# Competitiveness, gender and handedness: a large-sample intercultural study

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DISCUSSION PAPER

Institutt for samfunnsøkonomi
Department of Economics

**SAM 02/2020**

**ISSN: 0804-6824**

January, 2020

# Competitiveness, gender and handedness: a large-sample intercultural study

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**Abstract**

We conduct a large-scale intercultural experiment to elicit competitiveness and ask whether individual and gender differences in competitiveness are partially determined by nature. We use being a "lefty" (i.e., having either a dominant left hand or a dominant left foot) as a proxy for nature, as it is associated with neurological differences which are determined prenatally and reflects a masculinized neurology. That way we use handedness and footedness as a proxy for innate differences. In large-scale data with incentivized choices from 3683 participants from India, Norway and Tanzania, we find a significant gender gap in competitiveness in all cultures. However, we find inconsistent results when comparing the competitiveness of lefties and righties. In north-east India we find that lefties of both genders are significantly more competitive than righties. In Norway we find that lefty men are more competitive than any other group, but women's competitiveness is not related to handedness or footedness. In Tanzania, we find no effect of handedness or footedness on the competitiveness of either gender. The merged data show weak evidence of a positive correlation between being a lefty and competitiveness for men, but no such evidence for women. Thus, our data do not provide robust evidence that gender differences in competitiveness are partially determined by nature, where nature is represented by the complex, physiologically-rooted phenomenon of handedness.

We thank Anne-Lise Breivik for great research assistance. We also thank Monica Backer-Grøndahl Blaalid for research assistance in Tanzania and Frøya P. Stavem, Andreas Olden, Sara Skjeggestad Meyer, Valeria Shutova, Julie Eikaas, Daniel Flokenes, Sigurd Berstad, Kristina Vikesund, Henrik Bjarte Reigstad, Einar Blix Husby, Eirik André Strømland, Anna Blomkvist, Maria Seidel, Marta Bakke, Eirik Berger, Margit Grape, Sigrid Johanne Husøy, Adnan Abbas, Emilie Viung, Martin Bryne, Elise Ivara Dahl, Øyvind Bjørndal, Andreas Masvie, Johannes Tyrihjell, Elin Nordheim, Daniel Bjorvatn, Cathrine Haug, Sigve Skjerven Huus, Aleksander Kjeserud, Yngve Rubi, Ellen Marie Kvamme, Rune Ingebrehsen, Birgitte Nergård, Oda Tungodden, Markus Tungodden, Bendik Nagel Støren, Ida Kjørholt for research assistance in Norway. The research was partially funded by the Research Council of Norway through its Centres of Excellence Scheme, FAIR project No 262675.

## 1. Introduction

Recent research in economics suggests that noncognitive skills are important in determining education and labor market outcomes (Cunha and Heckman, 2007). To what extent these skills are determined by nature is still largely an open question. In this paper we focus on competitiveness, which is an economically relevant trait. A large literature finds that men are more competitive than women (Gneezy et al. 2003, Niederle and Vesterlund 2007, Croson and Gneezy 2009, Niederle and Vesterlund 2011), and this difference is often cited as a potential partial explanation for gender differences in labor market outcomes (Zhang, 2012, Buser et al., 2014, Reuben et al. 2015, Berge et al., 2015, and Buser et al. 2017). In this paper we ask whether nature plays a role in determining individual differences in competitiveness.

There is evidence that the gender differences in competitiveness is partially due to socialization. For example, Gneezy, Leonard and List (2009) compare patriarchal and matrilineal societies and find a large gender gap in a patriarchal society in Tanzania but not in a matrilineal society in India. Andersen et al. (2013) obtain a similar result comparing a matrilineal and a patriarchal society from the same region in India.

Other studies investigate the role nature plays in shaping economic preferences.[2] Comparing the behavior of monozygotic and dizygotic twins, a series of studies demonstrate that giving and reciprocity in the trust game (Cesarini et al., 2008), responder behavior in the ultimatum game (Wallace et al., 2007) and generosity in the dictator game and risk attitudes (Cesarini et al., 2009) are partly hereditary. Other studies have found links between specific genes and behavior in the dictator game (Knafo et al., 2008; Israel et al., 2009). Economists have also looked into the effect of hormones on economic behavior. Buser (2012) and Wozniak et al. (2014) both find that for women, the inclination to compete varies over the menstrual cycle and with the intake of hormonal contraceptives, but Ranehill et al. (2017), in a placebo-controlled study, find no impact of contraceptives. Apicella et al. (2011) find no effect of testosterone on tournament entry in men.[3]

There are also important evolutionary arguments that point towards a biological basis of gender differences in competitiveness. Males historically invest less in parenting which means that their

2 This has also motivated research on gender differences in competitiveness among young children (Gneezy and Rustichini, 2004; Sutter and Rützler, 2010, Dreber et al., 2011).

