THE RISE AND FALL OF COMPETITIVENESS:

Experimental Evidence from Individualistic and Collectivistic Societies

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Competitiveness pervades life: plants compete for sunlight and water, animals for territory and food, and humans for mates and income. Here we investigate human competitiveness with a natural experiment and a set of behavioral experiments. We compare competitiveness in traditional fishing societies where local natural forces determine whether fishermen work in isolation or in collectives. We find sharp evidence that fishermen from individualistic societies are far more competitive than fishermen from collectivistic societies and that this difference emerges with work experience. These findings suggest that humans can evolve traits to specific needs, support the idea that socio-ecological factors play a decisive role for individual competitiveness[1,2], and provide evidence how individualistic and collectivistic societies shape economic behaviour[3-8].

Individuals frequently face a decision, which can affect their wellbeing and even survival: to compete or not to compete. Natural and social scientists argue that competitions and the right dose of competitiveness significantly determine not only the future of the individual but even the evolution of the whole specie[9,10]. Yet,

behavioral experiments with humans show that there are large differences in competitiveness between individuals that cannot be readily explained by genetic endowments, abilities, or risk attitudes[11-13].

One alternative explanation for the underpinnings of how human competitiveness evolves and why there might be large variations is based on learning theories. Observational learning describes individuals' tendency to adapt by imitating successful behavior. Social or cultural learning models attribute an important role to individual experiences in the social and physical environments for the formation of traits and norms[14-16]. Thus, individual variations in competitiveness may be the result of exposure to different environments and pressures.

In this study we investigate how local natural forces cause human competitiveness to change. We compare competitiveness in geographically proximate individualistic and collectivistic fishing societies with behavioral experiments. Our key exogenous variation is whether fishermen spend their lives at a lake or at the sea. The main difference between these societies is that at the sea ecology favours fishermen to work in collectives, whereas the lake ecology guides them to fish in isolation—there are scale diseconomies rather than economies to people. As a result, the output of the fishermen in the individualistic lake societies should depend on their willingness to compete with other fishermen for the best fishing spots, the best sales, and the most beneficial trade relations whereas such individual competitiveness is unnecessary in the collectivistic sea societies. We hypothesize that these differences result in changes in individual competitiveness and that lake fishermen become more competitive than sea fishermen with exposure to these local pressures.

The behavioural experiments we employ in the field facilitate comparisons and control of causal factors[17]. Fishermen at the sea and at a nearby lake took part in

experiments in which we measure their propensity to compete for high monetary stakes. We chose a task that was simple and unfamiliar to the subjects to capture primitive competition preferences. The task was to throw a tennis ball ten times into a bucket that was set three meters away. Competitiveness was identified by a single choice: subjects decided whether or not they want to compete in this task before they started throwing the balls. They were informed that if they decided to not compete they would earn one monetary unit per successful attempt. In contrast, if they decided to compete they would earn three monetary units per successful attempt, but only if they outperformed one unknown other subject; if they scored less than this other subject they would not earn anything. In case of a tie they would earn one monetary unit per successful attempt[18]. Subjects did not know against whom they compete, and to rule out fairness or other social considerations, their decision did not affect another subject (nobody could be dragged into competition).

We selected eight small traditional individualistic and three collectivistic fishing societies in Brazil (Figure 1) that are in close geographical proximity to measure individual competitiveness. As aforementioned, the main difference between these societies is that fishermen located on the lake work on their own in small boats, while at the sea fishermen work on larger boats in teams (28.6% go fishing in teams of two, 35.7% in teams of three, and the remaining 35.7% in teams of four to eight individuals). Thus, while fishermen at the lake spend much of their lives in isolation competing against other fishermen on the lake and fish markets, fishermen at the sea are together with their team members and do not compete against other individuals.

