SELF-CONFIDENCE AND STRATEGIC BEHAVIOR

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Abstract. We test experimentally an explanation of over and under confidence as motivated by (perhaps unconscious) strategic concerns, and find compelling evidence supporting this hypothesis in how participants send and respond to incentivized statements of confidence. In two-player tournaments where the highest score wins, one is very likely to enter when one knows his or her stated confidence is higher than the other player's, but very unlikely when the reverse is true. Consistent with this behavior, stated confidence by males is inflated when deterrence is strategically optimal and is instead deflated by males and females when hustling (encouraging entry) is strategically optimal; this behavior is consistent with the equilibrium of the signaling game. Based on the theory of salient perturbations, we suggest that there is a strategic foundation of overconfidence. Since overconfident statements are used in familiar situations in which it is strategically effective, it may also occur in the absence of strategic benefits, provided the environment is similar.

Keywords: Self-confidence, overconfidence, salient perturbations, analogies, strategic deterrence, unconscious behavior, self-deception, hustling, experiment

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1. Introduction

Belief about one's abilities is an important ingredient in many decisions, including making career choices, undertaking enterprises, and taking risks. There is considerable evidence that statements people make about their abilities often don't accurately re ect their real abilities. This phenomenon has typically manifested as overcon dence: well known studies in psychology and economics claim that people are overcon dent in their ability (e.g., Svenson, 1981; Dunning, Meyerowitz, and Holzberg, 1989).[1] So an overarching question concerns the roots of such apparent overcon dence in relative ability and the corresponding bene ts that might explain the persistence of the phenomenon. For example, a commonly-suggested potential personal bene t from overcon dence is the consumption value (ego utility, in Koszegi, 2006) from the belief that one is talented. In this view, people feel better with a favorable self-perception, even at the cost of being overcon dent when reality intrudes.

We consider here an alternative explanation, and postulate a strategic foundation of overcon dence. Overcon dent statements are often made to a ect the belief of others about one's ability. This occurs in strategic situations where this e ect is possible; these are common in social life. For instance, appearing more con dent is likely to increase one's chances to be hired for a job or to receive a promotion, and may discourage others from competing for that same position or entering the same market. It may also elicit cooperation by others if they are in search for talented colleagues to start a joint project. In some other situations, it may pay to appear to be less con dent than one actually is. Such is the case of a pool hustler, or at the workplace if this elicits help by others. We propose that the use of overcon dent statements extends to a larger set of environments: Since this behavior is systematically used in familiar situations in which it is strategically e ective, it may then occur even when no e ect on other's behavior can be expected, provided the environment

[1] Moore and Healy (2008) mention a taxonomy of overcon dence, consisting of \(1) overestimation of one's a-321(8(util(n.g)-417(aa

in which they are made is similar to those in which such effect would be reasonable. The extension of behavior to similar environments where it may not be optimal may be facilitated if such behavior is automatic and in part unconscious. Our explanation relies upon theoretical literature on bounded rationality. The starting assumption is that cognitive limitations prevent people from calculating optimal behavior in each and every situation. Instead, it is more reasonable to assume that people make the same decisions in different situations that appear similar. This idea is presented in Myerson (1991) and further developed in a formal model in Samuelson (2001).[2] Myerson (1991) proposes that apparent suboptimal behavior can sometimes be understood by assuming that observed behavior is optimal in a related but more familiar environment, which he calls a salient perturbation.

The discipline imposed by the theory is that this environment must satisfy three conditions. First, it has to be similar to the situation the individual is really facing (has to be a *perturbation*). Second (*familiarity*), the perturbation must be more familiar to the subject than the real situation. Finally (*optimality*), the observed behavior must be optimal in the salient perturbation of the actual game. Samuelson (2001) presents a formal model showing how salient perturbations may arise as optimal planning of behavior in different environments with cognitive costs. He assumes that people plan their actions by keeping a stock of models and matching situations they encounter to the analogies they have in mind. They have to pay cognitive costs for the planning, which are higher for more complex plans. Apparent anomalies in behavior (compared to the optimal one) can be expected if situations are relatively rare but resemble a more frequently observed interaction.

Many examples can be given, for example in visual perception, in which individuals interpret what they see in terms of a salient perturbation. For example when one is sitting in a stationary train, the movement of another train is interpreted and perceived as self-motion (vection illusion (Dichgans and Brandt, 1978)). The link to Myerson's salient perturbations is apparent. The real but unfamiliar situation (you are still, the world is moving) is automatically interpreted by drawing on the more familiar situation (you are moving, the world is still) which is the salient perturbation.

[2]See also Gilboa and Schmeidler (1995), which provides a simple axiomatization of a decision rule that chooses a \best" act based on its past performance in similar cases.

The example of vection illustrates another property of salient perturbations. The attribution of movement to the other train is automatic, unconscious rather than a deliberate updating. Familiarity a ects the degree of awareness. Behavior becomes automated and unconscious in situations that occur very frequently. By contrast, situations that look unfamiliar and have no readily available analogy are more likely to induce deliberate and re ective behavior. To illustrate, people drive automatically on a familiar route but have a heightened awareness of their environment when driving on an unknown road. A more deliberate and re ective behavior is costly in terms of the attention which has to be devoted to information processing, so the use of automatic processes can be explained, consistent with Samuelson's (2001) model, as cost reduction.

In summary we claim that biases in statements and beliefs over one's ability are important factors leading to behavior thateterturbative os-4505(optimal051)-3-40tbnvironmen cn wihc cn1(ot-304(cns-383

bla13ectsveda-3345(c9n-384458e)-305(t9-30v)2uos-404t-30l1(1(r)-356(tra)-eat)27(ts)-4525T1e 58ec9n28(eha)28(vio overconfidence is the optimal strategic behavior, because the hustling perturbation is much less common in real life. In this case the response to the salient perturbations is more likely to be a reflective, thoughtful, deliberate response. Let us now describe in some detail our experimental strategy and main findings.

We first use an incentive-compatible mechanism to elicit confidence in one's relative ability in a equilibrium of the game. An interesting finding in the deterrence treatment is that we also find an increase in reported confidence by male players in the role of receiver.

The hustler treatment has a double interest for our test of the theory. First, it provides a test of the idea that the confidence in the statements about one's skill follows strategic considerations, in the direction that is appropriate in the environment, not necessarily overconfidence. Second, this treatment has special interest because hustling is a less familiar situation, and so we expect that a more reflective type of behavior would be triggered as a result. Therefore, we did not expect to find that receivers in the hustler treatment would adjust their reported confidence in comparison to the baseline treatment, and the data show that indeed they do not.

Using the baseline treatment, where statements about abilities are made but no other subject could observe them, we explored the idea that overconfidence happens at an unconscious level . In this treatment, overconfidence does occur even though it can only be self-signaling. It has often been suggested that biased information processing is at the core of this. According to this view, people process information in a self-serving way, which, if true, may happen at an unconscious level. To test this, we consider an updating task where one receives a negative (but noisy) signal. We then compare behavior in an environment in which people receive feedback about own performance when we control for con dence. In fact, the di erence in con dence across gender only manifests for those people who choose to enter the tournament, with little di erence in stated con dence levels for men and women who choose not to enter into the competition. In the strategic-encouragement treatment, both the stated con dence levels and entry rates for males and females were almost the same, again not providing evidence that women shy away from competition.

