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Gender, age, and competition: A disappearing gap?

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ABSTRACT

Research on competitiveness at the individual level has emphasized sex as a physiological determinant, focusing on the gap in preference for competitive environments between men and women. This study presents evidence that women's preferences over competition change with age such that the gender gap, while large for young adults, disappears in older populations due to the fact that older women are much more competitive. Our finding that tastes for competition appear just as strong among older women as they are among men suggests a simple gender-based view of competitiveness is misleading; age seems just as important as sex.

1. Introduction

The gender gap in willingness to enter competitive environments has captured a great deal of attention from economists. A burgeoning literature documents the male–female gap across a wide range of settings, explores its policy implications, and examines its role in the differential success of men and women in labor markets (Gneezy et al., 2003; Gneezy and Rustichini, 2004; Niederle and Vesterlund, 2007; Booth and Nolen, 2012; Balafoutas et al., 2012; Almås et al., 2015; Niederle et al., 2013; Buser et al., 2014; Flory et al., 2015). The existence of aversion to competition can be very costly – for firms as well as for individuals. For firms, the use of relative performance based incentives and promotions may lead to loss of talent if highly skilled workers self-select out of competitive environments. For individuals, the widespread use of competition-based allocation mechanisms means avoiding competition can entail large costs: whether for a high-paying job, a position of authority, or rights to scarce resources, to opt out of competition often means foregoing large potential gains. A full understanding of the determinants of attitudes toward competition is thus critical for understanding the costs of competition aversion and the design of mechanisms to mitigate undesired effects of differences in competitiveness.

Experiments have consistently found that women are generally less willing than men to compete, even when it is in their material interest to do so (see Niederle and Vesterlund (2011) for a review). However, there is surprisingly little age

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diversity in existing evidence on this question when it comes to adults.[1] The findings come largely from young populations (e.g. university and primary or secondary school students), with little attention given to what happens to competitiveness as adults grow older. Our findings show this omission is not trivial: while we replicate the standard result among young populations that women are significantly less competitive than men, we find the gender gap disappears among more mature adults. Focusing on *competition preference*—a measure of competitiveness that controls for skill, risk appetites and other factors—we find that the age gap between mature women and young women is just as large as the gender gap between young women and young men. Furthermore, more mature women are just as competitive as all men. For men on the other hand, we find no evidence that age affects preferences over competition.

One important exception to the general focus on young populations in competition experiments is Mayr et al. (2012), who find changes in competition entry by age among adults aged 25–74, and a large gender gap in selecting into their competitive task that persists across all ages. In contrast, Charness and Villeval (2009) find competitiveness does not change with age, and finds no signs of an overall gender gap among individuals in their late teens to early seventies when controlling for risk tastes. Similarly, in one other study that includes adults of a broad age range, Buser et al. (2015) find the overall gender gap across all ages is considerably smaller than in most studies, disappears when controlling for risk, and does not exist among older individuals. Neither of the latter studies look at the effect of age separately for each gender.

In this paper we examine competitiveness among men and women from age 18 to 90 and find significant changes in competition preferences for women across age but no corresponding changes for men. These findings complement Mayr et al. (2012) by examining choices under a different structure of competition and by focusing more precisely on changes in competition preferences (independent from risk appetite and other factors) as they impact tournament entry. Moreover, we show that some of the age patterns they find may be driven in part by changes in tastes for competition per se. Unlike Charness and Villeval (2009) and Buser et al. (2015) we examine the interaction of age and gender, to find that women 50 and older are much more competitive than women under 50 and at least as competitive as men of all ages.

To test for the effects of age, we use data from laboratory experiments on competition with men and women of all adult ages. Our main sample draws from villages in rural communities of Malawi, a country in sub-Saharan Africa. To help verify the pattern we discover is not particular to our initial setting, we draw an auxiliary sample from an urban US population. While the smaller size of this second sample makes its results somewhat more speculative, the sharp similarity in the effects of age on competition preference within each gender across the two different societies is provocative. We focus on age 50 for much of the analysis (though we also test for more gradual age effects as well). For women, changes at this age would be predicted by recent work on sharp changes in competitiveness at puberty, the role of hormones in tastes for competition, and evolutionary psychology models. (We discuss this further in Section 5.) Theory suggests, and our data support, a strong relationship linking sex, age, and competitiveness.

In addition to our experimental results, we also replicate with our data the main findings on gender and competition preferences that helped launch this literature (Niederle and Vesterlund, 2007), when restricting to subjects of a similar age range. Age is a factor that is often overlooked in experimental studies. However, doing so may prevent a full understanding of the behaviors we wish to understand. While not the only area of importance, labor markets and the workplace have been focal points for the implications of differences in competition preference. Adults actively participate in the labor force throughout the middle and upper age ranges – even more so as the age of retirement rises – and prior work has highlighted the need to better understand how older workers respond to competition. This study helps address that gap. Our findings also have significance for the design of incentives, for empirical researchers and policymakers, and for the rapidly growing body of research on competitiveness.

2. Experimental design

To test the hypothesis that the gender gap in willingness to compete is a function of age, we use data from an experiment initially designed to examine gender differences in competitiveness among adults of a broad age range in rural Malawi. Upon discovery of a striking pattern with respect to age among women, we replicated the experiment in the US in order to test whether the age pattern would hold when changing the cultural setting. In our procedure, we rely heavily on the experimental protocol designed by Niederle and Vesterlund (2007; henceforth NV). We augment their design by eliminating the need for literacy, broadening the age-distribution of participants, and incorporating multiple cultures within the experiment.

As NV emphasize in their seminal study, an important challenge in identifying the effects of a given determinant (e.g. gender) on appetites for competition is the confounding effects of other omitted characteristics correlated with the determinant of interest. They note that gender differences in risk appetites, aversion to receiving feedback on relative performance, and in self-confidence can all create a gender gap in willingness to compete, in addition to a gender difference in tastes for competition itself. Their protocol resolves this problem by having subjects make two choices, both of which are affected by risk preferences, feedback-aversion, and self-confidence, but only one of which is affected by a taste for competing against

[1] Many studies examine competitiveness among children (e.g. Cardenas et al., 2012; Dreber et al., 2011; Dreber et al., 2014; Andersen et al., 2013; Sutter and Rützler, 2010), often identifying the absence of a gender gap among pre-adolescents and an 'age of onset' of gender differences. However, almost no studies examine the gender gap among older adults.

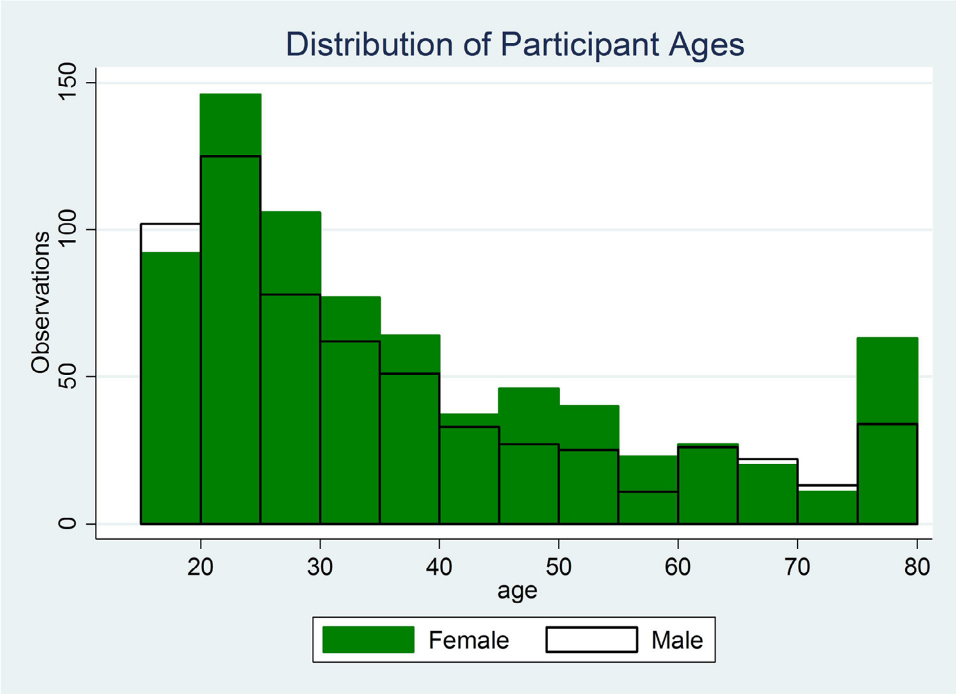

Fig. 1. Number of participants by age. Participants over the age of 80 are included in the category 75–80.

others per se. The choice affected by just risk preferences, feedback preferences, and confidence is used as a control in analyses of the choice to perform a task under competition incentives, so that the residual effect of gender on the competition choice reflects the gender difference in preferences for competition per se. In this way, changes in risk preferences with gender (and, in our case, age) that affect the willingness to enter a competitive setting are disentangled from changes in competition preferences with gender and age.

We specifically chose the NV design in order to control for these factors, to identify impacts on competition preferences. To implement it in a different setting we changed the task so all adults could complete it regardless of literacy. The task is to arrange shapes stamped on the sides of small wooden blocks in a row from smallest to largest. After completing one shape (e.g. stars), participants then arrange the next shape (e.g. squares) in ascending size. Payment is based on the number of shapes completed in a 3-minute interval. As in NV, there are four different rounds, and one is randomly chosen for payment. In round 1 (piece-rate), participants are paid X for each set of shapes completed. In round 2 (tournament), they receive $4X$ per success if they complete the most sets in their group of four, but receive nothing otherwise. The group is randomly determined, and participants never know who is in their group. In round 3, they first choose which of the two payment schemes to work under, then perform the task. In round 4, they choose to submit their past performance in round 1 to either the competition or piece-rate pay regime. At the end, they indicate how well they believe they did versus the others in their group.

The focus of the exercise is the choice of compensation scheme for round 3 – whether participants want to perform the task under competition against others. The other decisions and actions in the protocol generate controls to clarify the drivers of the round 3 choice and eliminate confounds in interpreting gender and age differences. The choice of this well-established design thus allows us to measure the impacts of preferences for competitive environments, independent of ability and risk aversion. For a more detailed discussion of the importance of removing confounds such as risk-aversion to identify effects on competition preferences, and how conditioning on these variables achieves this, see NV and Niederle and Vesterlund (2011); for more on our specific implementation of the NV design, see Appendix D.

