (Buser et al., 2014; Almenberg & Dreber, 2015). Furthermore, as

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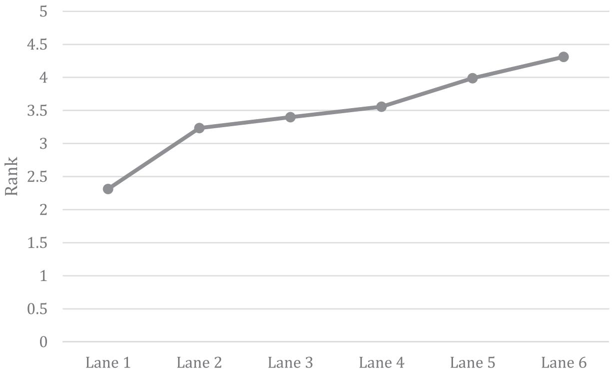
[7] While a racer’s engine is randomly assigned by lot, the starting lane or dock position is assigned in a more complicated way. The committee aims to reduce disparity in racers’ winning probabilities, and states publicly that lanes are assigned to equalize the condition of racers to run a close race. In this sense, the assignment of lanes has been done in a quasi-random way.

[8] Our seven stadiums (at Suminoe, Marugame, Kiryu, Miyajima, Biwako, Karatsu, and Amagasaki) are representative of the other stadiums. To check this, we compared average characteristics of our stadiums with the average for the rest with regard to each of the following: days of racing meets in a year; total number of visitors; average purchase per visitor; average revenue per day; and days of meets for SG and GI races. There was no statistically significant difference between our seven and all the others.

FIGURE 3.—MEAN OF PLACE IN THE RACE ACCORDING TO LANES



well as in formmation about racer's performance measured by the race time, time in exhibition run, and whether a penalty was received, we have detailed information about the characteristics of the race: place and day of the week, the grade of the race, gender composition of the race, and the condition of racers as captured, for examples, by their weight on the day of the race and their lane in the race. With regard to weight, although individuals are randomly allocated to single-sex and mixed-sex races, this occurs several months before the races in which they are to participate. Thus, racers might conceivably alter their weight in response to these allocations.

We use this rich data set to explore gender differences in performance in competitive circumstances. The subsample of women-race observations is slightly over 15,000, whereas that for men is over 120,000. Figure 3 shows the relation between place in the race and race lane. As is well known, racers gain an advantage if they are given an inner lane (Himura, 2015), and figure 3 illustrates this.

Racers are classified, as already noted, into five grades: SG, GI, GII, GIII, and "usual" races. To participate in the higher-grade races with greater prize money, racers are required to have performed well in races so far. Therefore, the higher the grade of race, the faster the participants should be.

Table 1 presents means, disaggregated by gender, of the main variables used in our analysis. (There are also some additional dummy variables included in estimation but not reported; these are presented in the table notes.) The means are calculated from person-race observations, and the number of these is reported in the bottom row of the table. Table 1 shows that average male race times are faster than those of women, and this difference is statistically significant. However, the difference in exhibition time between male and female racers is considerably smaller. This difference in race times may be due to male racers having better strategies in competitive circumstances, whereas in less competitive circumstances (exhibition run), men and women racers' abilities are almost equivalent.

TABLE 1.—BASIC STATISTICS AND DEFINITION OF VARIABLES USED IN ESTIMATION

	Women (1)	Men (2)	Difference (1) – (2)
Race time (seconds)	113.2	112.7	0.05***
Place in the race	3.68	3.43	0.25***
Exhibition time (seconds)	6.72	6.73	−0.01***
Weight (kg)	47.5	52.0	−4.5***
Number of lanes changed down toward the first lane	0.07	0.12	−0.05***
Number of lanes changed up toward the sixth lane	0.09	0.09	−0.005**
Poor navigation	0.0003	0.0004	−0.0001
Disqualification	0.0010	0.0012	−0.0002
Mixed-sex race	0.31	0.12	0.19***
Number of opposite-sex racers	1.25	0.15	1.10***
Number of higher-grade racers	1.77	1.53	0.24***
Number of lower-grade racers	1.36	1.47	−0.10***
Number of more experienced racers	2.54	2.36	0.17***
Number of less experienced racers	2.21	2.37	−0.15***
Number of heavyweight racers	1.51	4.45	−2.93***
Number of lightweight racers	0.14	3.54	−3.40***
Exhibition rank_1 (1st place)	0.182	0.165	0.017***
Exhibition rank_2	0.172	0.166	0.06*
Exhibition rank_3	0.167	0.166	0.001
Exhibition ranka_4	0.166	0.167	−0.001***
Exhibition rank_5	0.161	0.167	−0.006***
Exhibition rank_6 (last place)	0.152	0.167	−0.015***
Race grade_1 (SG)	0.002	0.001	−0.008***
Race grade_2 (GI)	0.048	0.055	−0.007***
Race grade_3 (GII)	0	0.01	−0.01***
Race grade_4 (GIII)	0.342	0.047	0.295
Race grade_5 (Usual)	0.608	0.878	−0.270
Lane_1 (inner lane)	0.154	0.168	−0.014***
Lane_2	0.159	0.168	−0.009***
Lane_3	0.160	0.167	−0.007**
Lane_4	0.165	0.167	−0.002
Lane_5	0.175	0.166	0.009***
Lane_6 (outer lane)	0.186	0.166	0.020***
Number of racers	202	1,430	
Observations	15,472	127,020	

