Helsinki Center of Economic Research

Discussion Papers

Competitive Behavior, Stress, and Gender

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Discussion Paper No. 396
November 2015

ISSN 1795-0562

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HECER
Discussion Paper No. 396

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Abstract

This paper investigates whether chronic stress and acute physiological responses to competitive stress can explain individual and gender differences in competitiveness. We measure individuals' autonomic nervous system activity in a resting state as well as under non-competitive and competitive incentives in a real task using heart rate variability measurement. We find that basal heart rate variability, a proxy for chronic stress, and acute competition-induced changes in heart rate variability predict self-selection into competition. Moreover, we observe that basal heart rate variability predicts self-selection into competition for women, but not for men. Overall, we find tentative evidence for gender differences in the relationship between physiological stress and a decision to enter competitive environments. Our results suggest that individual variation in autonomic nervous system activity and physiological responses to competitive stress predict self-selection into competitive environments, but do not explain gender differences in willingness to compete.

JEL Classification: C91, D01, D03, J16, J24

Keywords: competitiveness, experiment, gender, labour market, stress

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* The authors would like to thank Jonas Fooken and Ernesto Reuben for their detailed comments and suggestions when preparing and revising the manuscript. The authors would like to thank Krisztina Timko for research assistance. The paper has benefited from comments made by the participants of the Economic Science Association European Meeting in 2014, the IMEBESS in 2015 and the Annual Congress of the European Economic Association in 2015. This study has been funded by the aivoAALTO project of the Aalto University, the Yrjö Jahnsson Foundation, and the Research Foundation of Cooperative Banks, Finland. The authors declare no conflict of interest.

1 Introduction

Substantial anecdotal and scientific evidence suggests that women are more reluctant to compete than men. Various studies document that men tend to improve their performance in competitive environments more than women (Gneezy et al. 2003; Croson and Gneezy, 2009). In the same vein, several studies show that women may shy away from competition more often than men, even though there often are no gender differences in performance (Niederle and Vesterlund, 2007; Niederle and Vesterlund, 2011; Niederle et al. 2013). Gender differences in competitiveness seem to emerge at an early age (Gneezy and Rustichini, 2004; Glätzle-Rützler and Sutter, 2014) and be stronger in math-related tasks than in writing-related tasks (Günther et al., 2009; Dreber et al., 2014). The gender gap in competitiveness is documented across several societies (e.g. Andersen et al., 2013; Almås et al., 2014). However, there is also evidence suggesting that men and women compete equally in certain societies and circumstances (Dreber et al., 2011; Cardenas et al., 2012). Lately, Zhang (2014) and Buser et al. (2014) have investigated the external relevance of experimental designs developed to measure competitiveness and show that experimentally elicited preferences for competition are strongly correlated with the propensity to take a highly competitive high school entrance exam in China and to choose more prestigious academic tracks in Dutch secondary schools.

It is often argued that gender differences in competitiveness may provide an explanation for pervasive gender differences in labor market outcomes, educational attainment and political empowerment. To understand the connection between gender differences in willingness to compete and gender differences in career paths and earnings, it is important to identify biological and cultural determinants behind the gender differences in willingness to compete. However, relative little is known about the underlying psychological and physiological mechanisms that may explain the under-representation of women in competitive environments. Our study aims to contribute to the understanding of human competitiveness by investigating whether physiological measures of chronic and acute competitive stress can explain individual and gender differences in competitiveness.

A number of studies have lately recognized the importance of gender in people's physiological responses to stressful events and experiences. These studies show that men tend to have greater cardiovascular response to competitive stress than women, while women typically report higher levels of chronic and daily stress than men (Holt-Lunstad et al., 2001; APA, 2012). There is also a growing body of evidence suggesting that various work-related stressors have a disparate effect on women and men (Tytherleigh et al., 2007). Consequently, it seems plausible that different physiological responses to competition-induced acute stress and desire to avoid chronically stressful environments may explain individual and gender differences in selection into competitive environments.

The objective of this paper is threefold: (i) to measure individuals' autonomic nervous system activity in a resting state as well as under non-competitive and competitive incentive in a real task, (ii) to investigate whether heart rate variability, a robust biomarker of stress-induced autonomic nervous system activity, can explain individual and gender differences in competitiveness, and (iii) to examine whether the relationship between autonomic nervous system activity and willingness to compete is mediated by self-confidence and risk attitudes.

Stress is body's response to changes in the environment that create taxing demands. The stress response is geared to maintain our physiological and mental health in the face of *acute stressors* that are relatively contained events with limited duration. The acute stress response largely helps healthy individuals to adapt to new challenges and typically does not impose a health burden (Nelson, 2005; Rivers and Josephs, 2010). The stress response begins to falter under unremitting exposure to physiological and emotional stressors. The effects of *chronic stress* on neural, cardiovascular, immunological and reproductive health are morbid (Nelson, 2005; Sapolsky, 2005). Exposure to chronic stress also typically causes insufficient bodily response to acute stressors (Nelson, 2005). In this paper, we are particularly interested to investigate people's physiological response to competitive stress which roots from the imbalance between performance demands in a competition and individual's perception of her abilities to successfully meet those demands.[1]

In this study, we measure participants' autonomic nervous system activity using heart rate variability (HRV) measurement. HRV is a well-established physiological indicator of stress-induced activation of

[1] Like many other types of stressors, having to perform in a competitive environment may lead to a stress response which is adaptive for coping in the short-term, but may over time have pathological impact on person's mental and physical well-being. In colloquial language, stress is often used to only describe body's negative reactions to challenges. This practice also often applies to epidemiological work which tries to quantify the overall impact of chronic stress on health outcomes and estimate the costs of work-related stress in certain geographical areas and business sectors. For example, the American Psychological Association (APA, 2009) reports that 55 percent of the employees in the U.S. consider themselves to be less productive at work as a result of work-related stress. In the same vein, according to the APA (2007), 52 percent of the U.S. employees report that they have considered or made a decision about their career such as looking for a new job, declining a promotion or leaving a job based on work-related stress. The estimated overall cost of work-related stress to the U.S. industry is above $300 billion in a year due to absenteeism, turnover, diminished productivity and medical, legal and insurance costs (Rosch, 2001).

the autonomic nervous system (Task Force, 1996; Acharya et al., 2006). Low HRV values generally signal high sympathetic (stimulative) nervous system activity and occur during the states of high mental and environmental stress. Low HRV values in a resting state are associated with chronic mental and physical distress (Task Force, 1996; Acharya et al., 2006). By contrast, high HRV values in a resting state are associated with high parasympathetic (inhibitory) activity of the autonomic nervous system. Thus, high HRV values in a resting state are interpreted as signals for fast physiological recovery and good emotional regulation ability (Task Force, 1996; Acharya et al., 2006).[2] While HRV in a resting state can be interpreted as a proxy of chronic stress, short-term changes in HRV indicate acute engagement of the sympathetic nervous system and do not enable us to assess the adaptiveness of this response.

We use two different types of HRV data in this study. First, we measure participants' basal HRV during a five-minute period before participation in our experiment. This baseline HRV serves as an indicator of individuals' autonomic nervous system activity in a resting state and measures the level of chronic distress. The baseline HRV also creates a reference value to calculate relative changes in HRV that occur during the experimental tasks. Second, we record participants' HRV during our experiment to measure participants' acute physiological stress response to non-competitive and competitive incentives. By linking the HRV data with our measure of competitiveness, we can examine the predictive power of objectively measured physiological data on willingness to compete in a controlled environment which allows controlling for individuals' performance, risk aversion, confidence and preferences for performing in a competition.

Our paper is related to experimental studies investigating relationships between acute stress exposure, cognitive performance and competitiveness. Angelucci and Cordova (2014) investigate the impact of acute stress on cognitive performance and find that exposure to acute emotional stress may reduce women's performance and earnings compared to men's performance and earnings in a task where participants have to answer multiple-choice questions taken from the SAT. Buckert et al. (2015) investigate whether having to perform in a competitive environment causes acute stress reactions. They find that participants' heart rate and arterial blood pressure are higher when performing under competitive incentives than when performing under non-competitive incentives. However, they do not find any effect on participants' cortisol or testosterone levels. Buser et al. (2015) investigate whether an

[2] A number of epidemiological studies suggest that HRV in a resting state serves as an independent predictor of future health outcomes. In particular, Zulfigar et al. (2010) shows that high HRV is associated with cardiovascular health and healthy longevity among the elderly. Conversely, Dekker et al. (2000) show that low HRV predicts higher incidence of coronary heart disease in the general population.

acute stress response to mandatory competition predicts individuals' willingness to participate in a voluntary competition and find that salivary cortisol measured after mandatory competition does not predict willingness to compete among men, but is positively associated with the decision to enter competition among women.

Our investigation differs in several important aspects from the related studies. First, we measure individuals' heart rate variability in a resting state which serves as a proxy for chronic stress and enables us to investigate the association between basal heart rate variability and self-selection into competitive environments. Second, we measure individuals' heart rate variability throughout the exposure to piece rate and tournament incentives which resolves uncertainty about the correct number and timing of measurements. Third, heart rate variability is known to be a particularly fast-responding and selective measure of mental stress (Mulder, 1992). Consequently, even relatively short recordings of HRV are likely to provide an accurate measurement of cardiovascular and nervous system response to competitive stress.

Our results show that both basal heart rate variability and competition-induced acute stress response predict individual self-selection into competition. Moreover, we find that basal heart rate variability predicts self-selection into competition in a sub-sample of women, but not in a sub-sample of men. However, the association between basal heart rate variability and participants' decision to enter competition is not significantly different between men and women. We find the relationship between competition-induced acute stress response and self-selection into competition is mediated by self-confidence among the best performing men. Overall, we find tentative evidence for gender differences in the relationship between physiological stress and a decision to enter competitive environments.

This study establishes an association between autonomic nervous system activity and willingness to compete. This finding contributes to an evolving economic literature examining the origins and determinants of individual and gender differences in competitive behavior. Our results may also contribute to the literature examining the determinants of gender differences in labor market outcomes, educational attainment and political empowerment. In particular, the observation that a well-established proxy for chronic stress and acute physiological stress response to competitive incentives are associated with the self-selection into competitive environments may provide new insights to understand how organizational culture, work environment and occupational health affect career decisions and development of men and women.

Finally, our method and results may prove useful in developing alternative affirmative action policies and evaluating the mental and physiological consequences of policies designed to facilitate the promotion of women to high professional and managerial positions. People's stress levels and abilities to adapt to taxing changes are typically not fixed, but influenced by organizational culture and behavior at the workplace. Our results, speculatively, suggest that healthy levels of occupational stress may facilitate the self-selection of women into competitive professional positions. Likewise, policies that succeed in reducing women's exposure to distress at work and home may have an indirect effect on gender differences in labor market outcomes, educational attainment and political empowerment.

2 Study design

This section documents our data collection procedure and describes variables used to examine our research questions. First, we describe the design of our behavioral experiment. Second, we describe the data collection procedure for the heart rate variability data and document the preprocessing of these data. Third, we summarize other key variables used in the results section.

2.1 Experimental design

Our experimental design largely follows the within-subject design developed by Niederle and Vesterlund (2007). The basic task in our experiment is to add up sets of five two-digit numbers for five minutes. Participants solve these tasks individually. They are not allowed to use a calculator, but may use a scratch paper and pencil provided by the experimental team. The numbers shown on the computer screen are randomly drawn and presented in the following way, where participants fill in the sum in the blank box on the screen (Fig. 1A).

The experiment consists of five tasks and resting periods before, during and after the actual tasks (Fig. 1B). We implement the resting periods to reliably measure participants' autonomic nervous system activity during different tasks (Niizeki and Saitoh, 2012). At the beginning of the experiment, participants are requested to attach a heart rate variability measurement device to their chest (Fig. S1).[3] There is a two-minute practice period to familiarize with the task and screen layout. During the resting period before

[3] Participants attach the HRV measurement devices to their chest by themselves. Attaching these devices is straightforward and does not require any particular skill. Attaching the device to a female body does not substantially differ from attaching the device to a male body.

the experiment, participants fill a questionnaire concerning their personal background and receive written instructions for the first task.[4] Finally, there is a two-minute quiet resting period just before Task 1.