3. Main experimental results

Our main subject pool includes over 700 participants from 12 villages in Malawi. As seen in Fig. 1, participants represent a broad age distribution. With an overall mean age of 36, 39% are below age 26 (140 women and 151 men), 40% between age 26 and 49 (148 women and 140 men), and 21% age 50 or above (77 women and 74 men). They also are evenly split by sex: 50% male, 50% female. Detailed summary statistics by age groupings are shown in Table A1.1. The average success rate was 6.1 (6.5 for men, 5.7 for women, Wilcoxon rank-sum test $p < 0.01$) in round 1 and 7.4 in round 2 (7.8 for men, 7.1 for women,

Table 1
Effects of gender and age on tournament entry.

	(1)	(2)	(3)	(4)	(5)	(6)
Female	−0.079**	−0.099**	−0.078**	−0.105**		−0.084**
	(0.037)	(0.039)	(0.039)	(0.042)		(0.036)
Female over 49		0.091		0.141**	0.141**	0.105*
		(0.064)		(0.071)	(0.071)	(0.063)
Male under 49					0.105**	
					(0.045)	
Male over 49					0.109	
					(0.073)	
Piece rate			0.003	0.007	0.007	0.008
			(0.008)	(0.008)	(0.009)	(0.008)
Improvement			0.009	0.013	0.013	0.005
			(0.014)	(0.015)	(0.015)	(0.013)
Guessed rank			−0.007	−0.005	−0.005	−0.01
			(0.020)	(0.020)	(0.020)	(0.018)
Submit piece-rate to tournament			0.386***	0.391***	0.391***	0.381***
			(0.035)	(0.035)	(0.035)	(0.036)
Observations	730	730	728	728	728	728

Columns 1–5 show the estimated marginal effects from a Probit regression of the choice to select tournament for round 3 (main sample). Column 6 shows the result of linear probability model (OLS) with session fixed effects. For columns 1–4 and 6, the omitted category is men. For column 5, the omitted category is women under the age of 50. *Piece Rate* measures the number of successes in the first round, under the piece-rate regime. *Improvement* measures the increase in number of successes between the first and second round. *Guessed Rank* indicates the participant's belief about how well she performed, relative to the three others in her group. *Submit Piece-Rate to Tournament* is an indicator for whether the participant chose to submit her past performance in round 1 (piece-rate) to a tournament against the past piece-rate performance of the other members in her randomly assigned group. Standard errors are shown in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

$p < 0.01$). Women ranked themselves at 2.06 (2nd out of four) on average and men ranked themselves at 1.76 ($p < 0.01$). For the choice to submit the past piece rate performance, 46% of men and 45% of women chose the tournament regime (difference not significant). We thus see some differences by gender in the key variables produced by the NV protocol. Since these variables are designed to capture the effects of other factors besides competition tastes that affect the round 3 choice, the main estimations of the effect of age and gender on preference to compete in round 3 control for these variables.

To examine whether the gender difference is linked to participant ages, we run five Probit specifications that test for the presence and strength of a gender gap in willingness to compete (Table 1). Column 6 adds a linear probability model (OLS) with fixed effects for each session, to verify the results are not somehow driven by any changes in the lab environment that might occur from session to session. Columns 1 and 2 examine the gender gap and the age gap respectively without any controls. The remaining columns include the full set of variables available through the experimental protocol, in order to separate the effects of sex and age on competitiveness from the confounding influences of ability, beliefs over ability, risk aversion, and feedback aversion. As such we include the number of successes in round 1 and the change in number of successes between rounds 1 and 2, which control for the influence of ability and any potential boost in ability under competition. We also include participant guesses about how their performance ranked in comparison to the rest of their group (1 = best, 4 = worst), which controls for confidence in one's own relative ability. The final variable is the choice made in round 4 – whether to submit the round 1 piece-rate performance to a tournament pay regime. The difference between the decision in round 4 and that in round 3 is that only in the round 3 decision does the participant choosing the tournament actually perform against others. Since risk-aversion, feedback-aversion, and confidence affect both choices, including the round 4 decision controls for the influence of these factors on the decision to perform work in an environment of competition against others.

Column 1 of Table 1 shows that the unconditional gender gap in tournament entry in this sample of individuals from a broad age range is significant, though relatively small. Column 3 shows that the size of the gap remains approximately the same for the measure of competition preference – notably, it is about half the size of the gap found in NV. Accounting for age and gender together, however, reveals a striking pattern: the gap in competition preference between men and women is larger (and much closer to that found in other studies) among younger individuals, and non-existent among older individuals. Column 2 and columns 4 through 6 report results from a model which allows the age of women to have an independent effect on the preference for competing, in addition to gender, by including an indicator for being female and 50 or older—*Female over 49* (a dummy equivalent to the interaction between *Over 49* and *Female*). The specification in column 5 also adds indicators to test for an age effect among men.

We use age 50, as it is a widely accepted age past which significant numbers of women have experienced menopause symptoms, the onset of menopause coincides with a drop in the production of estrogen, and prior studies document the importance of hormonal changes in competitiveness (Wozniak et al., 2014; Buser 2012). The median age of menopause can vary somewhat across different populations, and may be affected by socioeconomic status, geography, race, and several other factors (Gold, 2011). However, 50 is often used as a threshold – for example, the Demographic and Health Surveys (DHS), the major source of detailed fertility data in developing countries, only interviews women who are between the ages of 15 and 49 (Rutstein and Rojas, 2006).[2] We do not have information on hormone levels of our subjects or their own experience of menopause, and we do not have enough observations to rule out other ages between 48 and 51 as ages at which the spike in competition preference might occur. Furthermore, since menopause is often experienced as a social or cultural event as well as a biological event, the findings of an effect at this age could come from either source. Nonetheless, as discussed in Section 5, evolutionary psychology arguments on the gender gap's origins suggest the transition to non-childbearing years as a natural place to test for changes in competitiveness.

Column 2 of Table 1 shows that women over the age of 49 are no less likely than men to enter tournaments (the sum of the coefficients for *Female* and *Female over 49* is essentially zero). That is, the gender gap in tournament-entry disappears when looking at older women. We note however that the difference in tournament-entry between older and younger women is not statistically significant for this unconditional analysis that does not isolate competition preference. Like column 2, columns 4 and 5 report the effects of gender and age, but now on competition preferences rather than unconditional tournament-entry (using the controls described above from the NV protocol). As the estimates in both columns show, women 50 and older are quite different from younger women in their tastes for competition. This is most clearly seen in column 5, which breaks the sample into four groups, with women under 50 being the omitted category. We see that older women and younger men clearly differ from younger women (the estimate for older men is similar to that for younger men, but not statistically significant). Also note that older women are not significantly different from either older men ($p = 0.709$) or younger men ($p = 0.639$), and that this is driven by a drop in the gender gap so large it mildly reverses its sign in the data (if anything, the older women in the sample display a slightly stronger preference for competition than the men). Finally, older men are not significantly different from younger men ($p = 0.973$).

Comparing columns 3 and 4, we see that when we control for women's age, the effect of gender on preference for competition is nearly 35% larger than if we ignore age, and the dissuasive effect of being female on probability of tournament entry is an 11 percentage point drop – closer to the estimated 16 percentage point drop found in NV. In the coefficient estimate for *Female over 49*, we see the effect of being 50 or older on women's preferences for competition is significant and large (14 percentage points) – high enough to completely erase the gap between men and women. Older women are significantly more competitive than younger women, and they are at least as competitive as men of all ages. Column 6 shows the results when including session fixed effects (using a linear probability model), and confirms the pattern of findings in Column 4.

This finding of a change in competitive behavior in moving from younger to older women is quite novel. To shed some light on the underlying sources of this change, we re-run the analysis in column 4, separately interacting the indicator variables *Female over 49* and *Female* with each of the four standard NV controls, allowing the NV controls to have different effects for older women (than for younger women) and for women (than for men). From this analysis, we find that the impact of the piece-rate performance on willingness to enter tournaments is significantly higher for women 50 and older than for younger women. (The impacts of the other NV controls on tournament-entry do not significantly differ between young women and older women or between women and men). This suggests that older women are more likely than younger women to seek competition when they are good at the task. (Put differently, among women good at the task, younger women are pushed away from tournament-entry by a distaste for competition, while older women do not show signs of a similar distaste pushing them away.) This finding is particularly important in light of one of the stronger findings in the original NV study: that even the most able women avoid competitive settings.

In addition, as columns 2 and 4 in Table 1 show, the rise in tournament entry when moving from younger to older women is statistically significant when including the round 4 submission choice, and not significant without it. (In the US sample discussed below, even the unconditional rise is significant, but the pattern in magnitude of the rise is the same as in Malawi – increasing when controlling for the round 4 choice.) This suggests tastes for risk and/or feedback may not rise with age among women in the same way that competition preference rises. It also clarifies that change in competition preference among women (rather than change in risk or feedback preference) is what drives the disappearance we find in the tournament-entry gender gap when looking at older women.

4. Comparisons with competitive behavior in other samples

The preceding results point to an intriguing new and overlooked aspect of the gender–competition relationship. Given the importance of this area, however, and the fact that Malawi differs in many ways from more developed countries, it is important to confirm whether these findings extend to modern industrialized economies. To verify the gender–age effects that we identify in our main sample are not somehow particular to Malawi, we therefore run the same exact experiment

[2] The 2016 DHS survey for Malawi shows that 59% of 49 year-old women in Malawi have not experienced a period in the past 6 months, never experienced a period, or have had a hysterectomy. In the US, studies show the average age for menopause is 51 (National Institute on Aging, 2013). However, menopause is defined as 12 months following the last period (as opposed to 6 months in the DHS survey) and therefore it is reasonable to expect that a woman who is medically declared menopausal at 51 has been experiencing symptoms or diminished hormonal levels for at least a year, or at the age of 50.