3 See Kosfeld et al. (2005), Zak et al. (2007), Zethraeus et al. (2009), Eisenegger (2010) and Buser (2012) for examples of studies on the effects of hormones on social preferences and Apicella et al. (2008) and Zethraeus et al. (2009) for studies on risk attitudes.

number of offspring is determined largely by their number of mates. In contrast, a female's number of offspring will be constrained by her resources, but not significantly affected by increasing the number of mates. A male's number of offspring therefore strongly depends on his ability to outcompete other males. This explains why males would be more aggressive and invest more in weaponry and ostentatious display (Trivers, 1972).

In this paper, we study one aspect of competitiveness and nature, using handedness and footedness as proxies for underlying neurological differences. Being a "lefty" (i.e., having either a dominant left hand or a dominant left foot) is associated with neurological differences which are fixed prenatally and reflect a masculinized neurology (see the next section for a summary of the literature on the causes and correlates of left-handedness). Under the null hypothesis that nature plays no role in competitiveness, there should be no correlation between the dominant side and competitiveness. On the other hand, since being a lefty reflects a masculinized neurology, and men are generally found to be more competitive than women, the alternative hypothesis predicts lefties to be more competitive than righties within each gender.

Our study is also a large-scale cross-cultural replication of the gender gap in competitiveness as measured by tournament entry (Niederle and Vesterlund 2007). Participants in our experiments choose between competitive and non-competitive payment schemes for their performance in real-effort tasks. We look at three diverse groups on three different continents: villagers in India, high-school students in Norway and high-school students in Tanzania for a total of 3683 participants. We find a large and significant gender gap in each location. The raw gap in choices ranges from 14 percentage points in India to 21 percentage points in Norway.

In the first society, a tribe in North-East India, we find that lefties (defined as people who are either left-handed, left-footed or both) are significantly and strongly more competitive than righties. The size of the effect is so large that it trumps the well-documented gender difference: lefty women are weakly more likely to choose the competitive option than the average man and the lefty effect is larger than the gender effect. Moreover, we find that this difference cannot be explained by differences in actual or expected performance.

These results suggest that competitiveness is partially determined by nature and that the gender gap in competitiveness may have neurological roots. Such a purely neurological effect should be constant across countries and cultures. We therefore ran two more studies with high-school students in two very different countries, Norway and Tanzania.[4] Norway is considered the most gender-equal society in the world, while Tanzania is considered one of the least gender-equal societies in the world.[5] Yet, in Norway, we find an even larger gender gap than in India, confirming earlier experiments conducted there (Almas et al. 2015). Moreover, the role of being lefty in the Norwegian sample is gender-specific. Lefty men are more competitive than righty men. Lefty women and righty women are equally competitive, and are less competitive than lefty or righty men. In Tanzania, we again find a large and significant gender gap in competitiveness, but handedness and footedness do not predict the competitiveness of either men or women.

A potential issue with using handedness as a proxy for underlying neurological differences is that handedness can be influenced by social pressure. In our data, left handed participants are relatively scarce in India and Tanzania compared to Norway. This could be evidence for social bias against being left handed that introduces a selection problem since some lefties may adapt to the culture and not be registered as lefty in our study. However, the results obtained from India and Tanzania are very different. Moreover using only footedness, which should be less affected by social pressure (Porac et al., 1986), hardly affects the results. In sum, we conclude that our data do not provide robust evidence that gender differences in competitiveness are strongly related to our proxy for nature.

## 2. Handedness as a proxy for neurological differences

Handedness is associated with well-documented neurological differences. While language ability is controlled by the left side (hemisphere) of the brain in almost all righties, it is bilateral or controlled by the right side in a significant proportion of lefties. Warrington and Pratt (1973) demonstrate this by temporarily shocking one side of the brain (a method known as E.C.T.). Lesion studies (using participants who experienced permanent damage to either the right or left side of their brain) demonstrate comparable results (Piercy, 1964), as do sodium amytal studies (where participants have half their brain put to sleep for a few minutes) (Branch et al., 1964), TMS studies (which use electric current to stimulate parts of the brain; Khedr et al., 2002) and simple reaction-time studies (where participants are presented with stimuli to one ear or one visual field, and reaction times and performance for various tasks are measured; Levy and Reid, 1978).

4 Other studies documenting gender differences in competitiveness in European high-school students include Sutter and Glätzle-Rützler (2014), Buser, Niederle and Oosterbeek (2014), Buser, Peter and Wolter (2017a,b).

5 See http://hdr.undp.org/en/data.

The brains of lefties exhibit lower rates of brain hemisphere specialization in general, meaning that lefties more commonly use both sides of the brain for a given task (Coren, 1993). The main connection between the two hemispheres of the brain (a thick band called corpus callosum, which contains millions of nerves and acts as a data-wire that allows the two hemispheres to speak to each other) is thicker in lefties (Witelson, 1985).

