Informational Differences and Performance: Experimental Evidence[*]

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August 23, 2012

Abstract

This paper provides experimental evidence on how informational differences may translate into performance differences in competitive environments. In a laboratory tournament setting, we manipulate beliefs about the effort-reward relationship by varying how much information people receive on the potential impact of luck on outcomes. We find that an informational disadvantage worsens the understanding of the effort-reward relationship, and significantly lowers performance. Our study is inspired by informational differences in the labor market where some individuals have less data on the determinants of economic success than others—due to social networks or the availability of similar others to learn from. (*JEL* C91, D81, M50)

[*] We wish to thank David Cesarini, Armin Falk, Guillaume Fréchette, Xavier Gabaix, Andy Schotter, and Richard Zeckhauser, along with seminar audiences at Universitat Autònoma de Barcelona (MOVE Workshop), Harvard Kennedy School, and the 2011 Stanford Institute for Theoretical Economics Summer Workshop, for helpful comments. Financial support from the Women and Public Policy Program and the Women's Leadership Board at Harvard Kennedy School is gratefully acknowledged.

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1 Introduction

People differ in the degree to hich the attribute economic outcomes to effort and luck. For example, Europeans are more likel than Americans to believe that luck, rather than effort or education, determines income (Alesina et al. 2001), and similarl omen are more likel than men to attribute success to luck (Fisman and O' eill 2009). In addition, differences in information ma affect ho people perceive the effort-re ard relationship. Specificall , some individuals might have more precise information on the determinants of economic success at their disposal than others, depending on ho man people the have available to learn from.

The number of similar others seems crucial for such information transmission. For example, in organizations, the demographic mix determines the set of comparable others. Role models and mentors tend to have the same demographic characteristics as their mentees (e.g., Holmes and O'Connell 2007; Ibarra 1992, 1993; Ragins 1999 for a revie). Countr -of-origin or same-language social net orks facilitate job seeking (Edin et al. 2003, Munshi 2003), business relationships (Jackson and Schneider 2010), as ell as the participation in elfare and social programs (Bertrand et al. 2000, Figlio et al. 2011). Information derived from a smaller sample ill likel be less precise, i.e., have a higher variance, than hen derived from a larger sample, potentiall creating an informational disadvantage for members of smaller groups.

We conduct a laborator experiment inspired b such labor market realit here some individuals have less information on the determinants of economic success than others. We assign information conditions randoml , and form t o groups that differ in the amount of information the receive on the effort-re ard relationship. The effect of such informational differences on performance is measured in a competitive setting. Similar to Orrison et al. (2004), e vie (promotion) tournaments as an essential incentive device in modern hierarchical organizations. In tournaments, the impact of informational differences on performance also depends on hom people compete ith and hat the kno about their competitors. To this end, e theoreticall and experimentall examine competition bet een equall informed as ell as bet een differentiall informed agents.

In the experiment, performance as measured in a real-effort task, namel b the number of ords found in a ord-find task, here subjects ere assigned to pairs and competed against their anon mous counterpart for a tournament prize. Tournament outcomes ere determined b both individual effort and a random bonus component. We created t o information conditions regarding the bonus component and, thus, the effort-re ard relationship: one group received information from a large sample of data, and another group received information from a small sample. Depending on the information condition, a person as either ell or poorl informed on the potential impact of the random component on tournament outcomes, and competed either ith an equall or ith a differentiall informed counterpart. We conjecture that individuals that are better informed on the role of the luck component for economic success ill exert more effort.

Experimental participants receiving less information on the effort-re ard relationship indeed perceived the variance of their bonus component to be larger, and subsequentl performed orse than better informed participants. Furthermore, the performance of an informationall disadvantaged agent as particularl depressed hen competing ith a better rather than an equall informed counterpart. This suggests that information potentiall affects performance through t o channels: b affecting ho ell agents understand the effort-re ard relationship and b creating "informational injustice" that additionall discourages the disadvantaged from exerting effort.

Our ork contributes to earlier experimental studies examining the role of uncertaint and information on individual performance in competitive environments, hich is not conclusive. Bull et al. (1987) and Freeman and Gelber (2010) varied the amount of information on the past performance of competitors that their experimental subjects had available. For a h pothetical effort task, Bull et al. (1987) reported that subjects ho ere informed of their counterparts' decisions after each round exerted less effort than those ho did not receive an information. In contrast, Freeman and Gelber (2010) ho used a real-effort task (mazes) found that providing more information on the historical performance of competitors led to higher effort on average. In both cases, the uncertaint about the effort-re ard relationship as influenced b the amount of information subjects had available on their competitors' past performance, making best-responding a difficult problem, as past performance ma not necessaril map directl into future performance and responses are interdependent. We var information exogenousl – unlike, for instance, Celen and H ndman forth., ho allo ed their subjects to costl acquire information about the decisions of predecessors – and independentl of subject performance, enabling us to determine the impact of the perceived importance of luck on effort. In our setup, informational differences result from differences in sample sizes, hich – in addition to mimicking labor market realit – is an intuitive a to communicate differential degrees of uncertaint to subjects.

