Performance in competitive Environments: Gender differences

Uri Gneezy
Technion and Chicago Business School

Muriel Niederle
Harvard University

Aldo Rustichini
University of Minnesota

Gender differences in representation in high profile jobs remain a pervasive phenomenon and are a major factor for the gender gap in earnings.

Several Possible Explanations:

- Men and Women may differ in their abilities / preferences, which leads to occupational self selection.

- Discrimination, which leads to differential treatment of men and women with equal preferences and abilities (Goldin and Rouse AER 2000, Wenneras and Wold 1997).

We propose and test an alternative explanation:

Women and men differ in their ability or propensity to perform in environments in which they have to compete against one another.

Since incentive schemes commonly used in job evaluation and performance are often highly competitive, they may elicit different performance from men and women.

Little attention has been given to gender differences in competitive behavior in either the economics or the psychology literature.

Goal: Explore possible gender differences in behavior in competitive environments.

Controlled Experiments:

- Precisely measure performance.
- Exclude discrimination (and any expectation of discrimination.)
- No issue of selection of participants into different environments.

Economic Relevance:

- Understanding the reasons for the gender wage gap, the glass ceiling effect.
- Designing optimal incentive schemes.
- Deciding in unbiased ways, which are the most able persons.

Policy Applications:

- Affirmative action.
- Single-sex versus mixed schooling.

Our Experiment

Participants:

Technion undergraduate students. (Degree in Engineering)

Each session: 3 women and 3 men.

Each treatment: 10 groups of 6 participants each. Hence in each treatment 30 women and 30 men.

384 participants in 64 experimental sessions.

Always different participants in different treatment: (Between subject design.)

Payment: Participants receive 20 NIS show up fee. (4NIS=1$).

The Task:

Solving Mazes.

(http://games.yahoo.com/games/maze.html)

After all participants solved one maze of level 2, the final part of the instructions were distributed.

Competitive and Non Competitive Environments

Benchmark:

Performance of participants when their reward is independent of the performance of others.

Treatment 1: Piece Rate Payment

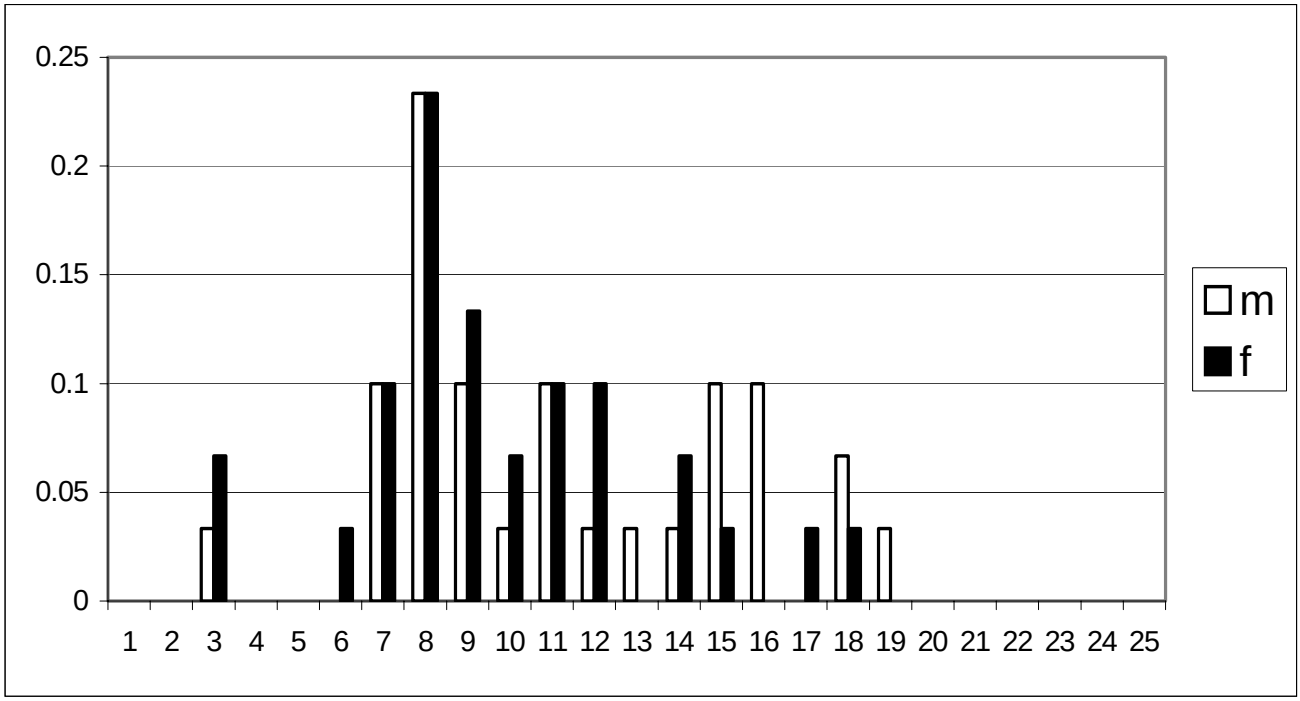
3 women and 3 men in the lab.

15 minutes to solve mazes (of difficulty level 2).

Participant receives 2 shekels for each solved maze.

Participants do not know how much the others earned.

Results of Piece Rate:



Male average: 11.23

Female Average: 9.73.

Comparing the two distributions: The p-value of the Wilcoxon Mann-Whitney test is 0.2023, the difference is not significant.

Impact of Competition on the performance of men and women.

Treatment 2: Competitive Pay / Tournament

3 Women and 3 Men solve mazes for 15 minutes.

The person that solves the most mazes receives 12 shekels for each maze solved.

Others receive nothing.

As in the other experiments: Participants do not know how much others earned, i.e. also not who won.

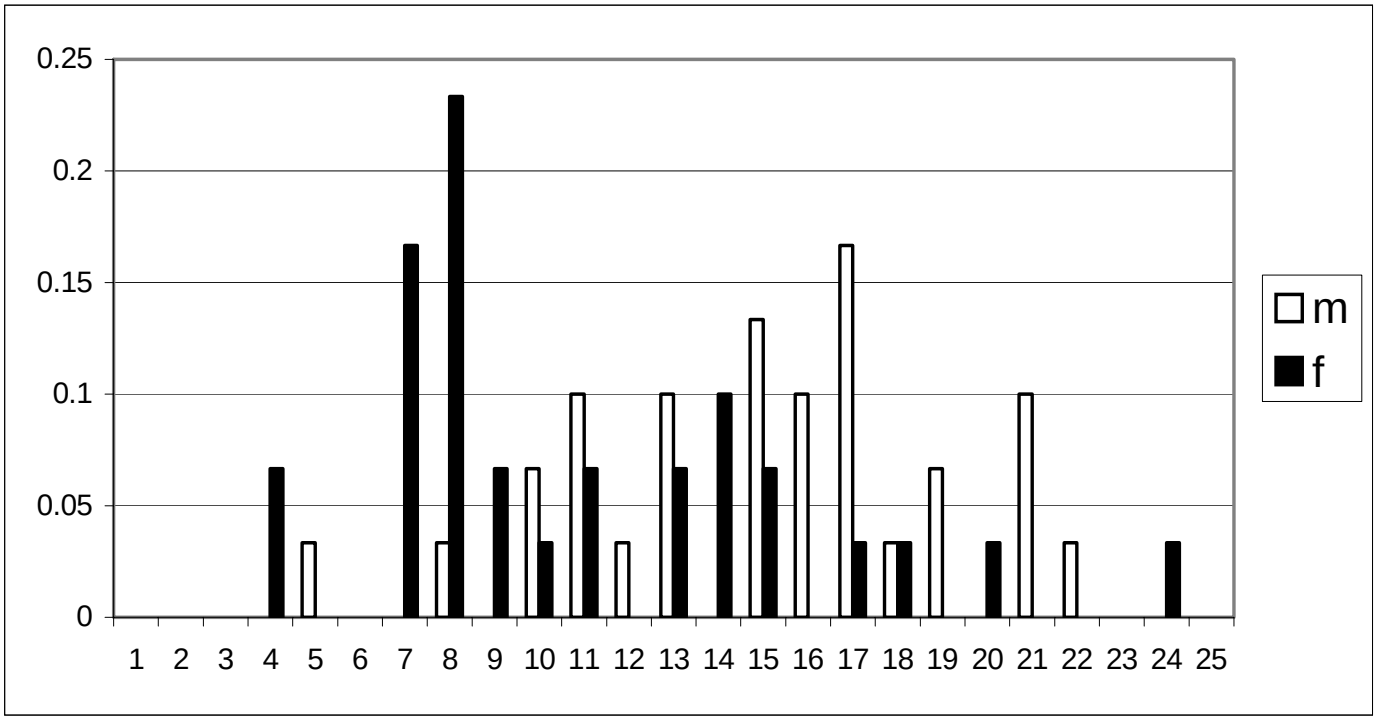
Results:

Significant Increase in Performance

Tournament average: 12.95

Piece Rate average: 10.48

p-values of WMW-test: 0.007 significant differences.



Significant Gender Difference

Mean for men: 15, Women: 10.8. p-value of WMW test is 0.0004.

Men strongly react to Tournament incentives:

Tournament: 15

Piece Rate: 11.23: significant difference (p-value 0.001).