There is evidence that left-handedness is associated with a masculinized neurology. Virtually all studies have found a greater proportion of male lefties than female lefties (Halpern, 2000). Lefties excel at cognitive tasks at which males excel, such as mental rotation (Porac and Coren, 1981) and lefties disproportionally suffer from diseases and social problems which predominantly affect males (Coren, 1993). One of the most prominent theories for the origin of handedness posits that this is because left-handedness is associated with higher levels of prenatal hormone exposure (Geschwind and Galaburda, 1987).[6] Empirical support comes from the fact that women whose mothers took a synthetic hormone (DES) during pregnancy to reduce the risk of birth complications have a higher incidence of left-handedness (Smith and Hines, 2000). Similar results have been found for congenital adrenal hyperplasia (CAH), a genetic disorder that causes female fetuses' adrenal glands to secrete male sex hormones during prenatal development (Nass et al., 1987), and the ratio of the length of the second to fourth fingers (2D:4D), a proxy for prenatal sex hormone exposure (Stoyanov et al., 2009).[7]

Psychologists and economists have also conducted research that documents differences between left-handers and right-handers, often in traits and outcomes that exhibit gender differences. Traits such as creativity (Coren, 1995), novelty-seeking (Goldberg et al., 1994), spatial ability (Sanders et al., 1982) and performance at mental rotation tasks (Porac and Coren, 1981) are positively correlated with left-handedness. On the other hand, left-handedness is associated with worse average outcomes in a range of early childhood development indicators (Johnston et al., 2009) and a higher prevalence of mental illness (Coren, 1993). In terms of economic outcomes, Denny and O'Sullivan (2007) find that left-handed men, but not women, have higher wages while Ruebeck et al. (2007) find no strong overall effect of handedness on earnings. Faurie et al. (2008) find that left-handers of both genders have better educational and professional career outcomes. Lefties have also been found to be overrepresented in male-dominated professions such as architects (Peterson and Lansky, 1974), mathematically oriented scientists (Temple, 1990), chess players (Coren, 1993) and

6 Other determinants of left-handedness are genes and differential brain structures caused by stressors during pregnancy or birth (Goodman 2014).

7 The ratio of the length of the index finger to the length of the ring finger (2D:4D), which is established in utero, has been used extensively as a marker for the strength of prenatal hormone exposure (see Manning, 2002, for an introduction).

U.S. presidents.[8] Goodman (2014), in an attempt to reconcile these disparate results, combines five datasets from the UK and the US and finds that, on average, left-handers earn less and have lower human capital.

## 3. Design and data collection

### 3.1 India

We measured handedness, footedness, and competitiveness among 1132 participants from seven villages in the Meghalaya region of India, in 2010. Several weeks before the study, village headmen were asked to enroll villagers interested in the study. Headmen were asked to inform villagers that they would be paid a 100-rupee (approximately $2 at the time) show-up fee for half a day's participation in experiments, and that they may earn additional money depending on their performance in the experiments. All participants signed a consent form and were 18 years or older.

On arrival at each experimental site, participants were directed to stand in two separate lines, one for each gender, outside of the experimental room. The first six participants from each line were taken aside and an experimenter explained the task to them. The instructions were translated from English to the local language (Khasi) and were checked by having a different person translate them back into English. The instructions were read aloud first to the group of participants and then one on one. Participants were also given some test questions to make sure they understood the instructions.

The experimental task (adopted from Gneezy et al., 2009) was to toss a tennis ball into a bucket that was placed 3 meters away. Participants were informed that they would have 10 chances to toss the ball. A successful shot meant that the tennis ball entered the bucket and stayed there. Participants approached an experimenter individually, and were randomly and anonymously matched with another participant. The random other participant was from another group that had previously performed the experiment, and the matching was not dependent on the payment choice of either player. No other information was given about the individual to whom they were matched.

The only decision participants were asked to make was whether they wanted to be paid according to a piece rate payment scheme or a competitive scheme. This choice serves as our measure of competitiveness. The two options were (i) 20 rupees per successful shot, regardless of the

8 Since, 1929, half of the U.S. presidents have been left handed or ambidextrous (Hoover, Truman, Ford, Reagan, Bush Sr., Clinton, and Obama).

performance of the participant they were matched with, and (ii) 60 rupees per successful shot if they outperformed the other participant, 20 rupees if they tied, and zero if they underperformed relative to the other participant. Participants made their choice before performing the task but only after they fully understood the instructions and the payment schemes. After choosing the incentive scheme, participants completed the task and were told how the other participant performed. Some participants were asked to guess their performance after making their choice but prior to completing the task. In line with the given instructions, participants were never given the opportunity to learn with whom they were paired.