A

39	91	78	43	28	

B

	Task / feedback	Payment scheme	Duration (min.)
Resting	Filling questionnaires, practice	-	~10
Task 1	Adding numbers, individual	Piece rate	5
Pause	No. of problems solved / correctly solved in Task 1	-	5
Task 2	Adding numbers, groups	Tournament	5
Pause	No. of problems solved / correctly solved in Task 2	-	5
Task 3	Adding numbers, individual or groups	Piece rate or tournament	5
Pause	No. of problems solved / correctly solved in Task 3	-	4
Task 4	No. of problems solved / correctly solved in Task 1 Choice: piece rate or tournament for Task 1	Piece rate or tournament	~2
Pause	Rank guess in Task 1, rank guess in Task 2	Payments from correct guesses	4
Task 5	Adding numbers, individual or new groups	Piece rate or tournament	5
Resting	Rank guess in Task 5, filling questionnaires,	Payment from a correct guess, Holt & Laury	~18

Figure 1: Task (A) and timing (B)

Participants perform the arithmetic task under different incentive schemes. The compensation scheme in Task 1 is a non-competitive piece rate scheme. Participants receive a fixed payment of 25 eurocents for every correct answer. We measure participants' performance by the number of attempts to solve the problem and by the number of correct answers. The participants’ final score is determined by the number of correctly solved problems. Participants receive feedback about their own absolute performance after each task. They receive information about the number of attempts to solve the problem and about the number of correct answers. Importantly, participants do not receive any feedback about the performance of other participants before completing all experimental tasks.

The compensation scheme in the second task (Task 2) is based on a tournament between four randomly assigned subjects. The participant who correctly solves the largest number of problems in a group is the

[4] The full set of experimental instructions is made available in the Electronic Supplementary Material.

winner and earns four times more for each correctly solved problem than in the piece rate task. In other words, the winner earns one euro per correct answer. All other participants earn nothing. In case of a tie, the winner is randomly chosen among the high performers. The tournament is designed so that a performance leading to a 25 percent chance of winning the tournament receives the same expected payoff as from the piece rate. Participants are informed before Task 2 that the gender composition in the group is mixed.

In Task 3, participants select which of the two compensation schemes shall apply to their future performance. If they choose the tournament scheme, their performance during the Task 3 is compared with the performance of the other group members in Task 2. Consequently, the number of competitors in the tournament is kept independent of other participants' decisions. This procedure guarantees that participants' beliefs about the choices of other participants may not affect their choice. Furthermore, winning the tournament in Task 3 does not impose negative externalities on others.

In Task 4, participants choose between the piece rate and tournament compensation scheme for the past performance in Task 1. At this stage, participants do not perform the arithmetic task, but decide which incentive scheme shall apply to their past piece rate performance. Before making their decisions, participants are reminded about their absolute performance in Task 1. If they choose the tournament compensation scheme, their performance during Task 1 will be compared with the Task 1 performance of other group members. If an entering participant has the highest performance, he/she wins the tournament. Task 4 is an individual decision task where participants' beliefs about the choices of other participants may not affect their choice. Task 4 has the same payoff structure than Task 3, but eliminates all aspects of performing in a competitive environment. Consequently, the contrast between Tasks 3 and 4 allows us to examine whether the knowledge of having to perform in a tournament affects the selection of preferred payment schemes. Moreover, Task 4 enables us to examine whether heart rate variability predicts tournament entry when participants do not have to perform in a competitive environment.

After the fourth task, participants are requested to guess their rank in their group in Task 1 and Task 2, respectively. Participants are informed that they will be rewarded with one euro for each correct guess. In the event of a tie in the actual rank, we reward every guess that could be correct. The reward mechanism is implemented to incentivize participants to state their true beliefs about their ranking.

After completing all arithmetic tasks,[5] there is an 18-minute long resting period. During this resting period, we elicit participants' risk preferences using an incentivized measure for risk aversion developed by Holt and Laury (2002) and a general measure of risk-taking propensity derived from a one-item survey question (Dohmen et al., 2011). We elicit participants' general willingness to compete using a one-item survey question. Participants are requested to report their perception of task difficulty on a scale from 1 to 7, where 1 signifies very easy and 7 signifies very difficult. In addition, participants are requested to report whether they believe that the task favors one gender over the other. In other words, we ask whether the participants believe that men or women are able to correctly solve more problems.

At the end of the experiment, participants receive their payment based on their performance in one of the five tasks. Participants are requested to choose one out of the five cards faced down on their computer screen. The cards are in a random order. The chosen card determines which of the five tasks is selected for the payment. The total payment for each participant includes a five euro show-up fee, earnings from one randomly chosen task, earnings from the belief elicitation questions and earnings from the incentivized measure for risk aversion. The experiment lasted about 90 minutes. Participants earned on average 12.28 euro (Std. = 5.32).

The experiment was conducted using the z-Tree software (Fischbacher, 2007) in the PCRC Decision Making Laboratory at the University of Turku, Finland. We used a standard subject pool which mainly consists of university students enrolled at the University of Turku. The experiment was conducted in two consecutive days. There were two consecutive sessions per day. There were 20 participants in each session. The total number of participants was 80, consisting of 39 male and 41 female participants. Invitation letters to the subject pool members stated that participants' heart rate variability will be measured during the experiment. Only non-smoking participants were allowed to participate in the experiment. The experimental protocol was approved in advance by the Research Ethics Committee of the Aalto University, Finland. All subjects signed informed consent forms before participating in the experiment. The complete experimental instructions given to participants are available in the Electronic Supplementary Material.

[5]As shown in Fig. 1B, the experiment included a fifth task. In this task, participants are requested to choose between a piece rate and tournament compensation scheme and perform the five-minute arithmetic task once again. The difference between Task 3 and Task 5 is that in Task 5 only those participants who choose a tournament compensation scheme will be compared with each other. Results from the fifth task are reported elsewhere.

2.2 Experimental variables

Heart rate variability. We use heart rate variability (HRV) as an indicator of stress-induced activation of the autonomic nervous system. HRV has proven to be a reliable method to measure bodily stress for clinical and research purposes (Task Force, 1996; Hynynen et al., 2011; Niizeki and Saitoh, 2012), but has been rarely applied to study economic questions.[6]

To measure our participants' heart rate variability we used the FirstBeat Bodyguard heart rate monitor (www.firstbeat.fi). The device is non-intrusive and attaches directly to the skin with two electrodes (Fig. S1). For the HRV data analysis, we used Kubios HRV 2.0 software (Tarvainen et al. 2014). We identified from the beat-to-beat interval series artifacts that are larger or smaller than 150 milliseconds compared to the local average. We applied then cubic spline interpolation to replace these missing intervals. Finally, the resulting corrected beat-to-beat interval series were visually inspected for potentially remaining outliers. At this stage, we had to exclude three participants from our HRV data set due to technical problems.[7]

We use the Root Mean Square of the Successive Differences (RMSSD) to measure the variation of consecutive beat-to-beat intervals.[8] We compute for each subject four different RMSSD values: one baseline value and three task-related values. The baseline value is computed using a five-minute long period shortly before Task 1. The values for task-related RMSSDs are calculated using a five-minute period that matches to the performance period in Task 1, Task 2 and Task 3. In addition to the absolute RMSSD values, we measure competition-induced changes in heart rate variability using differences in RMSSD between Task 1 (piece rate) and Task 2 (tournament). This competition-induced relative change

[6] There are only a handful of studies that apply heart rate variability measurement to study economic questions. Falk et al. (2011) study physiological response to perceptions of unfairness and find an inverse relationship between heart rate variability and the degree of fairness. Brandts and Garofalo (2012) examine how the gender composition of an audience impacts decision-makers' responsibility and heart rate variability. They do not find any relationship between gender composition of the audience and heart rate variability. Dullect et al. (2012) examine the physiological foundations of tax compliance in a laboratory experiment and find that higher tax compliance is associated with lower heart rate variability. Dulleck et al. (2014) discuss the applicability of heart rate variability measurement techniques in economic experiments and illustrate the measurement technique in an Ultimatum Game experiment. There are no prior studies examining the predictive power of HRV on economic decisions.

[7] One participant was excluded from the data set due to a technical problem with the HRV measurement device during the measurement period. In this case, no HRV data were recorded. Two participants were excluded from the data set due to unconceivable noise in the beat-to-beat intervals.

[8] For a detailed computation of the Root Mean Square of the Successive Differences see the Electronic Supplementary Material.

in RMSSD measures individuals’ autonomic nervous system response to competitive incentives and is defined as:[9]

$$Relative\ change\ in\ RMSSD = 100 * \left(\frac{RMSSD(Task2) - RMSSD(Task1)}{RMSSD(Task1)}\right). \quad (1)$$

Willingness to compete: Participants' choice in Task 3 serves as an incentivized measure for participants’ willingness to compete.

Choice of compensation scheme for past piece-rate performance: Participants' choice in Task 4 indicates participants’ choice of compensation scheme for past piece-rate performance. This choice provides us a measure to gauge participants’ preferences for rank-based remuneration in the absence of having to perform in a competitive environment.

Competition attitude: We use participants’ answers to a one-item survey question about their general attitude to competition as a measure for their general willingness to compete. This variable takes values from 0 to 10, where 0 denotes the lowest willingness to compete and 10 denotes the highest willingness to compete.

Risk attitude: To assess the role of risk aversion on individuals’ willingness to compete we use a general risk attitude question (Dohmen et al., 2011) and an incentivized risk measurement technique developed by Holt and Laury (2002). In the general risk attitude question, participants are requested to indicate their general risk taking willingness on a scale from 0 to 10, where 0 stands for “not willing to take risk” and 10 stands for “completely willing to take risk”. The incentivized risk measurement lottery contains ten paired lottery decisions with modest payoffs. Participants have to choose between two options in each of the ten prospects. The break-even point where participants switch from the low risk option to the high risk option indicates their degree of risk aversion. The full payoff table for the incentivized risk aversion measure is available in the Electronic Supplementary Material.

Confidence in task performance: We measure participants’ confidence in their performance by eliciting their beliefs about their relative performance in Task 1 and Task 2. In practice, participants’ are requested to guess their rank among the group members. The lower the guessed rank (1 = the best performing group

[9] We additionally use a complementary definition for competition-induced changes in heart rate variability by normalizing the changes in RMSSD using baseline data instead of Task 1 data. We report all results in the results section using the definition described in Equation (1). We report supplementary results in the Electronic Supplementary Material using the alternative definition for competition-induced changes in heart rate variability.

member), the higher the confidence on being the best performing member in the group. Conversely, the higher the guessed rank (4 = the worst performing group member), the higher the confidence on being the worst preforming member in the group.

3. Results

This section summarizes our main empirical findings. First, we investigate whether men and women differ in their performance, winning probability and competitiveness. Second, we investigate participants' autonomic nervous system activity under non-competitive and competitive incentives. Third, we examine whether heart rate variability explains individual and gender differences in selection into a competitive environment. Finally, we evaluate the robustness of our findings and study more closely the link between heart rate variability and willingness to compete.

3.1 Gender differences in performance, probability of winning and competitiveness

We find no significant gender differences in average performance in any task (Fig. 2, two-sided t-tests, $p > 0.13$). In the piece rate incentive scheme, the average number of correctly solved problems by men is 9.10 (Std. = 4.01) and by women 7.93 (Std. = 2.71). In the tournament, the average number of correctly solved problems by men is 10.38 (Std. = 4.21) and by women 9.98 (Std. = 2.70).[10] Consequently, both men and women perform significantly better under the tournament (Task 2) than under the piece rate (Task 1) compensation scheme (two-sided paired t-test, for men $p = 0.01$, for women $p < 0.01$). This effect may be caused by learning or differences between the incentive schemes.[11]

On average, men consider the arithmetic task slightly more challenging than women (on a scale from 1 to 7, average for men is 4.36 and average for women is 3.80; two-sided t-test, $p = 0.06$). The majority of participants (56 percent) find that the arithmetic task favors men, while only 4 percent of the participants find that the arithmetic task favors women. The remaining 40 percent of the participants find that the arithmetic task is gender-neutral. Thus, the majority of our participants seem to hold the stereotypical belief that men perform better in an arithmetic task than women (Reuben et al., 2014).

[10] Figure S2 in the Electronic Supplementary Material presents the distribution of men's and women's performance in Tasks 1 and 2.

[11] The experimental design used in this study does enable to separate the effect of learning and incentives on performance. A number of existing studies with real-effort tasks suggest that initial learning may have a substantial effect on performance. In our study, a two-minute practice period before the first task may have reduced the impact of initial learning on performance.

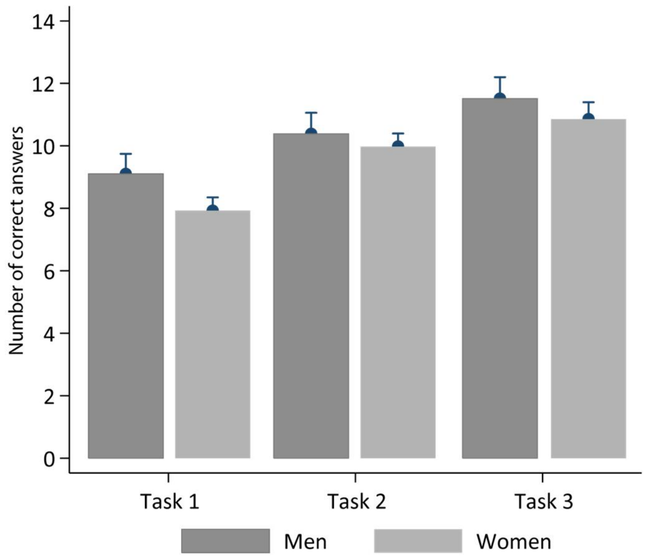

Figure 2: The average number of correctly solved problems by task and gender. Error bars indicate the standard error of the mean.