Statistically significant at ***1%, **5%, and 1%. Number of competitors whose status is higher than the racer is used to capture other racers' skill and techniques. Number of competitors whose status is lower than the racer also included. In addition, we obtain the graduation period (from Yamato speedboat racers school where boys and girls must graduate to get a racer license). Time passed since graduation is considered to be the degree of experience. From this, we construct the number of competitors who have experience higher (or lower) than the racer and include it as a control. Heavyweight racers are defined as equivalent to or heavier than 48.2 kg, which is the 75th percentile for a male racer's weight. The number of heavyweight racers is the number of heavyweight racers participating in the race. Lightweight racers are defined as equivalent to or heavier than 50.2 kg, which is the 25 percentile for female racers' weight. The number of lightweight racers is the number of lightweight racers participating the race. Poor navigation is defined as unfairly interfering with other racers, although not to a serious degree. If its degree is serious, the racer is disqualified. Racers attempt to avoid poor navigation and disqualifications, so their occurrence is very rare. Therefore, mean values of poor navigation and disqualifications are very low.

The second row of table 1 reports the race rank. Thus, for all race observations, the average was between third and fourth place, with the difference between genders being 0.25 and statistically significant. The weight differences between women and men (reported in the fourth row) are as expected: men are significantly heavier.

The fifth row of table 1 shows that in the turnaround period before the formal start of the race, 5% of female racers changed their initial lane down toward the first lane, as compared with 8% of men, a statistically significant difference. This suggests that male racers have a more aggressive strategy than women racers. (This is consistent with existing studies—for example, Gneezy et al, 2009, and Apicella & Dreber, 2015.) One might expect aggressive lane changing to increase the probability of being caught for poor navigation and being disqualified. However, dummies for poor navigation and disqualification show that only 0.04%

of men are caught for poor navigation and 0.12% disqualified, percentages only slightly higher than the 0.03% and 0.10%, respectively, found for women, and the differences are not statistically significant. Thus, while male racers appear to be more aggressive in terms of lane changing, they are no more likely to be caught for risky navigation. The proportions of women and men in mixed-sex races are 31% and 12%, respectively. Across all races, women face an average of 1.25 opposite-sex racers, while men face only 0.15.

Since boat racing ability, as measured by race time and place in race, differs slightly across the sexes, we need to control for ability when estimating the determinants of race time and race place for the mixed-sex and single-sex races. We construct two variables using the information we have for racers' grades (A1, A2, B1, and B2): the number of higher-grade and the number of lower-grade racers an individual faces in a race. Women typically face 1.77 higher-grade and 1.36 lower-grade racers, while the comparable figures for men are 1.53 and 1.47, respectively. To calculate racers' experience, we obtained each racer's graduation date and use time elapsed since then as our proxy for experience. We find that averaging across races, women typically face 2.54 more experienced racers and 2.21 less experienced racers, while the comparable figures for men are 2.36 and 2.37, respectively.

There is a considerable difference in the gender composition of race grades. First, consider the gender proportions of participants in race grade 5 (the "usual" races). Here we see that 60% of woman-race observations are found in the lowest-grade race as compared with 88% of men-race observations. However, in race grade 4, there are only 5% of all male observations, which is lower than the 34% for female. Aggregating race grade 4 and race grade 5 indicates that almost 95% of male observations, as well as of female observations, are found here. There is little difference in the gender rates for race grades 1, 2, and 3, although it should be noted that race grade 3 is 0 for women and so women racers did not participate in GII races at all. As noted in section IIB, there are only eight races for GII in a year; thus, it is unsurprising that no women were observed here. In table 1 we also include means for randomly assigned starting lane (the lane or pit from which a participant starts at the very beginning of the race, before the turnaround period, as illustrated in figure 1).

Table A.1 in the online appendix shows differences in key variables between single-sex and mixed-sex races and also between women and men racers in each of these group types. For our purposes here, the most interesting comparison is female racer time between the single-sex and mixed-sex races: women run about 1.4 seconds faster in single-sex races than in mixed-sex races, a difference that is statistically significant at the 1% level. For men, there is no statistically significant difference in race times between the single-sex and mixed-sex races. Accordingly, the raw data show that women racers' performance is influenced by the gender composition of the race, but this does not hold for men racers. With regard to the single-sex races, we find that the gender difference in race time is only 0.1 second—a tiny amount, although statistically significant. In the mixed-gender races, male racer time is significantly faster by 1.6 seconds than women's. Therefore, the gender difference in the mixed-sex races is sixteen times larger than in single-sex races.