Finally, participants were asked which hand they primarily used to write with and which foot they primarily used to kick with. If participants were not sure, we asked them to try kicking or writing. We discussed the topic of prejudice against left-handers with village headmen and participants, who denied that there was prejudice or pressure to convert. The ball-throwing task was chosen because it was simple to explain and implement. Furthermore, we are not aware of any other popular task in this society that is similar to the ball-throwing task. Indeed, the villagers play cricket and soccer for sport, but because our task can only be completed with an underhand toss, these traditional skills do not advantage individuals with experience in any of these games.

### 3.2 Norway

We collected the Norwegian data in 2014. A team of research assistants visited 20 high schools in the Hordaland region of Norway and collected data from 571 participants. The team recruited students during breaks from the students' classes.

To participate in the experiment, students first had to participate in a task that revealed whether they were lefty or not. To incentivize participation in the task, the team informed the students that five randomly selected participants would receive an Apple iPad. The task consisted of first throwing a ball into a standing bucket from a distance and then try to kick the ball into a lying bucket from the same distance. Students who wanted to participate in the task provided their contact details (name and phone number) as well as gender. To obfuscate the purpose of the task, the students were also asked whether they participated in "any forms of sport." When all the students who wanted to participate in the task had filled out the information, they would start trying to throw and kick the ball into the standing and lying bucket, respectively. One of the research assistants noted in a hidden column on the sheet whether the students used their left hand or their left foot for the throwing and kicking exercise, respectively.

When the initial task was completed, the team informed the students that some of them would be invited to participate in a classroom experiment later the same day for a show-up fee of 100 NOK (about 13 dollars) and the potential to earn additional money during the experiment. Since the schools allowed students to participate in the experiment during their normal class hours, nearly all of the students who were invited to participate in the experiment could attend if they wanted.

Later the same day, the team sent out text messages to all the invited students. All the students who had used their left hand or left foot during the initial task were invited to the main experiment and a sufficient number of righty males and females were invited to ensure a full and gender-balanced session. In the main experiment, the participants were assigned to a classroom and a session leader read instructions aloud from a script that was identical across schools. To ensure full anonymity, all participants were assigned an anonymous participant number that would be used for assigning payments after the experiment.

The task consisted of counting the number of white cells in large matrices of white and black cells. The participants had five minutes to complete a maximum of 20 such matrices. We first elicited participants' beliefs about how good they were relative to other participants doing the same task in a different room. After the belief elicitation, the participants could choose whether they wanted to work for a piece rate or a tournament rate. The piece rate was five NOK for each correct answer, whereas the tournament rate was 15 NOK for each correct answer if they scored higher than a randomly selected participant from a different room (or five NOK for each correct answer in case of a tie). After the participants had completed the task, they were asked about their self-reported tolerance for risk and a few questions on background characteristics (including their parents' education levels).

When the students had completed all the questions, they were asked to hand in the sheets and come back at a scheduled time to collect the payments. The team of research assistants calculated the payments and prepared envelopes with the payouts. The students would then pick up the envelope with their assigned participant number and cash earnings at the scheduled time.

### 3.3 Tanzania

We collected data from six high schools in Tanzania in 2015. A team of research assistants visited the schools and recruited participants for the experiment. The students answered questions about their name, age, and gender and were assigned a unique participant number. All participants in the experiment completed two tasks, but the order of the tasks varied between the participants. The first task was similar to the ball-throwing task used in India and the second task was similar to the matrix task used in Norway.

The first task (for half of the participants) was a ball throwing exercise where the participants would have 10 chances to throw a tennis ball into a standing bucket placed three meters away from the participant. Before the participants were allowed to start the task, they had to choose whether they wanted to be paid according to a piece rate (500 TZS for each successful shot; i.e., around 20 Eurocents) or a tournament rate (1500 TZS for each successful shot if they scored higher than a randomly selected participant from a different room; 500 TZS in case of a tie). Before the participants made their decision on piece rate versus tournament rate, the team of research assistants asked a series of control questions to test for understanding of the payment schemes. Participants were also asked to throw and kick a ball to measure their handedness and footedness.

The second task (which was the first task for the other half of participants) consisted of counting the number of white cells in large matrices of white and black cells. The task consisted of 20 matrices and the participants had five minutes to complete as many matrices as possible. As in Norway, the participants first indicated confidence in how good they were compared to participants doing the same task in a different room. The participants were then asked to choose whether they wanted a piece rate pay (500 TZS for each correct answer) or a tournament pay (1500 TZS for each correct answer if they scored higher than a randomly selected participant from a different room; 500 TZS in case of a tie). After completing the task, the participants answered questions on their self-reported tolerance for risk and background characteristics of their parents.

When all the students had completed both tasks, the team of research assistants calculated their payments and prepared envelopes with the earnings. The participants could then pick up the envelope that contained their unique participant number and the cash earnings.