The remainder of the paper is organized as follo s. In Section 2, e discuss the theoretical frame ork, and derive h potheses for our experiment. The experimental design is presented in Section 3. Section 4 reports the experimental results, and Section 5 concludes.

2 Theoretical Framework

We model effort choices among competing agents using a tournament-theoretical framework (Lazear and Rosen 1981). We propose a setting in which two agents compete against each other. They belong either to the better informed group receiving a large data sample or the worse informed group with a small data sample. Each agent can control the mean of the output distribution by means of effort exertion, which is costly ($C(\;) > 0$). Furthermore, a stochastic luck component ε is realized. This leads to the following observable output:

$$q_i = \; _i + \varepsilon_i; i = L; S \tag{1}$$

where L and S stand for two different agents with a large and a small data sample, respectively.

In this rank-order tournament, agent L differs from agent S in the perceived distribution of the luck component, so that L is better informed about the effort-reward relationship. As in the experiment, we distinguish between two cases: we compare the performance of L- and S-players when each type of player either assumes to compete with an equally informed counterpart, or assumes to compete with a differentially informed counterpart.

2.1 Heterogenous Beliefs under the Assumption of Identical Information

Our general setup is akin to that in Lazear and Rosen (1981). The specificity of our model lies in the beliefs of L and S:

- Agent L believes all luck components to be independent s.t. $\varepsilon_{L;L} \; N \; 0; \; {}^2_L$ and $\varepsilon_{S;L} \; N \; 0; \; {}^2_L$

Furthermore, the following general assumptions apply:

- We consider a single tournament round.
- The cost function $C(\,)$ is quadratic and not a source of agent heterogeneity.
- The firm derives a marginal social return V from each unit of effort that an agent exerts, and acts in a perfectly competitive market.
- We denote the tournament prize spread by $W \;\; W_1 \;\; W_2$ where W_1 and W_2 are the winner and loser prizes, respectively.

Before we move to the analysis of the game, we introduce the notion of a performance gap in this tournament.

Definition A performance gap exists if $_L \neq \; _S$.

If equilibrium effort choices differ between agents, and $W > 0$, this results in a pay gap, as different levels of effort exertion imply different probabilities of winning the tournament. The probability of winning the tournament is equal to:

$$prob_i(q_i > q_j) = prob_i(\;_i \;\; _j > \varepsilon_j \;\; \varepsilon_i) \tag{2}$$

where $i \neq j$.

Given the above-mentioned distributional assumption, $E[\varepsilon_j \;\; \varepsilon_i] = 0$, with the variance depending on the beliefs of the respective player (L, S). If $\;^2_L < \;^2_S$, agent S underestimates the impact of effort on actual pay. As we shall see, the equilibrium investment in effort is a function of $prob_S(q_S > q_L) = g(\;_S \;\; _L)$ for S and $prob_L(q_L > q_S) = h(\;_L \;\; _S)$ for L. Here, $g(\;_S \;\; _L)$ and $h(\;_L \;\; _S)$ are the probability density functions of a normal distribution with zero mean and variance $2\;^2_S$ and $2\;^2_L$, respectively, so this is the channel through which the perceived variance of the luck component impacts effort choice.

From Lazear and Rosen (1981) we know that a decrease in the precision with which the agents understand the effort-reward relationship leads to reduced effort provision by risk averse agents. In the case of risk neutrality, however, this effect would be offset by an increase in the prize spread, assuming homogenous agents. Hence, in Lazear and Rosen (1981), for risk neutral agents with homogenous beliefs about the error term, the optimum investment in effort does not vary with the variance of the luck component.

Given that in our model we have two types of agents with heterogenous beliefs, this result does not hold. Prize spreads cannot be optimally adjusted for both groups at the same time,[2] and thus, even under risk neutrality, we expect a worse understanding of the effort-reward relationship to result in less effort. Accordingly, we assume risk neutrality, and continue with the analysis of the game.

Unlike agent S, agent L perfectly observes the variance (this assumption can be relaxed, as we simply require L's belief to be closer to the firm's reality than S's belief), but both agents assume identical information conditions, i.e., $\varepsilon_{x,y}$ and $\varepsilon_{y,y}$ for $x, y \in \{L, S\}$, $x \neq y$ have the same distribution. In this setup, a performance gap follows from Lazear and Rosen (1981). The proof of the following proposition is in Appendix A.

