Confidence and Communication: Too much air time for some?*

Iuliia Grabova†

November 20, 2023

Most recent version available here

Abstract

This paper studies how beliefs about one's own relative skill affect communication, especially the decision to talk - instead of letting other people do the talking. I use a laboratory experiment to investigate whether overconfidence leads to less successful conversations. In a communication game with aligned incentives, two senders try to inform a receiver. The accuracy of each sender's information depends on his relative skill, such that the more skillful sender should do the talking. Senders who overestimate their skill may fail to be informative. A treatment variation creates an exogenous shock to senders' confidence level. The results confirm that increased confidence leads to more talking. The conversation, however, does not become less informative. In the treatment with upward shift in confidence, senders coordinate better who should talk and who should stay silent. I find that competition for attention impedes coordination, whereas feedback about relative skill facilitates it.

JEL-classification: C91; D83

Keywords: Self-confidence; Overconfidence; Communication; Experiment

*I would like to thank Georg Weizsäcker, Emanuel Vespa, Yiming Liu, Valeria Burdea, Joël van der Weele, Tobias Gamp, Dirk Engelmann, Jonas Radbruch, Sebastian Schweighofer-Kodritsch, Jeroen van der Ven, Joel Sobel, Marta Serra-Garcia, and Kirby Nielsen for interesting discussions and helpful suggestions. I thank the German Science Foundation for generously funding this project via CRC TRR 190.

†Humboldt-Universität zu Berlin and DIW Berlin, graboviu@hu-berlin.de

1 Introduction

Beliefs about one's own relative skill matter for many economic decisions, like educational and career choices (Murphy and Weinhardt 2020, Elsner et al. 2021, Barron and Gravert 2022), market entry (Cain et al. 2015), and portfolio management (Daniel and Hirshleifer 2015). Yet, little is known about how these beliefs affect communication, especially the decision to talk - instead of letting other people do the talking. Are the people who decide to speak up in a team meeting, present in front of an audience or share a post on social media really more competent relative to others? Some research says no: various experts (managers, securities analysts, lawyers, etc.) are often charged with being overconfident about their relative skill or the quality of information they have (Huffman et al. 2022, Chen and Jiang 2006, Goodman-Delahunty et al. 2010). Moreover, there is evidence to suggest that people with limited competence overestimate their relative skill, whereas highly competent individuals are less overconfident in their relative self-assessments (Kruger and Dunning 1999). Thus, the less competent experts might engage in conversations and mislead the listeners.

This paper experimentally investigates whether overconfidence about one's own relative competence leads to less successful conversations. In a communication game with aligned incentives, two senders (he) inform a receiver (she). Both senders share a common goal to inform the receiver as well as possible, but differ in their relative competence. When the receiver has limited time and can only focus on one message, it is most efficient for the more competent sender, who has better information, to do the talking while the less competent sender remains silent. However, if the senders misjudge their own levels of competence, the effective coordination between them may not occur. For instance, if the less competent sender who is overly confident takes control of the conversation, while the more competent sender, who is less confident, does not contribute, the communication will be inefficient as less accurate information will be transmitted to the receiver. The lab experiment allows to establish a causal relationship between confidence and communication. By introducing a treatment that provides an exogenous shock to the senders' confidence levels, I can measure the causal effect of the shift in beliefs on selection into talking. The results confirm that an upward shift in confidence translates into higher frequency of talking. Surprisingly, this does not lead to a decrease in the quality of information shared. In fact, senders from the treatment with an upward shift in confidence solve their coordination problem with higher precision, as they coordinate better who should talk and who should remain silent.