While in this section we explored correlations in the raw data, in section V, we will use fixed-effects regression techniques to control for other factors affecting our variables of interest. Before presenting these results, we outline our econometric model.

IV. The Econometric Model

Our randomization is key to enabling us to document our basic stylized fact: that the same woman performs relatively worse in terms of her race time in mixed-sex races as compared with single-sex races, while for the average male racer, the opposite is true. We report in our tables of regression results for place in race and race time, a baseline model with the minimum of controls. We estimate this separately for the subsamples of male and female racers, as well as for the pooled sample of men and women. We also report estimates from an expanded specification with additional controls in order to see if the direct effect of the mixed-sex variables alters once we control for the ability, experience, and weight of competitors in each race. If male competitors are of higher ability or have more experience, the estimated coefficient to the treatment variables in the baseline model might be an overestimate of the actual true effect on females of being in a mixed-sex race. We also include in the expanded specification the weight of competitors, since heavier racers run more slowly. Later in the paper, we will investigate if women might reduce their effort in mixed races, and men might increase their effort, by engaging in strategic behavior with regard to the outcome variables of lane changing or weight.

Our expanded specification for various outcome measures is

$$R_{itk} = \alpha_0 + \alpha_1 M_{itk} + X_{it}^{'}B + Y_{it}^{'}C + e_i + m_{tk} + u_{itk}. \quad (1)$$

The dependent variable R denotes the performance of individual i on race day t at stadium k. These include place in race, the natural log of race time in seconds, lane changing, poor navigation, disqualification, and exhibition time. In equation (1), the constant is denoted by α_0, while α_1 is the marginal effect of the independent variable of interest, M. (In some specifications, M will be the mixed-sex dummy, while in others, it will be the number of opposite-sex racers.) Other controls are captured by the row vector $\boldsymbol{X}_{it}$.

As illustrated in figure 3, place in race depends on lane. Furthermore, on a race meeting day, there are twelve races in a stadium. Superior-graded racers tend to participate in

TABLE 2.—DEPENDENT VARIABLE: PLACE IN THE RACE (FIXED-EFFECTS ESTIMATES)

	Baseline			With Control Variables for Ability		
	(1) All	(2) Women	(3) Men	(4) All	(5) Women	(6) Men
Mixed-sex dummy* Women racer dummy	0.93***			0.74***		
	(0.04)			(0.04)		
Mixed-sex dummy	−0.28***			−0.19***		
	(0.01)			(0.01)		
Number of opposite-sex racers		0.19***	−0.23***		0.19***	−0.17***
		(0.01)	(0.01)		(0.01)	(0.01)
Number of higher-grade racers				0.18***	0.16***	0.18***
				(0.004)	(0.01)	(0.004)
Number of lower-grade racers				−0.17***	−0.16***	−0.17***
				(0.004)	(0.01)	(0.004)
Number of more experienced racers				0.06***	0.03	0.06***
				(0.01)	(0.03)	(0.01)
Number of less experienced racers				0.06***	0.01	0.06***
				(0.01)	(0.03)	(0.01)
Number of heavyweight racers				−0.03***	−0.06***	−0.03***
				(0.002)	(0.01)	(0.002)
Number of lightweight racers				−0.02***	0.03***	0.01
				(0.005)	(0.01)	(0.01)
Lane_1	[2.31]	[2.56]	[2.28]	[2.31]	[2.56]	[2.28]
Lane_2	0.81***	0.57***	0.84***	0.78***	0.54***	0.81***
	(0.01)	(0.05)	(0.02)	(0.01)	(0.05)	(0.02)
Lane_3	0.92***	0.71***	0.95***	0.90***	0.68***	0.92***
	(0.02)	(0.05)	(0.02)	(0.01)	(0.05)	(0.02)
Lane_4	1.05***	0.88***	1.07***	1.01***	0.83***	1.03***
	(0.02)	(0.05)	(0.02)	(0.02)	(0.05)	(0.02)
Lane_5	1.38***	1.26***	1.40***	1.31***	1.16***	1.33***
	(0.02)	(0.05)	(0.02)	(0.02)	(0.05)	(0.02)
Lane_6	1.63***	1.48***	1.64***	1.54***	1.36***	1.56***
	(0.02)	(0.05)	(0.02)	(0.02)	(0.05)	(0.02)
Control group for Mixed-sex dummy × Women racer dummy	[3.44]			[3.44]		
Control group for mixed-sex dummy	[3.46]			[3.46]		
Control group for women racer dummy	[3.43]			[3.43]		
Groups	1,632	202	1,430	1,632	202	1,430
Observations	139,929	15,210	124,719	139,929	15,210	124,719