Proposition 1 If $\sigma_L^2 < \sigma_S^2$ and both agents assume that each of them faces identical information conditions, a performance gap exists s.t. ${}_S < {}_L$.

Agent S does not invest efficiently and ${}_S < {}_L$, i.e., the equilibrium investment in effort of L is greater than that of S. This is due to the fact that S underestimates the responsiveness of pay to effort, whereas L knows the correct distribution of the luck component. Hence, there is a performance gap in equilibrium, and S is less likely to win the tournament than L.

that $_S <$ $_L$ as long as $W_2 <$ $_L$ 4 $_L \ln \frac{e_S}{L}$ $\sqrt{V}$, and both agents invest ine ciently. With full updating and $e^2_S =$ ^2_L for S, the performance gap vanishes.

2.2.2 Informational Injustice and Fairness Considerations

Given our proposed information conditions (ith one group being orse informed than the other), it is conceivable that particularl the informationall disadvantaged agents might deviate from the behavior laid out above, and – instead of ackno ledging that their perceived variance of the luck component is an upper bound – feel discouraged, hich ould in turn lead to a orsening of the perceived effort-re ard relationship. That is, the informationall disadvantaged group ould implicitl derive disutilit in the form of a higher perceived variance of the luck component, discouraging effort and therefore smothering economic prospects. For simplicit , e assume that L does not exhibit positive inequit aversion (hich is an extreme case of the t pical assumption that agents care more about negative than about positive inequit). Then, denote b $\bar{}_S$ agent S's perceived variance incorporating the option to rationall update her beliefs, but adjusted b a penalt (leading to a higher variance) due to negative inequit aversion:

$$\begin{aligned} \bar{}^2_S & \quad {}^2_S + \max \ {}^2_S \ e^2_S; 0 \quad \max \ {}^2_S \ e^2_S; 0 \\ & = {}^2_S + (\quad) \max \ {}^2_S \ e^2_S; 0 \ ; \end{aligned} \tag{3}$$

here , $2 R^+$ are eights for negative inequit aversion and rational variance correction, respectively, and ^2_L $e^2_S <$ ^2_S ith e^2_S as S's updated estimate of the actual variance ^2_L.

We have alread covered the cases here in Proposition 2a, so e are left ith $>$, hich implies that $\bar{}^2_S >$ ^2_S. In the next proposition, e demonstrate that even ith full updating the performance gap idens if S exhibits negative inequit aversion and L does not take it into account. This setup can be interpreted as follo s: S has a small data sample suggesting some $^2_S >$ ^2_L, but – given that she realizes that her perceived variance of the luck component is an upper bound – full updates her beliefs to $e^2_S =$ ^2_L. S exhibits negative inequit aversion because she kno s that the provided information is less precise. This leads to the follo ing proposition, ith the corresponding proof in the Appendix.

Proposition 2b If $^2_L <$ ^2_S but (1) the players fully update their beliefs such that $e^2_S =$ ^{2}

As in Section 2.2.1, the long-run tendenc of the performance gap ill be to shrink hen L becomes a are of S

can be larger when the agents are aware of the informational di erences than when they assume identical information conditions.

one person per pair received information on the large sample and the other person in the pair received information on the small sample, and this as common kno ledge. We refer to this as di erent-information tournament .

After an initial practice round, the task as repeated four times (ith a different letter matrix and ord list in ever round). Subjects remained in the same pair for the duration of the experiment. In rounds 1 and 2, subjects ere confronted ith a ide range of potential bonus values from 0 to 100. In rounds 3 and 4, e decreased the range of bonus values b limiting them to be bet een 30 and 70. Performance is likel responsive to both experience ith the task and the range of potential bonus values (as predicted b the theor). At the end of each round, subjects ere informed of their task score, their final score, their counterpart's final score, and the tokens the on. The did not receive information on their counterpart's task score, and ere thus unable to determine ith certaint hether the on/lost because of their counterpart's performance or the randoml dra n bonus. As an example, Appendix B provides the instructions for S-pla ers in the different-information tournament.

Besides the subjects' performance on the ord-find task, e collected three additional pieces of information.27( )289enha37(co1n/lost)-e(inform7(ere)-422co1nrange)-3 1(in)o1nhighe( )2732-339(3)--3 1(in)o1n for a stud that lasted one hour.