The remainder of this paper is structured as follows. In section 2, we provide a review of the literature. We describe our hypotheses and our experimental design in section 3. We present our experimental results in section 4, and we discuss the motivation of biased con dence in section 5. We conclude in section 6.

2. Background and literature review

The ideas of salient perturbations and analogies are consistent with some earlier experimental ndings. Framing e ects can be understood by assuming that di erent descriptions of a task trigger di erent analogies. A prisoner's dilemma framed as the \Community Game" elicits more cooperative behavior than if framed as the \Wall St. Game" because the label \Wall Street" is associated with more competitive behavior (see Liberman et al., 2004). Likewise, cooperation with an anonymous stranger in a one-shot game can be explained with predictions from the theory of repeated games if the repeated game is the salient perturbation of the one-shot game.

Social psychology has long considered the issues of self-esteem, overcon dence, and self-deception: for example Baumeister (1998) provides an extensive review of the overcon dence phenomenon; and further evidence and discussion on the topic of self-esteem can be found in Leary, Tambor, Terdal, and Downs (1995) and Leary (1999), where image concerns lead to a selective demand for information. Berglas and Jones (1978) and Kolditz and Arkin (1982) also study how self-handicapping is related to social saliency: Kolditz and Arkin (1982) nd that subjects take performance-impoverishing drugs after receiving positive feedback about their past performance when their choice of drugs is visible to the experimenter. However, when subjects choose whether or not to take the performance-impoverishing drugs in private, no subjects take them. This suggests that performance/con dence is a social signal.

Rabin and Schrag (1999) provide a model of confirmatory bias, where people misinterpret new information as supporting previously held views; in this model a confirmatory bias induces over-confidence. An agent may come to believe with near certainty in a false hypothesis, even though he or she receives an unlimited amount of information. Koszegi (2006) provides a formal economic feedback is always correct but incomplete (e.g., people are told they are not in the top 20%, but not if they are in the middle 60% or bottom 20%). Instead, we provide noisy feedback, which is not always correct. This makes it possible for participants to attribute any negative feedback to external causes, i.e., to `bad luck' (noise).[6]

Eil and Rao (2011) study how people process and acquire objective information regarding intelligence and beauty. They rank 10 people in a group, and elicit the complete belief distribution over all possible ranks; participants receive incomplete but truthful feedback. Each person's rank was compared to an anonymous participant, with feedback about this comparison. People are found to respond much more to positive feedback than to negative feedback. Even in a non-own-performance control treatment, updating and information acquisition were unbiased. While one gets more precise information with their set-up, it is much more complicated for participants; updating seems to be quite noisy and errors appear to be common even in the control treatment.[7] The fact that updating is unbiased in the neutral task may be due to the fact all subjects start from the same symmetric (uniform) distribution in that case: Each rank is equally likely at the start. The advantage of our simple set up is that participants make very few errors on the neutral abstract task. We also ensured that the distributions of the priors are similar in both tasks, so that di erences in updating cannot be due to di erent prior distributions.

Burks, Carpenter, Goette and Rustichini (2012), based on data in Burks et al. (2009), investigate whether concerns for self-image contribute to overcon dence and whether con dence judgments are consistent with Bayesian information processing starting from a common prior. They reject both hypotheses. Their results indicate that individuals with higher beliefs about their skills are more likely to demand information, rather than less likely. These results clearly reject self-image concerns as a mechanism that yields overcon dent judgments, and are consistent with the hypothesis that overcon dence is a form of social signaling. In their experimental design there is no strategic

[6]Studies in psychology suggest that attributing success to one's self and attributing failures to external sources (such as `noise') is a commonly employed strategy by people (see, e.g., Wolosin, Sherman, and Till, 1973).

[7]There is also a possible alternative interpretation of their results, in that people with high con dence on the intelligence tests are smart, and better at updating. Since they are more likely to get positive feedback, the results could re ect the fact that smarter people are better at updating. However, since they nd similar results in the case of beauty, this alternative interpretation can 0.398 wativeir,Th(of)]TJ -406nivp people2-357(arof)]TJ -406niv1(n,)-3tople2-406(up)-29(da

environment that can affect confidence, so a direct test of the hypothesis is difficult. In this paper we introduce the strategic environment explicitly, and study the strategic motivation underlying such signaling.

Grossman and Owens (2010) study how one's beliefs about own performance (on a quiz) are affected by noisy, but unbiased feedback. In the main treatment, participants overestimate their own scores, believing that they have received unlucky feedback. However, this is driven not by biased information processing, but rather by overconfident priors. In a control treatment, each participant expresses beliefs about another participant's performance, with (on average) accurate posteriors. Even though feedback improves estimates about performance, this does not lead to improved estimates of related performances. This result suggests that how people use performance feedback to update beliefs about own ability differs from how they update their beliefs about own performance, which may relate to the issue of why overconfidence persists.

3. Hypotheses and Experimental Design

3.1. **Model.** The key tool we use to test our hypotheses is a tournament game where players can

(1)

	${}^{2}_{0}$	${}^{2}_{1}$
${}^{1}_{0}$	$0; 0$	$b; a$
${}^{1}_{1}$	$a; b$	$d; d$

We focus on the case for which a player is better o if the opponent is weaker (b 0; d a) and if she herself is stronger (a 0; d b): To make things interesting we assume a O^2 d; so that a strong receiver prefers playing the tournament to the outside option if he knows that the sender is a weak type, but prefers the outside option if he knows that the sender is a strong type. We also assume that d 0, implying that a weak receiver always prefers to stay out.

This game re ects situations in which people can strategically manipulate how con dent they appear to others. Under the assumptions made, a weak receiver will always opt out of the tournament, but for a strong receiver this choice will depend on his beliefs about the sender's type. The best strategy for the sender depends crucially on her outside option. If her outside option is high, she is better o if she does not have to compete with the receiver in the tournament. The sender can achieve this by appearing strong, i.e., over-report. On the other hand, if her outside option is low, she prefers that the receiver competes with her. In this case, the sender can achieve this by appearing weak, i.e., under-report. Indeed, both over- and under-reporting may occur in equilibrium (see Appendix B for details).[8]

In the experiment, we implemented two conditions. In the deterrence treatment, parameters are such that senders *over-report* in equilibrium (i.e., claim to be a weakly higher type than they really are). In the treatment,32658(senderr)-323(under-rep)-28(ohe)-32i(In)-328(equilibri51.)-44Whiloplexperimene

even absent for stated underconfidence, because environments where stating underconfidence is optimal are less widely experienced.

H4: Males will exhibit higher stated confidence levels and are more likely to enter the tournament than females, even after controlling for performance.

Thus, in line with previous research, we also predict that males are more likely to enter the tournament than females, controlling for confidence.

3.3. **Experimental design.** Sessions were conducted in Amsterdam with 16 to 28 participants depending on the number of subjects showing up for the experimental session. Instructions were displayed on a computer screen and read aloud. Participants were told that their decisions would remain anonymous to the other people present unless explicitly indicated otherwise, and that they would receive their earnings in an envelope from a person in a different room who could only see login numbers and could not match these numbers to names or faces. Participants were paid for one task chosen at random.