## 4. Sample

Table 1 shows descriptive statistics separately for each location. The proportion of participants who compete varies across location. 31 percent of villagers in India, 48 percent of high-school students in Norway, and 23 and 25 percent of high-school students in Tanzania (depending on the task) chose the competitive option. The rate of left-handedness (and to a lesser degree left-footedness) also varies across countries, with rates highest in Norway, where roughly 11 percent of the students in the pre-selection sample are either left-handed or left-footed, and lowest in Tanzania, where only roughly 5 percent of the students in the sample are either left-handed or left-footed. In particular, only 3 percent of participants in Tanzania are registered as left-handed, hinting at potential cultural bias against left-handedness.

**Table 1. Descriptive statistics**

| | (1)<br>India | (2)<br>Norway | (3)<br>Norway (pre-sample) | (4)<br>Tanzania |
|---|---|---|---|---|
| Competition (ball task) | 0.311 | | | 0.232 |
| | (0.463) | | | (0.422) |
| Competition (matrix task) | | 0.476 | | 0.252 |
| | | (0.500) | | (0.434) |
| Performance (ball task) | 3.173 | | | 5.042 |
| | (1.776) | | | (1.984) |
| Performance (matrix task) | | 7.306 | | 8.775 |
| | | (2.935) | | (3.585) |
| Confidence (ball task) | 5.158 | | | 6.847 |
| | (2.159) | | | (2.111) |
| Confidence (matrix task) | | 6.287 | | 6.219 |
| | | (1.756) | | (2.879) |
| Risk seeking | | 6.179 | | 7.836 |
| | | (1.988) | | (2.668) |
| Lefty | 0.068 | 0.342 | 0.113 | 0.049 |
| | (0.252) | (0.475) | (0.316) | (0.217) |
| Left-footed | 0.049 | 0.250 | 0.085 | 0.043 |
| | (0.215) | (0.434) | (0.279) | (0.203) |
| Left-handed | 0.051 | 0.247 | 0.080 | 0.027 |
| | (0.221) | (0.432) | (0.272) | (0.161) |
| Female | 0.516 | 0.513 | | 0.508 |
| | (0.500) | (0.500) | | (0.500) |
| Age | 33.0 | | | |
| | (14.4) | | | |
| N | 1132 | 571 | 2397 | 1980 |

Note: confidence is measured as the expected number of successful tosses (from 0 to 10) in case of the ball task and expected performance decile (relative to other participants) in the matrix task.

## 5. Results

### 5.1 India

Of the 1132 participants, 77 (6.8%) were lefty and 548 (48%) were male. Following the literature (e.g. Porac and Coren, 1981), we define as lefties all individuals who answered left to either the handedness or footedness question or both. We find a large gender difference in competitiveness (38.5% of men and 24.1% of women chose to compete; p=0.00, Fisher's exact test). On average, participants completed 3.2 successful tosses. For the 785 of whom we asked the expected number of successful tosses, participants completed 3.0 successful tosses but expected to make 5.2. Lefties are more likely to compete than righties, both among men (54.9% vs. 36.8%; p=0.015; Fisher's exact test) and among women (42.3% vs. 23.3%; p=0.035). Strikingly, the effect of being a lefty is so strong that it trumps the well-documented effect of gender: the difference in the likelihood to compete between lefties and righties is larger than the difference between men and women.

Table 2 reports marginal effects from probit regressions of the choice to compete on being a lefty.[9] The regression in Column 1 replicates the above result that men are significantly more likely than women to choose competition. Column 2 adds a lefty dummy to the regression and shows that the effect of being lefty is even larger than the gender difference. Column 3 controls for performance which hardly affects the results because there is no significant gender difference or handedness difference in performance.[10] Columns 4 and 5 report regressions separately by gender and confirm that the effect of being lefty is similar and significant for both men and women.

**Table 2: Probit Regressions of Competitiveness on Being a Lefty (India)**

| | (1) | (2) | (3) | (4)<br>male | (5)<br>female |
|---|---|---|---|---|---|
| Female | -0.141*** | -0.132*** | -0.132*** | | |
| | (0.026) | (0.026) | (0.027) | | |
| Lefty | | 0.168*** | 0.168*** | 0.176** | 0.166** |
| | | (0.051) | (0.051) | (0.069) | (0.078) |
| Performance | | | √ | √ | √ |
| N | 1129 | 1129 | 1129 | 546 | 583 |

Notes: Marginal effects are from probit regressions of being a lefty on choosing the competitive payment scheme. The dependent variable equals 1 if the participant chose the competitive payment scheme and 0 otherwise. Lefty equals 1 if the participant indicated that she/he writes with her/his left hand (or both hands) or kicks with her/his left foot (or both feet). Robust standard errors in parentheses; 3, 2, or 1 stars indicate significance at the 1%, 5%, or 10% level respectively.

9 We drop 3 observations for which we miss the performance measure (number of successful tosses).

10 We do not have a baseline measure of performance and our performance control therefore consists of performance in the task after choosing the incentive scheme. Using this control potentially biases the estimates of gender and handedness differences in competitiveness because the choice of competing (or not) might itself affect performance. In particular, it could bias against finding group differences if individuals who choose not to compete put in a lower effort.