We ran the experiments in the Harvard Decision Science Laborator in the spring of 2010. 20 subjects participated in nine sessions ith 22 or 24 subjects in each of them, and e have valid score data for 812 individual outcomes.[5]

4 esults

We first report descriptive statistics. Then, e examine our central prediction, Implication 1: agents ho are provided ith a smaller sample of information on possible bonus values (S-pla ers) perform orse than their counterparts ith more precise information (L-pla ers), and this effect is due to the perceived variance of the bonus component. Finall , e test Implications 2a and 2b, i.e., hether the performance gap varies depending on hether subjects assume identical information conditions (in the identical-information tournament) or are a are of informational differences (in the different-information tournament).

[Insert Figure 1 about here]

On average, subjects found 10.13 ords (ith a standard deviation of 3.88) out of a total of 20 ords available in a given letter matrix. Women and men differed slightl in their performance, ith omen marking 10.35 ords correctl and men finding 9.78 ords on average ($p < 0:05$). This difference as entirel driven b performance in the first round, and omen and men did not differ at all in their performance in the remaining three rounds. Figure 1 presents the distribution of the number of ords people found in the pooled sample. T pical outcomes ranged from 5 to 1 ords per matrix. Four participants, i.e., roughl 2 of our subjects, found the maximum of 20 ords in at least one round.

Examining Implication 1, e first revie differences in the mean number of ords found b L- and S-pla ers. Table 1 reports the data pooled across both treatments (cf. first panel) and separatel for each treatment condition (cf. second and third panels). Within each panel, in the first ro e present performance levels aggregated over all four rounds, in the second for the ide-range rounds (rounds 1 and 2), in the third for the narro -range rounds (rounds 3 and 4), and in the last ro for the rounds here people had alread gained one round's experience ithin a given range condition (rounds 2 and 4). L-pla ers found about one ord more than S-pla ers on average ($p < 0:01$).

[5] We dropped all scores of a subjectafter incidents involving IT or other problems during the experiment, which explains the loss of 12 out of 824 outcomes.

[Insert Table 1 about here]

Considering identical-information and different-information tournaments separatel in the second and third panels, the performance gap bet een L- and S-pla ers is exacerbated in the different-information tournament. In the third panel, L-pla ers found 1.3 ords more than S-pla ers on average, hich corresponds to an increase of one-third of a standard deviation. Experience increased the performance gap to 1.8 ords in rounds 2 and 4. On average (cf. first ro of the second and third panels), the performance gap as mainl driven b S-pla ers ho performed significantl orse hen competing against L-pla ers rather than against identicall informed counterparts ($p < 0{:}05$). In contrast, the better informed group as not differentiall affected b the t o treatment conditions.

[Insert Table 2 about here]

People's scores improved over time, but no clear learning pattern is observable (see Table 2, hich presents mean scores b round). In particular, scores decreased bet een rounds 2 and 3 for S-pla ers in the identical-information and for L-pla ers in the different-information tournament, refuting simple learning but suggesting the existence of adjustment costs to the ne bonus range in round 3. We do not assign particular importance to this, other than noting that learning alone cannot explain the d namics e observe. On average, performance levels ere significantl higher in the narro -bonus-range rounds 3 and 4 as compared to the ide-range rounds 1 and 2, hich

S-pla ers reported the range to be 0.50 (ith perceived, normalized mean bonus values of 0.51 and 0.45, respectivel).[7] To more easil interpret the effect on performance, e include 1

Having sho n that informational differences impact performance through the perceived variance of the bonus component, e no discuss Implications 2a and 2b, namel hether the performance gap shrinks or idens hen informational differences are public information. Based on the theoretical discussion in Section 2.2, e h pothesize that the difference in perceived variance in the different-information tournament is not the same as the one in the identical-information tournament.

Given the mean scores in Table 1, informational injustice and fairness considerations (as in Implication 2b) might affect performance directl rather than through a rational understanding of the effort-re ard relationship.

to perceived informational injustice, leading to a larger performance gap in the different-information than in the identical-information tournament, is supported.

[Insert Table 4 about here]

In order to explore hether there is an differential impact of the different- vs. identical-information treatment operating directl through the sample sizes rather than indirectl through Perceived range, e also consider the reduced-form estimation (i.e., regressing scores on the large-sample indicator and the remaining variables included in Table 3a) in Table 4 . Columns 1 to 3 demonstrate that our results regarding Implication 1 are robust to the inclusion of multiple controls: L-pla ers outperformed S-pla ers overall. Column 4 sho s that hile L-pla ers outperformed S-pla ers in the different-information tournament (the sum of the coefficients of Large sample and Large sample Different info is significant at the 2 level), the performance difference – albeit positive – does not significantl exceed that in the identical-information tournament. Thus, rational updating in the absence of negative inequit aversion is unlikel to explain our findings, as the performance gap is not smaller in the different-information than in the identical-information tournament. Either the t o channels of influence discussed in Propositions 2a and 2b do not matter, or the cancel each other out.