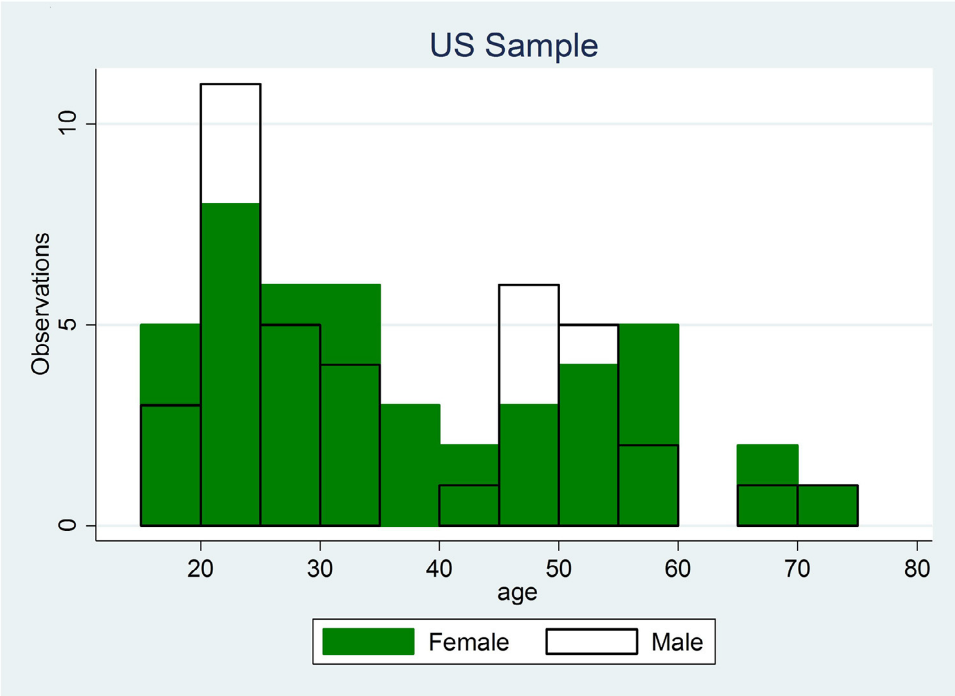

Fig. 2. Number of participants by age in the US sample.

with an auxiliary sample with a broad age range from the US. This sample is smaller, and the results thus somewhat more exploratory in nature, yet the similarity in findings is striking.

A total of 84 individuals participated in our US version of the experiment. The age and gender distributions as shown in Fig. 2 are similar to Malawi: with an overall mean age of 36, 33% are below the age of 26 (14 women, 14 men), 42% between the ages of 26 and 49 (19 women, 16 men), and 25% age 50 or above (12 women, 9 men); the gender split is nearly even, with 54% of the participants comprised by women.[3]

Table 2 shows estimates from regressions identical to those in Table 1, but for the US sample. With the exception that in the US the gender gaps in tournament entry (column 1) and competition preference (column 3) are not significant in the full sample of all ages (while in Malawi they are significant and relatively small), the results are very similar across the two samples. In particular, when we account for the impacts of age, we see the gender gap is large and significant among young adults, non-existent among older adults, and disappears because women over 50 are significantly more competitive than those under 50. Despite the limitations of the constrained sample size for US subjects, the changes are large and statistically significant for both non-parametric tests and regression estimates, and robust to several sensitivity checks.[4] (See Appendices B and C for further analysis of the US data and robustness checks.) Note that in columns 2 and 4–6, just like in Malawi, older women in the sample are actually somewhat more competitive than all men (i.e. the gender gap's sign is mildly reversed) though the difference is not significant.

To summarize, Tables 1 and 2 show a pattern which is consistent across Malawi and the US: women's preferences for competition significantly rise after the approximate age of menopause, men's preference for competition does not significantly change with age, and the rise for women is more than large enough to erase the gender gap. While the smaller US sample suggests caution before drawing definitive conclusions, the sharp parallel in results across the two settings is provocative.

We now turn to a closer look at the relationship between these data and other studies on competitiveness. First, to verify we are indeed picking up changes in the relationship between gender and competition preference first identified

[3] The sample of 12 older women in the US is sufficient to detect statistically significant differences between younger and older women under the prior that the magnitude of the difference would erase the gender gap observed in NV for tournament entry (over a 30 percentage point difference). The sample for older men in the US is too small to detect significant differences between older and younger men, although we note the data finds no differences by age for men.

[4] For example: 42% of women under 50 (i.e. 13 of 33) compete in round 3, compared to 67% of all men (i.e. 26 of 39) (χ^2-test $p<0.05$); among women over 50, 75% compete (9 of 12), compared to the 42% under 50 that compete (Fisher's exact test of the difference: p-value 0.064), and the same proportion of men under 50 as 50 or older choose to compete (67%, or 20 out of the 30 under 50, and 6 of the 9 who are 50 and older). See Appendix B for more detailed discussion of the US results.

Table 2
Effects of gender and age on tournament entry, US sample.

	(1)	(2)	(3)	(4)	(5)	(6)
Female	−0.156	−0.237**	−0.140	−0.246**		−0.208*
	(0.106)	(0.111)	(0.114)	(0.120)		(0.108)
Female over 49		0.293**		0.339***	0.334***	0.369**
		(0.123)		(0.114)	(0.116)	(0.158)
Male under 49					0.259**	
					(0.120)	
Male over 49					0.155	
					(0.183)	
Piece Rate			−0.020	−0.005	−0.01	−0.014
			(0.024)	(0.026)	(0.028)	(0.021)
Improvement			−0.019	−0.01	−0.014	−0.018
			(0.040)	(0.041)	(0.042)	(0.036)
Guessed Rank			−0.097	−0.121	−0.122	−0.100
			(0.085)	(0.090)	(0.090)	(0.074)
Submit piece-rate to tournament			0.365***	0.373***	0.378***	0.331***
			(0.111)	(0.114)	(0.114)	(0.115)
Observations	84	84	84	84	84	84

Columns 1–5 show the estimated marginal effects from a Probit regression of the choice to select tournament for round 3 (main sample). Column 6 shows the result of linear probability model (OLS) with session fixed effects. For columns 1–4 and 6, the omitted category is men. For column 5, the omitted category is women under the age of 50. *Piece Rate* measures the number of successes in the first round, under the piece-rate regime. *Improvement* measures the increase in number of successes between the first and second round. *Guessed Rank* indicates the participant's belief about how well she performed, relative to the three others in her group. *Submit Piece-Rate to Tournament* is an indicator for whether the participant chose to submit her past performance in round 1 (piece-rate) to a tournament against the past piece-rate performance of the other members in her randomly assigned group. Standard errors are shown in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3
Comparing results across different experimental settings.

	Univ. of Pittsburgh students (Reported in NV)		Malawi adults 18–25	
	(1)	(2)	(3)	(4)
Female	−0.162*	−0.38***	−0.144**	−0.180***
	[0.05]	[0.00]	[0.03]	[0.00]
Tournament performance	−0.009	−0.015	−0.0134	−0.0204
	[0.42]	[0.41]	[0.35]	[0.13]
Improvement	0.011	−0.015	0.0402	0.0446*
	[0.44]	[0.50]	[0.12]	[0.07]
Guessed rank	−0.120**		−0.0485	
	[0.01]		[0.14]	
Submit piece-rate to tournament	0.258**		0.389***	
	[0.012]		[0.00]	
Observations	77	80	291	291

Estimated marginal effects from Probit regressions in 2 different samples of participants which experienced the same basic experimental protocol. Columns 1 and 2 contain results reported in NV, for which subjects are students from the University of Pittsburgh. Columns 3 and 4 show results from the individuals between the ages of 18 and 25 from our primary sample. Brackets contain p-values, to facilitate comparison with the results reported in NV. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

in NV, and as further evidence of the robustness across multiple environments of the preference difference NV identifies, Table 3 compares the data patterns in their study to the patterns among student-age participants in our sample. We begin with the specification that best identifies the independent impact of gender on competition preferences per se (i.e. with the full set of controls). As shown in column 1, NV find that after conditioning on performance and the other controls to isolate the effect of gender on tournament preference, the effect of being female is to lower the likelihood of competing by an estimated 16.2 percentage points. We see in column 3 that the corresponding estimate is remarkably similar in Malawi when restricting to 18–25 year-olds, at 14.4 percentage points. That is, for young adults, the effect of gender on competition preferences per se leads to very similar estimated drops in propensity to compete across the two very different societies. On the one hand, this highlights the robustness of the gender effect on competition preference originally identified in NV, across quite different environments. It also helps verify our experimental design replicates findings on competition preferences of previous studies when using populations of similar ages.

Columns 2 and 4 of Table 3 show how estimates of the gender effect compare when excluding the controls for the influence on tournament entry of general factors besides competition preference (such as confidence, risk, and feedback aversion). The results suggest the gender gap for tournament entry in Malawi is less sensitive to gender differences in other general factors compared to the NV sample, and instead driven mostly by the preference difference for competition across men and women.[5] We also see a remarkably strong similarity when comparing the gender estimates for young adults in our US sample with those for the students in NV, despite the limited number of subjects (see Table A2.1 and Appendix B for discussion).

As discussed in the next section, a discontinuous change in competition preference among women around age 50, and no change among men, is consistent with one of the leading explanations on origins of the gender gap as well as recent evidence of an important role played by hormones. However, in a different experiment, Mayr et al. (2012) report strong evidence of a continuous increase in the likelihood to enter tournaments up to age 50 among both men and women, with milder evidence of a decrease thereafter. In comparing data patterns between that study and this one, it is helpful to bear in mind two key distinctions in approach.

First, there is a structural difference in competition across the two settings in that subjects in Mayr et al. (2012) do not compete with nearby individuals, but instead work alone to beat an unknown score drawn from a database of past performances by others. This introduces a relational distance not present in the standard NV design – one that may be important if it deemphasizes adversarial aspects of competition, or creates other changes that could affect subjects' choices.[6]

Second, the approach of Mayr et al. (2012) enables analysis of the net effects of age and gender on *competition entry* (with checks to eliminate confidence or ability as drivers), whereas we focus on the effects of age and gender on *competition preference*. Both approaches help us understand the role of gender and age on competitiveness and both yield insights with important practical implications. The first approach captures the composite impacts on competition-entry of changes in preferences over risk, feedback, and competition, as age and gender changes. The second focuses on isolating the changes in tastes for competition as one of the fundamental constituents driving propensity to compete. This requires a method to separate the effects of age and gender on competition preference from their effects on the other factors that impact competition entry. Risk preference is one of the most commonly discussed: as Mayr et al. (2012) note, their findings could be partly picking up changes in risk appetites across the age groups in their sample.[7] Not only might men and women differ in risk preferences (Croson and Gneezy, 2009), but Brinig (1995) finds experimental evidence of age effects on risk aversion that strongly differ by gender.[8] This highlights the need for some way to control for changes in these other factors in order to isolate changes in competition preferences. NV resolves this through a clever design that we borrow.