Even though there are no statistically significant differences in performance between men and women, we find that men are slightly more likely to win the tournament than women. We assess the probability of winning the tournament by performing a simulation where we draw 10000 groups consisting of two men and two women using the sample of 39 men and 41 women with replacement. We repeat this 100 times and arrive at a result that, conditional on gender, the probability of winning the Task 2 tournament is 30.1 percent for a man and 19.4 percent for a woman. In a sample of 39 men and 41 women, this difference is marginally significant (two-sided t-test, p = 0.08). In particular, the probability of winning the tournament begins to diverge for performances greater than 13 correctly solved problems (Fig. S3). The probability of winning the tournament with 13 correctly solved problems is 55.5 percent for a man and 48.8 percent for a woman. The probability of winning the tournament with 15 correctly solved problems is 75.3 percent for a man and 66.2 percent for a woman.

In Task 3, 54 percent of women and 74 percent of men choose the tournament compensation scheme (Fisher's exact test, p-value = 0.066).[12] The choice of compensation scheme does not divide women on the basis of their performance. The women who choose the tournament incentive scheme solve only

[12] Our results show that the proportion of men choosing the tournament compensation scheme in Task 3 equals the previously reported proportions in other Western subject pools. However, the proportion of women choosing the tournament compensation scheme is slightly higher in our experiment than in many previously reported experiments. For example, see evidence for university students in the U.S. (Niederle and Vesterlund, 2007, Niederle et al., 2013), for university students in Germany (Müller and Schwieren, 2012) and for high-school students among two different ethnic groups and the Han Chinese in China (Zhang, 2014).

slightly more problems than the women who choose the piece rate (Table 1; two-sided t-tests for mean performance, Task 1, p = 0.07; Task 2, p = 0.33; Task 3, p = 0.08; Task 2 – Task 1, p = 0.32). However, the choice in Task 3 seems to divide men into two groups. The men who choose the piece rate compensation scheme in Task 3 perform significantly worse in all tasks than the men who select the tournament scheme (Table 1; two-sided t-tests for mean performance, Task 1, Task 2 & Task 3, p < 0.01; Task 2 – Task 1, p = 0.74).

Table 1: Average performance (number of correct answers) by choice of payment scheme in Task3.

Gender	Chosen Payment Scheme	Task 1 (Piece rate)	Task 2 (Tournament)	Task 2 – Task 1	Task 3 (Own choice)
Women	Piece rate (N=19)	7.11 (0.61)	9.53 (0.67)	2.42 (0.50)	9.84 (0.80)
	Tournament (N=22)	8.64 (0.56)	10.36 (0.53)	1.73 (0.47)	11.73 (0.70)
Men	Piece rate (N=10)	5.80 (0.57)	6.80 (1.14)	1.00 (0.89)	8.30 (0.76)
	Tournament (N=29)	10.24 (0.73)	11.62 (0.69)	1.38 (0.59)	12.62 (0.79)

Note: Standard deviations in the parentheses.

On average, the gender difference in the tournament entry is 20 percentage points. At the same time, we find that the gender gap in entry increases with performance. By dividing the subjects by gender and their performance quartile in Task 2, we observe that all men in the best performing quartile choose the tournament compensation scheme, whereas 67 percent of the women in the first quartile enter the tournament (Fig. 3A). Gender difference in the tournament entry is marginally significant in the two high-performing quartiles (Fisher exact test, p = 0.069, conditional on Task 2 performance), but not in the two low-performing quartiles (Fisher exact test, p = 0.527, conditional on Task 2 performance).

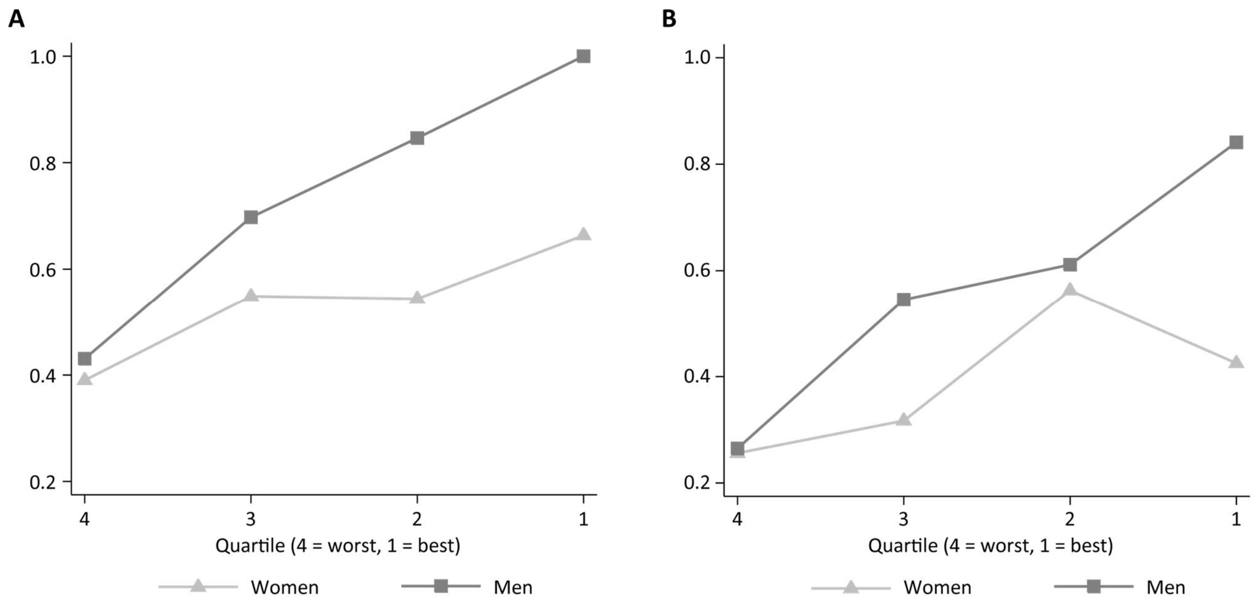

Figure 3: The proportion of participants selecting the tournament in Task 3 conditional on Task 2 tournament performance quartile (Panel A) and the proportion of participants selecting the tournament in Task 4 conditional on Task 1 performance quartile (Panel B).

In Task 4, 56 percent of the men and 39 percent of the women choose the tournament compensation scheme (Fisher's exact test, p-value = 0.179).[13] By dividing the subjects by gender and their performance quartile in Task 1 (Fig. 3B), we observe that the proportion of men and women choosing the tournament compensation scheme is lower in all performance quartiles in Task 4 than in Task 3.

3.2. Heart rate variability and competitiveness

We have observed in Section 3.1 that men and women of the same ability differ in their selection into a competitive environment. In this section, we investigate participants' heart rate variability under different incentive schemes and examine whether differences in heart rate variability explain individual and gender differences in selection into a competitive environment.

[13] This result together with the results presented in Table 7 indicates that there are no significant gender differences in self-selection into tournament in Task 4. This result replicates the findings reported by Niederle and Vesterlund (2007).

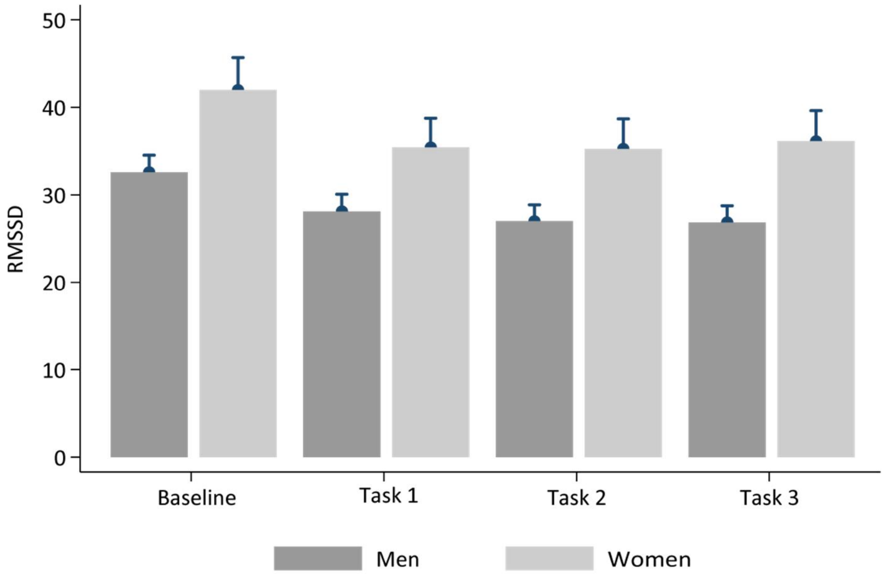

Figure 4: Mean RMSSDs by task and gender. Error bars indicate the standard error of the mean.

We find that women on average exhibit higher absolute heart rate variability than men (Fig. 4). This effect is statistically significant during the baseline measurement and all arithmetic tasks (two-sided t-test for mean RMSSD, baseline: $p = 0.027$; Task 1: $p = 0.063$; Task 2: $p = 0.038$; Task 3: $p = 0.010$). Figure 4 shows that both genders exhibit lower heart rate variability during the arithmetic tasks than during the baseline measurement (paired two-sided t-tests for mean baseline RMSSD and Task 1 or Task 2 related RMSSD: $p < 0.01$ for both genders). In other words, we observe that both genders experience an acute physiological stress response to the arithmetic task. However, we do not observe significant difference in participants' stress response when moving from piece rate incentives to a forced tournament (paired two-sided t-tests for Task 1 vs. Task 2 related RMSSD: men, $p = 0.126$; $p = 0.856$).[14]

[14] The fact that there is a substantial decrease in HRV when moving from baseline to a piece rate but no significant decrease in HRV when moving from the piece rate to a forced tournament suggests that participants on average react stronger to the introduction of math problems than to tournament incentives. However, this does not indicate that the initial drop in HRV is necessarily a good predictor of voluntary selection into a competitive environment. The placebo regressions reported in the Electronic Supplementary Material (Table S1) show that the changes in HRV when moving from baseline to the piece rate are not associated with participants' tournament entry decisions.

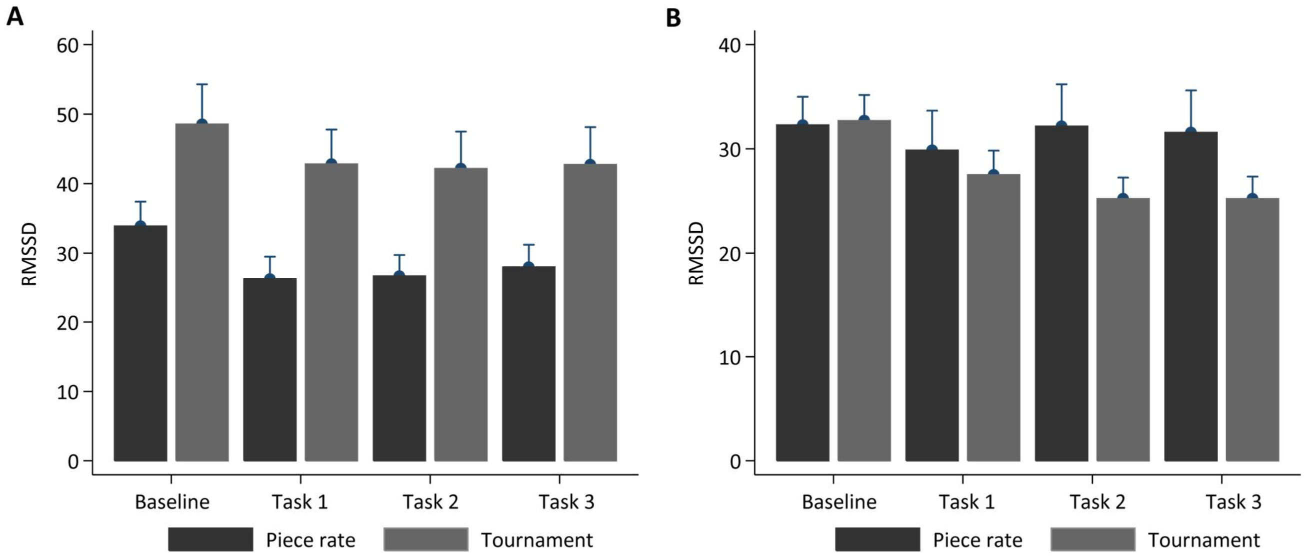

Figure 5: Mean RMSSDs of women (Panel A) and of men (Panel B) by task and choice of payment scheme in Task 3. Error bars indicate the standard error of the mean.