Women do not react to Tournament incentives:

Tournament: 10.8

Piece Rate: 9.73: no significant difference (p-value 0.6226).

- No significant gender gap in mean performance in the piece rate treatment: 1.5.
- Large and significant gender gap in mean performance in tournaments 4.2.

Furthermore, tournaments significantly increase the gender gap in mean performance compared to a noncompetitive piece rate: 4.2 >>1.5.

Bootstrapping: 1000 iterations. p-value 0.034, hence significant increase.

Are all men / women equally affected?

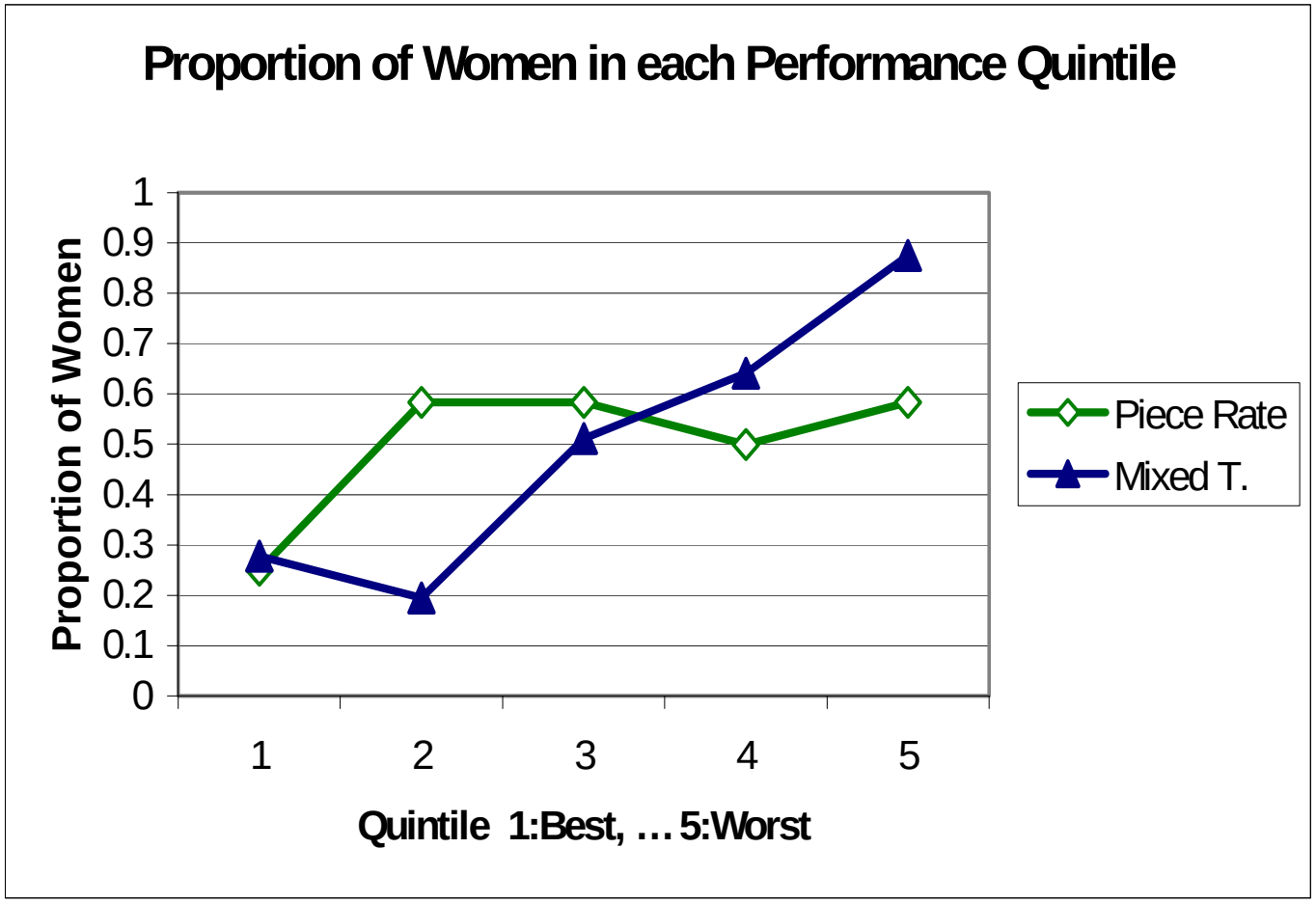
How do these average experiences translate to behavior within each group?

Consider for each treatment performance quintiles: Rank participants according to their performance (without forgetting their gender).

First quintile: 20 percent participants that solved the most mazes.

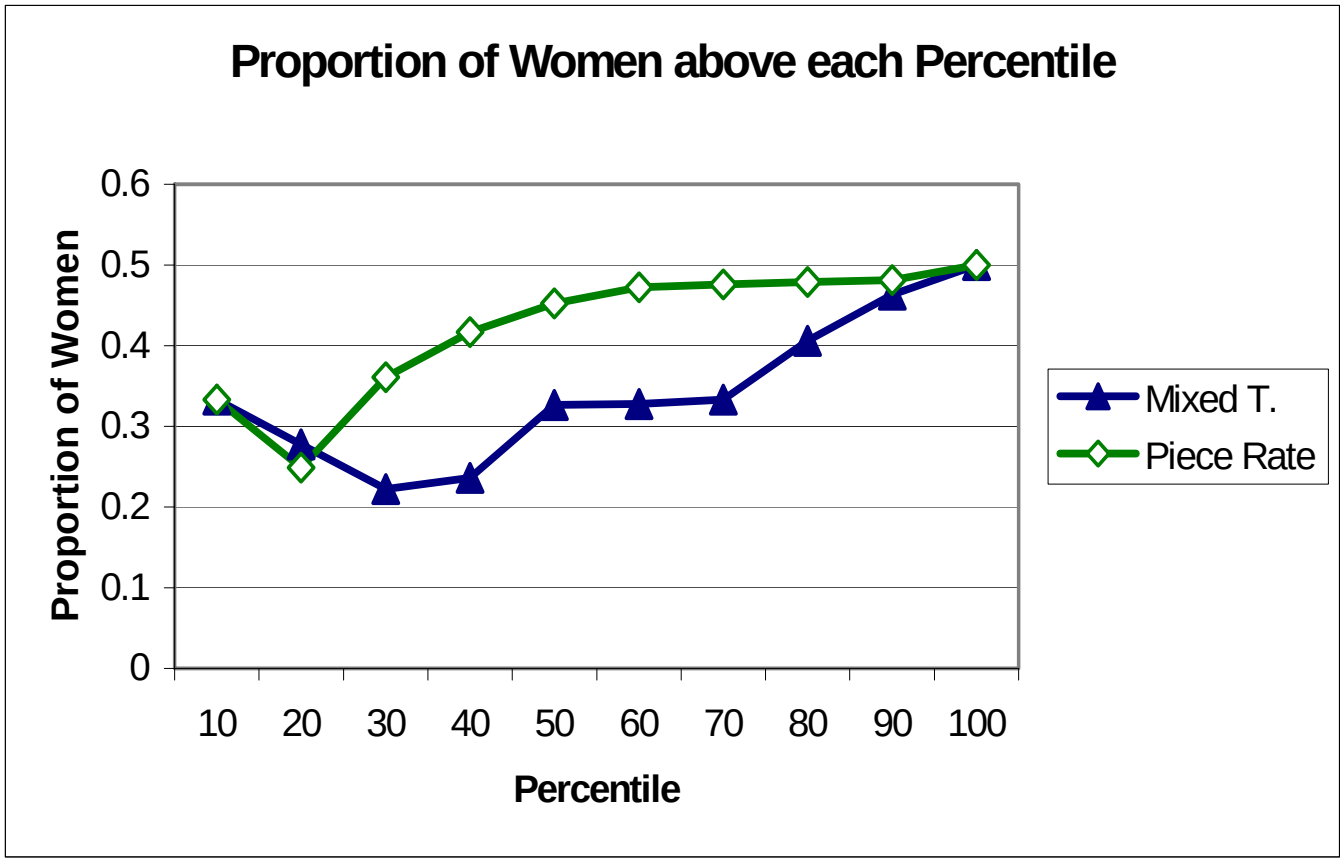
Second quintile: the next 20 percent best participants. …

For each treatment consider for each quintile the proportion of women in this quintile.


Proportion of Women in each Performance Quintile
Proportion of Women
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1
2
3
4
5
Quintile 1:Best, … 5:Worst
Piece Rate
Mixed T.

Consider cumulative graph:

For each decile: Consider the proportion of women among the participants whose performance ranks them higher than this decile.



Results so far:

- Tournaments result in a significant increase in the gender gap in mean performance as compared to the piece rate.

Reasons for this gender gap: Tournament incentives

- do not increase mean performance of women.
- significantly increase mean performance of men.

WHY?

Gender Differences in Risk-Aversion?

Difference between tournament and piece rate:

- Payment depends on the performance of the other participants.
- Payment is uncertain.

Is the gender gap in mean performance in tournaments driven by the uncertainty only, through gender differences in risk-aversion?