Despite these important differences in approach, the patterns discovered in Mayr et al. (2012) are also instructive for our analysis: since their findings may be driven in part by changes in competition taste, we examine our data for evidence of a similar type of relationship between age and competition preferences alone. The strongest part of their findings is the upward slope showing a continuous rise in propensity to select their competition regime, among both men and women. Table 4 thus reports results from Probit regressions that test for evidence of a smooth change in preferences for competition as age increases among men and women in our sample. In columns 1 and 2, the estimates for $Female \times age$ are positive but insignificant, and in column 2 the estimate for $Male \times age$ is similarly not significant. Columns 3 and 4 restrict the sample to adults under the age of 50 to test for the possibility of a continuous age effect in the same ages where Mayr et al. (2012) find an increase—the estimates for the gender-continuous age interactions are once again not significant. Appendix B discusses results for a similar analysis among our US participants, also showing the coefficient estimates for $Female \times age$ and $Male \times age$ are not significant in any of the four specifications (Table A2.2).

In addition, Appendix C tests for a quadratic relationship between age and competition tastes. As Table A3.2 shows, here we find some evidence of a continuous quadratic effect that operates simultaneously with the discrete effect. (Notably, the quadratic effect only exists for women; age still has no effect on men.) This is interesting, as it suggests that in addition to the strong discrete impact we find there may also be a continuous age pattern of changes in competition preference similar to the changes in competition entry observed by Mayr et al. (2012). However, as we discuss in Appendix C, the effect sizes show our continuous estimates are relatively small compared to the very large discrete effect. We conclude that, when isolating the effects of gender and age on the preference for competition (separate from their effects, for example, on risk-aversion), the discrete age effect for women is a superior fit with our data, though it may be accompanied by a less pronounced quadratic impact of age as well.

[5] Whereas in the US the gender gap is an estimated 38 percentage points when not controlling for the other general factors and drops by 56% when adding the controls, in Malawi the gender gap is an estimated 18 percentage points without the controls and drops by only 20% when they are included. See Table 3, columns 2 and 4.

[6] Competing without visible opponents may depersonalize competition, make it more abstract, or heighten its aspect as a risky individual challenge while diminishing its aspect as a contest with another. Gillen et al. (2015), which also has subjects doing the task at different times against unseen opponents, find evidence the gender gap in competition entry for their task is largely driven by risk preferences, and is much smaller than commonly found – about one third the size of that in NV.

[7] Indeed, in another setting where subjects without observable opponents are also told they are competing with others doing the task at another time, Gillen et al. (2015) argue the tournament entry gender gap they find is almost entirely driven by differences in risk appetites. This highlights the importance of risk controls in this setting, if one wants to find impacts on competition tastes.

[8] In one of the few other experiments on age and risk tastes, Harbaugh et al. (2002) find no gender–age interaction.

Table 4
Continuous effects of age on tournament entry.

	Full sample		Under 50	
	(1)	(2)	(3)	(4)
Female	−0.167**	−0.182**	−0.177*	−0.268*
	(0.073)	(0.087)	(0.107)	(0.138)
Female × age	0.002	0.002	0.003	0.002
	(0.002)	(0.002)	(0.003)	(0.003)
Male × age		−0.001		−0.004
		(0.002)		(0.004)
Piece rate	0.007	0.005	0.005	0.003
	(0.008)	(0.009)	(0.010)	(0.010)
Improvement	0.013	0.012	0.020	0.018
	(0.015)	(0.015)	(0.016)	(0.016)
Guessed rank	−0.006	−0.006	−0.009	−0.009
	(0.020)	(0.020)	(0.023)	(0.023)
Submit piece-rate to tournament	0.386***	0.386***	0.374***	0.373***
	(0.035)	(0.035)	(0.040)	(0.040)
Observations	727	727	579	579

Estimated marginal effects from a Probit regression of the choice to select tournament for round 3 (main sample). Columns 3 and 4 are restricted to participants under the age of 50. The variable *Female* is an indicator for whether the participant is a woman. *Age* is the continuous age of the individual, in number of years. *Piece Rate* measures the number of successes in the first round, under the piece-rate regime. *Improvement* measures the increase in number of successes between the first and second round. *Guessed Rank* indicates the participant's stated belief about how well she performed, relative to the three others in her group. *Submit Piece-Rate to Tournament* is an indicator for whether the participant chose to submit her past performance in round 1 (piece-rate) to a tournament against the past piece-rate performance of the other members in her randomly assigned group. Standard errors shown in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

5. Possible mechanisms

Discussion of the underlying drivers of gender differences in competition preferences typically falls into one of two broad categories: (i) culture, context, and socialization; (ii) physiology and evolution. The findings of this study are consistent with two mechanisms that fall into the latter class of explanations – one that has been part of this literature since its very beginnings and another that has surfaced more recently.[9]

As early as the first studies on gender differences in competition, one of the main hypotheses advanced on their origins – and consistently cited since – is human evolution.[10] This view holds the differences derive from natural selection and the benefits and costs of competition for reproduction through mating, childbearing, and child rearing among human ancestors. For males, winning competitions can increase their number of offspring. For females, however, competitiveness is less likely to increase the number of offspring than it is for males and in fact is likely to impose a reproductive *cost* during a key lifecycle stage. Due to the importance of direct maternal inputs in early life, if a competition outcome left a mother less able to care for her very young offspring, the offspring would face higher chances of death (Campbell, 2002; Campbell, 2004). Since a mother's resources also affect her investments in offspring quality (and thus survival chances), it is not the case that competing has no benefits. It is that the reproductive payoff of winning resources and using them to invest in offspring quality would be weighed against the reproductive cost of losing.

Most women past their childbearing years are mothers. However, once their offspring had passed the vulnerable early years, the reproductive cost of competing and losing would fall, while the reproductive benefits of winning would remain.[11] The evolution-based argument has been used chiefly to explain greater competitiveness observed in men (among young adults), with little attention paid to this other prediction it implies – that preferences over competition among adult women

[9] The fact that preferences change in women and not in men is also consistent with findings by DellaVigna et al. (2013) that explain behavior differences by gender as the result of differences not only in means but also variances of preference distributions. They show this can result in a large proportion of women on the margin of certain types of actions (e.g. pro-social decisions), making their choices especially sensitive to small shifts in the setting or in preferences.

[10] For summaries of the evolution viewpoint in economics, see NV and Gneezy and Rustichini (2004). Sex-based behavior in the evolutionary literature extends back to Darwin (1871), Bateman (1948) and Trivers (1972). Dekel and Scotchmer (1999), Robson (1996), and Robson and Samuelson (2009) discuss evolutionary models more formally in contexts of risk aversion.

[11] Besides investing in her older juveniles, mothers could give resources to adult children, to be shared with their own offspring, or give resources directly to their grandchildren. All would raise her reproductive success (and genetic bequest). Cassar et al. (2016) find empirical support for this tradeoff, showing women can be as competitive as men if rewards go to their teenage kids.

should depend on age, not just falling when reaching childbearing age but also rising once past the age where one can have young children. Our findings that competition preference is low among young women, increases among female participants right at the age at which significant numbers of women have experienced or are experiencing menopause, and does not change with age among our male participants, is consistent with these predictions. Thus, if the mechanism that decreases competitiveness as women reach childbearing age has any link with the process of human evolution, it is plausible this effect would dissipate after menopause.

More recently, several studies suggest hormones are pivotal in competitiveness – in particular, among women. Some (e.g. Andersen et al., 2013) show how competitiveness among girls changes at puberty while others (e.g. Wozniak et al., 2014; Buser, 2012) more directly examine the role of hormones on competition preferences of adult women. Wozniak et al. (2014) reviews the literature on neuroendocrinological links between hormones and brain activity, and suggests that hormones (particularly progesterone and estrogen, both of which decrease with menopause) might suppress competitive preferences in women. Recent evidence also suggests the hormone cortisol can have a positive effect on willingness to compete among women (Buser et al., 2017; Zhong et al., 2018), and cortisol levels rise with menopause (e.g. Woods et al., 2006; Woods et al., 2009). On the other hand, Apicella et al. (2011) find men's competitiveness is unrelated to hormone levels, suggesting that even if testosterone levels fall as men age, men's competitive preferences may not change. Thus it is possible that the sharp change in hormone levels at adolescence suppresses competitiveness among women and that another large change in hormone levels at menopause would be associated with a rise in competitiveness. The fact that major hormonal changes coincide with the age at which competition preference changes for women in our results, and the fact that among men there is neither a similar age of sharp hormonal change nor a change in competition preference, is consistent with hormones having a strong influence.

Although this paper focuses explicitly on an effect at age 50 because this age is suggested by these literatures, in Appendix A we examine the data for evidence of any other structural break by age (between the ages of 21 and 55). The results show that for males, there is no evidence that being below or above any particular age threshold affects competition preference. For females, the threshold is most notable in Malawi at 50 and in the US it first appears at 48 but is also significant at 50.

Our findings for a discrete change in behavior around age 50 therefore support two mechanisms advanced in the literature that are consistent with a biological cause.[12] However, they do not preclude an important role played by culture, context, or the effects of socialization, such as those found in Gneezy et al. (2009), Niederle et al. (2013), and Andersen et al. (2013). Cultural factors likely magnify or dampen behaviors that may originally stem from the logic of evolution, and behavior can be jointly determined by physiological and social drivers. Further studies exploring the mechanisms through which physiological determinants and social determinants interact represent an intriguing area for future research.

6. Conclusion

This study sheds new light on limits to gender differences in competition preferences. While other studies have shown the difference can be influenced by culture (Gneezy et al., 2009), we find it also depends on age. These results indicate there is at least as much difference in competitiveness between younger women and older women as there is between younger women and men, and that more mature women are no less fond of competition than men.