Concluding em rks

This paper explores the impact of noise in people's perceptions of the effort-re ard relationship on their performance in a tournament setting, and demonstrates ho informational differences can translate into differences in performance. In our laborator experiment, e implement a ne mechanism to manipulate beliefs about the role of luck for tournament outcomes b var ing the amount of information people received on the latter, building on the simple statistical idea that smaller samples are noisier than larger samples. We sho that receiving more information on the role of luck improves the understanding of the effort-re ard relationship, and leads to significantl better performance. This has broader implications, and could help explain ho beliefs about one's initial conditions ma influence one's future labor market outcomes.

Consider our findings in the context of a ell-kno n labor market phenomenon, namel the (rigidit of the) underrepresentation of omen in top management positions. Women onl hold a small fraction of leadership positions in the corporate orld (Bertrand and Hallock 2001). At the Fortune 500 companies in 2010, 2.4 percent of the CEOs, 14.4 percent of the executive officers, and

15.7 percent of the board members ere female.[11] Most notabl , omen are also consistentl more likel to attribute success to luck rather than individual effort (Fisman and O' eill 2009).

Our paper suggests h this might be the case, and hints at a potential mechanism underl ing the persistence of gender gaps at the top: hen people (have to) source career-relevant information on the effort-re ard relationship from similar others, omen being in the minorit in top management positions are at a disadvantage because the size of the group of similar others determines ho precise the information received is. As a consequence, omen might end up overestimating the importance of luck in the effort-re ard relationship and, thus, put forth less effort in the orkplace. This in turn affects their likelihood of success under performance pa schemes and eventual promotion in an organization.

The theoretical frame ork in this paper fits gender imbalances in organizations quite nicel , as gender gaps are most pronounced in senior positions characterized b competitive ork environments here managers are involved in promotion tournaments ith substantial uncertaint about ho effort translates into re ards. As in our model, promotion tournaments involve unique prize schemes, e.g., ages are often defined for different career stages and hardl var among individual emplo ees ithin a given slate. Tournaments tend to be particularl harsh at the top of the age distribution, given that the loser prize t picall decreases across the age distribution. An extreme example is the up-or-out s stem implemented b firms in ver competitive industries – e.g., consulting, investment banking, or legal practices – and in academia such that candidates belo a certain percentile in the performance ranking are dismissed (corresponding to a loser prize of $W_2 = 0$ in our model, hich is reminiscent of Proposition 2a and the discussion in Section 2.2.1, here e have sho n that an upper bound on W_2 is a sufficient condition for a performance gap), hile the remaining emplo ees are promoted.

For our model to appl in this context, some aspects of career-relevant information must be gender-specific.[12] Informal accounts suggest this is the case. The scarcit of senior colleagues of the same sex puts female junior managers at a disadvantage: junior omen "have inadequate information about acceptable (or successful) modes of behavior..." (Blau et al. 2005, p. 177). Similarl , Ibarra (1992, p. 7) argued that "organizational demograph " constrains omen's available set of comparable others to learn from: "Women and minorities usuall have a much smaller set of 'similar others' ith hom to develop professional relationships based on identit -group homophil ." Such

[11] http://www.catalyst.org/publication/132/us-women-in-business

[12] In addition, the career relevance of such information must be independent of whether the rm discriminates in any form against any group, or whether returns to information vary between groups, which seems plausible.

net orks matter: examining the effectiveness of same-sex net orks in a professional service firm here onl a small minorit of omen held senior management positions, Ibarra (1993) found that men reaped greater benefits from their larger same-sex net orks than omen.

The patterns of behavior for the informationall advantaged and disadvantaged groups found in our experiment are compatible ith other laborator and field observations based on omen and men. Gneez et al. (2003) as ell as Booth and olen (2009) present experimental evidence suggesting that the gender performance gap is particularl pronounced in mixed or male-dominated competitive environments as compared to same-sex competitions. Reminiscent of our findings, gender differences in performance ere also driven b omen – or, in our case, the informationall disadvantaged group – adjusting their behavior to the different environments: omen performed better in same-sex than in mixed-sex competitions, hile men's performance as not affected b the gender composition (Gneez et al. 2003). A similar pattern has been found in performance evaluations in an organization here omen ere in the minorit , namel among officers in the Israeli militar : omen ere evaluated more positivel the larger their relative share in a group as, hereas men's evaluations ere invariant to the gender balance (Paz and Oron 2001). More generall , our findings relate to earlier ork in sociolog and political science, "critical mass theor ," suggesting the importance of relative group size for economic success (Kanter 1977).