We ran a total of 22 sessions with a total of 464 subjects; seven of Treatment 1 ($N = 144$), three of Treatment 2 ($N = 68$), seven of Treatment 3 (three with low outside option, $N = 60$, four with high, $N = 96$), and five of Treatment 4 ($N = 96$). Sessions lasted for 40 to 50 minutes, with an average payment of €14 (of which €7 was a show-up fee). Sessions ended with a questionnaire. Almost all participants (96 percent) were undergraduate students (average age 22 years, standard deviation 2.96; see Table 2 for details), with the majority studying economics or business; 44 percent of these subjects were female.

In every treatment, participants were randomly allocated to groups of four individuals. In each group, two players were randomly given the role of senders and the other two the role of receiver (in the instructions we always used neutral labels "A" and "B" for the two roles); each sender was randomly matched with one receiver. All participants received the same 15 questions taken from Raven's Advanced Progressive Matrices (APM), a measure of cognitive ability (Raven, 2000). Participants had eight minutes to answer as many questions as they could, and did not get any feedback after completion on the number of questions they answered correctly. The experimental instructions can be found in Appendix A. Payments were presented in points: One point was worth one euro. In the period in which the experiment was run e1 was worth approximately between $1.30 and $1.40. In the exposition below we translate points directly into euro, although the instructions were strictly in terms of points.

When taking the APM test, participants only knew that they would be asked to evaluate their performance later and that every sender would be matched to a receiver with a possibility for the player with the higher rank to earn 10 points, that is, e10. Upon completion, participants were informed about all the subsequent steps in the experiment. First, one was asked to indicate one's con dence of having a score in the top two of their group, on a probability scale from 0 percent to 100 percent. They received payment for accuracy according to a quadratic scoring rule; for a stated probability p (their report divided by 100), a subject was paid e10 times $1 \quad (1 \quad p)^2$ if he really was in the top 2, and e10 times $1 \quad p^2$ if he was not. As can be seen in the instructions, we provided assurances that this mechanism favored accurate reporting for this part of the experiment.

Table 1 gives an overview of the di erent treatments. In the baseline treatment, no one could see the con dence of another player, each receiver could observe the reported con dence by the paired sender in the other treatments. In all treatments there was a possible tournament between the paired sender (S) and receiver (R). In Treatments 1-3, the player with higher rank received e10 and the other received nothing. Entry by both players was mandatory in Treatments 1 and 2, but each R faced a strategic decision in Treatments 3 and 4: After observing S's reported con dence, R chose whether or not to enter a tournament. In the low-outside-option version of Treatment 3, R received e3.5 by staying out, while in the high-outside-option version of Treatment 3, R received e5.5 for doing so.[9] In these treatments, S preferred that R opted out of the tournament since that would secure e10. In Treatment 4, if R chose not to enter, R received e5.5 and S received e10. If R chose to enter and won, then R received e10 and S received e15, while if R entered and S won, then R received 0 and S received e25; thus, S preferred that R enter the tournament. In

[9]We initially used an outside option of e3.5, but found that 28 of 30 receivers entered the tournament. We then switched to an outside option of e5.5.

Treatments 3 and 4 participants must trade off honest reporting against trying to influence the opponent's entry decision.

The description we have just given, including whether or not any player could see the reported confidence of others, or whether player R was given a choice between playing in or out, was common information and known to all subjects before they reported their confidence. They were also told, in all treatments, that they would find out at the end of the game who had the higher rank between the two matched S and R players, but would learn neither their rank in the group of four nor the number of questions answered correctly.

Table 1: *Overview of treatments*

Treatment	Receiver observes Sender's reported confidence?	Payoffs if receiver opts out of tournament $(S;R)$	Payoffs if receiver enters tournament $(S;R)$	
			Sender wins	Receiver wins
1: Baseline	No	N/A	(10,0)	(0,10)
2: Social	Yes	N/A	(10,0)	(0,10)
3a. Deterrence (low)	Yes	(10, 3.5)	(10,0)	(0,10)
3b. Deterrence (high)	Yes	(10, 5.5)	(10,0)	(0,10)
4. Hustler	Yes	(10, 5.5)	(25,0)	(15,10)

Notes: S stands for Sender, R for Receiver.

Treatment 1 had some additional components, the Reports and the Machine questions:

Reports. First, after reporting their confidence, participants were sent a report telling them if they were among the top 2 of their group or not. They were told that the report was always correct when one was in the bottom 2, but that the report was incorrect in 50% of the cases when one was in the top 2. There was no deception: Reports to participants were determined as stated. After receiving the report, they were asked if they thought they were in the top 2 or not. They received €10 for a correct assessment.

Machine questions. Subsequently subjects were given an abstract scenario. Two machines in a production hall produce rings: the left machine produces 50% good rings and 50% bad rings, the right one produces 100% good rings. A mechanic inspects one of the machines every day by however that the rate in the hustler treatment (27 percent) was nearly double that in the deterrence treatment (14 percent). In data pooled over the conditions, 71 percent of the people report a con dence level above 50 percent and only 20 percent report a con dence level below 50 percent; a binomial test nds this asymmetry to be highly signi cant ($Z = 17:00$, $p = 0:000$).

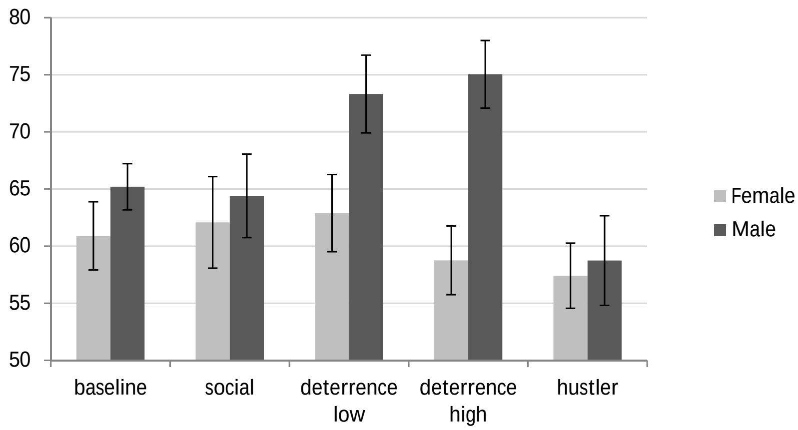
Table 2: *Summary statistics*

	Mean	Std. Error	Min.	Max.
Test				
Number correct answers	8.75	0.11	1	15
Con dence	63.75	1.02	0	100
Background characteristics				
Age	21.96	0.14	17	49
Number of siblings	1.48	0.05	0	7
Gender (fraction females)	0.44			
Member of sports club	0.49			
Took Raven test before	0.54			
Familiar with condition probs.	0.61			
Study category				
Economics/Business/Finance	0.58			
Social Sciences and Law	0.15			
Physics, Math, Computer science	0.07			
Other study or not student	0.20			
N	464			

Figure 1 shows a treatment and gender e ect with respect to mean reported con dence. Men are considerably more con dent in the strategic deterrence conditions compared to the involuntary-entry and hustler treatments, while no di erence is found for women. There is no di erence in the stated con dence level of men and women in the hustler treatment.