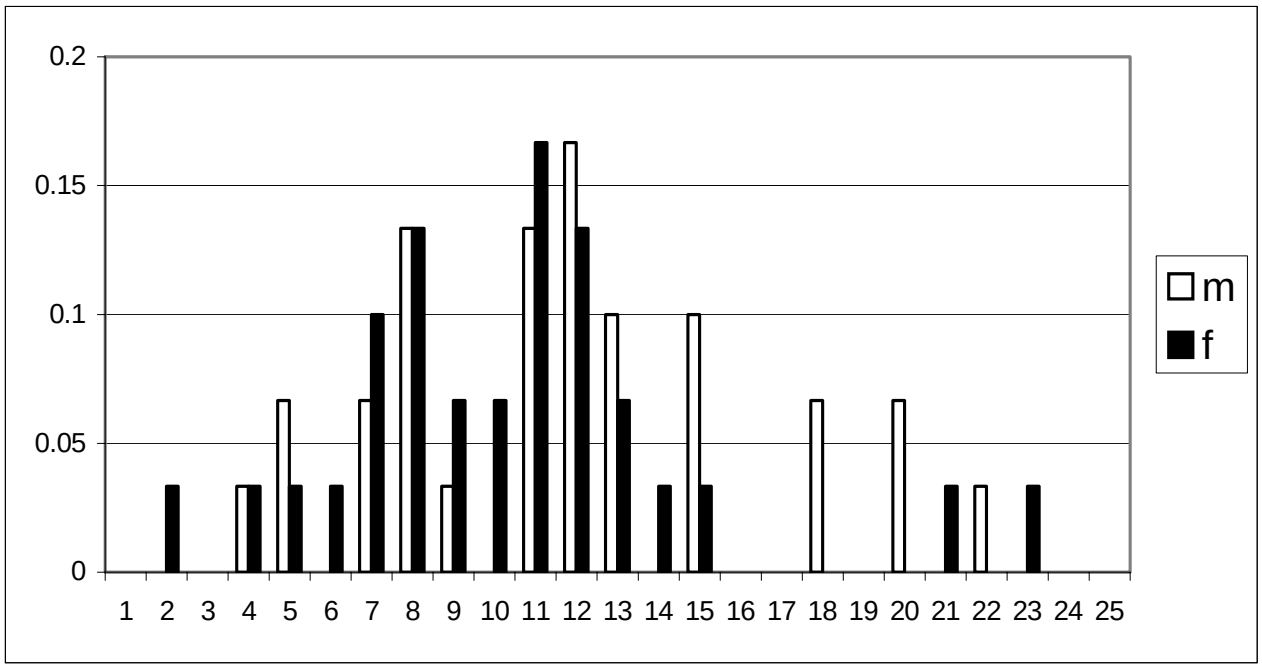
Big Debate: Possible Gender differences on Risk-Aversion. Byrnes, Miller and Schafer (1999), Eckel and Grossman (2000). If anything, women are more risk-averse.

To discern effect of risk aversion, need to consider incentives where the payment is uncertain, though independent of the performance of others.

Treatment 3: Random Pay

Group: 3 Men and 3 Women: Solve mazes for 15 minutes. At the end: One person is chosen randomly and receives 12 shekels for each maze she or he has solved. Other participants receive no payment additional to show-up fee.

Results Random Pay:



Mean for males: 11.83, for females: 10.33.

WMW p-value: 0.165. Difference is not significant.

Random Pay versus Piece Rate

Differences is not significant for men (0.6449) and women (0.6130).

Random Pay versus Tournaments

Difference is significant for men (0.0065) but not for women (0.6226).

Performance differences in mixed tournaments are not driven by the uncertainty, through gender differences in risk aversion.

Why do tournaments result in a significant increase in the gender gap in mean performance as compared to the piece rate?

Why do women not increase their performance in mixed tournaments while men do?

1. Women do not compete against men:

Rational Explanation:

Participants have some ability to solve mazes. Output is jointly determined by effort, ability and noise. If it is common knowledge that women are (slightly) worse at solving mazes than men, their optimal effort level may be lower than that of men.

Additional Explanation:

Women may think that they are worse than men in solving mazes in competitive environments, beyond possible actual gender differences.

. . .

These explanations hinge on the identity of the competitors. Women might still be effective in competitive environments and be motivated by competitive incentives.

2. Women do not compete at all:

Women cannot solve more mazes.

Women can not / do not want to compete per se.

These are reasons that determine the behavior of women in tournaments *per se.*

(i) Women are not sensitive to incentive schemes at all.

(ii) Women do not like to compete.

- Different socialization
- Not increasing performance (effort) in the tournament as opposed to random pay: Contributing to a public good.

. . .

3. The performance of men is too high (not that of women too low):

Maybe men provide too much effort, and hence output, in tournaments, not women too little.

To investigate these issues: Single-sex tournaments: 6 Women only and 6 Men only.

Reason to have also Men single-sex tournament.

- Maybe men only compete a lot when women are around: Evolutionary Argument.
- If men only perceive other men as “real” competitors, men in mixed tournaments only compete against 2 other subjects. However, optimal effort in tournaments depends on the number of competitors. Hence we do not want to compare the performance of women in single-sex tournaments to the one of men in mixed tournaments.

Treatment 4: Single-sex Tournaments

Exactly like the other tournament, only that now there are either 6 women or 6 men.

5 sessions of each gender, i.e. 30 women and 30 men.

Results:

Men in single-sex tournaments look like men in mixed tournaments:

Men single sex: 14.3 Men mixed: 15 mazes

p-value of WMW: 0.5630: no significant difference.

Hence men are not strongly affected by the fact that they do not compete against women.

Are Women Competitive?

Women in Single-sex Tournaments Versus women in non competitive environments

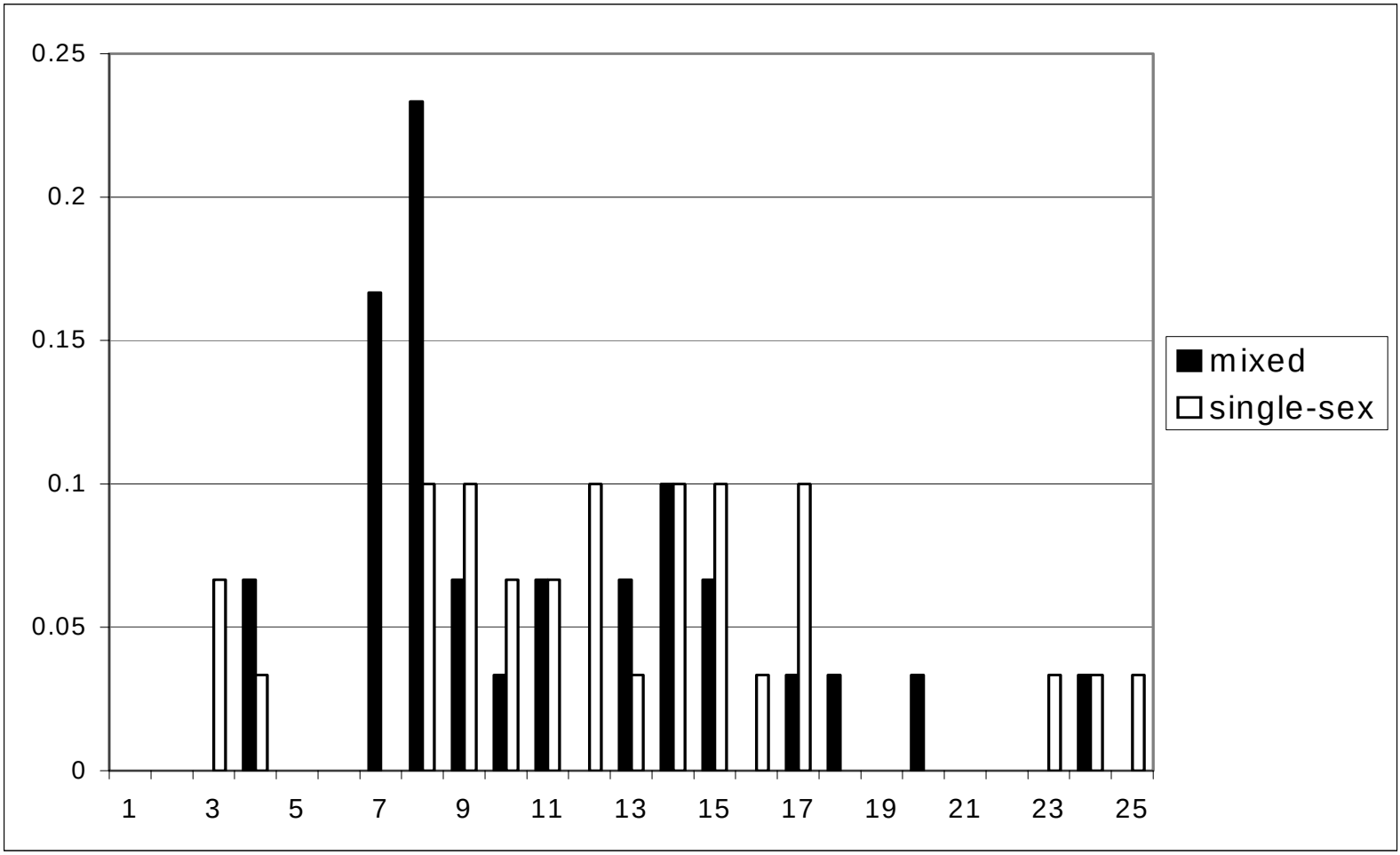
Single-sex tournaments: 12.6

Random pay: 10.33 (p-value two-sided: 0.0469)

Piece Rate: 9.73: (p-value two-sided: 0.0148)

Women react strongly to tournament incentives in single-sex groups.