In the following, we examine changes in heart rate variability separately for men and women. We find that women who choose to enter the tournament in Task 3 have significantly higher baseline heart rate variability than women who choose the piece rate incentives (Fig. 5A; two-sided t-test for mean RMSSD: $p = 0.037$). Likewise, we find that the women who choose to enter the tournament in Task 3 have significantly higher heart rate variability during Task 1 (two-sided t-test for mean RMSSD: $p = 0.009$), Task 2 (two-sided t-test for mean RMSSD: $p = 0.017$) and Task 3 (two-sided t-test for mean RMSSD: $p = 0.026$) than women who choose the piece rate incentives. By contrast, Figure 5B shows that there are no significant differences in baseline (two-sided t-test for mean RMSSD: $p = 0.960$), Task 1 (two-sided t-test for mean RMSSD: $p = 0.697$), Task 2 (two-sided t-test for mean RMSSD: $p = 0.145$) and Task 3 (two-sided t-test for mean RMSSD: $p = 0.183$) heart rate variability between the men who choose the tournament and piece rate incentives. Overall, we observe that the women who shy away from the competition have lower heart rate variability than the women who enter the competitive environment, whereas the men who choose to enter competition exhibit similar heart rate variability than the men who choose the piece rate incentives.

We have so far focused on the absolute heart rate variability indices during the baseline measurement and arithmetic tasks. Figure 6 shows competition-induced changes in heart rate variability by gender and choice of payment scheme in Task 3 using a relative RMSSD measure defined in Equation 1. We measure competition-induced stress response as a difference in heart rate variability between the piece rate incentive scheme (Task 1) and the forced tournament (Task 2). These values are normalized by dividing the difference by Task 1 values. We find that the competition-induced change in heart rate variability is significantly different between the men who enter the tournament in Task 3 and the men who choose the piece rate in Task 3 (two-sided t-test, p = 0.003). In particular, we find that heart rate variability decreases between Tasks 1 and 2 among the men who choose the tournament, whereas the heart rate variability increases between Tasks 1 and 2 among the men who choose the piece rate incentives (Fig. 6).

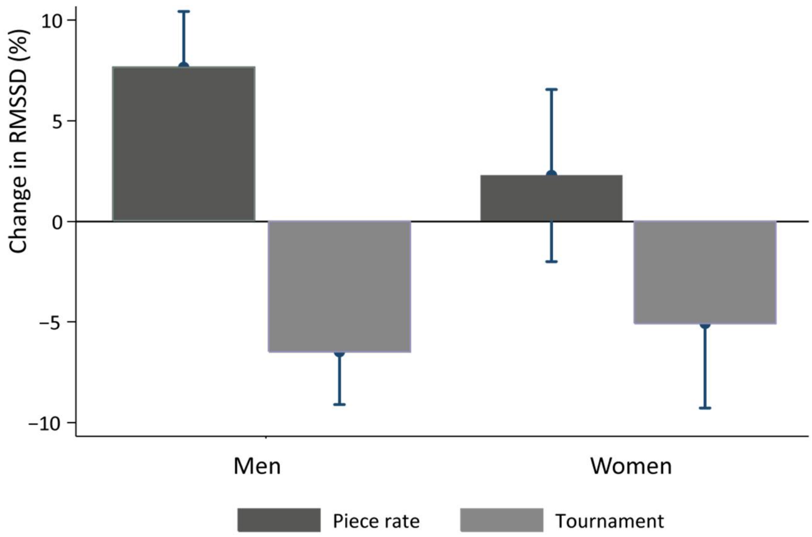

Figure 6: Mean difference between RMSSD (Task2) – RMSSD (Task1), relative to the Task 1 RMMSD, by gender and choice of payment scheme in Task 3. Error bars indicate the standard error of the mean.

We interpret the decrease in heart rate variability among the men who enter the tournament in Task 3 as a *competition-induced acute engagement of the sympathetic nervous system*. By contrast, we do not observe that there are significant differences in competition-induced changes in heart rate variability between those women who enter the tournament in Task 3 and those women who choose the piece rate incentives (two-sided t-test, p = 0.231). We observe that the men who experience a competition-induced acute engagement of the sympathetic nervous system are more likely to self-select into competition than the men who do not experience acute engagement of the sympathetic nervous system during competition. At the same time, we observe that the self-selection into competition is not associated with competition-induced changes in heart rate variability among women.[15]

[15] The results concerning the association between competition-induced changes in heart rate variability and tournament entry among the men and women are robust to the alternative definition of competition-induced changes in heart rate variability where we normalize the changes in RMSSD using baseline measurement instead of Task1 data. We find in Table 4 that the

3.3 Explanations for gender differences

We have seen that both the baseline levels of HRV and the competition-induced changes in HRV are associated with participants' decisions to enter into a competitive environment. In the following, we examine the robustness of these observations and assess the impact of various observable behavioral characteristics on tournament entry decisions. We estimate various probit regressions for the tournament entry decisions in Task 3 and Task 4.[16]

Table 2 shows that the gender difference in tournament entry is 20.2 percentage points after controlling for participants' performance in Task 2. We compare the models reported in columns (1) – (4) to assess how the gender gap changes when including our measures for basal HRV and competition-induced changes in HRV in the model. We find that including the basal HRV in the regression model increases the gender gap in tournament entry from 20.2 percentage points to 23.8 percentage points. By contrast, including competition-induced change in HRV decreases the gender difference in tournament entry from 20.2 percentage points to 17.8 percentage points. Including both stress variables in the model at the same time (column 4) increases the gender gap to 24.1 percentage points. These changes in the gender gap are statistically insignificant (Wald tests for the equality of coefficients: $p > 0.171$). Column (5) in Table 2 shows that basal HRV and competition-induced changes in HRV are significant predictors of tournament entry after controlling for participants' performance, confidence, risk attitude, competition attitude and competition-induced changes in performance. Even though the basal HRV and the competition-induced changes in HRV are significant predictors of tournament entry, they do not close the gender gap in competitiveness.

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self-selection into competition is associated with competition-induced changes in heart rate variability also among women after controlling for their confidence and propensity to take risks.

[16] We also estimate logit models for all model specifications reported in Tables 2 - 6. The results from these models are qualitatively similar to the results presented in Tables 2 - 6. We present here only the average marginal effects of probit models for brevity and clarity of interpretation. We report in Table 7 linear probability model estimates due to a small sample size and clarity of interpretation. We also estimate all model specifications using participants' (simulated) individual probability of winning the tournament instead of participants' performance in the tournament (for example, see Table S8). All results reported in Tables 2 - 6 are robust to the using of individual probabilities of winning the tournament instead of participants' performance. In addition, we estimate all model specifications using an alternative definition of competition-induced changes in heart rate variability by normalizing the changes in RMSSD using baseline measurement instead of Task1 measurement. All results reported in Tables 2 - 6 are robust to the using of data normalized by baseline measurement. We report in the electronic Supplementary Material also pairwise correlation coefficients between all variables included in Tables 2 – 7 (Tables S11-S13).

To study the tournament entry decisions of men and women, we estimate in Tables 3 and 4 several regression models separately for men and women. Column (1) in Table 3 shows that basal HRV is a significant predictor of tournament entry among women. By contrast, column (2) in Table 3 shows that the competition-induced acute stress response is not directly associated with the tournament entry among women. However, we note that the models (1) – (3) including only measures for performance and heart rate variability do not fit the data particularly well. Inserting variables measuring confidence and risk aversion to the simplified regression models (column 4) has two notable consequences. First, inserting confidence and risk aversion to the simplified model substantially improves the model's fit. Second, we find that in this more accurate model both the basal HRV and competition-induced acute stress response are statistically significant predictors of women's tournament entry.[17]

Table 3: Probit models on Task-3 payment scheme choice for women
(1 = tournament, 0 = piece rate)

	(1)	(2)	(3)	(4)
Performance	0.036	0.024	0.024	-0.005
	(0.027)	(0.027)	(0.027)	(0.019)
Baseline RMSSD	0.008***		0.009***	0.007***
	(0.003)		(0.003)	(0.002)
RMSSD change		-0.004	-0.006	-0.007***
		(0.004)	(0.004)	(0.003)
Confidence				-0.124*
				(0.065)
Risk attitude				0.086***
				(0.013)
Observations	38	38	38	38
Pseudo R^2	0.117	0.032	0.161	0.618
Correctly classified (%)	65.79	63.16	63.16	86.84

Table reports average marginal effects with standard errors in parentheses. Performance denotes the number of correctly solved arithmetic problems in Task 2. RMSSD change denotes competition-induced change in heart rate variability measured in normalized RMSSD values. Confidence denotes participants' guesses about their rank among the group members in Task 2 and takes values from 1 to 4, where lower values indicate higher self-confidence. Risk attitude denotes participants' answer to a general risk question on a scale from 1 to 10 where lower values indicate lower willingness to take risks. ***significant at p < 0.01, **significant at p < 0.05, *significant at p < 0.1.

[17] Tables 2 - 6 report coefficients for risk attitude using a one-item survey question for general risk attitude. The qualitative nature of the results reported in Tables 2 - 6 is robust to the alternative of using an incentive compatible method to elicit participants' risk preferences (Holt and Laury, 2002).

Column (1) in Table 4 shows that the basal HRV is not a significant predictor of tournament entry among men. By contrast, column (2) in Table 4 shows that the competition-induced acute stress response is associated with the tournament entry among men. Column (4) shows that the competition-induced change in HRV remains a highly significant predictor of tournament entry after controlling for confidence and risk attitude. We find that one standard deviation increase in the basal HRV increases the probability of tournament entry by 33.3 percentage points among women and decreases the probability of tournament entry by 2.3 percentage points among men. Likewise, we find that one standard deviation increase in the competition-induced acute stress response increases the probability of tournament entry by 29.6 percentage points among women and by 8.3 percentage points among men.

Table 4: Probit models on Task-3 payment scheme choice for men
(1 = tournament, 0 = piece rate)

	(1)	(2)	(3)	(4)
Performance	0.052***	0.041***	0.041***	0.014
	(0.012)	(0.012)	(0.012)	(0.017)
Baseline RMSSD	0.0003		-0.002	-0.001
	(0.005)		(0.005)	(0.004)
RMSSD change		-0.009***	-0.009***	-0.006**
		(0.003)	(0.003)	(0.003)
Confidence				-0.139**
				(0.067)
Risk attitude				-0.018
				(0.024)
Observations	39	39	39	39
Pseudo R^2	0.261	0.406	0.409	0.542
Correctly classified (%)	82.05	79.49	79.49	89.74

Table presents average marginal effects with standard errors in parentheses. Performance denotes the number of correctly solved arithmetic problems in Task 2. RMSSD change denotes competition-induced change in heart rate variability measured in normalized RMSSD values. Confidence denotes participants' guesses about their rank among the group members in Task 2 and takes values from 1 to 4, where lower values indicate higher self-confidence. Risk attitude denotes participants' answer to a general risk question on a scale from 1 to 10 where lower values indicate lower willingness to take risks. ***significant at $p < 0.01$, **significant at $p < 0.05$, *significant at $p < 0.1$.

Our results suggest that basal autonomic nervous system activity and physiological responses to competitive stress may predict individual selection into competitive environments. We also find that there are some differences in variables that predict the tournament entry decision among men and women.

In particular, we observe that basal HRV and risk aversion predict entry to the tournament for women, but not for men.[18] We find that competition-induced acute stress response is associated with the tournament entry among men in all models, whereas the association is statistically significant among women only after controlling for confidence and risk aversion.

Table 5: Probit models on Task-3 payment scheme choice for high performers (1 = tournament, 0 = piece rate)

	(1)	(2)	(3)	(4)	(5)
Woman	-0.253**	-0.225**	-0.260***	-0.276***	-0.205**
	(0.113)	(0.112)	(0.101)	(0.098)	(0.102)
Performance	0.041	0.034	0.018	0.012	0.001
	(0.036)	(0.033)	(0.033)	(0.029)	(0.031)
Baseline RMSSD		0.004		0.008*	0.005*
		(0.004)		(0.005)	(0.004)
RMSSD change			-0.006**	-0.009**	-0.007**
			(0.003)	(0.003)	(0.003)
Confidence					-0.107
					(0.083)
Risk attitude					0.023
					(0.030)
Competition attitude					0.021
					(0.018)
Performance change					-0.119
					(0.315)
Observations	38	36	36	36	36
Pseudo R^2	0.141	0.163	0.241	0.339	0.472
Correctly classified (%)	76.32	77.78	88.89	86.11	88.89

Table presents average marginal effects with standard errors in parentheses. Woman is a dummy variable, where women = 1 and men = 0. Performance denotes the number of correctly solved arithmetic problems in Task 2. RMSSD change denotes competition-induced change in heart rate variability measured in normalized RMSSD values. Confidence denotes participants' guesses about their rank among the group members in Task 2 and takes values from 1 to 4, where lower values indicate higher self-confidence. Risk attitude denotes participants' answer to a general risk question on a scale from 1 to 10 where lower values indicate lower willingness to take risks. Competition attitude denotes participants' answer to a general competition attitude question on a scale from 1 to 10 where lower values indicate lower willingness to compete. Performance change denotes the difference in the number of correctly solved arithmetic problems between Tasks 2 and 1. Positive values indicate greater performance in the tournament compensation scheme than in the piece rate. *** significant at $p < 0.01$, ** significant at $p < 0.05$, * significant at $p < 0.1$.