Statistically significant at ***1%. Robust standard errors clustered on races are shown in parentheses. Values within brackets are mean values of the base group (control group) for dummy variables. Dummies for race grade, location dummies, and interaction dummies between locations and days are included but not reported. Number of interaction dummies between locations and days are 630.

the tenth to twelveth races among them even if there are only "usual" races in the day. In equation (1), these other factors are incorporated in the vector $\boldsymbol{Y}_{it}$. C is the column vector of coefficients to be estimated. As explained in the previous section, we have data for seven racing stadiums and the races that occurred almost every day for around one and half years. The conditions of races and racers vary by place and day because of weather and the random allocation of engine and boat. To control for conditions, we include dummies for place and days of the race and their interactions, as represented in equation (1) by m_{tk}. Unobservable individual time-invariant characteristics, e_i are controlled for through fixed-effects estimation.

V. Results

A. Place in Race

Table 2 reports determinants of place in race, which ranges from first to sixth. Fixed-effects estimates of the parsimonious baseline model are presented in the first three columns of table 2. We control for the randomly assigned starting lane as well as additional controls listed in the table notes. For all tables of estimates, we report in parentheses robust standard errors clustered on races. In brackets in each table, we provide means for the outcome variable for the relevant control group.

The first column of table 2, estimated for the sample of all men and women, shows that a woman places worse (that is, further from first place) when she is in an opposite-sex race, while a man places better (closer to first place) in mixed-sex races. For example, a woman randomly allocated to a mixed-sex race performs almost one place worse (the coefficient is 0.93) than if she were in a single-sex race, ceteris paribus. Men randomly assigned to mixed-sex races do significantly better than they do in single-sex races (the coefficient is −0.28). This implies that men racers's place in the race improves by 0.28 point on the 6 point scale when they run in the mixed-sex races than in the single-sex races.

The second and third columns of table 2 are estimated on the subsamples of women and men, respectively, and the treatment variable is now the number of opposite-sex racers (rather than the simple dummy variable used in the first column). For women, the estimated coefficient to the number of opposite-sex competitors is 0.19 and is precisely estimated, meaning that a woman's place is worsened by 0.19 on the 6 point scale with the number of opposite-sex competitors. In contrast for men, we find that the estimated coefficient to the number of opposite-sex competitors is −0.23, implying that a man's place is improving by 0.23 on the 6 point scale in the number of opposite-sex competitors. These effects are statistically significant at the 1% level.

We now turn to another control variable of interest: the randomly assigned starting lane (from which a participant starts at the very beginning of the race, before the turnaround period). The innermost lane is the base in the regression tables. Estimated coefficients for dummy variables for the other lanes are statistically significant and positive. The magnitude of the coefficients is monotonically increasing across lanes; racers randomly allocated to outer lanes are less likely to win than those allocated to the inner lane.

Our randomization is key to establishing a basic stylized fact: that the same woman performs relatively worse in terms of her place in race in mixed-sex races as compared with single-sex races, while for the average male racer, the opposite is true. Given this basic fact, can we say any more about how to interpret this finding? One candidate mechanism is that women who face higher-ability competitors choose to exert less effort, and this is why they do worse in mixed-sex races. To explore this potential mechanism, we include additional variables. Thus, in the last three columns of table 2, we include proxies for relative ability and experience (the numbers of higher-grade and lower-grade racers that an individual competes against in a race, as well as the numbers of more experienced racers and less experienced racers.)[9] In appendix table A.4, we show the randomization balance of our ability measures across mixed-sex and single-sex races.

We also include variables indicating the number of heavyweight racers and the number of lighter-weight racers an individual competes against. Lighter racers can race faster (less resistance in water) than a heavyweight one, and they can maneuver more quickly and have an advantage in invading an inner lane.[10] The greater the number of competitors who are lighter than a given racer, the less likely it is that that racer will win. Since women racers are lighter on average than men, the inclusion of this variable might reduce the estimated coefficient to gender.

Estimates reported in the last three columns of table 2 show that even controlling for relative ability, experience, and weight, women are more likely to place lower when racing against mixed-sex racers than they are when racing against all-female racers, while men place better (closer to first place) with mixed-sex competitors than they are with single-sex. The magnitude of the coefficients to the treatment variables differs slightly in this expanded specification, but it is still the case that women in mixed-sex races are slightly less likely to be poorly placed and men are slightly less likely to be well placed, as compared to the estimates with no ability controls. These effects remain statistically significant at the 1% level.

We now turn to the estimated impact of the other controls. Table 2 shows that across all specifications in columns 3 to 6, more higher-grade (higher-ability) participants in a race reduce the likelihood of being well placed, while more lower-grade racers increase the likelihood of being well placed. This is as expected. Turning to experience, we see the estimated coefficients to these variables are positive for both more experienced and less experienced participants, but this effect is small and imprecisely estimated for women.

The estimated coefficient to the number of heavyweight racers is negative and statistically significant. The more heavyweight racers there are in a race, the more likely it is that a woman will place, a finding consistent with weight-reducing maneuverability and speed. The more lightweight racers there are in a race, the less likely is a woman to place.