Women's performance in mixed versus single sex tournaments:



Women in Single-sex Versus Mixed Tournaments:

Single-sex tournaments 12.6

Mixed Tournaments 10.8

p-value of WMW (two sided) is 0.1025.

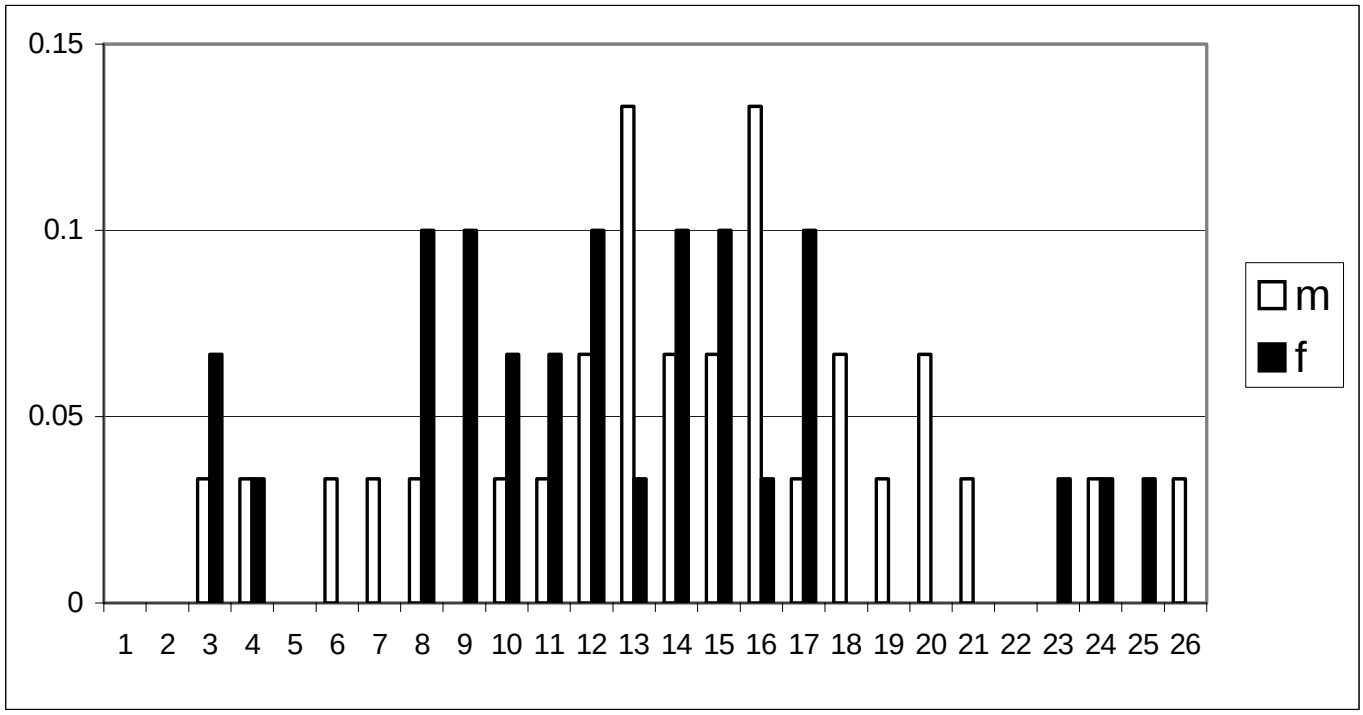
However this does not imply that women are as apt as men in competing.

Therefore we:

- Compare distributions of men and women in single sex tournaments.

- Compare gender gaps in mean performance across all incentive schemes.

Women versus Men in single-sex tournaments



Men: 14.3

Women: 12.6

WMW test: p-value 0.1346, the difference is not significant.

Gender gap in mean performance:

Mixed Tournament: 4.2

Single sex tournament: 1.7

Piece Rate: 1.5

Random pay: 1.5

Moving from mixed to single sex tournaments significantly reduces the gender gap in mean performance:

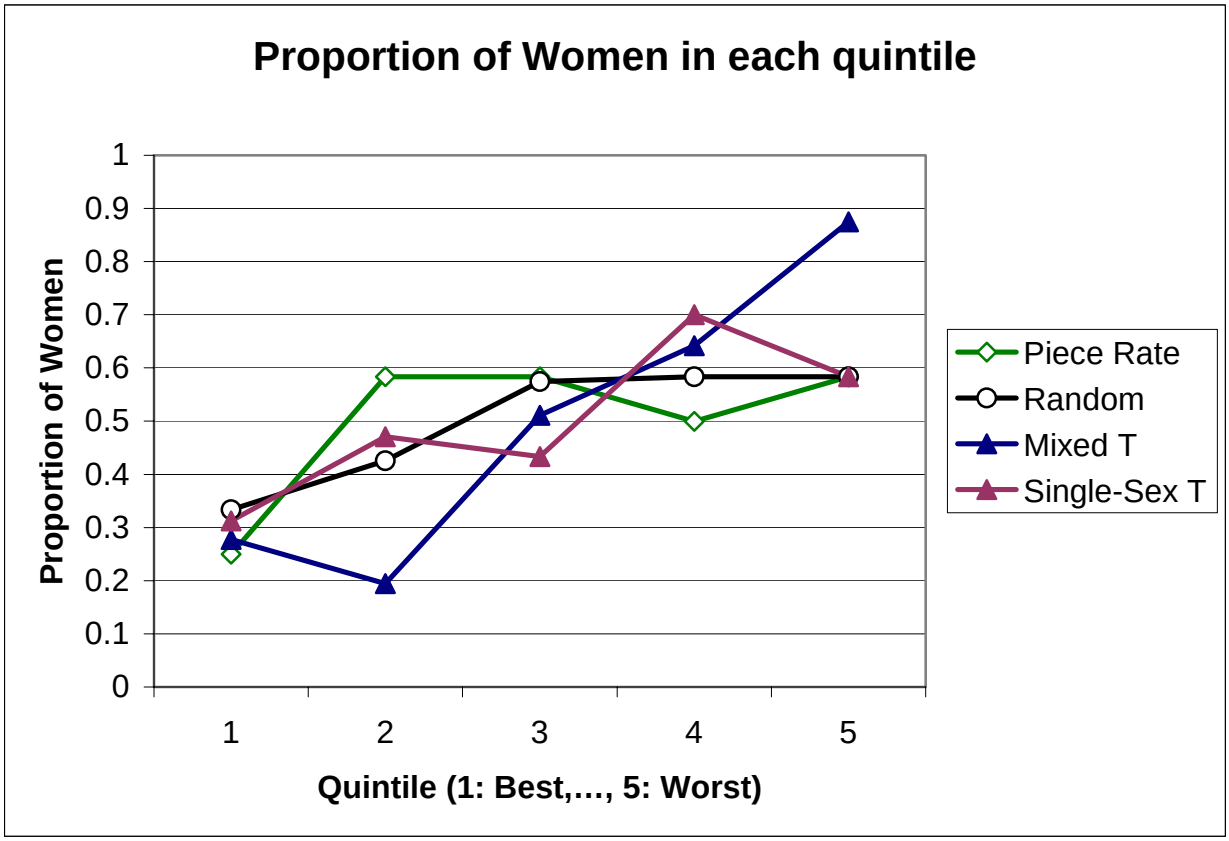
Repeat our bootstrap procedure, and find p-value of 0.082, hence the reduction in the gender gap is significant.

However no significant difference in the gender difference in performance when moving from single-sex tournaments to piece rate (0.459) and random pay (0.535).

Are all men / women equally affected?