[18] We test whether there is a statistically significant difference in the impact of basal HRV and competition-induced acute stress arousal on tournament entry between men and women. The interaction terms reported in Table S2 indicate that there are no statistically significant gender differences in the impact of basal HRV and competition-induced acute stress response on tournament entry.

Table 5 complements our previous analyses by reporting the same models than Table 2 for the high-performing participants (top 50 percent in Task 2).[19] We observe in Table 5 largely the same pattern of results than in Table 2. The gender gap in entry is 25.2 percentage points among the top performers after controlling for performance. Consequently, the gender gap is substantially larger among the top performers than in the entire population. Participants' performance in Task 2 does not predict tournament entry among the top performers. At the same time, column (3) shows that the competition-induced acute stress response is a highly significant predictor of tournament entry among the top performers. Furthermore, column (5) shows that the competition-induced acute stress response is the only statistically significant predictor of tournament entry besides gender among the top performers in a model which includes the effects of basal HRV, performance, confidence, risk attitude, general preference for performing in a competitive environment and competition-induced changes in performance.

We have seen that the basal HRV and the competition-induced acute changes in HRV predict entry into tournament in Task 3. In the following, we examine whether our indicators of chronic stress and acute competitive stress predict tournament entry also in Task 4 which keeps the payoff structure unchanged but eliminates all aspects of performing in a competitive environment. We assess the impact of basal HRV and competition-induced acute changes in heart rate variability by estimating the same models for tournament entry than for Task 3.

Table 6 shows that the gender difference in tournament entry in Task 4 is 12.1 percentage points after controlling for participants' performance in Task 1. The size of the gender gap is substantially smaller in Task 4 than in Task 3 and statistically not significant. Columns (2) – (5) in Table 5 show that the basal HRV and the competition-induced changes in heart rate variability do not explain entry into tournament in Task 4. Column (5) completes the picture by investigating the effects of confidence, risk attitude and general preference for performing in a competitive environment. We find that participants' propensity to take risks and confidence are the only significant predictors of tournament entry in Task 4. Overall, we observe that the basal HRV and the competition-induced changes in HRV predict tournament entry in Task 3, but not in Task 4. We interpret this as evidence that the basal HRV and the competition-induced

[19] The models reported herein include only participates whose performance is strictly above the median. The qualitative nature of the results presented in Table 5 is robust to including participants with a median performance in the models. We estimate the same model specifications reported in Table 5 also for low performers (below median performance). These models show that there is no significant gender difference in tournament entry among the participants with a below median performance. Competition-induced acute stress response does not significantly predict tournament entry among the low performers. The tournament entry decision is mainly driven by baseline RMSSD values, confidence and risk attitude among the low performers. These models are reported for brevity in the Electronic Supplementary Material (Table S3).

changes in HRV predict tournament entry in an environment where participants have to knowingly perform in a tournament, but not in an environment where participants do not have to perform in a competitive environment.

Table 6: Probit models on Task-4 payment scheme choice (1 = tournament, 0 = piece rate)

	(1)	(2)	(3)	(4)	(5)
Woman	-0.121	-0.123	-0.119	-0.122	0.068
	(0.103)	(0.108)	(0.105)	(0.108)	(0.100)
Performance	0.046***	0.043***	0.046***	0.046***	0.004
	(0.015)	(0.016)	(0.017)	(0.017)	(0.019)
Baseline RMSSD		0.000		0.000	-0.001
		(0.003)		(0.003)	(0.002)
RMSSD change			0.003	0.003	0.002
			(0.003)	(0.003)	(0.003)
Confidence					-0.216***
					(0.055)
Risk attitude					0.071***
					(0.017)
Competition attitude					-0.009
					(0.017)
Performance change					-0.142
					(0.098)
Observations	80	77	77	77	77
Pseudo R^2	0.090	0.078	0.084	0.084	0.336
Correctly classified (%)	65.00	63.64	66.23	67.53	71.43

Table reports average marginal effects with standard errors in parentheses. Woman is a dummy variable, where women = 1 and men = 0. Performance denotes the number of correctly solved arithmetic problems in Task 2. RMSSD change denotes competition-induced change in heart rate variability measured in normalized RMSSD values. Confidence denotes participants' guesses about their rank among the group members in Task 2 and takes values from 1 to 4, where lower values indicate higher self-confidence. Risk attitude denotes participants' answer to a general risk question on a scale from 1 to 10 where lower values indicate lower willingness to take risks. Competition attitude denotes participants' answer to a general competition attitude question on a scale from 1 to 10 where lower values indicate lower willingness to compete. Performance change denotes the difference in the number of correctly solved arithmetic problems between Tasks 2 and 1. Positive values indicate greater performance in the tournament compensation scheme than in the piece rate. ***significant at $p < 0.01$, **significant at $p < 0.05$, *significant at $p < 0.1$.

We have seen that competition-induced acute engagement of the sympathetic nervous system predicts entry into competitive environments where people have to knowingly perform in a tournament. In the following, we complement this observation by examining more closely the role of confidence and competition-induced changes in HRV as predictors of tournament entry. In particular, Table 7 presents interaction coefficients between confidence and competition-induced acute stress response among men and women. Columns (1) and (4) show estimates among the top 50 percent based on performance in Task 2, columns (2) and (5) show estimates among the top 75 percent based on performance in Task 2. Finally, columns (3) and (6) show the estimates among all men and women.

We observe that there is a significant interaction between confidence and competition-induced acute stress response among the men. In contrast to the results reported in Table 3, we find that the physiological response to competitive stress is not directly associated with the tournament entry decision among all men in Table 7. However, we find that the competition-induced change in HRV and the interaction term between the competition-induced change in HRV and confidence are jointly highly significant predictors of tournament entry (Wald test: p = 0.02). Columns (4) - (6) show that confidence and competition-induced change in HRV are not associated with the self-selection into tournament among women. We conclude that the impact of autonomic nervous system activity on willingness to compete is mediated by self-confidence among men, but not among women.

Table 7: Linear probability models on Task-3 payment scheme choice (1 = tournament, 0 = piece rate)

	Men			**Women**		
	Top 50%	Top 75 %	All men	Top 50%	Top 75%	All women
	(1)	(2)	(3)	(4)	(5)	(6)
RMSSD change	0.014***	0.006	-0.003	-0.004	-0.009	0.004
	(0.018)	(0.004)	(0.004)	(0.028)	(0.023)	(0.021)
Confidence	-0.182***	-0.218***	-0.248***	-0.173	-0.189	-0.223**
	(0.033)	(0.040)	(0.040)	(0.168)	(0.127)	(0.101)
RMSSD change x	-0.015***	-0.009***	-0.005**	-0.002	-0.007	-0.004
Confidence	(0.002)	(0.002)	(0.002)	(0.010)	(0.009)	(0.008)
Constant	1.172***	1.190***	1.245***	1.162***	0.999***	1.068***
	(0.029)	(0.065)	(0.070)	(0.082)	(0.323)	(0.251)
Observations	20	31	39	16	31	38
R^2	0.671	0.615	0.506	0.161	0.160	0.160

Table reports linear probability model coefficients with robust standard errors in parenthesis. RMSSD change denotes competition-induced change in heart rate variability measured in normalized RMSSD values. Confidence denotes participants' guesses about their rank among the group members and takes values from 1 to 4, where lower values indicate higher confidence. RMSSD change x Confidence is an interaction term. ***significant at p < 0.01, **significant at p < 0.05, *significant at p < 0.1

4 Conclusions

There are pervasive gender differences in labor market outcomes, educational attainment and political empowerment across cultures and political systems. At the same time, competitive incentive schemes and tournament-based promotion mechanisms pervade the work place and political organization. This paper aims to increase our understanding of individual and gender differences in competitiveness by developing an experimental design which enables to measure chronic stress as well as the acute physiological effects of competitive stress. We use this data to examine whether physiological effects of stress can predict entry into competitive incentive schemes.

Our results show that basal heart rate variability and acute physiological response to competitive stress are strong predictors of participants' entry into competition. However, the associations between heart rate variability and participants' decisions to enter competition are not significantly different between men and women. Overall, our results suggest that individual variation in basal autonomic nervous system activity and physiological responses to competitive stress predict self-selection into competitive environments, but do not explain gender differences in willingness to compete

This study establishes an association between autonomic nervous system activity and willingness to compete. There is little doubt that the same biological foundations that guide participants' behavior in our experimental setting guide individuals' behavior and decisions in the real world. However, there is larger uncertainty about the external relevance of our findings. While we are not capable to directly assess the question of external relevance using our existing data, a representative survey of the U.S. population (APA, 2009) documents that more than 50 percent of the employees have considered or made a decision about their career such as looking for a new job, declining a promotion or leaving a job based on work-related stress. This evidence suggests that our findings may have some external relevance and open new perspectives to understand the causes of individual differences in labor market outcomes, educational attainment and political empowerment.

If our results have external relevance, they would indicate that individual variation in autonomous nervous system activity explains people's educational and career-related decisions. This result would in turn have important ramifications for the design of optimal organizations and incentive schemes. In particular, the result that a physiological indicator of accumulated distress explains women's decisions to enter competition may provide a partial explanation for the pervasive under representation of high-qualified women in competitive organizations. Thus, speculatively, our findings suggest that organizational structures and work environments that achieve healthy levels of occupational stress may automatically facilitate the self-selection of women into competitive professional positions.

The robustness of our results and their external relevance has to be further studied before we can begin to make forceful arguments that the observed regularities readily generalize to naturally-occurring environments. While there is preliminary evidence showing that experimentally elicited preferences for competition are associated with different field measures of educational attainment, there is large uncertainty about the relevance of our physiological stress measures. It is important to notice that reliable physiological measurement of stress remains challenging and is subject to difficulties in interpretation. There is no clear consensus about the validity and reliability of alternative measurement techniques. Only future research can show whether our results can be replicated in other circumstances and using alternative techniques for physiological stress measurement. It also remains to be studied whether inducing distress or relaxation before making decisions about the future compensation schemes have a causal effect on competitiveness. Finally, an important question is whether currently recommended practices for stress management by medical institutions affect employees' willingness to enter competitive environments

Acknowledgements: The authors would like to thank Jonas Fooken and Ernesto Reuben for their detailed comments and suggestions when preparing and revising the manuscript. The authors would like to thank Krisztina Timko for research assistance. The paper has benefited from comments made by the participants of the Economic Science Association European Meeting in 2014, the IMEBESS in 2015 and the Annual Congress of the European Economic Association in 2015. This study has been funded by the aivoAALTO project of the Aalto University, the Yrjö Jahnsson Foundation, and the Research Foundation of Cooperative Banks, Finland. The authors declare no conflict of interest.

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Supplementary Material for Competitive Behavior, Stress, and Gender

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1. Material and Methods

1.1 Computation of the Root Mean Square of Successive Intervals

We use throughout the paper the Root Mean Square of Successive Differences (RMSSD) to measure the variation of beat-to-beat (BTB) intervals. The RMMSD is defined as

$$RMSSD = \sqrt{\frac{1}{N-1}\sum_{j=1}^{N-1}(BTB_{j+1} - BTB_j)^2},$$

where BTB_j denotes the value of jth beat-to-beat interval and N is the total number of successive intervals.

1.2 Information about the Heart Rate Variability Measurement Device

We measured our participants' beat-to-beat intervals using the FirstBeat Bodyguard1 heart rate monitor. The device was attached to skin using two electrodes: one (yellow snap) to the right side of the body, just below the collar bone, and the another (red snap) to the left side of the body below the heart (on the rib cage). The measurement accuracy for recording beat-to-beat intervals is 1 ms with a sampling frequency of 1000 Hz. The accuracy of the measurement device does not differ from standard clinical ECG recording devices with off-line R-wave detection.

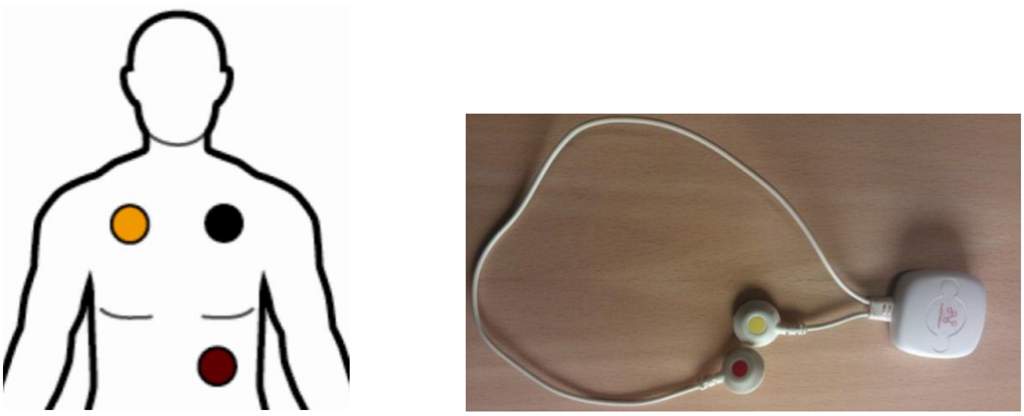

Figure S1. Heart rate variability measurement device.