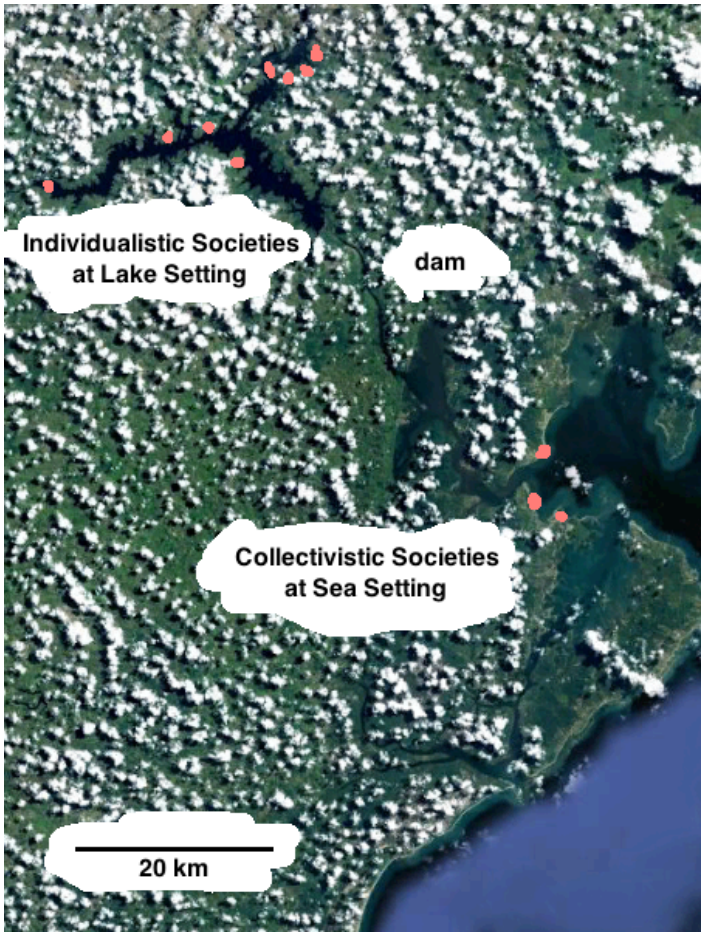


Figure 1: Field Setting. Our fishermen study was conducted in north-eastern Brazil in different individualistic and collectivist fishing societies in close proximity. The settings are connected by a river, only divided by a dam, and the collectivistic societies are at the estuary mouth of this river where fishermen fish in collectives. The individualistic societies are at the lake where fishermen go fishing alone. The societies are illustrated by pink dots.

As Figure 1 makes clear, the lake is connected to the sea by a river, only divided by a dam. The air-line distance between the lake and sea is approximately 50 kilometres, which roughly corresponds to the distance between the west and the east side of the lake. Despite the geographical proximity, we find no evidence for migration between individualistic and collectivistic societies, and did not meet a single fisherman who moved from one setting to the other or went fishing in both

settings. Immigration and emigration occur to some limited extent at the individualistic lake setting and we test for their roles subsequently.

On average our subjects are 38.2 years (± 13.3 s.d., *N*=289), lived for 28.3 years (± 15.8 s.d., *N*=289) in the same fishing society, and have worked for 18.4 years (± 12.4 s.d., *N*=289, variable=work experience) professionally as fishermen. In both settings, fishermen work for most of the year, and for five to seven days a week. They are heavily dependent on the shrimp and fish resources: there are very few other types of jobs in these societies, and fishing is often the only possible profession to provide fishermen and their families with income and nutrition. Fishermen from both individualistic and collectivistic are similarly educated (mean years in school=3.45; Mann-Whitney *U*-test, *Z*=0.813, *P*=0.416, two sided, *N*=287) and generate equal incomes from fishing (monthly mean=248.34 Brazilian Reais, Mann-Whitney *U*-test, *Z*=0.359, *P*=0.720, two sided, *N*=289).

Our first finding confirms our conjecture that individual competitiveness is more important in individualistic than in collectivistic societies. We observe that incomes from fishing and fishermen's individual competitiveness measured by the competition experiment are positively correlated at the lake in the individualistic societies (Pearson's, *R*=0.227, *P*=0.0016, *N*=191). Competitive lake fishermen earn on average almost *50%* more than not competitive lake fishermen (300.3 vs. 212.9 Brazilian Reais, Mann-Whitney *U*-test, *Z*=3.246, *P*=0.0012, two sided, *N*=191). There is no such comparable relationship in the collectivistic societies as competitive and not competitive sea fishermen earn approximately the same (Pearson's, *R*=0.047, *P*=0.641, *N*=98).