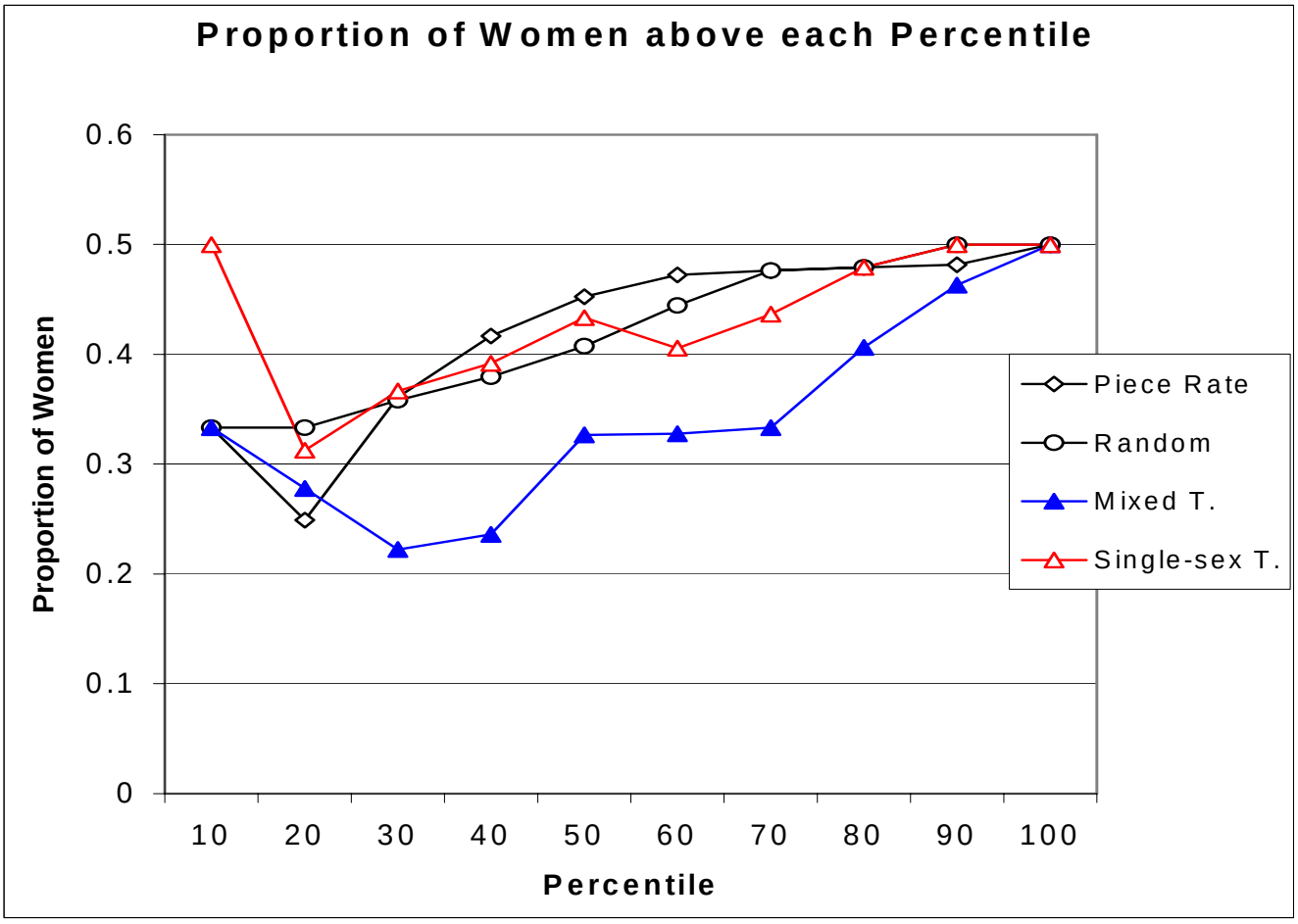
Consider for each quintile the proportion of men and women.

For the single-sex tournaments, we pool the observations of men and women and take quintiles of the overall distribution.

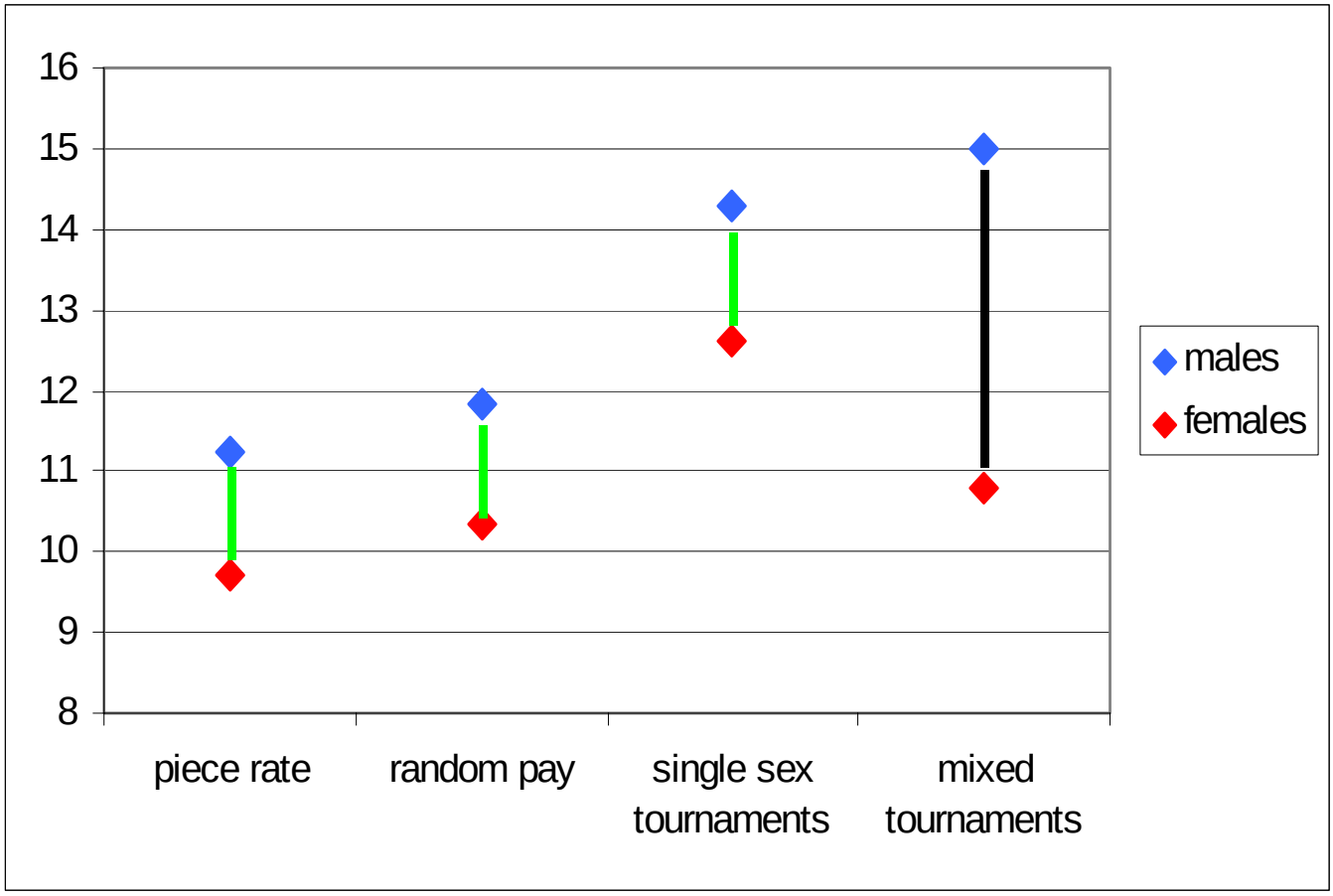


Consider cumulative graph:

For the single-sex tournaments, we pool the observations of men and women, and consider percentiles of the overall distribution.



Performance Averages: Men and Women



- Women do not compete against men.

- Women competing against women respond to competition as much as men do.

Possible explanations for the significant gender gap in performance in mixed tournaments:

Women are more risk-averse than men.

Women do not compete at all, because women

- do not react to incentive schemes,
- cannot solve more mazes (or only at high costs),
- do not want to increase performance in tournaments.

Men are the ones that perform too high in tournaments.

Women do compete, but not against men.

- Rational Explanation: Women are somewhat less good at solving mazes.
- Confidence Issue: Women think they are less able than men.

Women perform highly, whenever there are no men around.

Alternative explanation for the increase of performance of women in single sex tournaments compared to all other treatments: Women in single sex tournaments are only, or mostly, motivated not by the tournaments incentives, but by the fact that there are no men present in the experiment.
Need to test for effects of “presence of men”

Treatment 5: Single sex piece rate

Exactly like the other piece rate, only that there are either 6 women or 6 men. (2 Shekels for each maze solved). 2 sessions of each gender, i.e. 12 women and 12 men.

Results

Women: Single Piece R. 10 / 9.73: Mixed Piece R. (p: 0.83)
/ 12.6 Single Tournament (p: 0.13)
Men: Single Piece R. 11.08 / 11.23 Mixed Piece R. (p: 0.77)
/ 14.3 Single Tournament (p: 0.05)

Increase of performance of women in single sex tournaments is due to incentive scheme, not the absence of men.

Why do women not compete against men?

Rational Explanation:

In all treatments: performance of Men > Women.

Is this a possible explanation for the gender gap in mixed tournaments (if it is common knowledge)?

Two extreme assumptions about what participants know of their ability to solve mazes.

1. Participants solely know their gender.

Consider the performance of men and women in piece rate (and random pay and single sex tournaments). With those values simulate mixed tournaments: The probability to win the mixed tournament is 7-10% higher for men than for women.

Therefore women might have a lower optimal effort and performance in mixed tournaments.

2. Participants know where they stand on the probability distribution of their own gender.

A man and a woman who solve the same number of mazes under non competitive schemes (piece rate and random pay), face “different” competitors in the mixed tournaments.

Man faces 2 men (who are better than women, on average) and 3 women.
Woman faces 3 men who are better than women, on average) and 2 women.

Therefore, a man and a woman who solve the same number of mazes, face a difference in winning a simulated mixed tournament of 1 - 5 %.
Hence, a woman who solves the same number of mazes under noncompetitive schemes than a man, might solve less mazes in mixed tournaments than that man.

However, a woman who solves x mazes has a higher chance of winning the simulated tournament than a man who solves x-1 mazes. So, the performance of the x-woman under mixed tournaments should be at least as high as the one of the (x-1)-man.