Clearl , the gender balance in organizations ma affect omen's and men's productivit through a multitude of channels. For instance, a larger share of omen in an organization might be correlated ith a larger share of omen in the talent pool of organizationall relevant professions, thereb increasing the firm's economic benefits of adjusting orking conditions to omen's needs (see Bertrand et al. 2010 for a discussion). In addition, an increased proportion of omen in counter-stereot pical positions ma also affect implicit biases, changing omen's and men's beliefs about career trajectories (Beaman et al. 2009). More generall , differences in the evaluations of omen and men based on the gender composition of the group are also compatible ith statistical discrimination and information as mmetries here the emplo er is orse informed about the productivit of the minorit group than of the majorit group (Coate and Lour 1993), or here the minorit group has invisible abilities (Milgrom and Oster 1987).

Our paper suggests an additional mechanism through hich differences in performance, pa , and representation in leadership positions can emerge – informational differences due to the relative size of one's group. Organizational demograph ma thus be an important determinant of the productivit , promotion likelihood, and pa outcomes of an organization's emplo ees.

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T bles

Table 1: Differences in Mean Scores

Treatment	Rounds	Large sample (N = 102)	Small sample (N = 104)	Difference
All	All	10. 37	9. 32	1.005***
		[3.83]	[3.87]	[0.27]
All	1 & 2	10.134	9.203	0.931***
		[3.59]	[3. 2]	[0.3]
All	3 & 4	11.14	10.0 3	1.083***
		[4.00]	[4.08]	[0.40]
All	2 & 4	11.280	9.9	1.314***
		[3.9]	[4.05]	[0. 0]
Treatment	Rounds	Large sample (N = 46)	Small sample (N = 48)	Difference
Identical info	All	10.793	10.138	0. 5
		[3.85]	[3.90]	[0.40]
Identical info	1 & 2	10.231	9.800	0.431
		[3.72]	[3.]	[0.54]
Identical info	3 & 4	11.375	10.479	0.89
		[3.92]	[4.11]	[0. 0]
Identical info	2 & 4	11.231	10.505	0.72
		[4.13]	[4.05]	[0. 0]
Treatment	Rounds	Large sample (N = 56)	Small sample (N = 56)	Difference
Different info	All	10.509	9.205	1.304***
		[3.82]	[3.81]	[0.3]
Different info	1 & 2	10.055	8. 9	1.358***
		[3.50]	[3.52]	[0.47]
Different info	3 & 4	10.9 4	9.714	1.249**
		[4.08]	[4.04]	[0.55]
Different info	2 & 4	11.321	9.509	1.812***
		[3.84]	[4.00]	[0.53]

Notes (Tables 1 and 2): In the first t o columns, standard deviations are in parentheses. The third column indicates the results of a t o-sided difference-in-means test (ith standard errors in parentheses)   here */**/*** denote significance at the 10 /5 /1   level, respectivel .

Table 2: Differences in Mean Scores b   Rounds

Treatment	Round	Large sample (N = 102)	Small sample (N = 104)	Difference
All	1	9.554	9.0 8	0.48
		[3.57]	[3.48]	[0.27]
All	2	10.720	9.337	1.383***
		[3.54]	[3.75]	[0.51]
All	3	10.439	9.524	0.915*
		[3.57]	[3.8]	[0.53]
All	4	11.840	10. 02	1.238**
		[4.29]	[4.25]	[0. 0]
Treatment	Round	Large sample (N = 46)	Small sample (N = 48)	Difference
Identical info	1	9.75	9.851	-0.09
		[3. 4]	[3. 2]	[0.7]
Identical info	2	10. 9	9.750	0.94
		[3.78]	[3.73]	[0.78]
Identical info	3	10.953	9. 81	1.273*
		[3.30]	[3.85]	[0.7]
Identical info	4	11.778	11.277	0.501
		[4.43]	[4.2]	[0.91]
Treatment	Round	Large sample (N = 56)	Small sample (N = 56)	Difference
Different info	1	9.393	8.411	0.982
		[3.54]	[3.25]	[0. 4]
Different info	2	10.741	8.982	1.759**
		[3.35]	[3.77]	[0. 8]
Different info	3	10.03	9.393	0. 44
		[3.75]	[3.89]	[0.73]
Different info	4	11.891	10.03	1.855**
		[4.22]	[4.20]	[0.80]

Table 3a: Determinants of Perceived Variance of Bonus Component (First Stage)

Table 3b: Determinants of Task Performance (Second Stage)