We did not expect to nd a di erence in stated con dence between senders and receivers in the baseline treatment, since their roles do not di er in that treatment, and indeed we do not nd any: the con dence of males is 65 in both roles, and that of female senders and receivers is respectively

Figure 1. **Cumulative distribution functions of confidence, by gender and treatment.** Roles pooled. Error bars: +/- SE



60 and 62. We therefore pool these observations by gender. Compared to the baseline treatment, male senders in the social treatment only report 3 percent points higher confidence, a difference that is not significant (WMW, Z = 0:789, p = 0:430, two tailed test). They do however report significantly higher confidence in the deterrence treatments (73 percent, low and high outside option combined, Z = 2:342, p = 0:019) and significantly lower confidence in the hustler treatment (53 percent, Z = 2:007, p = 0:045). Male receivers also report significantly higher confidence in the deterrence treatments (76), while their reported confidence in the hustler treatment is comparable to that of males in the baseline treatment (65 percent, Z = 2:949; p = 0:003). The reported confidence of females is always between 60 and 63 (in both roles) and not statistically different from that in the baseline treatment in any of the treatments, except for female senders in the hustler treatment who report a significantly lower confidence of 51 (Z = 1:779, p = 0:075)

significant effect even accounting for the difference in the number of correct answers (9.10 with familiarity versus 8.20 without it).

Receivers in the deterrence treatment inflate their confidence levels to about the same degree as the senders (the coefficient for the interaction variable Deterrence*Sender is small and insignificant). The receiver's inflated levels of stated confidence cannot deter senders from entry, so this cannot reflect deliberate cognitive planning. It may instead reflect unconscious motivations generated by the competitive setting, so that people may not be flexible enough to adjust their behavior to their contingent role in the deterrence environment. Their behavior can be explained by assuming that the salient perturbation of the game is the game in which both players have a strategic value of deterring the other players.

Results (Confidence)

(1) *The real performance of participants, measured by the (unknown to the participants) number of correct answers, significantly influences reported confidence in the expected directions. Those people who are familiar with conditional probabilities also report higher confidence, after controlling for correct answers.*

(2) *Men report a significant 10 percentage points higher confidence in the deterrence treatment, even though it is only known after taking the test (but before the statement is given) that there will be strategic interaction. There is no significant treatment effect for women.*

(3) *There is also a significant treatment effect in the hustler treatment, as both male and female senders deflate their stated confidence by about 15 percentage points. However, receivers do not deflate stated confidence at all.*

(4) *The only case in which there is a difference in stated confidence between Senders and Receivers is the hustler treatment, where there is a difference for both males and females. In the deterrence treatment, the similarity of the behavior of players in the two roles may reflect an automatic response to competition on an unconscious level.*

The confidence reports in the deterrence and hustler treatments will be discussed again in the analysis of the strategic behavior of participants. Here we only mention that we cannot reject rational Bayesian updating using the Burks et al. (2009) allocation function. This may re ect our having only two intervals, either above or below the median.

4.2. **Voluntary tournament entry.** In the deterrence and hustler treatments, player *R* chooses whether to enter a tournament with player *S*, who is automatically entered into the tournament. This result contrasts with the other treatments in which both people are automatically entered into the tournament. *R* can take into account *S*

performance level was 8.82 for males and 8.56 for females, not signi cantly di erent (Wilcoxon ranksum test: $Z = 0{:}20$, $p = 0{:}843$, two-tailed test).

Figure 3. **Entry by gender.** Error bars: +/- SE

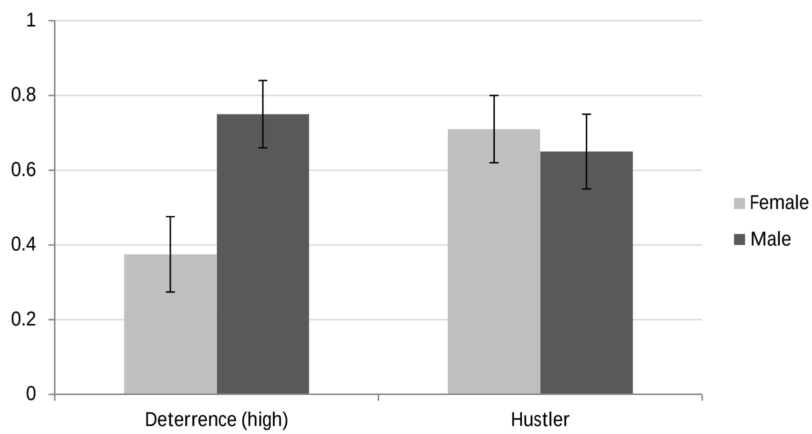


Table 4 reports the probit estimates of the decisions to enter the tournament.[12] The rst three

The three speci cations for the hustler treatment give similar results, with smaller magnitudes, but the coe cient for own con dence is not signi cant. Note that once again there is no evidence that women are *per se* less likely to enter.

[Table 4 about here]

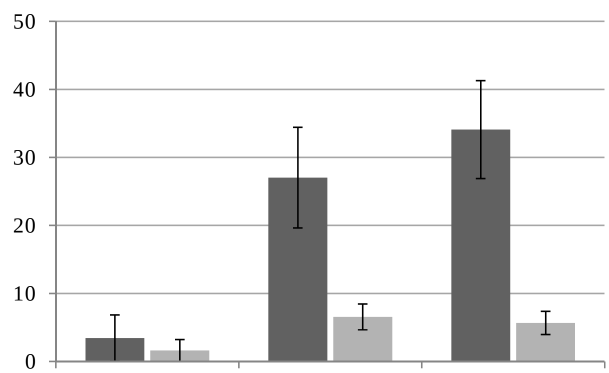
Results (Tournament Entry)

(1) *When deciding whether to enter the tournament, participants are more likely to enter when their con dence is higher; they are also sensitive to the con dence reported by the opponent: If own stated con dence is lower than that of the opponent, subjects are far less likely to enter.*

(2) *Females are less likely to enter the competition in the deterrence treatment, but this e ect*

more likely to be in the top 2 after receiving negative feedback; for someone with initial con dence above the threshold, the error would consist of believing the opposite. The two errors represent respectively a form of under-updating and over-updating.

Figure 4. **Updating error rates for reports and machine questions, by con dence interval.** An updating error is de ned as an answer di ering from the one provided by Bayesian updating of a prior equal to the stated con dence of the subject. Error bars: +/- SE



The test that errors are due to a general inability to update is provided by the comparison of the frequency of errors depending on whether or not the updated belief concerns one's own relative skill. Figure 4 compares mistakes made by subjects in each of those intervals after they receive negative feedback in the Reports and Machine settings. There are very few errors for people with stated initial con dence below 50 in either case. Updating mistakes are always rare with the Machine questions, as the percentage of mistakes ranges from less than two percent to less than seven percent. The picture is very di erent for the Report questions: 27 percent of subjects make under-updating errors in the interval between 50 and 67, and 34 percent of subjects believe negative feedback when stated con dence was larger than 67 percent.[15] The error rates on the Report questions are signi cantly higher than with the Machine questions (Test of equal proportions gives $Z = 3.72$ and $Z = 5.46$ for the respective comparisons, both $p = 0.000$).