Another aspect highlighted in my paper is that experts frequently engage in a competition for the attention of their audience. For example, on social media platforms, content creators vie for likes, retweets, and views from their followers. Similarly, within an organizational setting, employees compete against each other for recognition, bonuses, and promotions from management. When senders compete for attention, their motivation for communication changes. They face a tradeoff between providing the most accurate information and ensuring their presence or visibility to the listener.[1] The decision to talk depends on the relative importance of these two motivations, on the sender's relative competence, and on his belief about the importance of the message to the receiver. Thus, if the sender believes that the receiver highly values the message, the sender is motivated to share the accurate information. On the other hand, if the sender believes that the receiver does not consider the message important, he may still choose to communicate even if his competence is low. This is because transmitting less accurate information gives him a chance to reap the competition reward. Simulating this situation in the experiment, I find that competition for attention leads to more talking. The decision to talk is no longer based on the belief about sender's relative competence. As a result, competition for attention hinders the coordination of senders towards the most efficient communication outcome.

The final aspect that I investigate is the impact of feedback on one's own relative competence on the outcome of communication. I discover that providing feedback enhances the coordination between senders. More competent senders consistently contribute to the conversation, while less competent senders tend to stay silent. As a result, more accurate information is transmitted to the receivers. Interestingly, the receivers anticipate this improvement, but they underestimate the influence of the feedback and do not fully adjust their beliefs.

In the experiment, I consider a setting with two experts (senders) who give advice to one decision maker (receiver). Each expert receives a signal about the state of the

[1]his is relevant in cases of one-shot communication where senders have no reputation concerns.

world. The accuracy of the expert's signal depends oh his relative performance in a reasoning task.[2] If the expert scores higher than the other expert, he is referred to as the High Performer and receives a correct signal. The other expert is referred to as the Low Performer and gets either a correct or an incorrect signal. After both experts observe their signals, each expert simultaneously decides on whether or not to forward his signal to the decision maker. If only one expert decides to forward, his signal is directly transmitted to the decision maker. If neither expert or both experts decide to forward their signals, one of the signals is randomly chosen and transmitted to the decision maker. The decision maker gets one signal which is called advice and reports how likely it is that the advice coincides with the true state of the world. All three participants have aligned incentives. Both experts should provide the most accurate information to the decision maker. Ideally, the High Performer should forward his signal, while the Low Performer should not. The decision maker should then follow the given advice. However, if the Low Performer is overly confident, both experts might forward their signals. This impedes the transfer of knowledge, as the decision maker would now get the correct advice with a lower probability.

To identify how beliefs about one's own relative performance affect communication, I rely on the hard-easy effect. Moore and Healy (2008) show that individuals tend to underestimate their skills compared to others when it comes to hard tasks (underplacement), and overestimate their skills compared to others when it comes to easy tasks (overplacement). By manipulating the difficulty of the reasoning task, I create an exogenous shock to the experts' beliefs about their relative performance. The experiment allows me to elicit these beliefs in an incentive compatible manner. I find that in the Hard treatment with a difficult reasoning task, experts' beliefs about being the High Performer are much lower than those in the Easy treatment with an easy reasoning task. Comparing beliefs about the relative performance to the actual relative performance in the reasoning task, I am able to quantify the degree of over/underplacement which would be challenging to measure and quantify using observational data.

To study the effect of competition for attention, I design the Reward treatment. In this treatment, expert whose signal is forwarded to the decision maker gets an additional small reward. I then compare the results of the Reward treatment to those of the Hard

[2] I use relative performance as a proxy for the relative skill.

treatment which is the same except for the additional reward.

To examine how feedback about one's own relative skill influences the decision to talk, I implement the Feedback treatment. In this treatment, I provide experts with feedback about being the High/Low Performer. I then compare the outcomes of the Feedback treatment to those of the Hard treatment, which serves as a baseline for comparison.

This paper helps to develop a better understanding of why people talk, if they talk when they should, and gives some directions on how to optimally design environments that support fruitful conversations. I find that the exogenous shift in confidence level causally influences individual's decision to talk. In the treatment with induced high confidence more talking takes place and there is a higher chance to hear the truth. This is because more competent experts who typically lack confidence are more inclined to participate in conversations when their confidence is boosted. Competition for the listener's attention also drives experts to talk more often. However, the average accuracy of conversations do not improve due to lack of coordination among experts. On the other hand, feedback about one's own relative skill improves coordination of experts and leads to more efficient communication. The listeners though tend to underestimate the effect of the feedback.