Our basic stylized fact from the baseline model was that the same woman performs relatively worse in terms of her place in race in mixed-sex races as compared with single-sex races, while for the average male racer, the opposite is true. Our expanded specification shows that this remains a stylized fact even after controlling for the ability, experience, and weight of the other racers. But can we say any more about how to interpret this stylized fact? An additional candidate mechanism is that men might be more successful than women at changing lanes. Before investigating this in section IVC, we first report the impact of the treatment variables on racers' recorded time in seconds.

B. *Time in Race in the Baseline Model*

Race time and place in race are both relevant information for bettors. Although place matters more to the individual since it translates directly into winning, a participant wants to travel faster in order to place. Table 3A reports fixed-effects estimates of the log of recorded race time in seconds, with the baseline and the expanded specifications including the same sets of controls as in Table 2. Column 1 shows that women run more slowly in the mixed-sex race, while men's time is faster. The second and third columns of Table 3A are estimated on the subsamples of women and men, respectively, and the treatment variable for each is now the number of opposite-sex racers. For women, we find that the estimated coefficient to the number of opposite-sex competitors is 0.002 and is precisely estimated, meaning that women's time is increasing with the number of oppo-

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[9] In this, we follow Yamane and Hayashi (2015), who observe peer effects among competitors in swimming races.

[10] However, there are weight limits (51 kg for men, 47 kg for women). The difference in weight limit is the only advantage for women in the race. A racer whose weight is lower than the limit, is obliged to wear weights in his or her jacket.

TABLE 3.—FE ESTIMATES OF RACE TIME AND PLACE IN RACE, WITH ADDITIONAL CONTROLS

A. Dependent Variable: Log of Time Record in Races (Fixed-Effects Estimates)

	Baseline			With Control Variables for Ability		
	(1) All	(2) Women	(3) Men	(4) All	(5) Women	(6) Men
Mixed-sex dummy ×	0.009***			0.005***		
Women racer dummy	(0.001)			(0.001)		
Mixed-sex dummy	−0.002**			−0.0005		
	(0.0004)			(0.0004)		
Number of opposite-sex racers		0.002*** (0.0003)	−0.001** (0.0002)		0.001*** (0.0004)	−0.0006* (0.0004)
Control group for Mixed-sex dummy × Women racer dummy	[4.72]			[4.72]		
Control group for mixed-sex dummy	[4.72]			[4.72]		
Control group for women racer dummy	[4.72]			[4.72]		
Groups	1,632	202	1,430	1,632	202	1,430
Observations	139,929	15,210	124,719	139,929	15,210	124,719

B. Dependent Variable: Place in the Race and Log of Time Record in Races (Fixed-Effects Estimates): Examination of Opposite Gender Racers' Influence on Inner Lane (Advantageous) Racers' Performance

	Place in the Race		Log of Time Record in Races	
	(1) Women	(2) Men	(3) Women	(4) Men
Number of opposite sex racers × Inner lane dummy	0.04*** (0.01)	0.02 (0.02)	0.001*** (0.002)	0.0002 (0.0003)
Number of opposite-sex racers	0.18***	−0.18***	0.001***	−0.001*
	(0.01)	(0.02)	(0.0004)	(−0.0004)
Control group for inner lane dummy	[4.22]	[3.91]	[4.74]	[4.73]
Groups	202	1,430	202	1,430
Observations	15,210	124,664	15,210	124,664

Statistically significant at ***1%, **5%, and 1%. Robust standard errors clustered on races are shown in value in parentheses. Values within brackets are mean values of base group (control group) for dummy variables. All control variables included in columns 4 to 6 of Table 2 are included but not reported. Inner lane dummy is 1 if the racer's lane is Lane_1, Lane_2 and Lane 3; otherwise, 0.

site-sex competitors. In contrast for men, we find that the estimated coefficient to the number of opposite-sex competitors is is −0.001, implying that a man's time falls with the number of opposite-sex competitors; note, though, that for men, the effect is less precisely estimated and it is statistically significant only at the 5%. Thus, we show once again that women's and men's performance in these competitions differs depending on the gender of their competitors.

Controlling for ability, experience, and the weight of competitors in columns 4 to 6 of Table 3A, we find that the magnitude of the treatment effect is reduced in column 4, where we use only dummy variables for whether the race is mixed sex, though it is still very precisely estimated. In column 5 (women only), a woman's time is increasing with the number of male competitors, while a man's time is reduced with the number of female competitors, ceteris paribus.

C. *Lane-changing*

Are men more successful than women at lane changing, and might this help explain our stylized fact? In section II, we hypothesized that in mixed-sex races, women are less likely to change lanes either because they are less willing to engage in aggressive behavior or they are less confident in mixed settings. This would imply that not only are they less likely to squeeze their opponents out of their allocated lanes but are also more likely themselves to be blocked from retaining an advantageous lane.