Social pressure against using the left hand may exist, but no such pressure exists to kick with the right foot. Hence, if socialization explained our results, we would expect a larger effect for handedness than for footedness. In fact, we find the opposite. The difference between righties and lefties is bigger in magnitude using the footedness measure than the handedness measure. 60.0% of left-footers vs. 29.6% of right-footers chose to compete ($p<0.001$). These results are confirmed in Table A1 in the appendix, which reports marginal effects from probit regressions of the choice to compete on being left-footed, where we omit individuals who indicated being left-handed but not left-footed from the sample in order to not include lefties in the control group. Again, the effect of being a lefty is stronger than the effect of gender, and is significant within each gender.

There are two possible non-preference based explanations for the competitiveness difference between righties and lefties, both of which we can rule out. First, lefties may perform better than righties. Second, lefties may expect to perform better (even if they do not). We find no significant difference in the number of successful tosses between lefties and righties (ranksum test; $p=0.514$). Also, prior to performing in the task, we asked 785 of our 1132 participants how many shots they expected to make. Again, the difference is not significant ($p=0.468$).

If the effect of handedness truly reflects an effect of nature rather than socialization, we would expect it to replicate in culturally different settings. One sign that – despite the assertions of locals to the contrary – there is social pressure to use the right hand, is the relatively low proportion of lefties (77 out of 1055 people, 55 of whom are left-footed). In what follows, we will present results from replication studies conducted in Norway and Tanzania.

### 5.2 Norway

In our sample of Norwegian high-school students, we again find that men are more likely to choose competition compared to women (59% vs 37%; $p=0.000$; Fisher's exact test). This sample is smaller compared to the other locations but contains more lefties, as they were oversampled. We find that lefty men are slightly more likely to compete, but the raw difference is not statistically significant (64 vs 56 percent; $p=0.178$), and there is no difference between lefties and righties for women (36 vs 37 percent; $p=0.889$).

Using probit regressions in Table 3, we find no effect of being a lefty overall.[11] Lefty men, but not women, are significantly more likely to compete conditional on performance in the task, risk attitudes and confidence. In Table A2 in the appendix, we repeat this analysis using footedness only. The results are very similar.

**Table 3: Probit Regressions of Competitiveness on Being a Lefty (Norway)**

| | (1) | (2) | (3) | (4)<br>male | (5)<br>female |
|---|---|---|---|---|---|
| Female | -0.221*** | -0.213*** | -0.110*** | | |
| | (0.037) | (0.038) | (0.042) | | |
| Lefty | | 0.043 | 0.054 | 0.117** | -0.008 |
| | | (0.043) | (0.042) | (0.055) | (0.065) |
| Performance | | | √ | √ | √ |
| Risk | | | √ | √ | √ |
| Confidence | | | √ | √ | √ |
| N | 568 | 568 | 568 | 276 | 292 |

Notes: Marginal effects are from probit regressions of being a lefty on choosing the competitive payment scheme. The dependent variable equals 1 if the participant chose the competitive payment scheme and 0 otherwise. Lefty equals 1 if the participant indicated that she/he writes with her/his left hand (or both hands) or kicks with her/his left foot (or both feet). Robust standard errors in parentheses; 3, 2, or 1 stars indicate significance at the 1%, 5%, or 10% level respectively.

### 5.3 Tanzania

In our sample of 1975 Tanzanian high-school students, we again find that men are more likely to choose competition compared to women in both tasks (31 vs 15 percent in the ball task and 33 vs 17 percent in the matrices task; p=0.000 in both cases; Fisher's exact test). We find no strong differences between lefty and righty men on either task (26 vs 32 percent; p=0.418; and 29 vs 34 percent; p= 0.508). Neither is there a difference between lefties and righties for women (17 vs 15 percent; p=0.792; and 17 vs 17 percent; p=1.000).

Using probit regressions in Table 4, we confirm these results controlling for performance in the task, risk attitudes, confidence and task order.[12] In Table A3 in the appendix, we repeat this analysis using footedness only. Again, the effects are close to zero in both tasks. It is important to point out

11 We drop 3 observations for which we miss the confidence measure.

12 We drop 2 observations for the ball task and 7 for the matrix task for which we miss the risk preference or confidence measures.

that despite the large sample size, the number of lefties is fairly low (98 out of 1980 individuals, 85 of whom are left-footed), which could be a consequence of cultural pressure against being left-handed.