The paper makes contributions to several strands of literature. First, it contributes to the literature studying information transmission which shows both theoretically (Crawford and Sobel 1982, Battaglini 2002) and experimentally (Blume et al. 1998, Vespa and Wilson 2016) that if incentives of talkers and listeners are aligned, the full information transmission is possible. I find that even in the absence of strategic goals, the outcome of conversation is not straightforward due to several standard reasons: (1) biased beliefs about relative skill, (2) the difficulty of solving the coordination problem. Kawamura (2015) investigates the effect of biased beliefs in a standard two-person cheap talk model where talkers and listeners have aligned incentives. He shows that talkers' over- and underestimation of their own competence leads to information loss in communication. My paper confirms this result empirically. With respect to coordination, Enke et al. (2023) examine the impact of giving individuals the freedom to choose their level of involvement in decision-making processes. They investigate whether this freedom can help individuals filter out their own irrationalities and lead to more efficient aggregate outcomes. The study's results suggest that coordination on optimal outcomes is very heterogeneous and depends on the type of the bias that should be filtered. Similar to Enke et al. (2023), I find that less confident individuals tend to self-select out of communication and that individuals with lower performance are more overconfident than those with high performance. My paper is related in spirit to Vespa and Weizsaecker (2023) who investigate if people talk when they should.

Second, it adds to the existing body of literature on the competition between talkers. Studies by Charness et al. (2018) and Schwardmann and Van der Weele (2019) demonstrate that when talkers aim to persuade others of their superior performance, they tend to boost their confidence. In my paper, the incentives of talkers remain partially aligned: to convey accurate information and to capture the attention of listeners. This resembles theoretical framework proposed by Li et al. (2016) which suggests that as competition between speakers intensifies, the accuracy of communication decreases. I find that competition for attention leads to more talking, and hinders coordination.

Third, my paper relates to the literature on knowledge sharing (e.g., Mondak and Anderson 2004, Coffman 2014, Bordalo et al. 2019) that shows that individuals are less willing to share their knowledge with others in areas that are stereotypically outside of their gender's domain. From a broader perspective, I show that individuals are more willing to contribute their knowledge if the questions are easy. On hard questions, individuals have difficulty in recognizing their expertise. More skillful individuals are often underconfident about the relevance of their information and, thus, remain silent.

Third, my paper contributes to the literature documenting the effect on confidence on choices (e.g., Fehrler et al. 2020, Barron and Gravert 2022). Although a vast number of articles study overconfidence, assessments how an endogenous shift in confidence affects behavior is relatively rare. I extend this literature by examining the effect of an increase in confidence on talking.

The remainder of the paper is structured as follows. Section 2 describes the experiment and procedures. Section 3 presents theoretical framework and outlines hypotheses. Section 4 presents my results, and Section 5 concludes.

2 Experiment

In this section, I describe experimental design[3], treatments, and procedures.

2.1 Design

The experiment consists of two parts. In the first part of the experiment, participants are given a reasoning task. This task serves multiple purposes: first, it helps me determine how well participants perform relative to others to proxy their relative skills. Second, I manipulate the difficulty of the task to create an exogenous shift in participants' confidence levels. Finally, I collect information about participants' beliefs regarding their own relative performance, allowing me to assess if they have judged their skills accurately or if they have either underestimated or overestimated their skills. The second part of the experiment is the communication game that is designed to gather data on talkers' decisions to engage in conversations and on listeners' beliefs about talkers' competence.