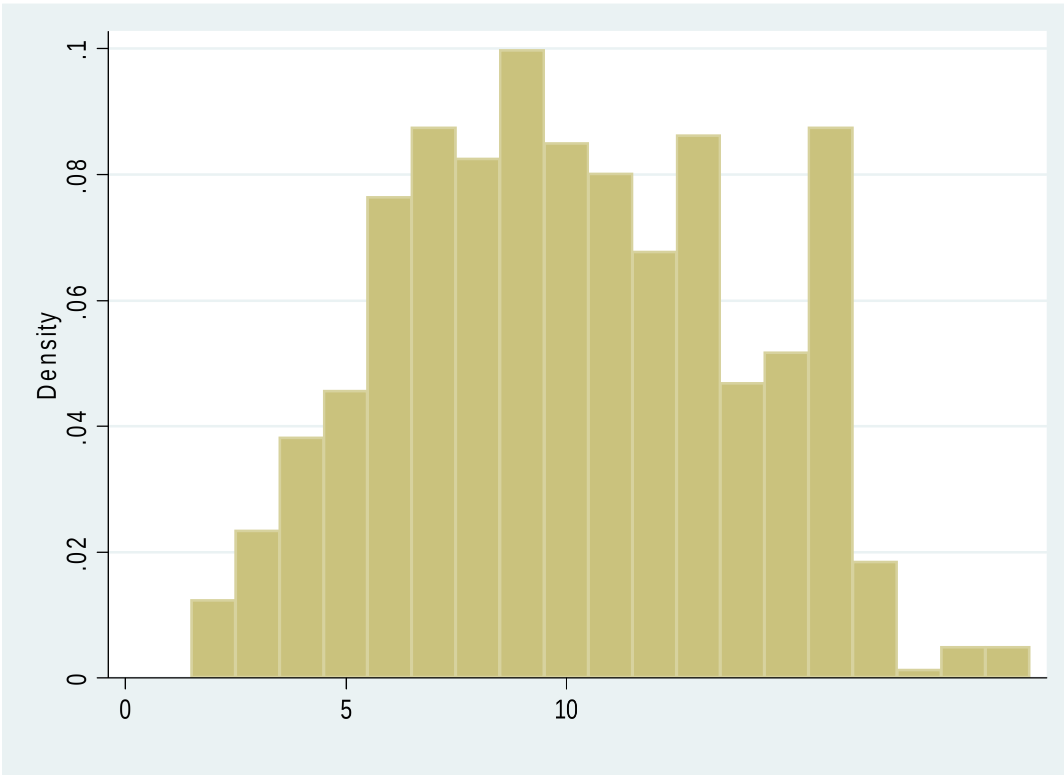
Table 4: Determinants of Task Performance (Reduced Form)

	Dependent variable: Score			
Large sample	1.005**	1.007**	1.117**	0.498
	[0.45]	[0.45]	[0.51]	[0. 8]
Diff. info			-0.541	-1.179*
			[0.48]	[0. 7]
Large sample Diff. info				1.217
				[0.92]
Rounds 2 & 4		0.972***	1.080***	1.080***
		[0.19]	[0.21]	[0.21]
Rounds 3 & 4		0.932***	0.771***	0.7 7***
		[0.1]	[0.19]	[0.19]
Female			0.32	0.290
			[0.49]	[0.49]
Student			1. 9 ***	1. 02***
			[0.5]	[0.5]
Constant	9. 32***	8. 79***		
	[0.34]	[0.34]		
Economic-background FE	o	o	Yes	Yes
Risk-aversion FE	o	o	Yes	Yes
# of observations	812	812	37	37

Notes: */**/*** denote significance at the 10   /5   /1   level, respectivel . In the linear regressions, standard errors are given in parentheses, and are clustered at the pair level. Self-reported economic

Figures

Figure 1: Histogram of Scores (Pooled)



Appendi A

Proofs

Proof of Proposition 1 (follows from Lazear and Rosen 1981) The optimum investment in effort $_i$ (i = L; S) ill be a function of W, the prize spread, and the variance of the net dose of bad luck (

Recall that depends on W, so the corresponding FOC is:

$$(V \quad C'(\quad))\frac{\partial}{\partial \quad W} = 0 \;, \quad V = C'(\quad). \tag{[redacted].9}$$

Combining ([redacted].), ([redacted].7), and ([redacted].9), one ields:

$$W \quad = \frac{V}{h(0)} = \frac{W_1 + W_2}{2 \quad h(0)}. \tag{[redacted].10}$$

Given that C( )

and L-pla ers are una are of this learning process on the part of the S-pla ers, the performance gap is characterized b the difference $h(\ _L \quad _S) \quad g(0) > 0$ here $g(0) > g(0)$ and $\ _S < \ _S$, so the performance gap remains but becomes smaller.