**Table 4: Probit Regressions of Competitiveness on Being a Lefty (Tanzania; balls)**

| | (1) | (2) | (3) | (4) male | (5) female |
|---|---|---|---|---|---|
| Female | -0.158*** | -0.159*** | -0.091*** | | |
| | (0.018) | (0.018) | (0.020) | | |
| Lefty | | -0.027 | -0.003 | -0.025 | 0.045 |
| | | (0.043) | (0.042) | (0.058) | (0.066) |
| Performance | | | √ | √ | √ |
| Risk | | | √ | √ | √ |
| Guess | | | √ | √ | √ |
| Task order | | | √ | √ | √ |
| N | 1973 | 1973 | 1973 | 972 | 1001 |

Notes: Marginal effects are from probit regressions of being lefty on choosing the competitive payment scheme. The dependent variable equals 1 if the participant chose the competitive payment scheme and 0 otherwise. Lefty equals 1 if the participant indicated that she/he writes with her/his left hand (or both hands) or kicks with her/his left foot (or both feet). Robust standard errors in parentheses; 3, 2, or 1 stars indicate significance at the 1%, 5%, or 10% level respectively.

**Table 5: Probit Regressions of Competitiveness on Being a Lefty (Tanzania; matrices)**

| | (1) | (2) | (3) | (4) male | (5) female |
|---|---|---|---|---|---|
| Female | -0.159*** | -0.160*** | -0.158*** | | |
| | (0.018) | (0.019) | (0.018) | | |
| Lefty | | -0.026 | -0.029 | -0.040 | -0.005 |
| | | (0.044) | (0.043) | (0.059) | (0.068) |
| Performance | | | √ | √ | √ |
| Risk | | | √ | √ | √ |
| Confidence | | | √ | √ | √ |
| Task order | | | √ | √ | √ |
| N | 1968 | 1968 | 1968 | 968 | 1000 |

Notes: Marginal effects are from probit regressions of being lefty on choosing the competitive payment scheme. The dependent variable equals 1 if the participant chose the competitive payment scheme and 0 otherwise. Lefty equals 1 if the participant indicated that she/he writes with her/his left hand (or both hands) or kicks with her/his left foot (or both feet). Robust standard errors in parentheses; 3, 2, or 1 stars indicate significance at the 1%, 5%, or 10% level respectively.

### 5.5 Merged data

In Table 6, we merge the data from all three locations and control for country-fixed effects and full interactions of country-fixed effects with the control variables. For Tanzania, we use the first decision and control for a task dummy (and full interactions of the controls with the task dummy). The overall gender difference in choosing to compete across locations is 16 percentage points (39% of men and 23% of women compete over all three datasets; p=0.000, Fischer's exact test). Using probit regressions controlling for gender, we find that lefties across the three locations are roughly 4 percentage points more likely to compete, an effect that is marginally statistically significant. The effect is slightly larger at 5 percentage points when we control for performance, confidence and risk attitudes.[13] Splitting the sample by gender in columns 4 to 7, we find some effect of being a lefty for men but not for women, but again, the coefficients for men are small and not very precisely estimated. These results replicate for the merged data from all three countries when we use footedness only in Table A5 in the appendix.

**Table 6: Probit Regressions of Competitiveness on Being a Lefty (merged)**

| | (1) | (2) | (3) | (4) male | (5) female | (6) male | (7) female |
|---|---|---|---|---|---|---|---|
| Female | -0.156*** | -0.153*** | -0.135*** | | | | |
| | (0.014) | (0.014) | (0.015) | | | | |
| Lefty | | 0.045* | 0.052** | 0.053 | 0.029 | 0.065* | 0.039 |
| | | (0.025) | (0.025) | (0.035) | (0.038) | (0.035) | (0.038) |
| Performance | | | √ | | | √ | √ |
| Risk | | | √ | | | √ | √ |
| Confidence | | | √ | | | √ | √ |
| Country FE | √ | √ | √ | √ | √ | √ | √ |
| Task order | √ | √ | √ | √ | √ | √ | √ |
| N | 3675 | 3675 | 3675 | 1797 | 1878 | 1797 | 1878 |

Notes: Marginal effects are from probit regressions of being lefty on choosing the competitive payment scheme. The dependent variable equals 1 if the participant chose the competitive payment scheme and 0 otherwise. Lefty equals 1 if the participant indicated that she/he writes with her/his left hand (or both hands) or kicks with her/his left foot (or both feet). Robust standard errors in parentheses; 3, 2, or 1 stars indicate significance at the 1%, 5%, or 10% level respectively.

[13] In India, we do not have a measure of confidence (expected successful tosses) for 347 participants and no measure of risk preferences for any participant. For these participants, we replace the confidence and risk measures with a constant and interact them with a dummy that indicates whether confidence or risk is missing.

## 5. Conclusion

We have used handedness and footedness as a proxy for underlying neurological differences to investigate whether individual differences in competitiveness are partially determined by biology. We find a strong relationship between handedness (and footedness) and competitiveness in a sample of Indian villagers of both genders. We attempt to replicate our findings in two culturally distinct settings, Norway and Tanzania. The results are mixed. In Norway, we find a weaker effect of handedness for men only, while we find no meaningful effects for either gender in Tanzania. Using footedness, which should be less subject to social pressure than handedness, does not significantly affect any of these results. Overall, the data do not provide robust evidence that gender differences in competitiveness are partly driven by nature.