The reasoning task. The reasoning task consists of 14 questions from the Raven's Advanced Progressive Matrices Test (RAPM, Raven 2000), which is frequently used to assess IQ levels. The questions are shown in the same order. In each question, participants need to identify the missing element that completes a pattern out of eight possible options. Participants have 7 minutes to solve as many questions as they can. During this time, participants are allowed to go back and forth between the questions and change their answers. Each correct answer is worth 0.20 euro and each incorrect or incomplete answer is worth 0.00 euro.

After the reasoning task, I elicit participants' beliefs regarding their relative performance. Specifically, I ask them to estimate the likelihood of being the High Performer (HP), i.e. "scoring higher than other participant randomly matched with you". To incentivize accurate guesses, I use the binarized scoring rule (Hossain and Okui 2013, Wilson and Vespa 2018). Participants can earn either 2 or 0 euro in the belief elicitation task. To prevent them from hedging, they are informed about the details of the belief elicitation task and its incentive scheme only after they have completed the reasoning task.

To create an exogenous shock to participants' confidence levels, I expose them to

[3] The text of the instructions is provided in the Appendix A.

either hard or easy version of the reasoning task. In the easy version, the 14 questions are selected from the easy and moderate difficulty levels of the RAPM Test. In the hard version, the questions are selected from the moderate and hard difficulty levels. Table1 summarizes how many answers were submitted by the participants, the number of correct answers, and participants' beliefs on scoring higher than other participant for each version of the reasoning task.

Reasoning Task	Mean	S.D.	Min	Median	Max	N
Hard						
N of submitted answers	9.39	3.54	1	10	14	345
N of correct answers	2.74	1.85	0	2	9	345
Subjective belief of being the HP	36.8	21.5	0	40	100	345
Easy						
N of submitted answers	12.4	1.91	7	13	14	129
N of correct answers	9.69	2.33	4	10	14	129
Subjective belief of being the HP	63.4	18.2	8	60	100	129

Table 1: Summary Statistics

The communication game. After completing the first part of the experiment, participants proceed with the communication game. All participants are randomly assigned to the groups of three: Expert A, Expert B and Decision Maker. The following is a summary of interaction within one group.

The Decision Maker ("she") would like to know the state of the world which could be either a or b with equal probability. She does not know the correct state, but can get an advice from an expert.

Each of the two experts ("he") receives a signal (a or b) about the state of the world. One of the two experts receives the 100%-accurate signal, i.e., the correct signal that coincides with the state of the world. The other expert receives the 50%-accurate signal, i.e., it is equally likely that the signal is correct or incorrect. The accuracy of experts' signals depends on their performance in the reasoning task. Whether Expert A or Expert B receives the correct signal (rather than the random signal) depends on his performance relative to the other expert in the first part of the experiment. The High Performer - the expert who answered more questions correctly - receives the fully informative signal, and the Low Performer - the other expert - receives the uninformative signal.

Each expert simultaneously decides whether to forward his signal to the Decision

Maker, thereby advising the Decision Maker. If one of the experts decides to forward his signal, the signal is directly transmitted to the Decision Maker. If both or none of the experts forward their signals, one of the two signals is randomly selected and transmitted to the Decision Maker.

Upon observing the advice from *one* expert, the Decision Maker has to evaluate its accuracy, i.e., to report how likely it is that the advice coincides with the state of the world.

The report of the Decision Maker determines the payment in the second part of the experiment. All three participants receive the same payment, which increases with the accuracy of the Decision Maker's assessment. The assessment is incentivized using the binarized scoring rule. The group members can earn either 8 or 0 euro. In order to earn the highest possible payment, (1) experts should inform the Decision Maker as well as possible, (2) the Decision Maker should aim to correctly assess how well informed she is.

2.2 Treatments

The experiment has a between-subjects design. In each session, participants are assigned to one of the four treatments.

Hard (H). In the Hard treatment, participants solve the hard version of the reasoning task. Their highest payment from the communication game is fixed at $X = 8$ euro.