Racers randomly allocated to the inner lane enjoy that advantage only if they retain that position. Our initial examination of lane changing is shown in table 3B, where we interact the number of opposite-sex racers with the inner lane dummy variable (taking the value 1 if the racer's lane is Lane_1, Lane_2, and Lane_3, otherwise 0). The first two columns present estimates of the determinants of place in race, and the last two columns display estimates of recorded race time in seconds. For women in an inner lane, their place in race and their time worsen in the mixed-sex races. Moreover, if they are initially randomly allocated to the inner lane, their performance worsens even more (the combined effect is 0.19 + 0.03 = 0.22).

To investigate further gender differences in lane changing, we next estimate the determinants of the number of lanes changed down, in the turnaround period, toward the first lane (the inner lane), excluding observations of those who were initially randomly allocated to an inner lane. The estimated coefficients for the variables of interest are reported in columns 1 to 3 of table 4. The dependent variable takes the value of 0 if racers do not change their lane

TABLE 4.—DEPENDENT VARIABLE: NUMBER OF LANES CHANGED DOWN TOWARD THE FIRST LANE AND TOWARD THE SIXTH LANE

	Towards the First lane (excluding 1 lane racers)			Towards the Sixth lane (excluding 6 lane racers)		
	All (1)	Women (2)	Men (3)	All (4)	Women (5)	Men (6)
Mixed-sex dummy × Women racer dummy	−0.06***				0.18***	
	(0.02)				(0.02)	
Mixed-sex dummy	0.04***			−0.03***		
	(0.01)			(0.008)		
Number of opposite-sex racers		−0.02***	0.03***		0.04***	−0.03***
		(0.005)	(0.008)		(0.007)	(0.006)
Number of higher-grade racers	−0.01***	−0.01***	−0.01***	0.02***	0.03***	0.02***
	(0.002)	(0.004)	(0.002)	(0.002)	(0.005)	(0.002)
Number of lower-grade racers	0.03***	0.01**	0.03***	−0.01***	0.01*	−0.01***
	(0.002)	(0.004)	(0.002)	(0.001)	(0.004)	(0.001)
Number of more experienced racers	−0.02***	−0.02**	−0.02***	0.02***	0.02**	0.02***
	(0.003)	(0.007)	(0.003)	(0.003)	(0.009)	(0.003)
Number of less experienced racers	−0.001	0.002	−0.001	−0.0002	−0.01	0.003
	(0.003)	(0.007)	(0.003)	(0.003)	(0.01)	(0.003)
Number of heavy weight racers	0.001	0.01***	0.001	−0.01***	−0.01	−0.01***
	(0.002)	(0.005)	(0.002)	(0.002)	(0.01)	(0.002)
Number of light weight racers	0.0003	−0.004	−0.004	−0.004	0.003	0.01
	(0.003)	(0.004)	(0.008)	(0.004)	(0.005)	(0.01)
Control group for Mixed-sex dummy × Women racer dummy	[0.15]			[0.14]		
Control group for mixed-sex dummy	[0.14]			[0.14]		
Control group for women racer dummy	[0.15]			[0.45]		
Groups	1,632	202	1,430	1,632	202	1,430
Observations	116,531	12,854	103,677	116,558	12,383	104,175

Statistically significant at ***1%. Robust standard errors clustered on races are shown in values in parentheses. Values within brackets are mean values of base group (control group) for dummy variables. Control variables included in table 2 are included but not reported here.

Guidance for dependent variable: In columns 1 to 3, the dependent variable is 0 if racers do not change their lane or change up the lane (toward 6) during the initial period of turnaround. The variable is a positive value if racers change down (toward 1). For instance, the variable is 5 (considered the most aggressive behavior) if racers change from lane 6 to lane 1 during the period. The variable is 1 if racers change from lane 6 to lane 5. In this way, the variable is considered a proxy for the aggressiveness of the strategy, which ranges between 0 and 5. In columns 4 to 6, the dependent variable is 0 if racers do not change their lane or change down the lane (toward 1) during the initial period of turn around. The variable is a positive value if racers change up (toward 6). Racers changed their lane toward 6 only if competitors behaved aggressively to intrude their lane because racers do not have incentive to change up. For instance, the variable is positive (considered as less aggressive to blocking competitors). The variable is 1 if racers change from lane 5 to lane 6. In this way, we make the variable a proxy for the degree of aggressiveness to block, which ranges between 0 and 5.

and is positive if they do, with the value increasing in the number of lanes changed.

We also estimate the number of lanes changed down toward the sixth (outer) lane excluding observations of those who were randomly allocated lane 6, with results reported in columns 4 to 6 of table 4. Here the dependent variable takes the value 1 if racers do not change their lane in the turnaround period and is positive if they do, with the value increasing in the number of lanes changed to a less advantageous position. This can therefore be thought of as a measure of inability to block more aggressive racers. For example, the dependent variable will take the value 1 if a racer has shifted one lane away from her allocated lane and into a less advantageous position.