2. Supplementary Figures and Tables

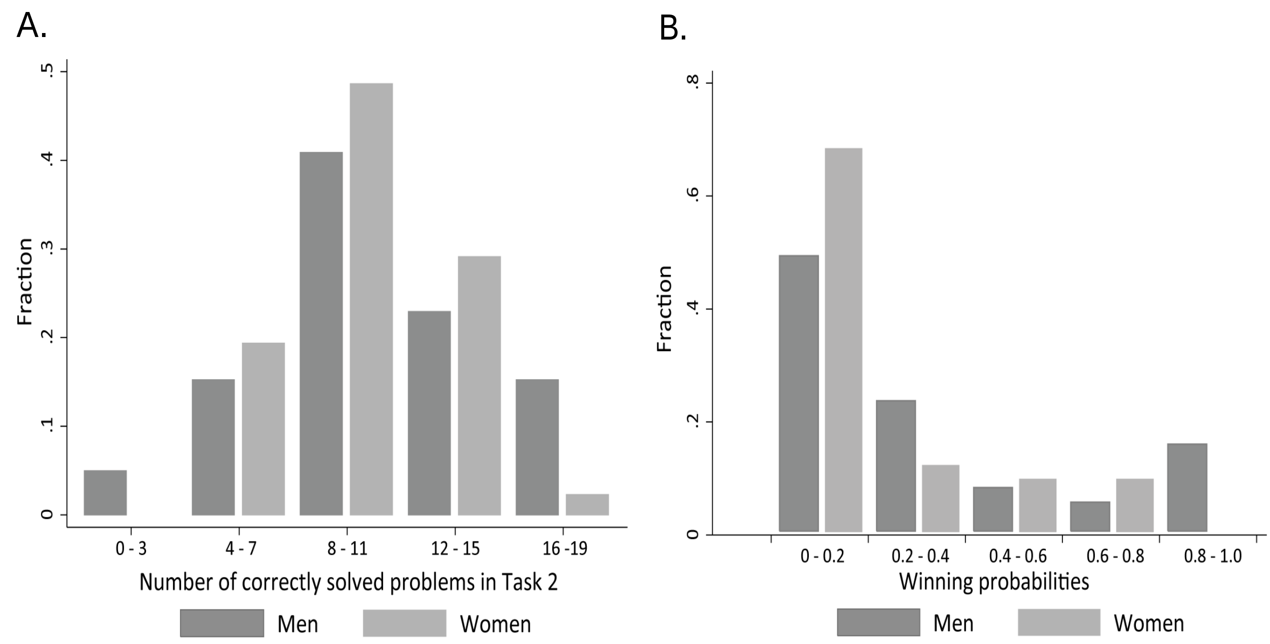

Figure S2: A) The performance distribution of men and women in Task 2. B) The probability of winning the tournament by gender in Task 2.

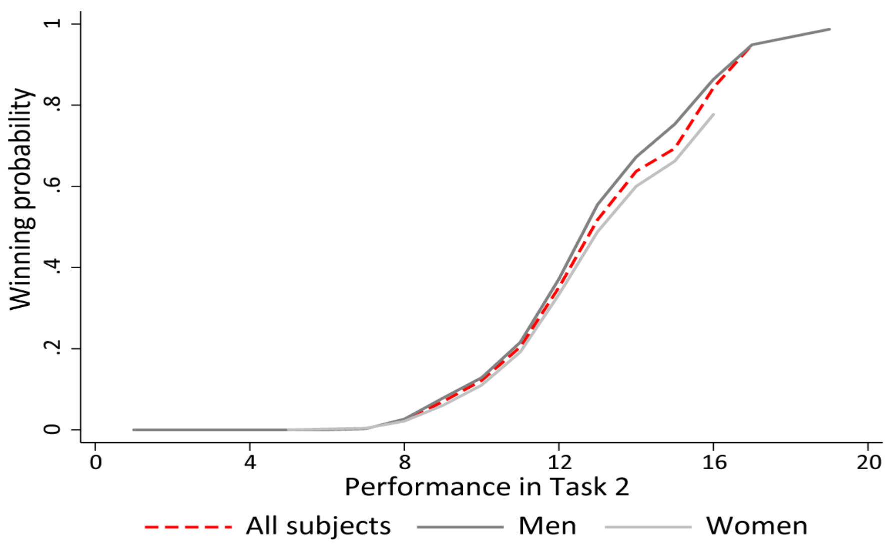

Figure S3: The probability of winning the tournament for a given performance among the men and women.

We find a significant gender difference in the average number of incorrectly solved problems in both competitive tasks (Fig. S1). Men make more mistakes than women in Task 2 (two-sided t-test, p = 0.02) and in Task 3 (two-sided t-test, p = 0.05).

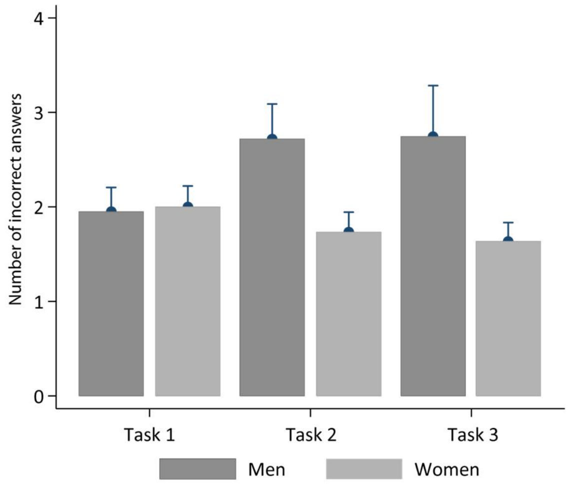

Figure S4: The average number of incorrectly solved problems by task and gender. Error bars indicate the standard error of the mean.

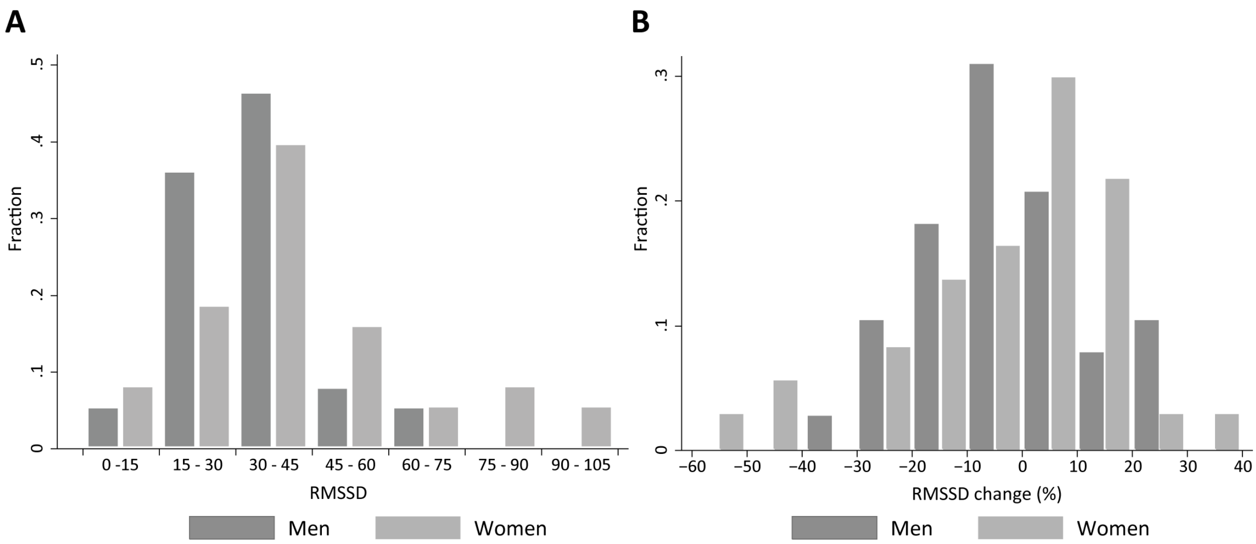

Figure S5: A) The distribution of RMMSD values during the baseline measurement among the men and women. B) The distribution of competition-induced changes in heart rate variability among the men and women.

Table S1: Placebo regressions for Task-3 and Task-4 payment scheme choice (1 = tournament, 0 = piece rate)

	Task 3					Task 4
	(1)	(2)	(3)	(4)	(5)	(6)
	All	Women	Men	Men top 50%	Men top 50%	All
Woman	-0.568					-0.327
	(0.323)					(0.298)
Performance	0.182***	0.104	0.238***			0.116**
	(0.057)	(0.084)	(0.091)			(0.050)
Baseline – Task 1	-1.331	-2.108*	-0.514	28.725	-3.473	-0.007
	(0.836)	(1.136)	(1.377)	(28.246)	(50.471)	(0.764)
Confidence				0.503		
				(1.753)		
Confidence × Baseline – Task 1				-13.643		
				(13.755)		
Risk attitude					-1.148	
					(0.991)	
Risk attitude × Baseline – Task 1					1.808	
					(6.688)	
Constant	-0.890*	-0.564	-0.564	0.221	7.609	-0.863*
	(0.532)	(0.815)	(0.815)	(3.419)	(6.237)	(0.481)
Observations	77	38	39	20	20	77
Pseudo R^2	0.156	0.082	0.264	0.396	0.355	0.078
Correctly classified (%)	67.53	68.42	82.05	95.00	85.00	63.64

Table reports probit regression coefficients with standard errors in parenthesis. Woman is a dummy variable, where women = 1 and men = 0. Performance denotes the number of correctly solved arithmetic problems in Task 2 in columns 1-5. Performance denotes the number of correctly solved arithmetic problems in Task 1 in column 6. Baseline – Task 1 denotes the difference in RMSSD between the baseline measurement and Task1 measurement in normalized RMSSD values. Confidence denotes participants' guesses about their rank among the group members in Task 2 and takes values from 1 to 4, where lower values indicate higher self-confidence. Risk attitude denotes participants' answer to a general risk question on a scale from 1 to 10 where lower values indicate lower willingness to take risks. Confidence × Baseline – Task 1 and Risk attitude × Baseline – Task 1 are interaction terms. ***significant at $p < 0.01$, **significant at $p < 0.05$, *significant at $p < 0.1$.

Table S2: Probit-regressions on Task-3 payment scheme choice
(1 = tournament, 0 = piece rate)

	(1)	(2)	(3)
Woman	-1.317	-0.589	-5.284
	(0.802)	(0.325)	(3.439)
Baseline RMSSD	0.002		-0.009
	(0.019)		(0.029)
RMSSD change		-0.054***	-0.044*
		(0.021)	(0.024)
Woman × Baseline RMSSD	0.019		0.058
	(0.022)		(0.037)
Woman × RMSSD change		0.041*	-0.005
		(0.023)	(0.034)
Performance			0.099
			(0.120)
Confidence			-0.950*
			(0.527)
Risk attitude			-0.120
			(0.162)
Woman × Performance			-0.132
			(0.177)
Woman × Confidence			0.085
			(0.745)
Woman × Risk attitude			0.718***
			(0.267)
Constant	0.594	0.702***	2.944
	(0.650)	(0.250)	(2.383)
Number of subjects	77	77	77
Pseudo R^2	0.076	0.135	0.591
Correctly classified (%)	62.34	67.53	88.31

Table reports probit regression coefficients with standard errors in parenthesis. Woman is a dummy variable, where women = 1 and men = 0. Performance denotes the number of correctly solved arithmetic problems in Task 2. Stress arousal denotes competition-induced change in heart rate variability measured in normalized RMSSD values. Confidence denotes participants' guesses about their rank among the group members in Task 2 and takes values from 1 to 4, where lower values indicate higher self-confidence. Risk attitude denotes participants' answer to a general risk question on a scale from 1 to 10 where lower values indicate lower willingness to take risks. ***significant at $p < 0.01$, **significant at $p < 0.05$, *significant at $p < 0.1$.