Easy (E). In the Easy treatment, participants solve the easy version of the reasoning task. Similar to the Hard treatment, the highest payment from the communication game is fixed at $X = 8$ euro.

Feedback (F). The Feedback treatment is similar to the Hard treatment. The only difference is that in the Feedback treatment, each expert receives feedback about his relative performance before deciding on forwarding his signal to the Decision Maker.

Reward (R). The Reward treatment is similar to the Hard treatment. In the Reward treatment, experts can earn additional reward for being visible. The Expert whose signal is transmitted to the Decision Maker earns $Y = 2$ euro in addition.

2.3 Procedures

The experiment was programmed in z-Tree (Fischbacher, 2007) and conducted at the WZB-TU experimental laboratory in 2023. Participants were recruited through an online database using ORSEE (Greiner, 2015) from a subject pool of mostly undergraduate students from all faculties. In total, 474 participants participated in 27 sessions, with 9 to 21 in each: 193 of them were female, 277 male, and 4 chose the option "diverse". Participants received a show-up fee of 7 euro plus their earnings from the two parts of the experiment. Mean earnings for the 60-minute sessions amounted to 16.15 euro. The relevant instructions were showed on the computer screens. In addition, participants were provided with the paper version of the instructions for the second part of the experiment. Participants had to answer a set of the comprehension questions before proceeding with the communication game: 53.59 % answered all 7 questions correctly, 29.54 % made one mistake, the rest 16.88 % made 2.73 mistakes on average.

3 Theoretical Considerations

In this section, I present a theoretical framework that is closely related to the experimental design. This framework serves to develop hypotheses and lays the groundwork for the subsequent discussion of results in the next section.

3.1 Communication Game

I consider an information-transmission game with two senders ("he") and one receiver ("she") that mirrors my experimental design. In this game, the receiver's goal is to form an accurate belief about the true state of the world θ, $\theta \in \{a, b\}$, that has ex-ante probabilities $P(\theta = a) = P(\theta = b) = 0.5$. To form this belief, the receiver may draw on a sender's advice.

Senders. Each Sender i gets a private signal $s_i \in \{a, b\}$ about the state θ. The accuracy of the signal $\eta_i \in \{\overline{\eta}, \underline{\eta}\}$ depends on the Sender's relative performance in the reasoning task. If Sender i performs better than Sender $-i$, he is the High Performer and observes a perfectly informative signal with accuracy of 100%, $P(s_i = \theta) = \overline{\eta} \equiv 1$.

Whereas Sender $-i$, the Low Performer, observes a signal with accuracy of 50%, $P(s_{-i} = \theta) = \underline{\eta} \equiv 0.5$. Senders do not know neither their relative performance nor the accuracy of their signals, but form beliefs about it, $\hat{\eta}_i = P(\eta_i = \overline{\eta})$. Upon observing his signal, each Sender simultaneously decides if he wants to costlessly forward it to the Receiver to inform her about the true state of the world.[4] If exactly one sender decides to forward the signal, his signal is directly transmitted to the Receiver. If none of the senders or both senders decide to forward their signals, one of the two senders is randomly selected and his signal is transmitted to the Receiver. The signal $s \in \{s_i, s_{-i}\}$ that is transmitted to the Receiver is called advice.

Receiver. Upon observing *one* Sender's advice s, the Receiver gives a belief report μ that the true state θ is identical to the advice.

Incentives. Payoffs are computed using a binarized scoring rule. All three participants receive a non-negative reward X with probability $1-(1-\mu)^2$ if $\theta = s$ and $1-\mu^2$ if $\theta \neq s$ where the randomness is resolved in a single draw.