Our second finding confirms our hypothesis that individual competitiveness is differently pronounced between individualistic and collectivistic societies. We find

large differences in individual competitiveness between lake and sea fishermen consistent with our hypothesis: 45.6% of the lake fishermen as compared to only 27.6% of the sea fishermen compete (Fisher exact test, P=0.003, two sided, N=289). Therefore, fishermen who fight for their survival in isolation are on average approximately *65%* more willing to compete in the experiment than fishermen who work in collectives.

Our third finding is that the gap between individualistic and collectivistic societies in individual competitiveness emerges with exposure to the lake and sea ecology. Figure 2 illustrates a linear estimation of the probability of competing for fishermen in the individualistic and collectivistic societies depending on work experience. First, we can see that both lines are initially very close to each other but then significantly disperse. Second, and in line with our hypothesis, we observe that the red line for the lake fishermen is increasing whereas the blue line for the sea fishermen is decreasing with work experience. The confidence intervals illustrate that the lake – sea gap in competitiveness becomes significant with approximately 17 years of work experience. Thus, there are particularly large differences in competitiveness for experienced fishermen. For example, in the sample of fishermen who have worked for at least 20 years, we observe that lake fishermen are approximately *2.6 times* more likely to compete than sea fishermen (54.4% vs. 21.3%, Fisher Exact test, P<0.0001, two sided, N=115). The interaction between society and work experience is significant at P=0.019 in a Probit model (N=289) and robust to the inclusion of control variables as we show in the supplementary information.

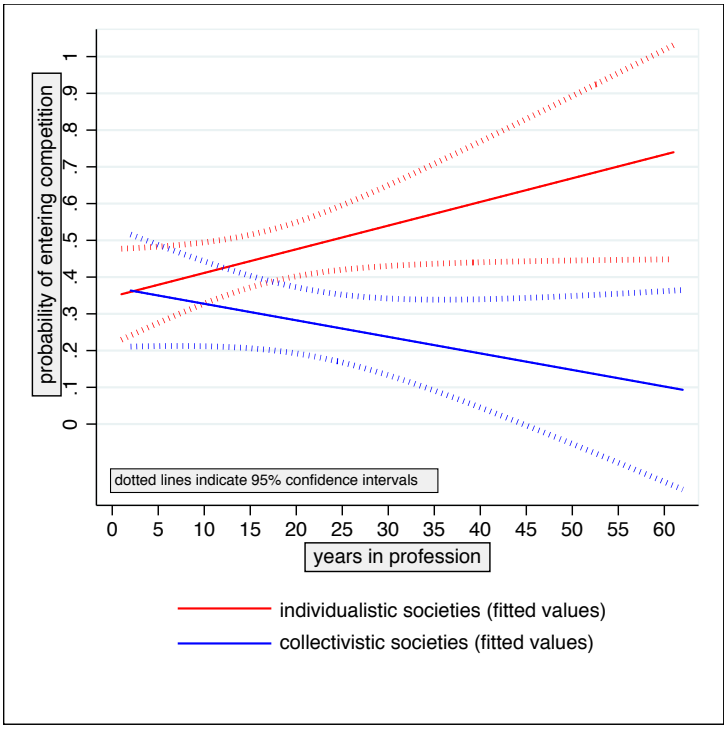


Figure 2: Changes in competitiveness with work experience across individualistic and collectivistic societies. Lines show linear estimates for probability of competition entry. Fishermen took part in behavioural experiments in the field measuring their competitiveness and were asked about their work experience (years in profession).

The different drifts in competitiveness in individualistic and collectivistic societies cannot readily be explained by genetic endowments. Yet, they could be the result of other factors than local natural forces such as differential abilities (to throw the ball), risk differences across societies[19], or immigration into and emigration out of societies. To test whether any of these factors constitute alternative explanations, we use data from these societies on abilities, risk preferences, immigration and emigration.