With full updating, S-pla ers ill update their beliefs s.t. $e^2_S = \ ^2_L$, and L-pla ers ill be a are of this, so that $\ _S = \ _L = \quad$.

Proof of Proposition 2b L's beliefs reflect the standard ash-Cournot case, hereas S – given her negative inequit aversion – feels discouraged and po erless, as reflected b a higher perceived variance of the luck component. Thus, the performance gap is characterized b the difference $h(0) \quad \bar{g}(\ _L \quad \bar{\ }_S)$ here $\bar{g}(\ )$ is the probabilit densit function of a normal distribution ith variance $\bar{\ }^2_S$ and $\bar{\ }_S$ is S's optimal effort given $\ _L$ and $\bar{g}(\ )$. Hence, as long as L kno s that S is orse informed (but does not incorporate S's inequit aversion), there ill be a performance gap because $h(0) \quad \bar{g}(\ _L \quad \bar{\ }_S) > 0$.

Finall , to see that the performance gap exceeds the one in Proposition 1:

$$p\frac{1}{4 \ ^2_S} > p\frac{1}{4 \ \bar{\ }^2_S} \exp \frac{(\ _L \quad \bar{\ }_S)^2}{4 \bar{\ }^2_S}) \quad h(0) \quad \bar{g}(\ _L \quad \bar{\ }_S) > h(0) \quad g(0).$$

Appendi B

Letter Matrix (Example: Nations of the World)

B	T	U	W	T	T	B	P	M	S	K	L	L	L	T	W	Q	N	B	V	ALGERIA
O	O	M	E	X	J	A	E	B	K	I	D	A	M	A	R	B	H	W	Y	BELGIUM
F	F	H	N	G	N	G	Y	O	M	U	H	J	I	U	T	K	U	B	W	CANADA
W	C	P	I	A	Y	L	S	T	A	K	C	S	A	R	I	V	Y	B	P	EGYPT
S	Z	E	M	U	T	P	E	V	I	R	T	K	Q	P	E	G	I	M	X	FINLAND
R	A	A	A	L	S	B	T	U	U	A	Z	Q	D	A	A	G	L	A	Q	GREECE
D	N	A	L	A	E	Z	W	E	N	I	X	W	D	V	O	N	L	E	F	HONDURAS
S	B	V	V	T	W	U	A	I	R	N	X	N	J	U	W	R	I	A	B	INDONESIA
N	G	Y	K	H	Y	D	F	T	B	E	A	R	C	B	V	V	X	G	H	JAPAN
S	F	T	V	A	R	Y	B	R	L	W	Y	A	O	I	I	N	T	M	Y	KOREA
A	G	D	D	I	M	D	G	U	R	A	U	S	E	D	E	C	J	A	U	LATVIA
R	U	W	P	L	B	G	Z	X	G	Q	M	T	F	M	A	J	I	X	W	MALTA
U	D	B	N	A	C	O	T	S	Z	U	N	P	E	N	U	S	D	F	H	NEW ZEALAND
D	H	N	X	N	O	I	D	B	H	A	R	Y	A	P	E	K	I	I	U	PANAMA
N	O	C	P	D	O	M	X	V	M	G	P	D	G	N	O	N	V	R	K	RWANDA
O	Q	L	L	J	M	H	I	B	R	A	A	H	O	R	L	Q	T	T	R	SINGAPORE
H	F	B	V	G	R	E	E	C	E	M	V	D	E	A	J	Q	B	L	P	THAILAND
A	B	I	T	L	K	P	H	C	W	B	N	A	N	P	J	P	G	U	O	UKRAINE
C	X	Q	U	G	I	Z	F	V	J	I	C	D	O	Z	K	N	T	I	V	VIETNAM
B	W	Y	L	D	I	S	I	N	G	A	P	O	R	E	V	I	D	K	M	YEMEN

Experimental Instructions

You are participating in a stud in hich ou ill earn some mone . The amount ill depend on ho ell ou do in a task plus a bonus (described belo). At the end of the stud , our earnings (1 token = $1) ill be added to a sho -up fee, and ou ill be paid in cash.

Main task We ill sho ou matrices containing letters. Some letters appear in random order

Calculation of payout The person getting the higher final point score in our pair ill receive 10 tokens. The person ith the lo er final point score ill receive 2 tokens.

How the study is conducted It is conducted in five stages.

Stage 1 You ill be informed of the lo est and the highest possible bonus (X and Y) contained in a given hat and the

Speci c instructions for how to mark the words Once e start, ou ill see a letter matrix on our screen. You can highlight the ords ou find b marking them ith our mouse. Your task is to mark as man correct ords as possible. We ill practice this in a trial round.