3.2 Strategies and Equilibrium Definition

Strategy of the Receiver. Receiver reports her belief μ that the observed advice s, $s \in \{a, b\}$, coincides with the true state of the world. The report of the Receiver can be expressed as $\mu = 0.5 \cdot P(\eta = \overline{\eta}) + 0.5$, where $P(\eta = \overline{\eta})$ is the probability that the observed signal is forwarded by the High Performer.[5]

Given the true belief $p = P(\theta = s)$ of the Receiver, the probability of receiving the reward X is given by

$$\pi(p, \mu) = p \cdot (1 - (1-\mu)^2) + (1-p) \cdot (1-\mu^2)$$

and the Receiver maximizes the probability of receiving the reward X by reporting $\mu = p$, i.e., she reports her true belief. Notably, the experiment uses a separate property of the binarized scoring rule: it not only induces the truth telling of the Receiver, but also encourages senders to forward the correct signal because the probability of receiving the

[4] I am restricting the communication game to the setting where senders are truth-telling, i.e., they forward their private information truthfully.

[5] See Appendix B.1 for the formal derivation of the strategy of the Receiver.

reward X increases with the probability that the advice is equal to the true state of the world.[6]

Strategy of the Sender. Sender i forwards his signal s_i if his expected payoff from forwarding it is larger than his expected payoff from not forwarding it. If Sender i believes that he is the High Performer with probability $\hat{\eta}_i$ and projects this information as in Madarász (2012), i.e., believes that Sender $-i$ is the High Performer with probability $\hat{\eta}_{-i} = 1 - \hat{\eta}_i$, the equilibrium strategy of Sender i is to forward the signal if and only if his belief about being the High Performer is larger than a threshold N:

$$\hat{\eta}_i > 0.5 \equiv N$$

Equilibrium. Assuming that every participant plays an intrapersonal game with beliefs $\hat{\eta}_i$, $\hat{\eta}_{-i} = 1 - \hat{\eta}_i$, and μ, there exist two candidate equilibria.

(1) Separating equilibrium where Sender i with $\hat{\eta}_i > N$ forwards his signal, Sender $-i$ with $\hat{\eta}_{-i} < N$ does not forward his signal, and the Receiver believes that the observed signal coincides with the true state with probability $\mu = 0.5 \cdot \hat{\eta}_i + 0.5$.

(2) Pooling equilibrium where both senders with $\hat{\eta}_i = \hat{\eta}_{-i} = 0.5$ are indifferent between forwarding their signals or not, and the Receiver believes that the randomly selected signal that she observes coincides with the true state with with probability $\mu = 0.75$.

3.3 Confidence Bias

Sender i has a confidence bias if he believes that his relative performance differs from his actual relative performance:

$$\hat{\eta}_i^b = \eta_i + b_i$$

where $\hat{\eta}_i^b$ is the Sender i's biased belief about his own relative performance, η_i is the Sender i's actual relative performance and b_i is the confidence bias (if $b_i > 0$, Sender i is overconfident; if $b_i < 0$, Sender i is underconfident).

[6] Appendix B.2 presents the two properties of the BSR

One sender is biased. Consider the following set of beliefs. Sender i has a confidence bias. He over/underestimates the actual probability η_i of performing better than Sender $-i$ by b_i, $b_i \neq 0$. Thus, Sender i believes that his relative performance is $\hat{\eta}_i^b$ and Sender $-i$'s relative performance is $1 - \hat{\eta}_i^b$. Moreover, Sender i assumes that his beliefs are seen as common knowledge by other participants. Sender $-i$ holds correct beliefs about his relative performance $\hat{\eta}_{-i} = \eta_{-i}$ and the relative ability of Sender i, $1 - \hat{\eta}_{-i}$. Sender $-i$ does not realize that Sender i is biased and assumes that his beliefs are common knowledge for other participants.

With this set of beliefs, Sender i forwards the signal if his expected payoff from forwarding s_i is larger than his expected payoff from not forwarding s_i. Thus, the equilibrium strategy of Sender i is to forward his signal if and only if

$$\hat{\eta}_i^b = \eta_i + b_i > 0.5 \equiv N$$

If Sender i is overconfident, he forwards s_i if his (biased) belief $\hat{\eta}_i^b$ about being the High Performer is larger than the threshold N. Thus, his actual threshold decreases by b_i. Compared to the unbiased Sender, the overconfident Sender forwards his signal if his actual performance is larger than $N - b_i$, $b_i > 0$. Applying similar logic, the underconfident Sender has a higher actual threshold. He forwards his signal if his actual performance is larger than $N - b_i$, $b_i < 0$.