Our study also constitutes a large-scale, intercultural replication of the gender gap in willingness to compete, which is well-documented in incentivized laboratory experiment using students at Western universities and which is particularly robust when using math-related tasks. We find a large and significant gender gap in all locations using both a ball-tossing task (India and Tanzania) and a numerical task (Norway and Tanzania).

A growing number of studies find that competitiveness predicts educational choices and success in the labor market, and may explain gender differences therein. This makes it important to investigate the sources of individual differences and gender differences in competitiveness. In particular, if competitiveness is partially determined by nature (or by social processes that are difficult to target through public policy), then rather than coming up with interventions to increase the willingness to compete of individuals belonging to underrepresented groups, we should focus on adapting educational and labor market settings to attract, for instance, more women into areas that are deemed to be competitive, but do not intrinsically need to be that way, such as science or economics. However, our results indicate that using handedness or footedness as proxies for innate differences might not be the best way to tackle the question of the role of nature versus nurture in shaping competitiveness or other individual traits.

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**Appendix: additional tables**

**Table A1: Probit Regressions of Competitiveness on Being Left-Footed (India)**

| | (1) | (2) | (3) | (4)<br>male | (5)<br>female |
|---|---|---|---|---|---|
| Female | -0.146*** | -0.134*** | -0.133*** | | |
| | (0.026) | (0.026) | (0.027) | | |
| Lefty | | 0.245*** | 0.246*** | 0.283*** | 0.201** |
| | | (0.059) | (0.059) | (0.079) | (0.094) |
| Performance | | | √ | √ | √ |
| N | 1107 | 1107 | 1107 | 533 | 574 |

**Table A2: Probit Regressions of Competitiveness on Being Left-Footed (Norway)**

| | (1) | (2) | (3) | (4)<br>male | (5)<br>female |
|---|---|---|---|---|---|
| Female | -0.220*** | -0.215*** | -0.111** | | |
| | (0.039) | (0.040) | (0.045) | | |
| Lefty | | 0.030 | 0.039 | 0.120** | -0.055 |
| | | (0.048) | (0.047) | (0.061) | (0.076) |
| Performance | | | √ | √ | √ |
| Risk | | | √ | √ | √ |
| Confidence | | | √ | √ | √ |
| N | 516 | 516 | 516 | 247 | 269 |

**Table A3: Probit Regressions of Competitiveness on Being Left-Footed (Tanzania; balls)**

| | (1) | (2) | (3) | (4)<br>male | (5)<br>female |
|---|---|---|---|---|---|
| Female | -0.158*** | -0.159*** | -0.091*** | | |
| | (0.018) | (0.018) | (0.020) | | |
| Lefty | | -0.029 | -0.006 | -0.029 | 0.044 |
| | | (0.046) | (0.045) | (0.061) | (0.073) |
| Performance | | | √ | √ | √ |
| Risk | | | √ | √ | √ |
| Guess | | | √ | √ | √ |
| Task order | | | √ | √ | √ |
| N | 1960 | 1960 | 1960 | 965 | 995 |

**Table A4: Probit Regressions of Competitiveness on Being Left-Footed (Tanzania; matrices)**

| | (1) | (2) | (3) | (4)<br>male | (5)<br>female |
|---|---|---|---|---|---|
| Female | -0.159*** | -0.159*** | -0.157*** | | |
| | (0.019) | (0.019) | (0.018) | | |
| Lefty | | -0.013 | -0.022 | -0.050 | 0.039 |
| | | (0.047) | (0.046) | (0.061) | (0.072) |
| Performance | | | √ | √ | √ |
| Risk | | | √ | √ | √ |
| Confidence | | | √ | √ | √ |
| Task order | | | √ | √ | √ |
| N | 1955 | 1955 | 1955 | 961 | 994 |

**Table A5: Probit Regressions of Competitiveness on Being Left-Footed (merged)**

| | (1) | (2) | (3) | (4)<br>male | (5)<br>female | (6)<br>male | (7)<br>female |
|---|---|---|---|---|---|---|---|
| Female | -0.157*** | -0.153*** | -0.135*** | | | | |
| | (0.014) | (0.014) | (0.015) | | | | |
| Lefty | | 0.051* | 0.055** | 0.068* | 0.019 | 0.081** | 0.021 |
| | | (0.028) | (0.028) | (0.038) | (0.045) | (0.038) | (0.045) |
| Performance | | | √ | | | √ | √ |
| Risk | | | √ | | | √ | √ |
| Confidence | | | √ | | | √ | √ |
| Country FE | √ | √ | √ | √ | √ | √ | √ |
| Task order | √ | √ | √ | √ | √ | √ | √ |
| N | 3588 | 3588 | 3588 | 1748 | 1840 | 1748 | 1840 |

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