Compute the (minimum) performance of women in mixed tournaments out of the performance in the piece rate and under random pay, by

- Order men by number of mazes solved in piece rate and random pay.
- Pair a woman who solved x mazes to a man who solved x-1 mazes.
- For all the men who solve x-1 mazes in the noncompetitive treatment, find the corresponding men in the mixed tournament (using rank order).
- Take the lowest number of mazes solved by those men.
- This number of mazes is the minimum that should be solved in the mixed tournament by a woman who solves x mazes in the noncompetitive treatment.

Compare the 60 values of how women should perform under mixed tournaments to their actual performance (30 values): Actual performance is significantly lower ($p=0.04$).

Therefore, the low performance of women under mixed tournaments cannot be solely explained by the hypothesis that a woman and a man of the same ability behave differently in mixed tournaments, solely because the women faces a tougher competition than the man.

Other Possibility:

Women may feel less confident in their ability and competence.

Do men and women feel equally competent and confident in their ability of solving mazes?

Do men and Women make different choices when they can chose the difficulty level in which they perform and will be evaluated?

Treatment 6: Choice of Difficulty

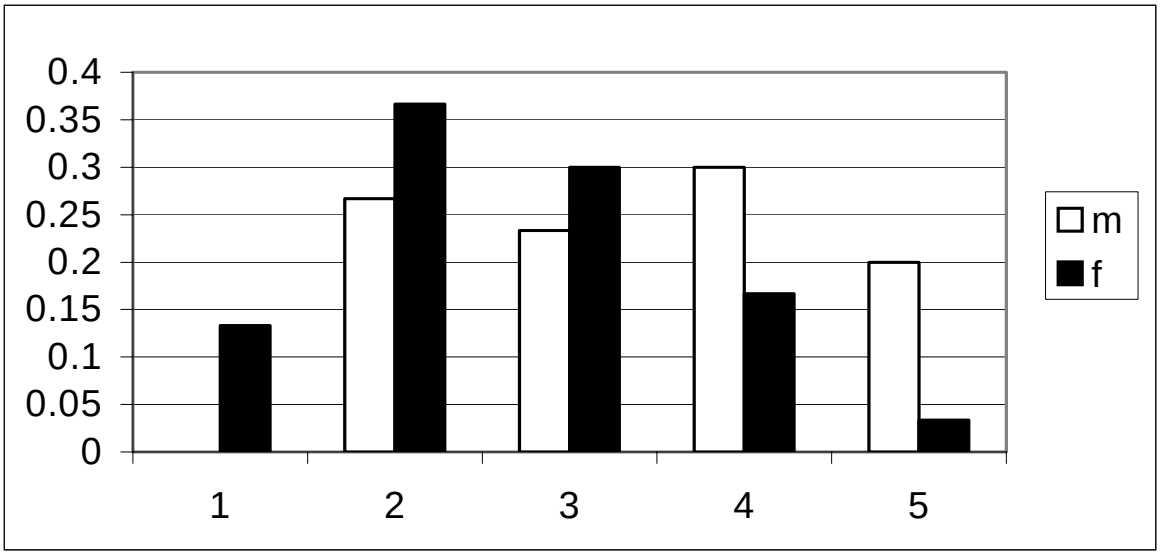
3 women and 3 men.

Participants choose difficulty level from 1 = easy to 5 = hard and play in this level for 15 minutes.

For mazes of level x receive x shekels for each maze solved.

Participants do not know choices or performance of others.

Results:



The mean choice

Men: 3.4

Women: 2.6 (p-value 0.0065), the difference is significant.

Both arguments: That subjects take gender as a signal for ability and that women feel less confident in their ability than men are possible explanations.

Impact of Incentive Schemes

Impact of Tournament incentives

Mean performance in mixed tournaments: 12.95

Mean performance in single-sex tournaments: 13.47

Difference is not significant (p-value 0.62)

Overall performance is certainly not adversely affected by running single-sex as opposed to mixed tournaments.

Performance in tournaments: mixed and single sex: is significantly higher than under random pay and piece rate.

Tournaments are not only used to provide incentives, but also to determine very high performing participants.

Winner of the 10 tournaments in each treatment:

Mixed Tournaments: 7 men, 2 women and 1 men and 1 women ex aequo, average performance: 19.4

Average performance (1000 simulated tournaments): 19.26

Single-sex tournaments: By design: 5 women and 5 men. Average performance: 20.5: No significant difference (p-value: 0.52)

Average performance (1000 simulated tournaments):

Women: 19.59, Men: 21.04 Average: 20.32

Average performance of winners in mixed and single sex tournaments is not significantly different.

Running single-sex as opposed to mixed tournaments has no adverse effect on average performance and performance of the winner.

Running single-sex as opposed to mixed tournaments is a strong form of affirmative action: Quota setting. In our case: Came at no cost.

Related Psychology Literature

Stereotypes

Stereotypes: Ongoing and Pervasive.

How can stigmatized individuals protect their self esteem?

Disengage and disidentify from domains in which they are threatened by stereotypes, i.e. expecting and experiencing poor performance and failure.

However: Female participants in our study: Technion undergraduate students who receive a degree in engineering. Therefore expect not much of an internalization of negative stereotypes than in the general female population.

Stereotype Threat Theory (Steele and Aronson 1997)

Even stigmatized individuals (e.g. women) who identify with areas in which they are threatened by stereotypes, are harmed by prejudices.

Stereotype Threat: Threat that a negative stereotype about the group one belongs becomes self-relevant as a plausible explanation for

- something one is doing
- for an experience one is having

that has relevance for one's self definition.

Example: If a woman fails a mathematics test, the reason, in her own eyes, may be not that she didn't study, was unlucky, had a bad day, but that she is a women and women are not good in mathematics, therefore the reason is that she is not good in mathematics.

This stereotype threat is an additional source of “test anxiety,” choking, one that is not experienced by people not stereotyped this way.

To apply stereotype threat theory to our results:

- Task identification: Women probably do not strongly identify with their ability of solving mazes. If they would: Their performance should be damped in tournaments as well as in noncompetitive environments.
- Women identify with their ability to perform in competitive environments: Then women should also do less well in single sex tournaments.
- Women identify with being as competitive as men. Then only mixed tournaments pose a threat.

However: Brown and Josephs (1999): Also positive stereotypes may be a burden (e.g. Men might think that they should be at least as competitive as women), and then mixed tournaments should harm the performance of men.

Difference of psychology experiments to our experiments:

- We introduce incentives.
- Only change the incentive scheme across treatments, not the description of the task.

Conclusions

Do men and women differ in their ability/propensity to perform in competitive environments?

- Noncompetitive environments: No significant gender difference in performance.
- Mixed competitive environments:

  Significant increase in performance for men but not for women.

  Significant gender gap in average performance.
- Single-sex competitive environments: Performance of women increases: No significant gender gap in average performance.

Possible Explanations:

- Men are slightly more able than women, hence if gender is a self-signal for ability, women may perform less in mixed tournaments.
- Women feel less competent than men.

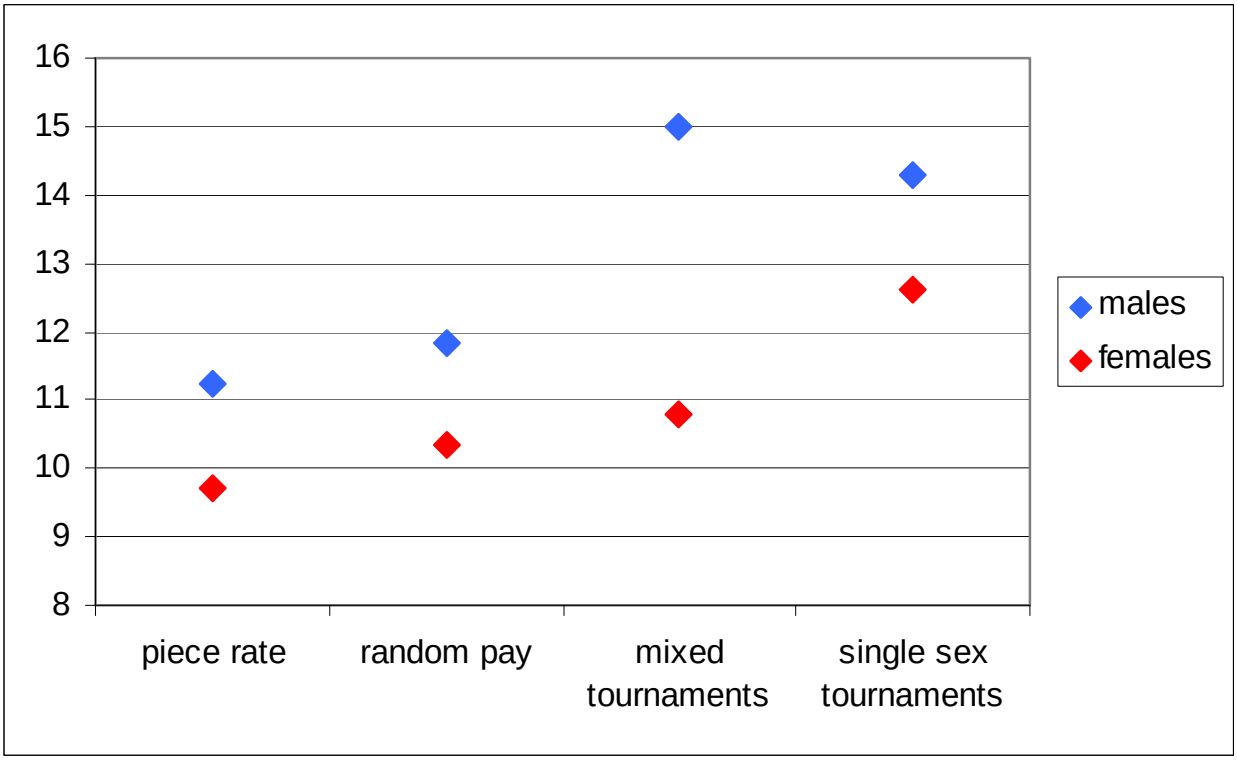
Regardless of the reason for the results, possible “policy” implications remain the same.