Our findings reconcile the apparent inconsistencies between the many studies that show sharp and robust gender differences in competition preferences when controlling for risk, and their absence in the two studies with a broad age range that also control for risk aversion (Charness and Villeal 2009; and Buser et al., 2015). They also complement Mayr et al. (2012) by focusing more specifically on one of the key determinants of competition entry – competition preferences – as well as show that some of the age patterns they find may be driven in part by changes in tastes for competition. These results suggest that by focusing on young populations, the early literature may be missing a broader relationship between sex, age, and tastes for competition. This is not to challenge the importance of understanding behavioral determinants among young adults and their impacts on early career choices: we continue to find that young women avoid competitive settings more than men. However, the tendency to omit older populations from these studies creates a potential risk that competitiveness may be misunderstood as a more male characteristic than it actually turns out to be. Apicella et al (2011) show no link between testosterone and competitiveness, and we show that competitiveness is as much a feature of a grandmother as of a young man.

Expanding the breadth of ages included in research on competitiveness also helps us identify more general relationships, deepen our overall understanding of competitiveness, and clarify the roles of other physiological factors besides gender. It is also important for understanding the behavior of more mature adults – in labor markets, the workplace, and other economic and social settings where competition plays a role. A clear understanding of how older employees respond to competition is critical for personnel policies and design of incentives for more senior and experienced workers.

[12] Note that the evolution and hormones mechanisms are mutually compatible.

Some words of caution are in order. While the importance of the age right around 50 for women's attitudes toward competition fits the age at which many women have experienced or are experiencing menopause and is consistent with the hypothesis that evolution partly explains the gender difference, our data do not permit an explicit test of menopause itself (or its hormonal changes) as the proximal cause of the sharp rise in women's tastes for competition. The striking similarity of the pattern across the Malawi and US samples, the fact that a critical fertility threshold lies at the center of the pattern, and the pattern's consistency with a model of maximizing reproductive success, suggests menopause as the likely driver. However, confirming the specific mechanism underlying the change in behavior constitutes an important avenue for further study.

Finally, our main sample is drawn from Malawi, and while these results are interesting in their own right, the differences from more developed economies could place constraints on broader implications of findings based on this sample alone. The fact that gender's impact on competition preference among young adults leads to an estimated drop in tournament-entry very close to that found among the similarly aged subjects in NV inspires confidence that our findings from Malawi yield insights also for high-income countries. Going further, we repeated the experiment with an auxiliary sample drawn from the US, and discovered the same age impacts on each gender as found in Malawi. Estimates of the spike in tournament entry of women after age 50 are significant, but the number of participants is lower than we would prefer before drawing firm conclusions. We therefore consider the US sample an exploratory one, and we interpret the results as provocative – the opening of a question rather than a definitive answer. Furthermore, we recognize that by comparing commonalities across two very different societies this study is likely to shed the most light on age effects that are linked with physiological transitions. This does not preclude the influence of culture or culture-based transitions, which may also help mediate the impacts of gender on competition preference, and which may vary from one society to another. Given the relative dearth of attention older individuals have received in this literature, additional studies with participants in the upper age ranges are needed. We see this is as an exciting area ripe for future research.

Acknowledgments

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Appendix A. Patterns with age across both samples

Table A1.1 shows the distribution of choices across age groupings in both samples, as well as for the other variables generated through the NV design.

In this paper, we focus on the discrete effect of age on competition preference among women around age 50 because theory motivates this from two directions. In this section, we take advantage of the broad spectrum of adult ages in our data to examine the evidence for alternative possible age thresholds, not connected to either explanation, across which behavior might change. We test for a structural break in the effect of gender on competition preferences between younger and older individuals, using all the data and testing discrete breaks at ages between 21 and 55 as the threshold for being categorized as "young" or "old".[13] Beginning with the same specification for the regression reported in column 2 of Table 1 (the specification which best isolates impacts on the preference for competition), we add a term interacting gender with an indicator for whether an individual is above a given age (i.e. in the older group):

$$y_i = \beta_0 + \beta_1 Female_i + \beta_2 Female_i \times Old_i + x_i'\theta + \epsilon_i$$

where the response variable is whether the individual chose to compete in round 3, and x_i is a vector of the standard NV controls (performance in round 1, improvement in round 2, believed relative ability, and round 4 choice of whether to submit past performance to a competition). We run the regression 35 times – once for each possible age threshold between 21 and 55. The coefficient on the interaction term represents the impact of being above the given age threshold on the effect of being female on an individual's preference for the competitive environment. We then run the same basic specification for males:

$$y_i = \beta_0 + \beta_1 Male_i + \beta_2 Male_i \times Old_i + x_i'\theta + \epsilon_i$$

This results in 137 specifications (35 each for men and women in Malawi, 35 for women in the US and 32 for men in the US). The resulting coefficients on the interaction term thus represent the effect of being above each given age threshold on an individual's competition preference, for men and women separately, in each society.

[13] The sample of men older than 52 is too small to identify the coefficient for the US.

Table A1.1
Summary statistics by sample, gender and age group.

Age group	Obervations	Piece rate	Tournament	Improvement	Guessed rank	Perform in tournament (Round 3 Choice)	Submit to tournament (Round 4 Choice)
Malawi							
Male							
18–29	183	7.7	9.2	1.6	1.6	50%	47%
30–39	74	6.4	7.6	1.2	1.8	46%	36%
40–49	34	5.9	7	1.1	1.6	38%	47%
50–59	16	4.9	5.4	0.5	1.7	63%	56%
60–69	33	4.1	5.2	1.1	2.1	33%	55%
70+	25	3.6	3.9	0.3	1.7	60%	52%
Female							
18–29	170	6.7	8.6	1.8	2	34%	39%
30–39	71	5.8	6.9	1.1	2.2	49%	55%
40–49	47	5	6	1.0	2.1	36%	53%
50–59	28	5.2	6.1	0.9	1.8	46%	25%
60–69	23	3.7	4.7	1.0	2.2	65%	65%
70+	26	2.5	2.9	0.4	2.2	31%	52%
US							
Male							
18–29	19	12.8	14.4	1.6	1.7	63%	47%
30–39	4	12.6	15.1	2.8	1.8	75%	50%
40–49	7	9.7	11.3	1.6	2	71%	29%
50–59	7	9.9	10.9	1.1	1.7	57%	57%
60–69	1	9	10.5	1.0	2	100%	100%
70+	1	6.8	8.3	2.0	2	100%	0%
Female							
18–29	19	13.1	14.6	1.6	1.9	42%	37%
30–39	9	11.3	12.6	1.2	2	56%	56%
40–49	5	11.2	13.8	2.6	2	20%	40%
50–59	9	10.8	12.5	1.8	1.8	78%	44%
60–69	2	8	9.5	1.5	3.5	100%	50%
70+	1	8.8	8	0.0	3	0%	0%

Piece Rate measures the number of successes in the first round, under the piece-rate regime. *Tournament* measures the number of successes in the second round, under competition incentives. *Improvement* measures the increase in number of successes between the first and second round. *Guessed Rank* indicates the participant's belief about how well she performed, relative to the three others in her group. *Perform in Tournament* is an indicator for whether the participant chose to perform the task under competition incentives. *Submit to Tournament* is an indicator for whether the participant chose to submit her past performance in round 1 (piece-rate) to a tournament against the past piece-rate performance of the other members in her randomly assigned group.

The coefficient estimates and confidence intervals for β_2 are displayed separately by gender and society in Fig. A1.1. As shown in the figure, for women, the sign of the estimated effect of being in the older group is always positive – whether in the US or in Malawi. The largest estimate occurs at age 48 in the US, and age 50 in Malawi – both estimates significant at the 0.05 level.[14] For men on the other hand, the estimated effect of being in the older group is sometimes positive and sometimes negative. More importantly, the 95% confidence interval of the estimated effect of being in the older group always includes zero by a wide margin when looking at men. If we repeat the analysis without any controls (testing for age thresholds for a change in unconditional tournament-entry), we find the results are virtually identical, except that the only significant threshold for women in the US is at 48 years of age. These results are available on request.

Thus, for males, there is little evidence that being below or above any particular age threshold affects their competition preference. For females, however, we find that those older than somewhere around 48–50 are significantly different from those younger than this threshold in both our main sample drawn from Malawi as well as our auxiliary sample from the US. Notably, these ages constitute the only threshold that is significant in both societies, which provides strong support for our rationale in studying effects around this age.

Interestingly, there is evidence in Malawi of an additional break around the age of 30. The fact that this pattern does not exist in the US sample points to the likelihood that cultural factors still play an important role. The interaction of social and physiological determinants of gender differences in preferences remains an important area for future research.

[14] In the US, the estimated effect of age thresholds at 48, 49 and 50 are statistically indistinguishable from each other.