What is the source of errors in the Reports? It is clearly not the case that our participants are unable to do the Bayesian updating task, given their performance on the Machine questions. Thus, it seems that there is something about own ability or performance that induces these errors. Our view is that this re ects a desire (perhaps on an unconscious level) for high self-esteeem or ego utility.[16] Nevertheless, this is also modulated by intelligence, as measured by the Raven test. Participants making updating errors on the Reports seem to do worse in terms of performance. If we group over-updating and under-updating errors, we nd that those making errors have fewer correct answers on the Raven test: 7.6 is the mean among participants making updating errors versus 8.3 of those who do not. Controlling for reported con dence, this di erence is signi cant (column 1 in Table 5).[17] Thus, a lower cognitive ability is associated with making updating errors. We nd a similar e ect for errors on the Machine questions but the coe cient is not signi cant (column 2). In the case of the Reports, the di erence in performance translates into a large e ect on the likelihood of actually being in the top 2 (19 percent versus 41 percent, $Z = 2.00$, $p = 0.045$), but not in the case of errors on the Machine questions (32 percent versus 37 percent, $Z = 0.41$, $p = 0.680$).

[Table 5 about here]

Results (Updating Errors)

[15]The fractions of errors in the intervals 50-67 and above 67 are not signi cantly di erent from each other (Z

(1) *Errors in updating are much more likely to occur for questions involving own skill judgment than for the abstract questions; hence such errors do not merely reflect a general inability to perform Bayesian updating. Errors in response to the abstract questions are rare.*

(2) *There is no significant difference in the rates of under-updating errors and over-updating errors.*

(3) *People who make errors on the Reports do worse on the Raven test and are much less likely to be in the top 2, controlling for confidence.*

5. Self confidence and its motivations

What do these results tell us on the origin and motivation of overconfidence? One key potential motivation for being overconfident that has been suggested is the ego utility that one derives, producing an increase in self-esteem. In our data we observe substantial overconfidence even when the stated confidence level is not observed by anyone else. This finding suggests that people are either poor judges of probabilities, or that they receive some internal benefit from this inflated belief, or that think they might influence others' behavior.

The fact that people make far fewer updating errors with the Machine questions suggests that the explanation of this overconfidence is not poor ability to estimate probability of events. On the other hand errors in updating do not exhibit any bias in the direction suggested by ego-utility or preservation of self-esteem. Many subjects with a prior stated probability lower than the threshold update and receive a negative report still state a probability larger than 50% that they are in the top 2, and this might be considered a bias induced by self-image preservation. But correspondingly many subjects who should, according to their maintain a probability larger than 50% do not do so facing a negative report, a bias that goes contrary to self-image preservation.

These results are consistent with our general hypothesis that views strategic concerns as a primary source of overconfidence. In fact we see strong evidence that an increase (decrease) in a sender's reported confidence can have deterrent (encouragement) value in terms of inducing the receiver in or out of the tournament. We also see some evidence (see Figure 1 and Table 3) that males report higher confidence in the strategic condition than in the baseline treatment. How close is this behavior to that which is optimal for senders? We take this up in the next subsection.

5.1. Optimality of decisions.

Behavior of receivers. We already saw that much of the behavior of receivers can be explained by the simple rule that a receiver enters if and only if his own confidence is at least as high as the reported confidence of the sender. To test how precise this description is we check it against the data, and find that the rule correctly classifies 87.5% of the receivers' decisions in the deterrence treatment (high outside option), and 81.25% in the hustler treatment. Moreover, most of the incorrectly classified decisions are close to the cutoff level.

Optimal reporting. If we assume that receivers indeed play this strategy, and that senders anticipate this, we can analyze the best response of senders. We will model this by assuming that players have types, $\theta \in [0;100]$; that are drawn from a continuous distribution function with density $f(\theta)$: We index players by $i = S;R$ (sender and receiver respectively). Players choose a message $t^i \in T = [0;100]$; so that the message space is the same as the type space. The message of a player is his reported confidence, and the type is his true belief about his confidence. In our experiment a receiver has no incentives to report a confidence that differs from his type, so we assume $t^r = \theta^r$: After observing t^s; receivers choose an action in the set $\{Out; In\}$. The assumed strategy of the receiver is then to play In if and only if $t^r \geq t^s$:

Let O^S be the sender's outside option payoff if the receiver chooses Out: If the receiver chooses In, the sender's payoff is v^h if he wins and v^l if he loses. The probability that the sender wins is $\pi(\theta^s; \theta^r)$: We will specify precise functional forms of π. The expected payoff for the sender of the tournament is then given by:

$$(2) \qquad \int_0^{t^s} O^S dF(\theta^r) + \int_{t^s}^{100} (\pi(\theta^s; \theta^r)(v^h - v^l) + v^l) dF(\theta^r):$$

The reason for reporting an inaccurate confidence level is to change the probability that the receiver chooses In: The optimal reported confidence for a risk-neutral sender is determined by:

$$(3) \qquad f(t^s)[O^S - \Phi(\tau^s; t^s)(v^h - v^l) - v^l] = c(t^s - \tau^s).$$

The RHS reflects the fact that players have the incentive provided by the quadratic scoring rule to report truthfully, creating costs when their reported confidence differs from their true belief (where $c = 2/10{,}000$). In the deterrence treatment, the term in brackets on the LHS is positive so that over-reporting is optimal ($O^S = v^h = 10, v^l = 0$), while in the hustler treatment this term is negative so that underreporting is optimal ($O^S = 10, v^h = 25, v^l = 10$).

We specify

$$(4) \qquad \Phi(\tau^s; \tau^r) = 1/(1 + e^{-\lambda(\tau^s - \tau^r)}),$$

where $\lambda = .021$ is estimated from the data of the baseline treatment in which there are no incentives to over-report. For $F(\cdot)$, we assume that players believe that types are normally distributed (truncated at 0 and 100) with mean 50 and standard deviation 21. The value of the standard deviation is estimated from the data and we take a mean of 50 to reflect that players do not believe that other players are on average overconfident.

Figure 5 plots the optimal reporting for senders under the assumptions made. The thin solid line represents truthful reporting. The thick solid line represents the optimal report in the deterrence treatment, and the dashed line for the hustler treatment. In both treatments it is optimal for senders to deviate substantially from their true belief. For instance, the optimal report for a sender with a confidence of 60 is 80 in the deterrence treatment, and 20 in the hustler treatment. In both cases the optimal deviation from truthful reporting is substantially larger than what we see in the data. Based on reported confidence levels in the baseline treatment, we should expect that the average confidence is about 20 higher in the deterrence treatment (we find roughly 0 for females and 10 for males), and 45 lower in the hustler treatment (we find about 10-15 lower). We should also find no reported confidence below 60 in the deterrence treatment (because even for type 0 the optimal report is above 60), or above 30 in the hustler treatment (because even for type 100 the optimal report is below 30), but we see quite a few examples in the data.

6. Conclusion

Our experiments examined the determinants of self-confidence, and the degree to which it reflects strategic concerns about social image (utility from the perceptions of others). Our main conclusion is that levels of stated confidence are likely to be influenced by strategic interest, perhaps unconsciously processed. We see evidence that people will inflate or deflate incentivized statements of confidence levels when doing so is strategically beneficial. We suggest that inflating confidence when doing so is not strategically beneficial reflects the notion of salient perturbations. In familiar situations overconfidence has strategic value, so that we may observe it in non-strategic environments that are similar to the familiar situation.

Our novel strategic environment (in which another party observes the stated confidence level of another and then chooses whether or not to enter a tournament with this other person) allows a direct test of the strategic-interest hypothesis. First, the social signal is perceived and has consequences: subjects in our experiment do respond to statements about confidence made by others, taking that information into account when choosing whether or not to enter. In the deterrence treatment, male (but not female) participants on average report significantly higher confidence levels than in the non-strategic treatments. Inflated confidence serves as an effective deterrent. Interestingly, males (but not females) do so in both roles, even when deterrence is impossible; this suggests processing on an unconscious level.