Table S3: Probit models on Task-3 payment scheme choice for low performers (1 = tournament, 0 = piece rate)

	(1)	(2)	(3)	(4)	(5)
Woman	-0.168	-0.264*	-0.132	-0.249*	-0.179*
	(0.144)	(0.145)	(0.147)	(0.145)	(0.106)
Performance	0.082**	0.077**	0.076**	0.075**	0.046
	(0.035)	(0.033)	(0.035)	(0.033)	(0.030)
Baseline RMSSD		0.008**		0.007**	0.010***
		(0.004)		(0.004)	(0.004)
RMSSD change			-0.005	-0.004	-0.004
			(0.005)	(0.005)	(0.004)
Confidence					-0.227***
					(0.048)
Risk attitude					0.052**
					(0.022)
Competition attitude					-0.002
					(0.019)
Performance change					-0.186*
					(0.107)
Observations	42	41	41	41	41
Pseudo R^2	0.085	0.141	0.095	0.156	0.537
Correctly classified (%)	66.67	68.29	65.85	60.98	90.24

Table presents average marginal effects with standard errors in parentheses. Woman is a dummy variable, where women = 1 and men = 0. Performance denotes the number of correctly solved arithmetic problems in Task 2. RMSSD change denotes competition-induced change in heart rate variability measured in normalized RMSSD values. Confidence denotes participants' guesses about their rank among the group members in Task 2 and takes values from 1 to 4, where lower values indicate higher self-confidence. Risk attitude denotes participants' answer to a general risk question on a scale from 1 to 10 where lower values indicate lower willingness to take risks. Competition attitude denotes participants' answer to a general competition attitude question on a scale from 1 to 10 where lower values indicate lower willingness to compete. Performance change denotes the difference in the number of correctly solved arithmetic problems between Tasks 2 and 1. Positive values indicate greater performance in the tournament compensation scheme than in the piece rate. ***significant at $p < 0.01$, **significant at $p < 0.05$, *significant at $p < 0.1$.

Table S4: Probit models on Task-3 payment scheme choice (1 = tournament, 0 = piece rate)

	(1)	(2)	(3)	(4)	(5)
Woman	-0.631**	-0.796**	-0.584*	-0.874**	-0.769*
	(0.313)	(0.339)	(0.323)	(0.357)	(0.433)
Performance	0.151***	0.166***	0.126**	0.147***	0.088
	(0.050)	(0.052)	(0.051)	(0.054)	(0.077)
Baseline RMSSD		0.022**		0.026**	0.039***
		(0.010)		(0.011)	(0.013)
RMSSD change			-0.019*	-0.023**	-0.034***
			(0.010)	(0.010)	(0.013)
Confidence					-0.990***
					(0.308)
Risk attitude					0.215**
					(0.096)
Competition attitude					0.037
					(0.073)
Performance change					-0.841
					(0.529)
Constant	-0.783	-1.610**	-0.553	-1.550**	0.159
	(0.511)	(0.651)	(0.526)	(0.672)	(1.426)
Observations	80	77	77	77	77
Pseudo R^2	0.137	0.186	0.168	0.240	0.486
Correctly classified (%)	66.25	76.62	67.53	71.43	87.01

Table reports probit coefficients with standard errors in parentheses. Woman is a dummy variable, where women = 1 and men = 0. Performance denotes the number of correctly solved arithmetic problems in Task 2. RMSSD change denotes competition-induced change in heart rate variability measured in normalized RMSSD values. Confidence denotes participants' guesses about their rank among the group members in Task 2 and takes values from 1 to 4, where lower values indicate higher self-confidence. Risk attitude denotes participants' answer to a general risk question on a scale from 1 to 10 where lower values indicate lower willingness to take risks. Competition attitude denotes participants' answer to a general competition attitude question on a scale from 1 to 10 where lower values indicate lower willingness to compete. Performance change denotes the difference in the number of correctly solved arithmetic problems between Tasks 2 and 1. Positive values indicate greater performance in the tournament compensation scheme than in the piece rate. ***significant at $p < 0.01$, **significant at $p < 0.05$, *significant at $p < 0.1$.

Table S5: Probit models on Task-3 payment scheme choice for women
(1 = tournament, 0 = piece rate)

	(1)	(2)	(3)	(4)
Performance	0.105	0.035	0.087	-0.033
	(0.082)	(0.080)	(0.085)	(0.130)
Baseline RMSSD	0.025**		0.029**	0.049**
	(0.011)		(0.013)	(0.023)
RMSSD change		-0.012	-0.019	-0.049**
		(0.012)	(0.013)	(0.023)
Confidence				-0.864
				(0.528)
Risk attitude				0.598***
				(0.212)
Constant	-1.901	-0.228	-1.855*	-2.340
	(1.044)	(0.818)	(1.081)	(2.480)
Observations	38	38	38	38
Pseudo R^2	0.117	0.000	0.161	0.618
Correctly classified (%)	65.79	63.16	63.16	86.84

Table reports probit coefficients with standard errors in parenthesis. Performance denotes the number of correctly solved arithmetic problems in Task 2. RMSSD change denotes competition-induced change in heart rate variability measured in normalized RMSSD values. Confidence denotes participants' guesses about their rank among the group members in Task 2 and takes values from 1 to 4, where lower values indicate higher self-confidence. Risk attitude denotes participants' answer to a general risk question on a scale from 1 to 10 where lower values indicate lower willingness to take risks. ***significant at p < 0.01, **significant at p < 0.05, * significant at p < 0.1.

Table S6: Probit models on Task-3 payment scheme choice for men
(1 = tournament, 0 = piece rate)

	(1)	(2)	(3)	(4)
Performance	0.223***	0.224**	0.223**	0.098
	(0.079)	(0.091)	(0.092)	(0.122)
Baseline RMSSD	0.001		-0.010	-0.006
	(0.021)		(0.026)	(0.030)
RMSSD change		-0.050**	-0.051**	5.556*
		(0.022)	(0.023)	(2.944)
Confidence				-0.947*
				(0.546)
Risk attitude				-0.122
				(0.164)
Constant	-1.469	-1.320	-0.989	2.846
	(0.976)	(0.810)	(1.166)	(2.432)
Observations	39	39	39	39
Pseudo R^2	0.261	0.406	0.409	0.542
Correctly classified (%)	82.05	79.49	79.49	89.74

The table reports probit coefficients with standard errors in parenthesis. Performance denotes the number of correctly solved arithmetic problems in Task 2. RMSSD change denotes competition-induced change in heart rate variability measured in normalized RMSSD values. Confidence denotes participants' guesses about their rank among the group members in Task 2 and takes values from 1 to 4, where lower values indicate higher self-confidence. Risk attitude denotes participants' answer to a general risk question on a scale from 1 to 10 where lower values indicate lower willingness to take risks. ***significant at $p < 0.01$, **significant at $p < 0.05$, *significant at $p < 0.1$.

Table S7: Probit models on Task-3 payment scheme choice for high performers (1 = tournament, 0 = piece rate)

	(1)	(2)	(4)	(5)	(6)
Woman	-0.967*	-0.916*	-1.149**	-1.406**	-1.348*
	(0.504)	(0.519)	(0.562)	(0.655)	(0.778)
Performance	0.155	0.138	0.078	0.061	0.005
	(0.050)	(0.139)	(0.148)	(0.148)	(0.202)
Baseline RMSSD		0.017		0.041*	0.032
		(0.017)		(0.027)	(0.031)
RMSSD change			-0.028*	-0.044**	-0.045**
			(0.014)	(0.021)	(0.022)
Confidence					-0.703
					(0.593)
Risk attitude					0.152
					(0.201)
Competition attitude					0.136
					(0.124)
Performance change					-0.781
					(2.073)
Constant	0.712	-1.100	0.281	-0.731	0.806
	(1.823)	(1.893)	(1.961)	(2.073)	(4.159)
Observations	38	36	36	36	36
Pseudo R^2	0.141	0.163	0.241	0.449	0.472
Correctly classified (%)	76.32	77.78	88.89	86.11	88.89

Table reports probit coefficients with standard errors in parentheses. Woman is a dummy variable, where women = 1 and men = 0. Performance denotes the number of correctly solved arithmetic problems in Task 2. RMSSD change denotes competition-induced change in heart rate variability measured in normalized RMSSD values. Confidence denotes participants' guesses about their rank among the group members in Task 2 and takes values from 1 to 4, where lower values indicate higher self-confidence. Risk attitude denotes participants' answer to a general risk question on a scale from 1 to 10 where lower values indicate lower willingness to take risks. Competition attitude denotes participants' answer to a general competition attitude question on a scale from 1 to 10 where lower values indicate lower willingness to compete. Performance change denotes the difference in the number of correctly solved arithmetic problems between Tasks 2 and 1. Positive values indicate greater performance in the tournament compensation scheme than in the piece rate. ***significant at $p < 0.01$, **significant at $p < 0.05$, *significant at $p < 0.1$.

Table S8: Probit models on Task-4 payment scheme choice
(1 = tournament, 0 = piece rate)

	(1)	(2)	(3)	(4)	(5)
Woman	-0.337	-0.338	-0.327	-0.335	-0.169
	(0.293)	(0.304)	(0.298)	(0.305)	(0.339)
Performance	0.128**	0.117**	0.126**	0.127**	0.094
	(0.050)	(0.050)	(0.052)	(0.052)	(0.065)
Baseline RMSSD		0.001		0.001	0.001
		(0.008)		(0.008)	(0.009)
RMSSD change			0.007	0.007	0.004
			(0.009)	(0.009)	(0.010)
Confidence					-0.315
					(0.226)
Risk attitude					0.244***
					(0.079)
Competition attitude					-0.035
					(0.068)
Performance change					-0.894**
					(0.409)
Constant	-0.970**	-0.917	-0.936*	-0.976*	-0.457
	(0.476)	(0.572)	(0.490)	(0.579)	(1.203)
Observations	80	77	77	77	77
Pseudo R^2	0.090	0.078	0.084	0.084	0.247
Correctly classified (%)	65.00	63.64	66.23	67.53	71.43

The table reports probit coefficients with standard errors in parentheses. Woman is a dummy variable, where women = 1 and men = 0. Performance denotes the number of correctly solved arithmetic problems in Task 2. RMSSD change denotes competition-induced change in heart rate variability measured in normalized RMSSD values. Confidence denotes participants' guesses about their rank among the group members in Task 2 and takes values from 1 to 4, where lower values indicate higher self-confidence. Risk attitude denotes participants' answer to a general risk question on a scale from 1 to 10 where lower values indicate lower willingness to take risks. Competition attitude denotes participants' answer to a general competition attitude question on a scale from 1 to 10 where lower values indicate lower willingness to compete. Performance change denotes the difference in the number of correctly solved arithmetic problems between Tasks 2 and 1. Positive values indicate greater performance in the tournament compensation scheme than in the piece rate. ***significant at $p < 0.01$, **significant at $p < 0.05$, *significant at $p < 0.1$.

Table S9: Probit models on Task-3 payment scheme choice (1 = tournament, 0 = piece rate)

	(1)	(2)	(3)	(4)	(5)
Woman	-0.165*	-0.200**	-0.148	-0.207**	-0.130*
	(0.095)	(0.093)	(0.094)	(0.089)	(0.073)
Probability of winning	0.564***	0.575***	0.419**	0.448**	0.127
	(0.191)	(0.185)	(0.195)	(0.181)	(0.166)
Baseline RMSSD		0.006**		0.007***	0.007***
		(0.003)		(0.003)	(0.002)
RMSSD change			-0.006**	-0.007**	-0.007***
			(0.003)	(0.003)	(0.002)
Confidence					-0.199***
					(0.042)
Risk attitude					0.040**
					(0.016)
Competition attitude					0.006
					(0.013)
Performance change					-0.134
					(0.090)
Observations	80	77	77	77	77
Pseudo R^2	0.111	0.156	0.145	0.212	0.479
Correctly classified (%)	65.00	67.53	63.64	71.43	85.71

Table presents average marginal effects with standard errors in parentheses. Woman is a dummy variable, where women = 1 and men = 0. Probability of winning denotes participants' simulated probability of winning the tournament in Task 2. RMSSD change denotes competition-induced change in heart rate variability measured in normalized RMSSD values. Confidence denotes participants' guesses about their rank among the group members in Task 2 and takes values from 1 to 4, where lower values indicate higher self-confidence. Risk attitude denotes participants' answer to a general risk question on a scale from 1 to 10 where lower values indicate lower willingness to take risks. Competition attitude denotes participants' answer to a general competition attitude question on a scale from 1 to 10 where lower values indicate lower willingness to compete. Performance change denotes the difference in the number of correctly solved arithmetic problems between Tasks 2 and 1. Positive values indicate greater performance in the tournament compensation scheme than in the piece rate. ***significant at $p < 0.01$, **significant at $p < 0.05$, *significant at $p < 0.1$.