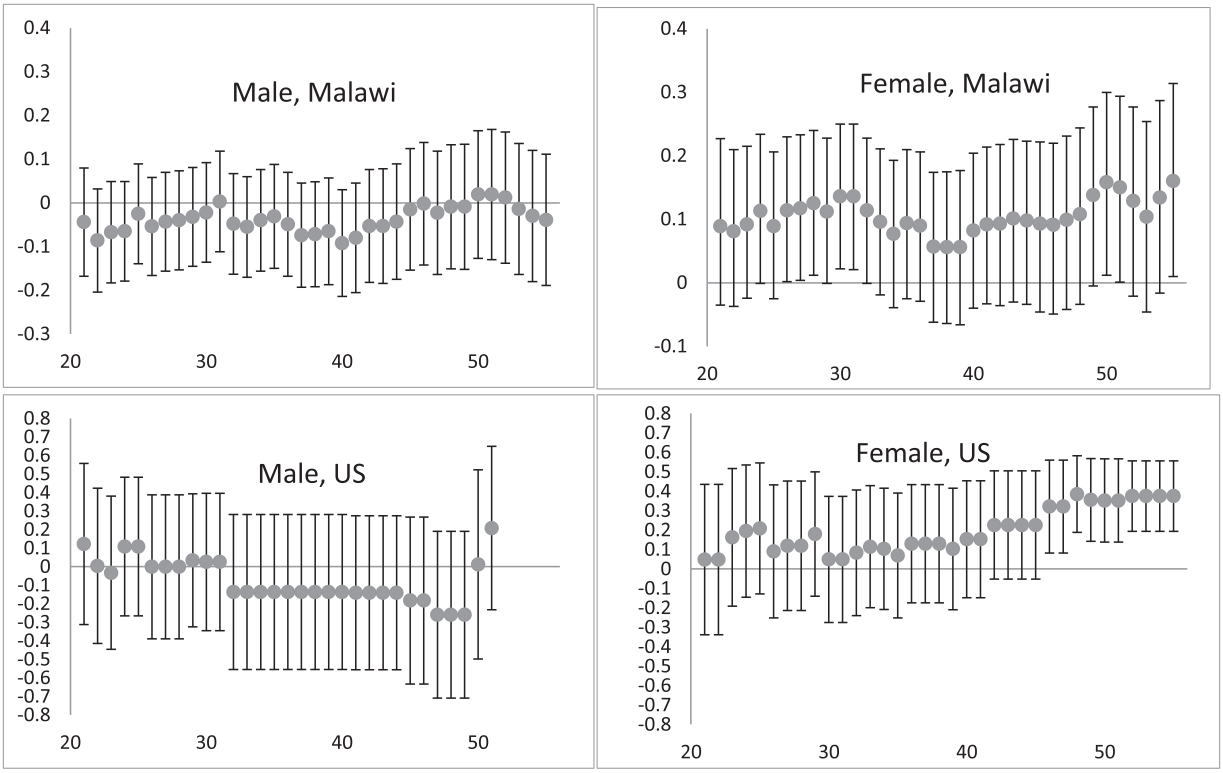

Fig. A1.1. Coefficients from regression testing for structural break in competition preference with age. The four figures above show the estimates and 95% confidence intervals for the coefficient on gender interacted with an indicator for being older than the given age threshold, in a regression of the choice to perform the task under competition on gender and the standard NV controls (performance in round 1, improvement in round 2, believed relative ability, and round 4 choice of whether to submit past performance to a competition). The estimates for the structural break parameter are shown for 35 different regressions for each sample and gender. Where the coefficient is significantly greater than zero, it suggests the average participant above the threshold is more likely to compete than the average participant below the threshold.

Appendix B. Gender and age effects in US sample

A. Summary statistics

Our second subject pool comes from an urban area in the US, drawing participants from staff and students at a large university and individuals in the surrounding community. In total, we had 84 US participants. As seen in Fig. 1 and Table A1.1, the participants represent a broad age distribution. With an overall mean age of 36, 33% are below the age of 26 (14 women and 14 men), 42% between the ages of 26 and 49 (19 women and 16 men), and 25% age 50 or above (12 women and 9 men). The gender split is nearly even, with 54% of the participants comprised by women. Task performance in the US was higher than in Malawi: the average success rate was 11.6 in round 1 (11.5 for men, 11.7 for women) and 13.2 in round 2 (13.1 for men, 13.3 for women), with no significant gender difference.[15] Overall willingness to compete is also higher in the US (58%).

B. Effects of gender and age

The unconditional gender gap in this sample is much smaller than that typically found in the US. While 67% of men select into the tournament, 51% of women do (χ^2-test, $p = 0.15$; also see Table 2, column 1). This stands in stark contrast to other studies in the US with similar sample sizes, but based on young adults, which often find gaps twice as large that are highly significant. In their seminal study using 80 student-age subjects, for example, NV find that the percentage of men that enter the tournament is more than twice the percentage of women, and the difference is significant at the 0.002-level.

[15] The higher average number of tasks completed in the 3 min period in the US compared to Malawi may derive from several factors, such as differing experience with sedentary cognitively-intense work, or familiarity with performing timed test-like tasks for short intervals. Human capital (lower in Malawi) may also play a role in the task. Visual pattern recognition may be a skill that is improved through schooling. Since such skills likely vary across individuals, this helps highlight the importance of using the regression analysis to control for performance when estimating the impact of gender and age on propensity to select into the tournament.

At first blush, these results appear inconsistent with the robust findings in the literature on large and highly significant gender differences in preferences for competition in the US and Europe.[16]

However, just as in the Malawi sample, the inconsistency is immediately resolved by accounting for age: the gender gap in competition preference exists and is strong, but only for younger women in the sample. When focusing on older women, the gap disappears. We see this in Table 2. First, in moving from column 1 to column 3, we note that including the controls employed through the NV experimental protocol to identify the effect of gender on competition preferences per se leaves the estimated impact of gender essentially unchanged (small and insignificant). However, columns 2 and 4 show that as soon as we control for women's age, the estimated effect of being female becomes large and significant: women under the age of 50 are 24–25 percentage points less likely to compete than men, after controlling for the influences of risk preferences, feedback preferences, ability, and confidence. This estimate is consistent with the gender effect reported in other studies in the US and Europe, which sample young individuals.[17] Moreover, the estimated effect of being 50 or older on women's preferences for competition is significant and large (0.339) – more than enough to completely erase the gap between men and women. (Appendix C and Table A3.1 discuss estimates suggesting older women's taste for competition may in fact *exceed* that among men of all ages in this sample, though the impacts on propensity to compete are not significant.) Non-parametric tests also show significant differences in tournament entry between women in the two different age groups. For example, 42% of women under 50 enter the tournament, compared to 75% of those 50 and older, (Fisher's exact test $p = 0.064$). (The proportion of males stays fixed at 67% across the two age groups.) Exactly two thirds of men under 50 choose to compete, matching precisely the proportion of older men who choose to compete (6 out of 9), matching the finding in Malawi that age does not have a significant effect on men's propensity to select into competition. Note also that Table 2 column 5 shows no significant difference in the estimates for *Male under 49* and *Male over 49*.

Thus, while overall levels differ somewhat, we observe in the US the exact same pattern of effects by sex and age on the preference for competing that we find in Malawi.

C. Robustness checks

These results are fairly robust to a variety of sensitivity checks. To examine whether the finding that older women are more competitive than younger women could be driven by one or two observations, we intentionally drop observations that would make it harder to detect an effect. If we drop a non-competing woman under age 50 from the sample, estimates from the Probit regression in Table 2 column 4 still indicate that being 50 or older makes a female subject significantly more likely to compete ($p = 0.038$), and a Fisher's exact test also shows the older group of women is significantly more likely to select into competition ($p = 0.064$). If we instead drop a competing woman age 50 or older from the sample, regression estimates again still indicate that women 50 or older are significantly more likely to choose competition ($p = 0.055$), and a Fisher's exact test shows the older group of women is significantly more likely to compete ($p = 0.081$). Alternatively, if we drop both a competing woman 50 or older and a non-competing woman under 50, Probit estimates remain significant ($p = 0.061$), and a Fisher's exact test remains significant at the 0.10-level ($p = 0.095$).

D. Comparing NV students to young adults in our sample

Table A2.1 compares the NV results to results for the same age group in our US sample. This comparison is noteworthy in that these participants are all drawn from the same culture. This may explain the stronger similarity with NV in terms of the role other general factors (besides competition tastes) seem to play in gender effects on tournament entry. Note that since NV reports *p*-values and reports results both with and without the variable for submitting the piece rate performance to a tournament, we follow the same convention here. After conditioning on performance in the task, NV finds that being female reduces the probability of competing by an estimated 38 percentage points in their sample of 80 students (significant at the 0.01-level), while we find an estimated 41 percentage point reduction in our sample of 28 similarly aged adults (significant at the 0.10-level). When adding the remaining NV controls that account for other factors that also affect willingness to compete, the magnitude of the estimated effect in NV drops by over 50% and the significance reduces substantially. Similarly, when including the full set of NV controls in our sample of 18–25 year-olds from the US, the estimated magnitude drops by nearly a half and the significance drops considerably. While the relatively small sample size of young adults in our US sample makes the estimate in column 4 imprecise, the basic pattern is remarkably similar to that of the students in the earlier study.

There is an interesting pattern that bears mentioning across the three samples of student-age adults. On the one hand, the estimated negative effect of *Female* on propensity to enter the tournament is very similar across all three samples (NV students, US young adults, Malawi young adults) when including the full set of controls from the NV protocol to identify

[16] Notably, however, these findings are consistent with the only 2 other experiments on competition using adults of a broad age range that we are aware of, Charness and Villeval (2009), and Buser et al. (2015), who find no gender gap across their sample as a whole when controlling for risk aversion. (They do not examine whether the gap interacts with age.)

[17] For example, among studies using student-participants, Gupta et al. (2013) find a marginal effect of −.36 without controlling for performance, Niederle and Vesterlund (2007) find a marginal effect of −.38 when controlling for performance, Niederle et al. (2013) find a marginal effect of −.36. Flory et al. (2015) find a smaller marginal effect, −.15, among participants of a broader age range than the typical student age (mean age 28).

Table A2.1
Comparing results across experimental settings within the US.

	Univ. of Pittsburgh students (Reported in NV)		US adults Ages 18–25	
	(1)	(2)	(3)	(4)
Female	−0.38	−0.162	−0.410	−0.242
	[0.00]	[0.05]	[0.07]	[0.43]
Tournament performance	−0.015	−0.009	−0.0615	0.0313
	[0.41]	[0.42]	[0.31]	[0.75]
Improvement	−0.015	0.011	−0.198	−0.170
	[0.50]	[0.44]	[0.06]	[0.24]
Guessed rank		−0.120		−0.809
		[0.01]		[0.047]
Submit piece-rate to tournament		0.258		0.829
		[0.012]		[0.037]
Observations	80	77	28	28

Estimated marginal effects from Probit regressions in 2 different samples of participants which experienced the same basic experimental protocol. Columns 1 and 2 contain results reported in NV, for which subjects are students from the University of Pittsburgh. Columns 3 and 4 show results from the 28 individuals (14 men and 14 women) between the ages of 18 and 25 in our sample auxiliary from the US. Brackets contain *p*-values, to facilitate comparison with the results reported in NV.

Table A2.2
Continuous effects of age on tournament entry, US sample.