In the presumably less-familiar hustler environment, we observe deflated confidence for both men and women in the role of senders, which serves to encourage entry. We argue that conscious cognition is present in this less-familiar environment. Strategic deterrence and hustling are consistent with the equilibrium we characterize; the degree to which one engages in costly strategic distortion depends on the values of the parameters in the game.

We also find a substantial proportion of updating errors about one's own ability. However, this is not a consequence of a generic error in Bayesian updating because people are much more accurate in updating their beliefs when the information is about an impersonal issue then they are when new information concerns their own ability. In fact, they are hardly ever wrong in the abstract setting. This shows that information processing when own reputation is at stake is of a different nature than abstract, neutral information processing.

When inflated reported confidence is strategic, it is natural to find gender differences in our participants' behavior, given the evidence of other gender differences such as with respect to financial risk preferences (Charness and Gneezy 2010, 2012), competition (Gneezy, Niederle, and Rustichini 2003), and even shame (Ludwig and Thoma 2012). But since hustling is a much less familiar environment and strategic distortion is presumably driven by cognitive ability (which is the same for men and women on the Raven test), we see men and women engaging equally in this behavior.

We also find no evidence that women shy away from competition. While men choose to enter a tournament much more frequently than women do in the deterrence treatment, there is no difference when one controls for confidence; there is no difference in entry rates or stated confidence in the hustler treatment. So women are not less competitive than men in our data.

There are a number of directions for future research. Is some of the observed behavior truly unconscious? To what extent is self-deception present? An additional question is whether the behavior we observe in the voluntary-entry treatment would persist over time, as would be predicted by the equilibrium we have described.

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Appendix A. Instructions

The comments in square brackets are meant to illustrate instructions to the readeraaa.9091 Tf 235.1 t299(w)27(

against a player B. If your rank is higher than the player with which you are matched, you can receive 10 points.

Part 2.

All four group members have now finished with the questions, and we have determined the rank of every person.

We now ask you to indicate how likely you think that you are among the top 2 of your group. You can indicate this on a scale from 0 to 100%. Indicating 0% means that you are sure you are not among the best 2 of your group, while indicating 100% means that you are sure you are among the top 2 of your group. Similarly, 50% indicates that you think it is equally likely that you are among the best 2 of your group, or that you are not among the best 2 of your group.

We will pay you for the accuracy of your estimate. You earn more points for this item if your estimate is more accurate. The formula that is used to calculate the amount of money you earn is chosen in such a way that your expected earnings are highest when you report to us what you really believe. Reporting any value that differs from what you believe decreases your expected score for this item. If you are interested, you can find some detailed examples of this to see how this works. [An explanation with examples was available to participants, see below.]

The role of player A and player B We matched you with one other randomly chosen person from your group. You are either Player A or B, and this is randomly determined.

[*baseline*] None of the players can see the other player's estimate of being in the top 2.

[*social*] Player A will not see the estimate by player B that he or she is among the best two in the group, but player B will see the estimate by Player A that he or she is among the best two of the group.

[*baseline and social*] Later on in the experiment, we will compare the rank of player A with the rank of player B, and for that item the player with the highest rank receives 10 points, the other nothing. Both of you will see who has the highest rank, and this ends the stage.

[*strategic deterrence and hustler*] Player A will not see the estimate by player B that he or she is among the best two in the group, but player B will see the estimate by Player A that he or she is among the best two of the group.

Later on in the experiment, after player B has observed the estimate of player A, player B will choose between two options: IN or OUT.

If player B chooses OUT, then for that item player B receives 3.5 [5.5] points and player A automatically receives 10 points. Both players will see who has the highest rank, and this ends the stage.

[*deterrence*] If player B chooses IN, we will compare the rank of player A with the rank of player B, and for that item the player with the highest rank receives 10 points, the other nothing. Both of you will see who has the highest rank, and this ends the stage.

[*hustler*] If player B chooses IN, we will compare the rank of player A with the rank of player B. For this item, Player A receives 25 points if (s)he is the highest ranked player, and 15 points if (s)he is not the highest ranked player. Player B receives 10 points if (s)he is the highest ranked player, and 0 points if (s)he is not the highest ranked player. Both of you will see who has the highest rank, and this ends the stage.

You can see what role you have on the top left of your screen (see the example below). [Participants could see their role on the next screen.]

Determination of your score What follows is a brief explanation about the determination of your score, showing that it is in your interest to report truthfully what you believe in order to maximize your expected earnings.

The score is determined as follows. You start with 10 points. We subtract points depending on how close your reported belief is to the outcome. The outcome is set to 1 if you are in the top 2, and to 0 if you are not.

For instance, if you report 70% (.7), and you are in the top 2 (outcome is 1), you are .3 away from the outcome, while if you are not in the top 2 (outcome is 0), you are .7 away from the outcome.

The di erence with the outcome is squared and multiplied by 10, and then subtracted from the 10 points that you start with. Thus in the example with 70%: if you are in the top 2, this gives you $10 \quad 10(.3)^2 = 9.1$. If you are not in the top 2, this gives $10 \quad 10(.7)^2 = 5.1$. You would weight these two scores by your belief about the likelihood of each occurring.

Larger di erences between your reports and the outcome decrease your score proportionally more than small di erences. To minimize the expected di erence, and maximize your expected score, you should report what you believe.

The following examples illustrate that your expected score is highest when you report your true beliefs. *All numbers used are for illustrations only and are no indication for the decisions for you to take.*

Example 1
You believe 50% and report 50%. As a simple example: if you believe there is a 50% chance you are in the top 2, and you report 50%, then there is always a di erence of .5 with the outcome, and since this is squared we always subtract 10 times $(0.5)^2$ points from your score, i.e. 2.5 points. Your expected score is 7.5.

You believe 50% but you report 100%. If you report 100%, then in one case there is no di erence (if you are in the top 2) and no points are subtracted. But in the other case the di erence is 1 (if you are not in the top 2), and then we subtract 10 times $(1)^2$ from your score. If you believe the likelihood of being in the top 2 is 50%, you expect this to happen in 50% of the cases, so the amount subtracted would be 10(0.5) = 5. This gives you an expected score of 5, which is lower than if you report your belief of 50%.

Example 2
You believe 70% and report 70%. As another example, suppose that you think there is a 70%

likelihood that you are among the best 2. If you report 70%, your score will be either 9.1 (if you

If you *are* among the top two of your group, the report is mistaken in half of the cases. That is, in half of the cases, the report correctly informs you that you are among the top two of your group. In the other half of the cases, the report is incorrect and says you were not among the top two of your group, even if you were.

Whether or not the report you receive is correct when you are among the top two of your group, Part 5.

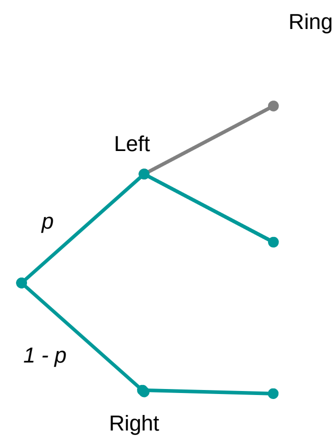
[*baseline and social*] In this part, you are informed if player A or B has the highest rank.