Table S10: Probit models on Task-3 payment scheme choice (1 = tournament, 0 = piece rate)

	(1)	(2)	(3)	(4)	(5)
Woman	-0.202**	-0.237***	-0.178*	-0.241***	-0.156**
	(0.092)	(0.090)	(0.091)	(0.086)	(0.075)
Performance	0.048***	0.049***	0.038***	0.040***	0.018
	(0.013)	(0.013)	(0.014)	(0.013)	(0.014)
Baseline RMSSD		0.006**		0.007***	0.008***
		(0.003)		(0.003)	(0.002)
RMSSD change			-0.006**	-0.006**	-0.006***
			(0.003	(0.003)	(0.002)
Confidence					-0.204***
					(0.049)
Risk attitude (Holt & Laury)					-0.046***
					(0.016)
Competition attitude					0.006
					(0.014)
Performance change					-0.196**
					(0.090)
Observations	80	77	77	77	73
Pseudo R^2	0.137	0.186	0.168	0.240	0.497
Correctly classified (%)	66.25	76.62	67.53	71.43	83.56

Table presents average marginal effects with standard errors in parentheses. Woman is a dummy variable, where women = 1 and men = 0. Performance denotes the number of correctly solved arithmetic problems in Task 2. RMSSD change denotes competition-induced change in heart rate variability measured in normalized RMSSD values. Confidence denotes participants' guesses about their rank among the group members in Task 2 and takes values from 1 to 4, where lower values indicate higher self-confidence. Risk attitude (Holt & Laury) denotes the point where participants switch from the low risk option to the high risk option. Higher values indicate lower willingness to take risks. Competition attitude denotes participants' answer to a general competition attitude question on a scale from 1 to 10 where lower values indicate lower willingness to compete. Performance change denotes the difference in the number of correctly solved arithmetic problems between Tasks 2 and 1. Positive values indicate greater performance in the tournament compensation scheme than in the piece rate. ***significant at $p < 0.01$, **significant at $p < 0.05$, *significant at $p < 0.1$.

Table S11: Pairwise correlation coefficients, all participants

	Willingness to compete	Performance	Baseline RMSSD	RMSSD change	Confidence	Risk attitude	Competition attitude	Performance change
Willingness to compete	1.000							
Performance	0.345***	1.000						
Baseline RMSSD	0.156	-0.125	1.000					
RMSSD change	-0.295***	0.233**	0.073	1.000				
Confidence	-0.512***	-0.522***	0.0905	0.117	1.000			
Risk attitude	0.360***	0.049	0.001	-0.011	-0.110	1.000		
Competition attitude	0.220*	0.110	-0.206*	-0.067	-0.265**	0.287**	1.000	
Performance change	-0.060	0.313***	0.100	-0.073	-0.188*	-0.227**	-0.177	1.000

*** significant at p < 0.01, ** significant at p < 0.05, * significant at p < 0.1

Table S12: Pairwise correlations coefficients, all men

	Willingness to compete	Performance	Baseline RMSSD	RMSSD change	Confidence	Risk attitude	Competition attitude	Performance change
Willingness to compete	1.000							
Performance	0.507***	1.000						
Baseline RMSSD	0.015	-0.037	1.000					
RMSSD change	-0.441***	-0.183	-0.261	1.000				
Confidence	-0.636***	-0.635***	-0.061	0.287*	1.000			
Risk attitude	-0.156	-0.033	-0.159	0.032	0.176	1.000		
Competition attitude	0.162	0.170	-0.061	-0.113	-0.197	0.298*	1.000	
Performance change	0.019	0.403**	0.199	0.034	-0.271*	-0.184	-0.212	1.000

*** significant at p < 0.01, ** significant at p < 0.05, * significant at p < 0.1

Table S13: Pairwise correlation coefficients, all women

	Willingness to compete	Performance	Baseline RMSSD	RMSSD change	Confidence	Risk attitude	Competition attitude	Performance change
Willingness to compete	1.000							
Performance	0.157	1.000						
Baseline RMSSD	0.323**	-0.209	1.000					
RMSSD change	-0.197	-0.323**	0.205	1.000				
Confidence	-0.359**	-0.320**	0.132	-0.044	1.000			
Risk attitude	0.679***	0.136	0.125	-0.031	-0.344**	1.000		
Competition attitude	0.240	0.021	-0.263	-0.030	-0.322**	0.264*	1.000	
Performance change	-0.072	0.208	-0.015	-0.182	-0.157	-0.240	-0.119	1.000

*** significant at $p < 0.01$, ** significant at $p < 0.05$, * significant at $p < 0.1$

3. Instructions

General information

You will participate in a study which is conducted by the Aalto University and the Joint Research Centre of the European Commission. Your responses will be strictly confidential, meaning that your name will never be associated with your test results. Please read the instructions carefully. Please do not communicate with other participants during the experiment. If you have any questions, please, raise your hand. We will answer your question personally.

We will measure your heart rate variability during the experiment. After reading these instructions, you have to install the heart rate monitor you will find on your desk. The device is attached to the skin with two sticky electrodes. The other end is attached to the right side, below the collarbone, and the other end to the left side, to the costal arch (see the instructions next to the device). After you have installed the heart rate monitor, you should sit still and avoid unnecessary movements. The device saves heart rate and motion data. We will use later this data in our analysis.

During the experiment, you will be asked to answer questions, for example, about your risk attitude, your life situation and your personal background. Please answer those questions carefully, as your answers are of utmost importance when analyzing the results of the experiment. The actual experimental task will consist of several different tasks. You will get separate instructions prior to each task.

At the end of the experiment, we will pay you 5 euros for participation. In addition, you can earn more during the experiment. Your earnings will depend on your own choices as well as on the decisions of other participants during the experiment. The experiment consists of five different tasks and there is always a break between the tasks. Each task will take up to five minutes. At the end of the experiment, one of the five pay-off relevant tasks will be selected at random. This randomly selected task will determine your pay-off from the experiment. Since your earnings will be determined on the basis of a randomly selected task, it is in your best interest to pay special attention to all the tasks assigned to you. Your earnings are differently determined in different tasks. In total, the experiment lasts about an hour. You can drop out of the experiment at any point for any reason.

In summary, your total earnings in this experiment consist of 5 Euro participation fee, a pay-off related with a randomly selected task, and a pay-off related with one background questionnaire. At the end of the experiment, your earnings will be paid to you in private.

Thank you for your participation!

0. Practice task

Before the start of the actual experiment, you can familiarize yourself with the experimental procedures and practice the use of the computer. In the following, the computer will display five randomly selected two-digit numbers. Your task is to calculate the sum of these numbers. During this practice period, you have two minutes to calculate the correct sum of as many series of numbers as possible.

You are not allowed to use a calculator or any other electronic devices to solve the problems. We have placed a pen and scratch paper in your cubicle. You can use the pen and paper at your own discretion. You submit your answers using your computer mouse and keyboard. You will have to enter your answer in the box at the end of each line. When you have answered, you will get the next five numbers. Your answers to the problems are anonymous. No other participant will see your answers at any stage. Your performance during the practice task does not affect your final payment. Once you have understood the instruction click CONTINUE on the computer screen. The task begins once all subjects are ready.

1. Task [Piece rate payment]

The computer will display five randomly selected two-digit numbers. Your task is to calculate the sum of the numbers. You have five minutes to calculate the correct sum of as many series of numbers as possible.

You are not allowed to use a calculator or any other electronic devices to solve the problems. We have placed a pen and scratch paper in your cubicle. You can use these devices at your own discretion. You submit your answers using your computer mouse and keyboard. You will have to enter your answer in the box at the end of each line. When you have answered, you will get the next five numbers. Your answers to the problems are anonymous. No other participant will see your answers at any stage.

If this task is the one randomly selected for payment at the end of the experiment, you will earn 25 cents of every problem you solved correctly. Wrong answers do not lower the payment. We refer to this payment scheme as the *piece rate payment*.

Once you have understood the instruction click CONTINUE on the computer screen. The task begins when all subjects are ready.

2. Task [Tournament payment]

The computer will display five randomly selected two-digit numbers. Your task is to calculate the sum of the numbers. You have five minutes to calculate the correct sum of as many series of numbers as possible.

You are not allowed to use a calculator or any other electronic devices to solve the problems. We have placed a pen and scratch paper in your cubicle. You can use these devices at your own discretion. You submit your answers using your computer mouse and keyboard. You will have to enter your answer in the box at the end of each line. When you have answered, you will get the next five numbers. Your answers to the problems are anonymous. No other participant will see your answers at any stage.

During the task, you will belong to a group of four. The members in each group are randomly selected so that each group includes both men and women. If this period is selected for the payment at the end of the experiment, your pay-off is based on your performance in comparison with the other group members. The individual, who correctly solves the largest number of problems, will earn 100 cents for every problem he/she solved correctly. Wrong answers do not lower the payment. The other group members do not earn anything. In the event of a tie, the winner will be randomly determined. You will not be informed about your rank until the very end of the experiment. We refer to this payment scheme as the *tournament payment*.

Once you have understood the instruction click CONTINUE on the computer screen. The task begins once all subjects are ready.

3. Task [Own choice]

As in the previous tasks, the computer will display five randomly selected two-digit numbers. Your task is to calculate the sum of the numbers. You have five minutes to calculate the correct sum of as many series of numbers as possible.

You are not allowed to use a calculator or any other electronic devices to solve the problems. We have placed a pen and scratch paper in your cubicle. You can use these devices at your own discretion. You submit your answers using your computer mouse and keyboard. You will have to enter your answer in the box at the end of each line. When you have answered, you will get the next five numbers. Your answers to the problems are anonymous. No other participant will see your answers at any stage.

In contrast to the previous tasks, you can now choose between the two previous payment schemes. If this task is the one randomly selected for payment at the end of the experiment, your earnings are determined as follows:

a) If you choose the *piece rate payment*, you will earn 25 cents of every problem you solved correctly. Wrong answers do not lower your payment.

b) If you choose the *tournament payment*, your earnings are based on your performance in comparison to the members of the same group as in the previous task (Task 2 – Tournament payment). If you choose the tournament payment and correctly solve more problems than the other members of your group solved during the Task 2, you will earn 100 cents for each problem you solved correctly. Wrong answers do not lower the payment. If you choose the tournament payment, but you do not manage to correctly solve more problems than the best of the other members in your group during the Period 2, you will not earn anything. In the event of a tie, the winner will be randomly determined.

You can indicate the desired payment scheme by selecting the scheme on your computer screen.

Once you have understood the instructions and selected the desired payment scheme click CONTINUE on the computer screen. The task begins when all subjects are ready.

4. Task [New choice]

In this task, you do not have to add numbers. Instead, you can reconsider the Task 1 (Piece rate payment). Your task is to choose the payment scheme you want to be applied to your performance in the Task 1. You can choose either the piece rate or the tournament payment.

If this task is the one randomly selected for payment at the end of the experiment, your earnings are determined as follows:

a) If you choose the *piece rate payment*, you will earn 25 cents of every problem you solved correctly in the Task 1. Wrong answers do not lower the payment.

b) If you choose the *tournament payment*, and you correctly solved more problems than the other members or your group solved during the Task1, you will earn 100 cents for each problem you solved correctly. The group is the same as in the Tasks 2 and 3. Wrong answers do not lower the payment. If you choose the tournament payment, but you did not manage to solve correctly more problems than the best of the other members of your group solved during the Task 1, you will not earn anything. In the event of a tie, the winner will be randomly determined.

On the computer screen, you are now told how many problems you solved correctly during the Task 1, and you are requested to indicate your desired payment scheme.

Once you have understood the instruction click CONTINUE on the computer screen. The task begins once all subjects are ready.

Risk Elicitation

Below are listed a variety of risky lotteries. On each row there are two options, A and B. For example, in the first A-option, you can win 2 euro with probability of 1/10 and 1.60 euro with probability of 9/10, while in the first B-option, you can win 3.85 euro with probability 1/10 and 0.10 euro with probability of 9/10. Mark in every row below which of the option do you prefer, A or B. After you have filled out the form we will randomly select one row and either option A or B. You will be paid based on your choice and the random draw.

Option A				**Option B**				**A or B?**
1/10	of 2.00 €	9/10	of 1.60 €	1/10	of 3.85 €	9/10	of 0.10 €	
2/10	of 2.00 €	8/10	of 1.60 €	2/10	of 3.85 €	8/10	of 0.10 €	
3/10	of 2.00 €	7/10	of 1.60 €	3/10	of 3.85 €	7/10	of 0.10 €	
4/10	of 2.00 €	6/10	of 1.60 €	4/10	of 3.85 €	6/10	of 0.10 €	
5/10	of 2.00 €	5/10	of 1.60 €	5/10	of 3.85 €	5/10	of 0.10 €	
6/10	of 2.00 €	4/10	of 1.60 €	6/10	of 3.85 €	4/10	of 0.10 €	
7/10	of 2.00 €	3/10	of 1.60 €	7/10	of 3.85 €	3/10	of 0.10 €	
8/10	of 2.00 €	2/10	of 1.60 €	8/10	of 3.85 €	2/10	of 0.10 €	
9/10	of 2.00 €	1/10	of 1.60 €	9/10	of 3.85 €	1/10	of 0.10 €	
10/10	of 2.00 €	0/10	of 1.60 €	10/10	of 3.85 €	0/10	of 0.10 €	