We see from the first three columns that for men, the treatment variables (either the mixed-sex dummy or the number of opposite-sex racers) significantly increase the probability of shifting toward the most advantageous lane, whereas they reduce it for women. The last three columns of table 4 show that for men, the treatment variables significantly reduce the probability of shifting toward the less advantageous lane, whereas they increase it for women. Taken together, these results suggest that women are less inclined to adopt strategically aggressive behavior—or are less successful at blocking it—during the turnaround period when men take part in the race. In contrast, men are more inclined to follow and succeed at strategically aggressive behavior during the turnaround period in the mixed-sex race. These results suggest that women in our data set are less aggressive than men and less able to block aggressive competitors and that this tendency is more pronounced when competing against men.

D. *The Determinants of Rule Breaking*

Next we turn to the determinants of breaking rules. Columns 1 to 3 in table 5 report fixed-effects estimates of disqualification, while columns 4 to 6 report the fixed-effects results for being penalized for poor navigation. The estimates show that neither of the treatment variables is statistically significant. Therefore, competing with opposite-sex racers does not have any effect on the likelihood of being caught for poor navigation or for being disqualified. In sum, the probability of losing points and grade by disqualification is the same regardless of gender, and this holds in spite of the fact that male racers are distinctly more active in lane changing. Since lane changing involves some risk of fouling, this suggests that males are able to develop aggres-

Table 5.—Dependent Variable: Dummies for Disqualification and for Poor Navigation (Fixed-Effects Estimations)

	Disqualification			Poor Navigation		
	(1) All	(2) Women	(3) Men	(4) All	(5) Women	(6) Men
Mixed-sex dummy × Women racer dummy	−0.001 (0.002)			−0.001 (0.001)		
Mixed-sex dummy	−0.0003 (0.0004)			0.0004	(0.0003)	
Number of opposite-sex racers		−0.0003 (0.0004)	(0.0005)	0.00002	0.0001 (0.0002)	0.0005 (0.0004)
Control group for Mixed-sex dummy × Women racer dummy	[0.001]			[0.0004]		
Control group for mixed-sex dummy	[0.001]			[0.0004]		
Control group for women racer dummy	[0.001]			[0.0004]		
Groups	1,633	202	1,431	1,633	202	1,431
Observations	142,492	15,472	127,020	142,492	15,472	127,020

Statistically significant at ***1%. Robust standard errors clustered on races are shown in values in parentheses. Values within brackets are mean values of base group (control group) for dummy variables. All control variables included in columns 4 to 6 of table 2 are included but not reported.

sively strategic skills without being caught for rule breaking. Clearly there is a trade-off between the improved likelihood of winning if a racer changes lanes, on one hand, and the greater probability of being caught for fouling while changing lanes, on the other hand. It is possible that less risk-averse and more confident racers are able to perfect their lane-changing techniques without penalties or disqualification. The gender differences we have observed are consistent with the experimental literature on gender difference in over confidence and risk aversion (see Niederle & Vesterlund, 2011; Eckel & Grossman, 2008). If on average men exhibit these traits more than women, they may have become well practiced in lane changing without being penalized. In contrast, more risk-averse or less confident women may run safely to avoid the penalty and keep grade and revenue.

E. *Estimating the Correlates of Weight*

Table 6A reports fixed-effects estimates of the correlates of weight in kilograms as measured on race day. Since racers receive their schedule several months before an event, it is possible for them to adjust their weight in advance according to the types of races to which they have been randomly allocated in order to run faster. To the extent that individuals feel threatened by running against the opposite sex, they may exert extra effort by losing weight for the mixed-sex races. Our estimates in panel (A) show that for women, measured weight is negatively associated with being in a mixed-sex race, and these coefficients are statistically significant at the 10% level. In contrast, for men, measured weight is positively associated with being in a mixed-sex race, and these coefficients are statistically significant at the 1% level. In our interpretation, a woman reduces her weight to prepare for competing with males. A male racer may fail to maintain a light weight because he does not take the female competitor seriously. But there are other factors that work to his advantage, including lane changing.

Table 6.—Dependent Variable: Log of Weight on Race Day and Log of Recorded Exhibition Time (seconds) before Races (Fixed-Effects Estimations)

A. Dependent Variable	Log of Weight on the Race Day			
	(1) Women	(2) Women	(3) Men	(4) Men
Mixed-sex dummy	−0.106* (0.061)		0.041*** (0.015)	
Control group for mixed-sex dummy	[3.86]		[3.95]	
Groups	202	202	1,431	1,431
Observations	15,472	15,472	127,020	127,020
B. Dependent Variable	**Log of Recorded Exhibition Time (seconds) before Races**			
Mixed-sex dummy	0.095* (0.061)		0.025 (0.022)	
Number of opposite-sex racers		0.020 (0.014)		0.036* (0.017)
Number of higher-grade racers	−0.008 (0.009)	−0.008 (0.009)	−0.012*** (0.003)	−0.012*** (0.003)
Number of lower-grade racers	0.011 (0.009)	0.012 (0.009)	0.010*** (0.003)	0.010*** (0.003)
Control group for mixed-sex dummy	[1.90]		[1.91]	
Groups	202	202	1,431	1,431
Observations	15,472	15,472	127,020	127,020