	Full sample		Under 50	
	(1)	(2)	(3)	(4)
Female	−0.415**	−0.321	−0.089	0.076
	(0.201)	(0.282)	(0.336)	(0.475)
Female × age	0.008	0.009	−0.006	−0.006
	(0.006)	(0.006)	(0.011)	(0.011)
Male × age		0.004		0.006
		(0.007)		(0.012)
Piece rate	−0.007	0.001	−0.033	−0.026
	(0.026)	(0.030)	(0.036)	(0.039)
Improvement	−0.015	−0.008	0.004	0.011
	(0.040)	(0.042)	(0.051)	(0.053)
Guessed rank	−0.129	−0.131	−0.225*	−0.229*
	(0.090)	(0.091)	(0.120)	(0.121)
Submit piece-rate to tournament	0.349***	0.347***	0.364**	0.369**
	(0.114)	(0.114)	(0.144)	(0.144)
Observations	84	84	63	63

Estimated marginal effects from a Probit regression of the choice to select tournament for round 3 (US sample). Columns 3 and 4 are restricted to participants under the age of 50. The variable *Female* is an indicator for whether the participant is a woman. *Age* is the continuous age of the individual, in number of years. *Piece Rate* measures the number of successes in the first round, under the piece-rate regime. *Improvement* measures the increase in number of successes between the first and second round. *Guessed Rank* indicates the participant's stated belief about how well she performed, relative to the three others in her group. *Submit Piece-Rate to Tournament* is an indicator for whether the participant chose to submit her past performance in round 1 (piece-rate) to a tournament against the past piece-rate performance of the other members in her randomly assigned group. Standard errors shown in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

gender effects on competition tastes. On the other hand, the drop in estimated magnitude for *Female* by roughly a half when moving from few controls to all the controls for other general factors (besides competition) occurs only in NV and in our US sample of young adults. The reduction in moving from few controls to all controls does not seem to occur for the young adults in Malawi. This suggests that, while the relationship between gender and competition preference is very similar for young adults in Malawi and the US (NV students as well as our US young adults), the relationship between gender and the *other* factors driving competition choice (such as risk and feedback preferences) may be different in Malawi than it is in the US samples (ours as well as that in NV).

E. Continuous effects of age in US sample

Table A2.2 reports the results for the US examining the impact of a linear age term, both for the full sample and for the sample of participants under the age of 50. This table is the analogue of Table 4 with the Malawi sample. None of the linear age terms are significant in this sample. However with the smaller sample, it is dangerous to read too much into a series of insignificant effects. Recall however that the inclusion of dummy for a woman over the age of 50 is highly significant in this sample.

Appendix C. Additional robustness tests

Table A3.1 compares women over the age of 49 to men of all ages. It shows regressions identical to column 3 of Tables 1 and 2 (the standard NV regression with the full set of controls to identify impacts on competition tastes), except that women under 50 are excluded from the sample. The coefficient estimate for *Female* thus represents the effect of being female and 50 or older on propensity to enter the tournament due to changes in competition preference. In both samples, this coefficient is positive, suggesting that women 50 and older have a *stronger* preference for competition than men of all ages, holding other factors (risk aversion, feedback aversion, confidence, etc.) constant. However, while this might be interpreted as mild evidence that older women may be more competitive than men, neither estimate is significant, so we cannot conclude this with any degree of confidence. However, this shows very clearly that women over the age of 49 are no less competitive than men of all ages.

Table A3.2 examines the potential impact of a quadratic specification for age interacted with gender, including a discrete effect at the age of 50, in our main sample. The table shows the coefficients (not the marginal effects) for a Probit and a linear probability model, to allow better interpretation of the overall impact of age on preference for competition. Among women, coefficient estimates are significant for all three age variables – both the linear and quadratic terms as well as the age 50 indicator. For men on the other hand, none of the age variables have a significant effect. To interpret the coefficient magnitudes and the role of the quadratic term, we focus on the linear probability model. The estimate for *Female* implies that a woman of age zero (outside of our sample) would be significantly less likely to compete than a man of age zero. By the age of 18, the joint effects of gender and the linear and quadratic age terms imply that women are 20 percentage points more likely to compete than at age zero. By the age of 49 women are 5 percentage points more likely to compete than women at age 18 (or 25 percentage points more likely than the implied estimate for women at age zero). However, by age 50, they are 28 percentage points more likely to compete than women at age 18 (or 48 percentage points more likely than that implied for women at age zero). That is, the predicted change in propensity to compete, after controlling for risk-aversion and other general factors, in moving from age 49 to 50 is an increase of 23 percentage points – more than four and a half times larger than the entire change in moving from age 18 to 49. To put these relative magnitudes in another perspective, we note the estimates for the age variables imply that the maximum competitiveness for women under the age of 50 occurs at age 38, and that the propensity to compete rises an estimated 7.4 percentage points in moving across the twenty years from age 18 to the local peak at age 38. The estimated 23 percentage point rise across one year from age 49 to 50 is over 3 times larger than the estimated 7.4 percentage point rise across the twenty years from age 18 to 38. Thus the estimated effect of the discrete change at age 50 is far larger than the estimated continuous effects of age

Table A.3.1
Comparing mature women to all men.

	Main sample (MW) (1)	Auxiliary sample (US) (1)
Female	0.0737	0.107
	(0.0725)	(0.146)
Piece rate	0.0231**	−0.00734
	(0.0110)	(0.0290)
Improvement	0.0154	0.0166
	(0.0208)	(0.0428)
Guessed rank	0.000985	0.0324
	(0.0274)	(0.108)
Submit piece-rate to tournament	0.428***	0.458***
	(0.0440)	(0.136)
Observations	440	51

Estimated marginal effects from a Probit regression of the choice to select tournament for round 3. The sample includes all men, but among women restricts to individuals 50 and older. Column 1 shows results from our main sample and column 2 shows results from our US sample. The variable *Female* is an indicator for whether the participant is a woman. *Piece Rate* measures the number of successes in the first round, under the piece-rate regime. *Improvement* measures the increase in number of successes between the first and second round. *Guessed Rank* indicates the participant's stated belief about how well she performed, relative to the three other individuals in her group. *Submit Piece-Rate to Tournament* is an indicator for whether the participant chose to submit her past performance in round 1 (piece-rate) to a tournament against the past piece-rate performance of the other members in her randomly assigned group. Standard errors are shown in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A3.2
Jointly testing continuous and discrete effects of age.

	Probit (1)	Linear probability (2)
Female	−1.442**	−0.485**
	(0.593)	(0.202)
Female × Age	0.0435*	0.0144*
	(0.0227)	(0.00763)
Female × Age^2	−0.000582**	−0.000191**
	(0.000270)	(8.96e−05)
Female over 49	0.684**	0.231**
	(0.338)	(0.116)
Male × Age	−0.0221	−0.00748
	(0.0204)	(0.00703)
Male × Age^2	0.000205	6.89e−05
	(0.000227)	(7.84e−05)
Male over 49	0.0872	0.0325
	(0.372)	(0.127)
Piece rate performance	0.0107	0.00398
	(0.0240)	(0.00824)
Improvement	0.0321	0.0107
	(0.0390)	(0.0133)
Guessed rank	−0.00815	−0.00343
	(0.0511)	(0.0176)
Submit piece-rate to tournament	1.034***	0.385***
	(0.101)	(0.0347)
Constant	−0.195	0.414**
	(0.488)	(0.169)
Observations	727	727

Estimated coefficients from a Probit regression and Linear Probability regression of the choice to select tournament for round 3 (main sample). The variable *Female* is an indicator for whether the participant is a woman. *Age* is the continuous age of the individual, in number of years. *Piece Rate* measures the number of successes in the first round, under the piece-rate regime. *Improvement* measures the increase in number of successes between the first and second round. *Guessed Rank* indicates the participant's stated belief about how well she performed, relative to the three others in her group. *Submit Piece-Rate to Tournament* is an indicator for whether the participant chose to submit her past performance in round 1 (piece-rate) to a tournament against the past piece-rate performance of the other members in her randomly assigned group. Standard errors shown in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

in the quadratic specification. However both effects are statistically significant and continuous age impacts should not be completely dismissed.

Appendix D. Experiment details and instructions

A. The task

The real effort task that we use was specifically designed to involve a simple cognitive exercise with very low education requirements to participate – arranging shapes in a row from smallest to largest. Each participant has a set of 6 blocks. Each side of a given block has one of 6 shapes. The task is to arrange all 6 blocks such that a given shape (e.g., star) appears facing up, and to align the 6 versions of that shape (e.g., all 6 stars) in order from smallest to largest. Upon completing one shape, the participant moves to the next shape. The blocks are designed so that the blocks must continuously be rearranged in moving from one shape to the next. All participants work with identical blocks and face the same order of shapes to complete.

B. Information on choices

As in NV, before making the choice for round 3, participants are informed that if they choose competition, their group is the same group they were placed in for round 2, and the performances they compete against are the round 2 performances. That is, they would compete with individuals who had been forced to compete, rather than individuals who had self-selected into competition. Before making the choice for round 4, participants are again informed that their group is the same group they were randomly placed in for round 2, and this time the performances they compete against are the round 1 (piece-rate) performances of the group. Thus, if they submit their piece-rate performance to competition, they compete with the (round 1) performance of all individuals in their group, not just those who chose to compete.

C. Sampling

In Malawi, we drew participants from twelve different villages, recruiting from the entire village population. Each village was visited a few days prior to the experiment, to notify residents and advertise the significant show up payment. We then randomly selected participants from the large pool that arrived. In the US, we recruited participants in three waves. The first set of sessions was conducted at a major university campus near the end of the work-day. We recruited participants from staff, graduate students, and undergraduates. The second set of sessions was on a Saturday afternoon on campus, with participants recruited from a farmer's market, a flea market, and a local swimming pool. This second session is the only session in which the experiment took place in a different location than the recruitment. The third set of sessions was conducted at a farmer's market, with participants recruited from the market, the nearby commuter rail station, and the surrounding community.

D. Set-up and payment amounts

All sessions (Malawi and US) were conducted in a room large enough to hold all participants and that was similar in size to standard experimental labs in the US. Since many adults are illiterate in rural Malawi, the instructions were read aloud in both countries. Facilitators demonstrated how to perform the task, kept track of participants' number of successes in each round, and recorded participants' choices. The only speaker during the session was the script-reader, who read the instructions for the experiment. Each session lasted about an hour, and included on average 16 participants, equally balanced between men and women. Procedures in the US were identical to those in Malawi. As in NV, participants are told they will be paid for one of the four rounds, selected at random. At the end, they are asked how they believe their performance compared to the others in their group for rounds 1 and 2, earning additional amount Y for correct guesses. Task payment amounts were $X = 50$ kwacha (approx. $.33), $Y = 20$ kwacha (approx. $.13) in Malawi, and $X = \$1$, $Y = \$0.50$ in the US.