Impact of different incentive schemes when participants are required to exert real effort:

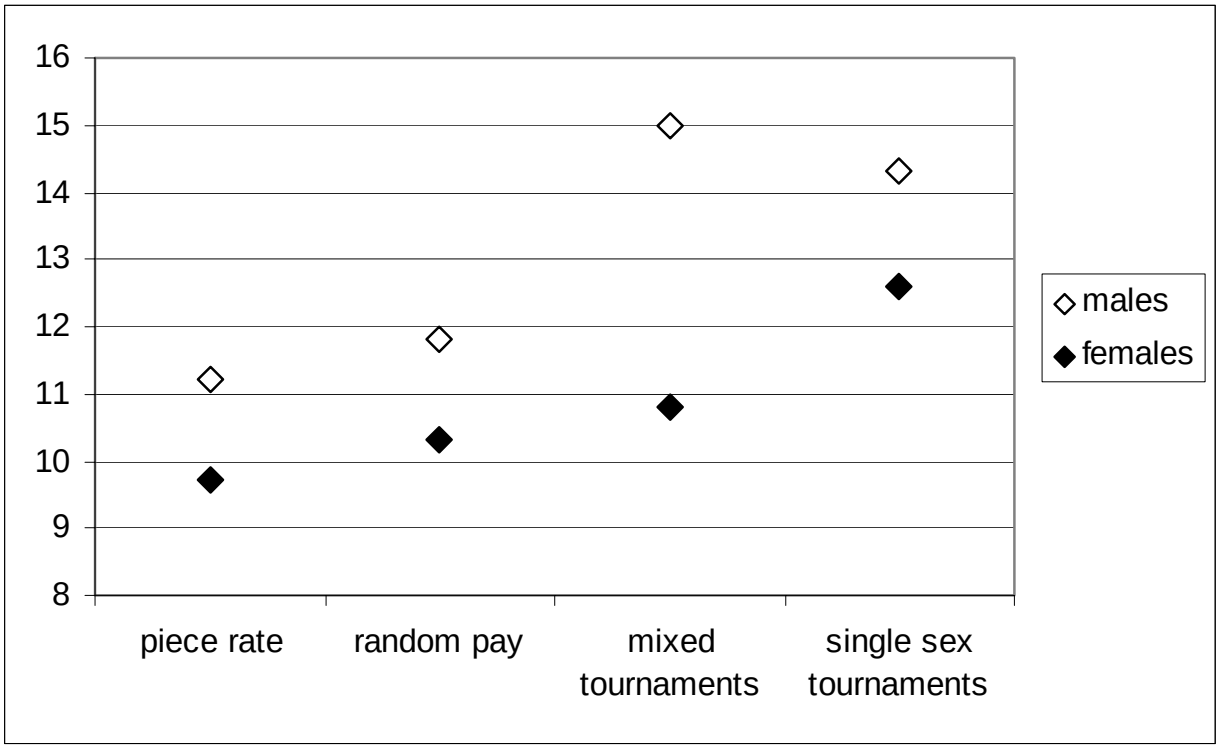
- Competitive incentives increase performance.
- Single-sex tournaments are as effective as mixed tournaments in eliciting performance of all participants, and the winners of the tournaments.

Single-sex tournaments: Strong form of affirmative action. This comes at no cost in performance in our experiment.

Performance Averages: Men and Women

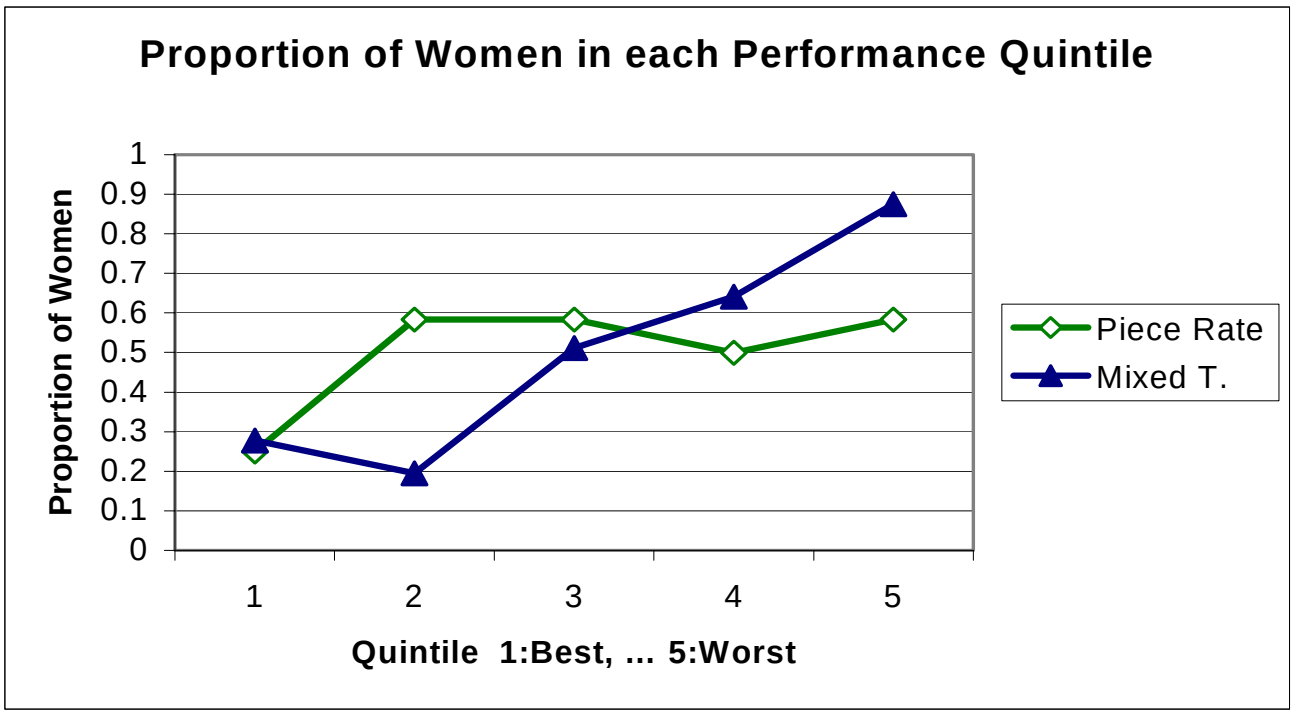


Performance Averages: Men and Women



- Women do not compete against men.

- Women competing against women respond to competition as much as men do.



1. Quintile: Proportion of Women: around 25%: significantly lower than 50% (0.04 in piece rate and 0.06 in Mixed Tournament).

Piece Rate: 14 or more mazes, mixed T: 17 or more mazes

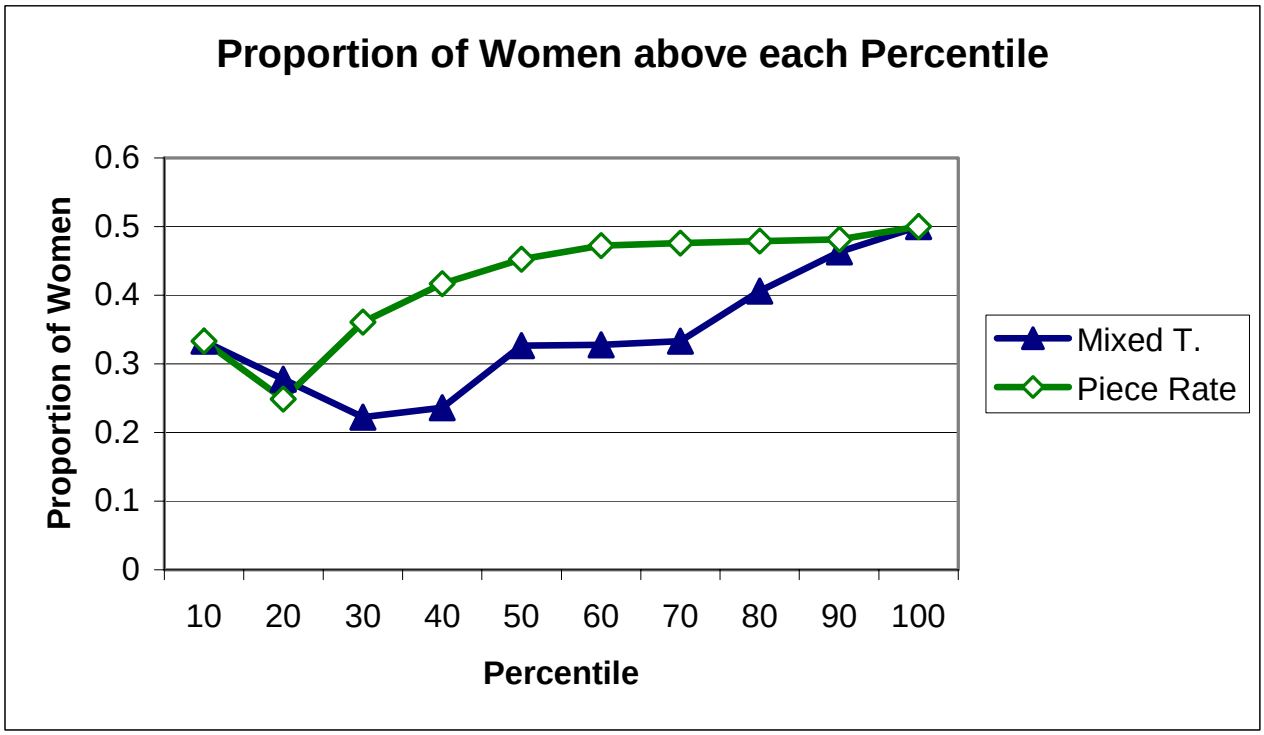
2. Quintile: Significant Difference (0.058). P.R.11-14, MT. 15-17.