[*strategic deterrence and hustler*] Player A will not see the estimate by player B that he or she is among the best two in the group.

Player B will see the estimate by Player A that he or she is among the best two of the group, and then gets the choice between two options: IN or OUT.

[We repeated the instructions of Part 2 in which the payo s were given for this item].

Figure 6. **Illustration of the signal structure in the Report and the Machine question.** This gure was not provided to subjects, and is only meant as illustration.



Appendix B. Model

In this appendix we characterize the equilibrium set of the extensive form game described in section 3.1. Our aim is to formally show that the following intuition is equilibrium behavior: (*i*) In the deterrence treatment, the sender has a relatively high outside option and will therefore overreport to appear strong and deter the receiver from entering the tournament, (*ii*

B.2. **Preliminaries.** Recall that $_j^i$ denotes player i 2 $f1;2g$ of type j 2 $f0;1g$. The sender is indexed as player 1 and the receiver as player 2. A weak player is indexed as 0, a strong player as 1. We assume that the payo s of players are symmetric as in the following payo table:

(5)

	$^2_0$	$^2_1$
$^1_0$	$0;0$	$b;a$
$^1_1$	$a;b$	$d;d$

This is the case for the deterrence treatment. We will return later to the hustler treatment which has asymmetric payo s. We consider:

$$a \quad O^2 \quad d \quad 0 \quad b; \tag{6}$$

where O^2 is player 2's outside option. This implies that *Out* strictly dominates *In* for a weak player 2. Strategies of player 1 are functions from type to probability on signals: $^1(^1;)$ 2 (T). Strategies of player 2 are functions from type and signal of player 1 to probability on actions: $^2(^2;t;)$ 2 $(fIn;Outg))$. To lighten notation we call in the following $(^2_1;t_0;In) = r;$ $(^2_1;t_1;In) = s$, where t_0 and t_1 are the low and high message respectively.

We now make precise what we mean by over- and underreporting.

De nition B.1. *(Over- and underreporting) We call an equilibrium in our game underreporting if:*

$$^1(^1_0;t_0) = 1; \quad ^1(^1_1;t_0) \quad 2\ (0;1): \tag{7}$$

that is if the low type only reports a low type, and the high type reports a low type with positive probability. We call an equilibrium over-reporting equilibrium if:

$$^1(^1_1;t_1) = 1; \quad ^1(^1_0;t_1) \quad 2\ (0;1): \tag{8}$$

B.3. **Types of equilibria.**

B.3.1. *Monotonic equilibria.* We rst examine monotonic equilibria, i.e., those where the function ^{1} ! ^{1} is increasing (higher types give higher signal). We then show that non-monotonic equilibria do not exist. In our simple model an equilibrium is monotonic if:

$$^1(^1_1;t_1) \qquad ^1(^1_0;t_1) \tag{9}$$

and we say it is strictly monotonic if the inequality (9) is strict.

The equilibrium set is easily characterized if we take into account the following. Take the $(;)$ 2 $[0;1]^2$ pairs describing as in (7) and (8) the strategy of player 1.

Lemma B.2. *If (6) holds, then for generic payo s the only monotonic equilibria are either the fully revealing truthful, or the two pooling (at the low and high type respectively) or the under or over-reporting equilibria.*

Proof. Su easily chara0.9091 Tf 8.31.90md [sw [(he)-404(under)-404(or)]TJ 0 -12.077(B.2.e Td [(710.9091 (th)]TJ

. 11.555 0 Tdr0

So except for non-generic cases in which the equality (10) holds, there is no equilibrium where $(\; ; \;) \in (0;1)^2$, so equilibria are on the boundary of the unit square. Monotonicity requires $1 \quad$, which excludes the strategies with $\; + \; > 1$ (such as the "reverse fully revealing" equilibrium $(\; ; \;) = (1;1)$). So we have either one of the three residual corners of the square, or a point in the two sides $\{0\} \quad (0;1)$ (under-reporting equilibria) and $(0;1) \quad \{0\}$ (over-reporting equilibria).

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B.3.2. *Fully pooling and fully separating equilibria.*

Lemma B.3. *If (6) holds a fully revealing equilibrium exists if and :03*

For the low signal pooling we have:

Lemma B.5. *If (6) holds a pooling equilibrium at the low signal exists if and only if either:*

$$O^2 \quad (a+d)/2 \text{ and } d \quad O^1 \quad \max\{2c; O^1 \quad b\} \tag{16}$$

or:

$$O^2 \quad (a+d)/2 \text{ and } O^1 \quad d \quad \max\{2c; b \quad O^1\} \tag{17}$$

Proof. With $r; s$ denoting as usual the probability that the high type Player 2 chooses In at t_0 and t_1 respectively, an equilibrium pooling on the low type exists if and only if with $r \in sign((a+d)/2 \quad O^2); s \in [0; 1]$ the inequality

$$(r \quad s)(d \quad O^1) \quad 2c \quad (s \quad r)(b \quad O^1)$$

holds. These hold if and only if (16) hold.

In the following we can then focus on the under and over reporting equilibria; remember that we have excluded by definition the fully pooling or fully separating equilibria from this set.

B.3.3. *Under-reporting equilibria.*

Lemma B.6. *An under-reporting equilibrium exists if and only if the inequalities in 6 and*

$$d \quad O^1 \quad \max\{2c; O^1 \quad b\} \tag{18}$$

for player 1 and

$$O^2 \quad (a+d)/2 \tag{19}$$

for player 2 hold.

Proof. We already know that at all equilibria, player 2 chooses *Out* at $\ {}^2_0$ irrespective of the signal. We check whether an equilibrium exists with $\ \in (0; 1]$. At $\ {}^2_1$ with such a strategy of player 1, player 2 chooses In at t in a best response if and only if the posterior $m(\ {}^1_0|t) \quad \frac{O^2 \ d}{a \ d}$. This is never the case if the signal is t_1, and it holds at t_0 when $\frac{1}{1+} \quad \frac{O^2 \ d}{a \ d}$. So the strategy of player 2 has only one indeterminate value $r \quad (\ {}^2_1; t_0; In)$ and we know that $r \in sign(\frac{1}{1+} \quad \frac{O^2 \ d}{a \ d})$, where the *sign* correspondence is 1, 0 at positive and negative values, and the unit interval at 0.

Our last step is to check when the best response of player 1 to such strategy has the under-reporting form, with $\ \in (0; 1]$. Since as we have seen player 2 exits at t_1, choosing t_1 gives $O^1 \quad c$ to the type $\ {}^1_0$ and gives O^1 to the type $\ {}^1_1$. For a given r, t_0 is better than t_1 for type $\ {}^1_0$ if $O^1 \quad c < (1 \quad (r/2))O^1 + (r/2)b$, and t^1 is indifferent to t_0 for type $\ {}^1_1$ if $O^1 = (1 \quad (r/2))O^1 + (r/2)d \quad c$. These two conditions are satisfied if for some $r \in (0; 1)$:

$$r(d \quad O^1) = 2c > r(O^1 \quad b)$$

which is equivalent to the additional condition (18).