E. Additional explanation of protocol and controls generated

Rounds 1 and 2 serve to familiarize subjects with each pay scheme. In addition, the number of successes in the first two rounds allows us to control for the influence of ability in the task (and any boost when competing) on the decision to compete. This allows us to ensure, for example, that it is not simply ability that drives lower willingness to compete among young women. The choice made in round 4 isolates the effects of sex and age on the preference for performing in competition against others, independent from the effects they have on willingness to be rewarded based on a relative evaluation. That is, the round 4 choice captures the influence of other factors that affect willingness to compete besides a preference for performing under competition per se, such as risk-aversion, feedback-aversion or self-confidence. For example, since risk preferences affect both the round 3 and round 4 choices, but only in round 3 does the participant enter and compete in a tournament, the choice to compete in round 3 conditional on the choice in round 4 captures the preference for competitive environments independent of risk preferences.

F. Instructions

Welcome

In the study today, we will ask you to complete a simple task in four different rounds. None of these rounds will take more than 5 minutes. Because we are not simply asking you questions, but asking you to perform a task, we will pay your for your work. You will receive {*amount*} at the beginning and at the end you will receive {*amount*} for having completed the four rounds. In addition, you can earn more money based on your performance in one of the four rounds.

In order to participate in this study you must be at least 18 years old and you must agree to participate in the study or you must have the permission of your parent or guardian.

We will now give you some information about the study today. In each round, we will ask you to do something that can earn you money. When you are done here, you go to the cashier, he will put four cards into a bag, and you will pick one of these cards from the bag without seeing the cards. These are the four cards, this one is for the first round, this one is for the second round, this one is for the third round and this one is for the fourth round [*speaker places cards in bag*]. You will be allowed to pick one just as this man is going to show you right now. He cannot see which card he will pick, but we are not choosing the card. You will receive money according to how well you have done for the round that you pick from the bag without seeing. We will explain to you exactly how you can earn money in each round. Some people will only earn the show up fee today. Others will earn more. But everyone who begins will earn {*amount*} and everyone who finishes will earn {*amount*} again.

This is the payment desk [*speaker points*]. When you are finished with the tasks, please go here to answer some questions that we will ask and after that please come here to receive your payment.

Explanation and practice round

Welcome to this study. Now your helper will give you the {*amount*} that we promised to give to you at the beginning of the study. Today we will ask you to perform tasks and make decisions. If you listen carefully, you can earn a large amount of money. So pay close attention to the instructions, and ask questions if you do not understand, because it may affect how much money you earn.

Please do not talk with one another at any time during this study. I am happy to answer any questions you have at any time. But please direct your questions only to me. The person sitting in front of you is here to help show you the task, and to record the decisions that you make. They are not allowed to help you make decisions; please do not ask them for help with the decisions we ask you to make.

You see the blocks that are in front of you. Please look at them and see the shapes and colors on each of the blocks. Take one of the blocks and show your helper each of the shapes on the block as he points to it on the paper in front of you. Every shape shown on the paper is shown on each of the blocks. The task we will ask you to perform today is to arrange the shapes in order from smallest to largest. The person helping you will now demonstrate for you how to complete the task. First, your helper will show you how to find all of the circles. When all of the circles are facing up, he or she will put them in order from the smallest circle to the largest circle. The circles are now finished and they are finished correctly. The task is complete.

We will now ask *you* to practice doing the task one time. Your helper will now turn your card to the next shape, which is a square. We want you to perform the task for the squares. When you think you are finished, look at your helper for confirmation. If you have completed the task correctly, your helper will nod his head. If you are incorrect, he will shake his head, and you must continue until the squares are arranged from smallest to largest.

The way you are paid for this task will change each round. So pay close attention to these rules each round and be sure you understand them, because they will affect how much money you can earn in that round. For each round, we will explain the rules, before we ask you to begin. Please do not begin until we tell you to.

We will ask you to perform this task as many times as you can within 3 min. As soon as you finish arranging the blocks for one shape, look to your helper and he or she will indicate to you whether you may move to the next shape. If he nods his head, then turn the paper in front of you to show the next shape and then begin the next shape. If your facilitator shakes his head this means you have not correctly completed the task and you need to keep trying. You have 3 min to complete as many shapes as possible. The number of tasks that you complete is recorded on the paper but we will never tell anyone else how you have done.

Does anyone have any questions about how to perform the task?

Round one: individual performance

We will now begin round one. Before we begin, we will explain how you will be paid for the tasks this round: If Round 1 is the task that you draw from the bag at the end, then you get {*X*} for each shape you successfully complete. For example, if you complete one set of shapes you receive {*X*}, if you complete two sets of shapes you receive {2*X*}, if you complete three sets of shapes you receive {3*X*}, if you complete four sets of shapes you receive {4*X*}, and so on for as many shapes as you complete. We call this *individual performance*. This is represented by the single person standing alone in the picture in front of you.

Please do not talk during the task or after you have finished. This is very important. If you have any questions, please raise your hand and ask me now. Once we begin, you cannot ask any questions. Do you have any questions before we begin?

Are the facilitators ready? *[When ready:]* Okay, go. *[When time is up:]* Okay, everyone please stop now.

Round two: compared performance

Now we will move to the second round. For this round, the task is exactly the same. However, the way you are paid is now different. In this round, your payment depends on your performance compared to a group of other participants. Each group consists of four people. The three other members of your group come from other participants. Your group members may be in this room right now, but they may not be. You will never know the names of the other people in your group and they will never know your name. The person sitting next to you is *not* in your group. Do you have any questions about who is in your group? If you have a question, please raise your hand and ask me now.

We will now explain how your payment is determined in this round. If round 2 is the task that you draw from the bag at the end, then your earnings depend on your number of successes compared to the three other people in your group. If you complete the most shapes in 3 min out of anyone in your group, you receive {*4X*} for each set you complete. But if someone else in your group completes the most shapes, you receive nothing.

One times {*4X*} is {*4X*}. Two times {*4X*} is {*8X*}. Three times {*4X*} is {*12X*}. Four times {*4X*} is {*16X*}. And so on. We call this *compared performance***.** This is represented by the group of 4 people standing together in the picture in front of you. You will not know how you did in the compared performance until the end of today's activity, when you receive your earnings.

Please do not talk during the task or after you have finished. This is very important. If you have any questions, please raise your hand, and ask me now. Once we begin, you cannot ask any questions. Do you have any questions before we begin?

Are the facilitators ready? *[When ready:]* Okay, go. *[When time is up:]* Okay, everyone please stop now.

Round three: choice of payment scheme, before doing task

Now we will move to the third round. The task in this round is exactly the same, but now you can choose which way you want to be paid. If round 3 is the one that you draw from the bag, then your earnings for this task are determined as follows. If you choose *individual performance,* you receive {*X*} per success and you will not be compared to anyone else.

If you choose *compared performance* your payment for this round is similar to the payment in round two. The only difference is that your performance in this round is compared to the performance of the other three members of your group *for round 2*, the one we just finished, instead of being compared to their performance this round. If you complete the task more times than the other people in your group did for round 2 then you will receive four times the payment from the individual performance, which is {*4X*} per success. You will receive no earnings for this round if you choose compared performance and you do not complete more sets of shapes than the other people in your group did for round 2.

Notice that this round is a little different than last round because nothing you do in this round can affect the earnings of other people in your group, and nothing that other people in your group do this round can affect your earnings from this round.

You will not know how you did in the compared performance until the end of today's activity, when you receive your earnings. Do you have any questions? If you have any questions, please ask me now.

Please do not talk as you are making your decision. If you would like to choose individual performance, please point to the picture of one person. If you would like to choose compared performance please point to the picture of the group.

Please do not talk during the task or after you have finished. Are the facilitators ready? *[When ready:]* Okay, go. *[When time is up:]* Okay, everyone please stop now.

Round four: choose scheme for past performance

For this new round, you do not have to do any tasks. Instead, you may be paid one more time for how you did in the first round of the experiment. Now we are going to ask you how you would like to be paid for the tasks that you completed in the first round. You can choose to be paid for your individual performance or compared performance.

If the fourth round is the one selected for payment, then your earnings for this round are determined like this. If you choose *individual performance,* you receive {*X*} per success you had in round 1. If you choose *compared performance,* your performance will be compared to the performance of the other three members of your group in the first round. If you completed the task more times in round 1 than they did in round 1, then you receive four times the earnings of the individual performance choice, which is {*4X*} per success. If you choose compared performance and you did not complete the task more times than others did in round 1 you will receive no earnings for this round. Do you have any questions? If you have any questions, please ask me now.

Please do not talk as you are making your decision. Now your helper will show you how many times you successfully completed the sets of shapes in the first round. Now your helper will show you a picture. If you would like to choose individual performance, please point to the picture of the one person. If you would like to choose compared performance please point to the picture of the group.

Belief-assessment questions

We will now ask you how you think you performed in the tasks, compared to the 3 other people in the group we assigned you to, for the first two rounds. You will earn *{Y}* for each correct guess. Please look at the picture of the four people. The highest person completed the most sets of shapes in your group; he is first in the group. The next person completed the second-most sets of shapes in your group; he is second. The next person completed the third-most sets of shapes; he is third. The final person completed the least sets of shapes in your group; he is fourth.

We will first ask you how you think you performed in Round 1, the *individual performance*. If you are correct, you will be paid an additional *{Y}* when we pay you your earnings. Before we ask you, do you have any questions? If you have any questions, please ask me now.

Please do not talk as you are making your decision. Now please silently show your helper how you think you performed in Round 1, the *individual performance,* compared to the other people in your group, by pointing to the position in the picture. Do you think you were the best? Do you think you were the second-best? Do you think you were third-best? Or, do you think you were last?

We will now ask you how you think you performed in Round 2, the *compared performance*. If you are correct, you will be paid an additional *{Y}* when we pay you your earnings.

Please do not talk as you are making your decision. Now please silently show your helper how you think you performed in Round 2, the *compared performance,* compared to the other people in your group, by pointing to the position in the picture. Do you think you were the best? Do you think you were the second-best? Do you think you were third-best? Or, do you think you were last?

Thank you very much for your participation today. You can go now. Please go to there to answer some questions for our study.

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