5. Quintile: Significant Difference (0.047). P.R. 3-8 (average: 6)

Mixed Tournament: 4-8 (average: 6.6)

Consider cumulative graph:

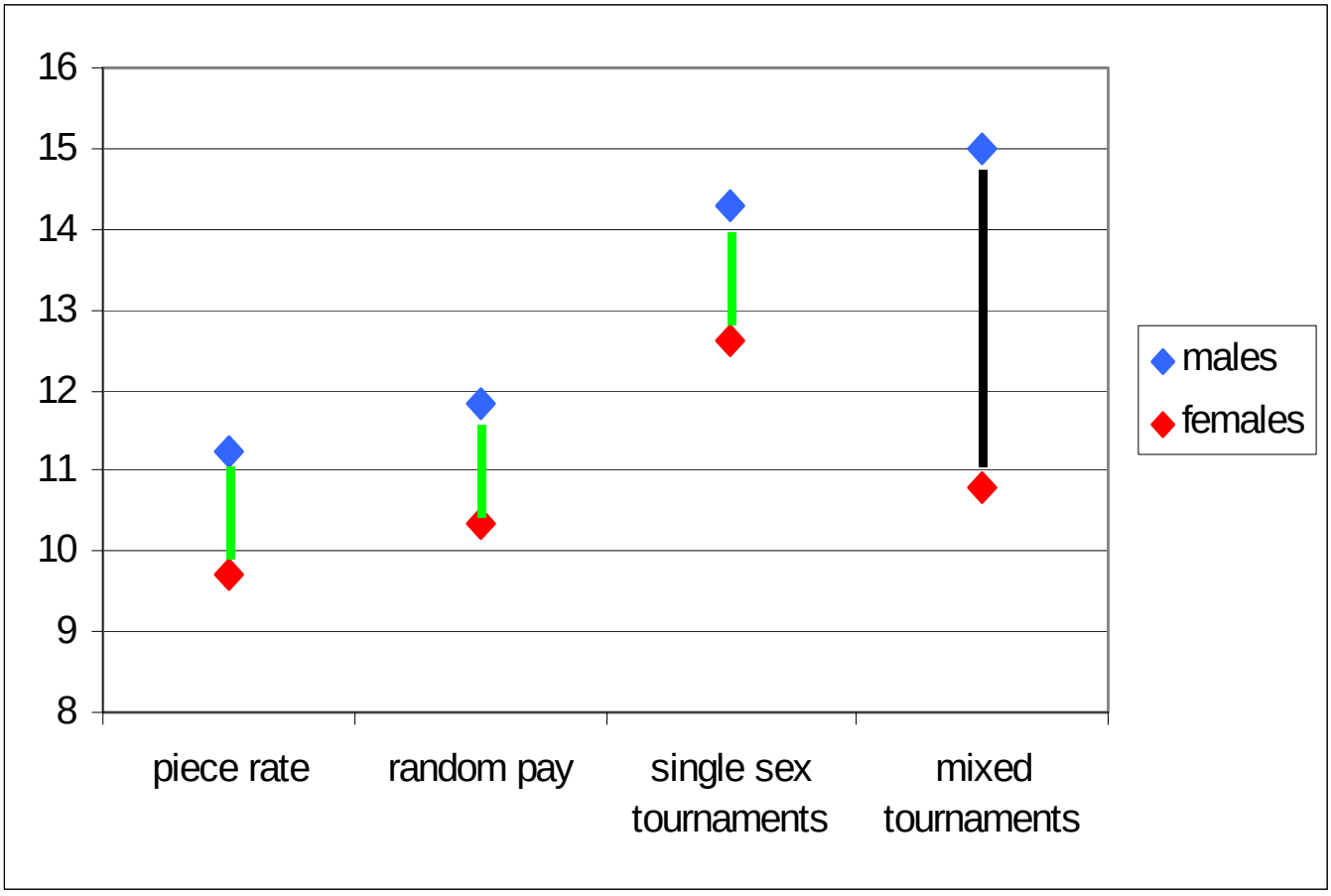
For each decile: Consider the proportion of women among the participants whose performance ranks them higher than this decile.



For example: 4. decile (40), among the top forty participants there are 42% women in Piece Rate and 24% in Mixed Tournament. (significantly lower: 0.07)

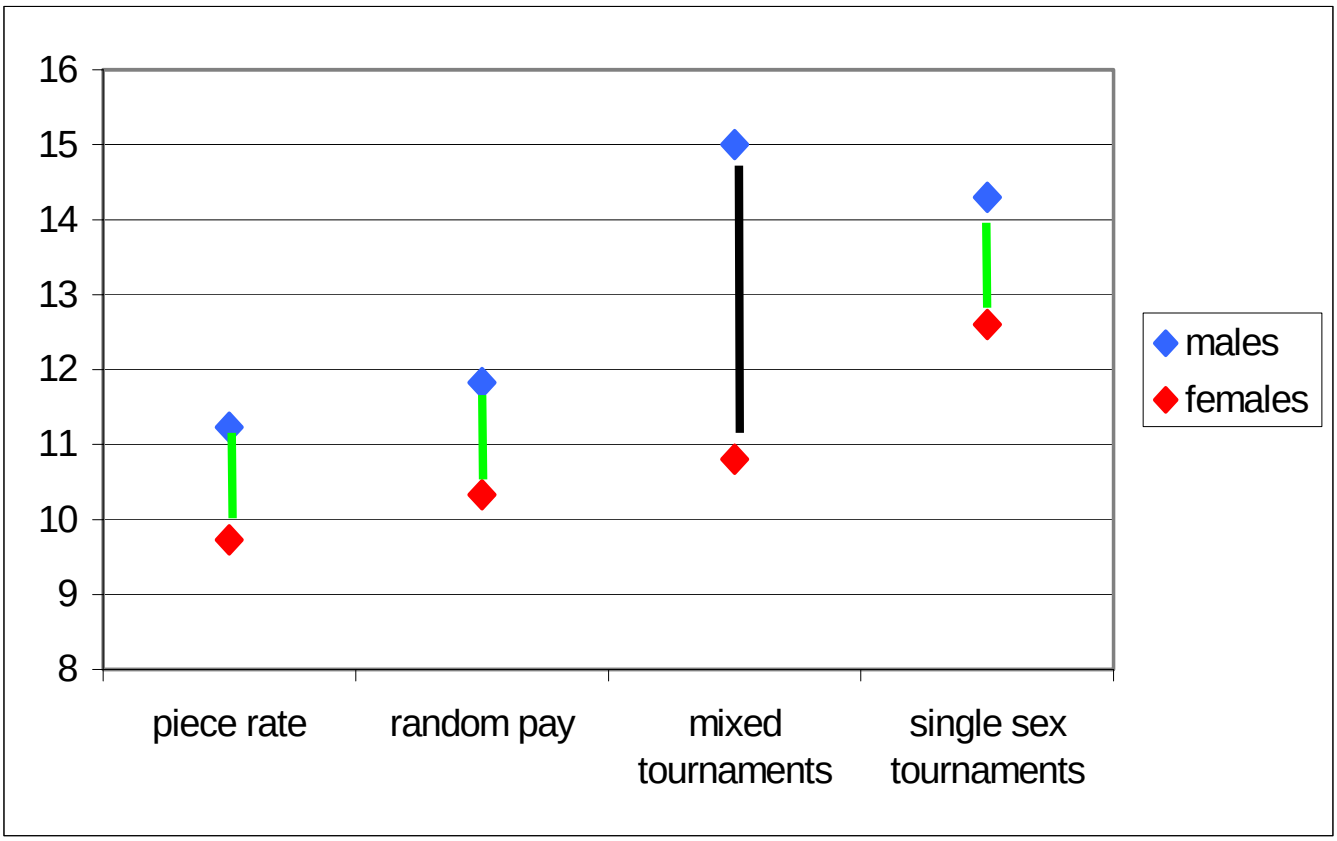
Significantly lower % in Mixed T. also for 60 and 80 (0.029 and 0.047).

Performance Averages: Men and Women



- Women do not compete against men.

- Women competing against women respond to competition as much as men do.


16
15
14
13
12
11
10
9
8
piece rate
random pay
mixed tournaments
single sex tournaments
males
females