Statistically significant at *10% and ***1%. Robust standard errors clustered on races are shown in value in parentheses. In panel A, where the dependent variable is the log of weight, the set of control variables is equivalent to that in columns 1 to 3 of table 2, but its results are not reported. In panel B, where the dependent variable is the log of exhibition time, the set of control variables is equivalent to that in columns 4 to 6 of table 2, but its results are not reported. Estimated coefficients and standard errors are multiplied by 100 for ease of presentation and interpretation.

F. *Performance in the Exhibition Run*

While strategy likely plays a smaller role in the exhibition run than in the race, because participants run solo in the exhibition run, there are ways for competitors to potentially affect their own performance. For example, competitors with a preoccupied or distant demeanor immediately before the exhibition might give different impressions to men and women because of gender differences in perceptions of it. Of course, such behavior is unobservable with our data, and we offer it only as a potential mechanism.

Panel (B) of table 6 reports fixed-effects estimates of exhibition run times. Here we see that both the mixed-sex race dummy and number of the opposite sex racers are positive but imprecisely estimated. The positive coefficients suggest that racers exhibit more slowly before the mixed-sex race regardless of gender. However, the reason is likely to differ between men and women. Though we cannot test for this, we hypothesize here that male racers may not make a full effort in the mixed-sex races because they discount female competition, whereas a woman racer may not bring her ability into full play because of perceived pressure from male racers.

Coefficients of number of higher-grade racers and number of lower-grade racers show the negative and the positive signs, respectively. It is interesting that these signs differ from those in table 2. What is more, they are significant for men but not for women. Men have greater incentives to run faster when competing with racers with better records. A woman's incentive, however, is influenced by her competitors' gender but not their skill and ability. All in all, table 2 and panel A of table 6 suggest that the effect of a competitor's skill and ability depends on whether strategic interaction is absent (panel A of table 6) or present (table 2).

VI. Conclusion

Speedboat racing in Japan takes the form of tightly controlled tournaments for which women and men racers receive the same intensive training. Women racers participate and compete in races under the same conditions as men, and all individuals are randomly assigned to mixed-sex or single-sex groups for each race. In this paper, we used a sample of over 140,000 observations of individual-level racing records obtained from the Japanese Speedboat Racing Association to examine how male-dominated circumstances affect women's and men's racing performance. We controlled for individual fixed effects plus a host of other factors affecting performance, including the ability of competitors within a race. Our estimates revealed that women are less likely to be placed in mixed-sex races than in all-women races, whereas men are more likely to be placed in mixed-sex races than men-only races. We found the same results when we used the dependent variable time in a race. Moreover, in mixed-sex races, male racers tend to be more aggressive, as proxied by lane changing, in spite of the risk of being penalized if they contravene the rules, whereas women's strategies are less aggressive. We find no difference in disqualification rates between genders. We suggest that gender differences in risk attitudes and confidence may result in different responses to the competitive environment and that gender identity is also likely to play a role.

The first finding above is of particular interest. It shows that female competitive performance, even for women who have chosen a competitive career and are very good at it, is enhanced by being in a single-sex environment rather than in a mixed-sex environment in which they are a minority. Our other findings are also of great interest, since they follow from our investigation of the mechanisms through which our first finding operates. In particular, we have argued that male racers are aggressive but not imprudent by taking into account competitors' condition, as well as the risk of disqualification when jockeying for position.

The gender proportion in the mixed-sex speedboat races is skewed toward men. Women racers assigned by lot to a mixed-sex race will typically face five male competitors or, rather infrequently, four. We suggest that this gender imbalance may trigger awareness of gender identity for both men and women and that this might go some way to explaining observed differences in behavior across mixed-sex and single-sex groups.[11] For example, a man's gender identity may lead him to consider being defeated by women to be more dishonorable than by men, and he will try to avoid it.

Our findings may well have implications for other activities in which men and women compete with one another and where the gender balance is skewed in favor of men. One example is in the STEM disciplines, where being in a minority may well affect the performance of the women in that situation.

Finally, we point out that sportspeople are likely to be particularly selected on willingness to compete, and to that extent, our effects of mixed-sex treatments may be relatively muted compared to other settings where selection is not as competitive. Alternatively, behavior in repeated (daily) interactions may differ from that in a short race. We hope that future research will explore these issues further.

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[11] According to the gender-identity hypothesis, a society's prescriptions about appropriate modes of behavior for each gender might result in individuals' experiencing a loss of identity should they deviate from the relevant code.

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