The equilibrium is based on the fact that player 1 may be willing to pay the cost of signaling t_0 to hustle player 2 in the tournament to get the payoff d; the gain is $(r/2)(d \quad O^1)$ and is equal to the cost c. Player 2 at $\ {}^2_1$ may choose In at the low signal t_0 because may get the high payoff a from $\ {}^1_0$ or the lower payoff d from $\ {}^1_1$, but overall this is the same as the *Out* payoff O^2.

B.3.4. *Over-reporting equilibria.* A similar analysis yields:

Lemma B.7. *An over-reporting equilibrium exists if and only if the inequalities in 6 and*

(20) $$O^1 \quad b \quad \max f2c; d \quad O^1 g$$

for player 1 and

(21) $$O^2 \quad (a + d)=2$$

for player 2 hold.

Proof. In this case at equilibrium $^1(\, ^1_1; t_1) = 1$, and $^1(\, ^1_0; t_1)$. The posterior beliefs are $m(\, ^1_0 j t_0) = 1$ and $m(\, ^1_0 j t_1) = \frac{}{1+}$. Player 2 weakly prefers *In* to *Out* if and only if $\frac{}{1+} \quad \frac{O^2 \quad d}{a \quad d}$, which is equivalent to $= \frac{O^2 \quad d}{a \quad O^2} = 1=$. His strategy is to choose *Out* at $^2_0$ and $^2(\, ^2_1; t_1$

$d \quad O_1$

B.4. Summary.

The strategic deterrence treatment. In the strategic deterrence treatment payoffs were symmetric, so the analysis of above applies. Specifically, if we subtract 5 from all payoffs, and make use of the fact that ties are broken by random assignment of the *win* outcome, the payoffs were:

(27)
$$\begin{array}{c|cc} & \sigma^2_0 & \sigma^2_1 \\ \hline \sigma^1_0 & 0; 0 & -5; 5 \\ \sigma^1_1 & 5; -5 & 0; 0 \end{array}$$

and outside options $O^1 = 5$ for player 1 and $O^2 = 0.5$. This is the case $O^1 - b = 10 \geq \max\{2c; d - O^1\} = 2c$ because $d - O^1 = -5$, and $(a + d)/2 = 2.5 > O^2 = 0.5$, hence (provided costs c are sufficiently low) we are in the over reporting branch (see theorem B.9).

The Hustler treatment. In the hustler treatment the payoffs from entering the tournament were not symmetric, and we represent them as follows:

(28)
$$\begin{array}{c|cc} & \sigma^2_0 & \sigma^2_1 \\ \hline \sigma^1_0 & e; d & g; f \\ \sigma^1_1 & a; b & e; d \end{array}$$

where $a = 25; b = 0; d = 5; e = 20; f = 10; g = 15$, and $O^1 = 10; O^2 = 5.5$ (again using the fact that ties are broken by random assignment of the *win* outcome). Note that

(29)
$$\text{for all } \sigma; O^1 < v^1(\sigma); f > O^2 > d > b$$

We look for equilibria of the under-reporting form, as in lemma (B.6).

Lemma B.11. *An under-reporting equilibrium of the game with tournament payoffs (28) exists if 30 and*

(30)
$$e - O^1 \geq 2c$$

hold.

The proof is a simple computation. The intuition for the equilibrium is clear. Player 2 of the low type prefers *Out* to *In* irrespective of what outcome he is expecting in the tournament. The high type will choose *In* if he gives enough weight to the event that he is facing a low type. At a monotonic under-reporting equilibrium the high signal t_1 reveals that the type is high, so player 1 of low type will not incur the cost of lying when by doing so he could only tempt player 2 to choose *Out*. The high type player 1 may be made indifferent between telling the truth and thus forcing player 2, out or hustling him by stating the low type, paying the cost, and getting with enough probability to reap the benefit of a match with a low type player 2. He can be made indifferent between these two options when the extra gain $r/2(e - O^1)$ can be made equal to the cost $2c$, for some r the probability that the high type player 2 plays *In* after a low signal. This is what condition (30) insures.

Appendix C. Regression Tables

Table 3: *Determinants of con dence* (scale 0 { 100)

Dependent var: : Confidence	(1)	(2)	(3)	(4)
Number of correct answers	3.50***	3.52***	3.52***	3.32***
	(0.39)	(0.39)	(0.38)	(0.40)
Social	0.29	0.05	0.08	-1.74
	(2.94)	(4.15)	(4.07)	(4.12)
Deterrence (low and high)	3.54	3.06	9.21**	9.26**
	(2.31)	(3.25)	(4.02)	(4.07)
Hustler	-5.55**	1.06	0.57	1.06
	(2.64)	(3.70)	(4.77)	(4.79)
Sender		0.26	0.65	1.02
		(3.31)	(3.27)	(3.26)
Social Sender		0.47	0.16	1.82
		(5.88)	(5.77)	(5.82)
Deterrence Sender		0.96	-0.00	-0.57
		(4.59)	(5.43)	(5.48)
Hustler Sender		-13.21**	-13.21**	-15.18**
		(5.24)	(6.47)	(6.46)
Female			-3.06	-2.57
			(2.76)	(2.78)
Deterrence Female			-11.00**	-12.30**
			(5.20)	(5.24)
Deterrence Sender Female			-0.71	-0.58
			(6.26)	(6.31)
Hustler Female			1.96	-0.04
			(6.27)	(6.28)
Hustler Sender Female			-1.00	0.51
			(7.97)	(8.04)
Familiar with conditional probs.				4.46**
				(1.93)
Constant	33.05***	32.78***	33.76***	31.54***
	(3.75)	(4.16)	(4.22)	(8.97)
Observations	464	464	464	462
R-squared	0.17	0.19	0.23	0.26
Adj. R-squared	0.16	0.18	0.21	0.23

Table 4: *Determinants of entering*

Dependent var: choice is In	Deterrence (high outside option)			Hustler		
	(1)	(2)	(3)	(4)	(5)	(6)
Own con dence	0.044***	0.015**	0.014*	0.012***	0.007	0.008
	(0.012)	(0.007)	(0.008)	(0.004)	(0.005)	(0.005)
Opponent's con dence	-0.029***			-0.005		
	(0.010)			(0.003)		
Con dence is lower[z]		-0.619***	-0.621***		-0.412**	-0.414**
		(0.138)	(0.141)		(0.181)	(0.190)
Female			-0.096			0.040
			(0.203)			(0.149)
Number correct answers			-0.019			0.016
			(0.042)			(0.046)
Risk aversion[y]			-0.030			0.044
			(0.080)			(0.044)
Observations	48	48	48	48	48	48
Pseudo R-squared	0.59	0.56	0.57	0.26	0.30	0.32

Notes: Probit estimates, reporting marginal e ects. [z]Lower con dence is equal to 1 if receiver's con dence is lower than the paired sender's, and 0 otherwise.[y]Eight missing observations were replaced by the mean in model (3). St. err. in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 5: *Determinants Updating errors and performance on the Raven task*

Dependent var:: Number of correct answers	(1)	(2)
Report error	-1.09**	
	(0.52)	
Machine error		-0.90
		(0.59)
Con dence	0.04***	0.03***
	(0.01)	(0.01)
Constant	6.09***	6.49***
	(0.68)	(0.72)
N	112	112
R-squared	0.11	0.10

Notes: Sample is participants in baseline treatment that received negative feedback. Over-updating and under-updating errors combined. St. err. in parentheses. *** p< 0.01, ** p <0.05, * p < 0.1.