This supplementary data suggests that none of these alternative explanations is consistent with the data. First, task proficiencies in the competition experiment are unrelated to work experience in individualistic and collectivistic societies (Pearson's,

p>0.188) and controlling for successful attempts does not affect the impact of society on competitiveness. Second, risk preferences identified in a lottery experiment are also unrelated to work experience in individualistic and collectivistic societies (Pearson's, p>0.32) and controlling for lottery investments does also not affect the impact of society on competitiveness. Third, fishermen who did or did not immigrate into the lake society are not differently competitive (43.9% vs. 46%, Fisher exact test, *P*=0.861, two sided, *N*=191) and fishermen who did or did not emigrate out of the lake society or stopped fishing are also not differently competitive (39.5% vs. 46.2%, Fisher exact test, *P*=0.579, two sided, *N*=170). Thus, immigration and emigration cannot drive the changes in competitiveness in the individualistic and collectivistic societies.

Another potential driver are differences in individualistic and collectivistic societies other than local natural forces affecting the manner in which members generate their living. To test for such other potentially unobservable differences, we conducted two additional competition experiments. First, we conducted the same competition experiments with women living in the individualistic and collectivistic societies who do not fish and are thus not differently affected by local natural forces. Second, we conducted group competition experiments with fishermen at the lake and sea to test whether there are differences in group competitiveness[20,21]. As group in contrast to individual competitiveness is not crucial at the lake, we should observe that group competitiveness is not more pronounced at the lake than at the sea. The task, choice, and parameters were identical to the individual group competition experiment. The only difference was that participants were told that they could either be paid depending on their own and an unknown partner's performance if they decide

to not compete or by their pair performance relative to another pair if they decide to compete.

The additional competition experiments suggest that society differences other than differential local natural forces are not responsible for the findings, as we find no differences at the lake and sea in women's competitiveness and fishermen's group competitiveness. Women in the individualistic societies who do not fish are equally competitive as women in the collectivistic societies who do not fish (15% vs. 14.7%, Fisher exact test, P=1, N=66) suggesting that traits evolved at work do not easily spread to other society members. Fishermen in the individualistic societies are similarly likely to enter into group competitions as fishermen in the collectivistic societies (36% vs. 35.8%, Fisher exact test, P=1, N=103).

By combining a unique spatial feature affecting living patterns with behavioural experiments in the field, we are able to gain insights into the underpinnings of human competitiveness. Our results show that local natural forces and socio-ecological factors can have an important impact on the shaping of competitiveness. We find that competitiveness changes with exposure to local natural forces: in the individualistic society where nature constrains humans to work and fight for survival in isolation, individuals become considerably more competitive, whereas the opposite holds in the collectivistic society where there is teamwork.

Our findings may also provide evidence in favour of endogenous preference formation[22,23] and highlight that natural pressures can have a large impact on norms of competition. Finally, our study informs the literature that has investigated the relationships between individualism, collectivism, and economic outcomes[3-8] and the role of the social environment for human traits[24-28].

Methods

Subjects. A total of 458 subjects – aged 18 to 87 – from traditional fishing societies at a lake and at the sea participated in this research, which took place in the state of Bahia in Brazil. The experiments were conducted in several individualistic (lake) and collectivistic (sea) societies. The main difference between the lake and sea societies is whether fishermen fish alone or in collectives. Fishermen at the sea fish in collectives because the sea ecology constrains them to use fishing instruments, such as large and heavy fishnets, that can be only handled by more than one person. For fishermen at the lake, however, it is not necessary to work in collectives because the lake ecology renders it possible to use fishing instruments that can be handled by one person. Fishermen at the lake compete against other fishermen for the best fishing spots, selling prices, and trade relations while such individual competition is largely absent at the sea setting.

Experimental procedures. In each experimental session, participants first received an identification code. Then, experimenters led each participant one by one to a separate place and explained the rules of the competition game verbally in detail and in private to the participants. We ensured that the participants who waited for their turn did not talk to others. All decisions were blind to other participants; i.e., we never told participants the choices of another participant and behaviour (ball throwing) in the competition game could not be observed. Participants earned a considerable amount of money during the experiments, typically more than their daily incomes. For more detail on the experimental procedures please consult the supplementary information.

Statistical methods. Our statistical analysis is based on non-parametric Mann-Whitney U-tests, Fisher exact tests, Probit regressions and Pearson product-moment correlations. If applicable, we always use two-tailed tests, and regressions with robust standard errors.

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