The strategy of the unbiased Sender $-i$ remains unchanged. He forwards the signal if and only if

$$\hat{\eta}_{-i} > 0.5 \equiv N$$

Both senders are biased. If both senders have confidence biases, do not realize it, and assume that their believes are seen as common knowledge for other participants, their strategies coincide with the strategy of the biased Sender i described above.

Welfare. Though in many settings overconfidence is beneficial, my analysis yields a different result. As long as participants cannot directly observe each other's states of mind, I show that they cannot be better off by being over/underconfident.[7]

[7] Compared to the result with optimal coordination and expected total welfare of $3X + Y$.

The intuition for this result is simple and compelling. In equilibrium, each participant correctly anticipates strategies of other participants. While the Sender's choice depends on his perceived characteristics, his actual payoff depends on his actual characteristics. If overconfident, the Sender mistakenly plays a strategy that would be optimal if his own relative performance was higher than it actually is. Hence, his actual payoff cannot be larger than the payoff of the unbiased Sender with the same characteristics, correctly playing his optimal strategy. Same holds if the Sender is underconfident.

Experiment. To study the effect of confidence, I manipulate the difficulty of the reasoning task. Providing participants with the easy task in the Easy treatment, I aim to shift the confidence about one's own relative performance upwards compared to the Hard treatment with the difficult task. Because the evaluation of the effect of confidence on communication relies on my experimental design generating exogenous variation in beliefs across treatments, my first hypothesis tests whether there is a shift in beliefs due to the hard-easy effect in my experiment.

H_0^S (H vs E): *Beliefs about one's own relative performance in the Easy treatment will be higher, on average, than beliefs in the Hard treatment.*

My second set of hypotheses focus on how the shift in beliefs influences the actions of senders and how the receivers evaluate the accuracy of the messages that result from these actions. The logic behind these hypotheses is that individuals who hold higher beliefs about their relative performance are more likely to forward their signals and that the receivers should expect this effect.

H_1^S (H vs E): *An exogenous increase in confidence will lead to a higher fraction of senders forwarding their messages.*

H_1^R (H vs E): *Receivers expect less informative messages in the Easy treatment than in the Hard treatment.*

3.4 Competition for Attention

Incentives. I introduce an additional competition for attention of the receivers by providing the sender whose signal is transmitted to the receiver with an additional non-negative reward Y, $Y < X$.

Strategy of the Sender. Senders faces a tradeoff between delivering the most accurate advice and being visible or present to the receiver. Their strategy changes accordingly. Making same assumptions as in the Subsection 3.2, the equilibrium strategy of Sender i is to forward the signal if and only if his belief about being the High Performer is larger than a threshold N_c:

$$\hat{\eta}_i > 0.5 - \frac{Y}{2X(\mu - 0.5)} \equiv N_c$$

where $\hat{\eta}_i$ is the Sender i's belief about being the High Performer, X and Y are the rewards, and μ is the Receiver's belief that the advice corresponds to the true state.

The threshold N_c decreases with increase in the ratio of the rewards Y/X and with decrease of the report μ. This means that if the Sender's belief, $\hat{\eta}_i$, remains fixed, he is more likely to forward the signal when the reward for being visible to the Receiver, Y, is larger compared to the common reward for giving accurate advice, X. Additionally, he is more likely to forward the signal when the Receiver's report about observing accurate advice is low.

Equilibrium. Assuming (1) common knowledge of $\hat{\eta}_i$, $\hat{\eta}_{-i}$, and μ for all three participants, and that (2) beliefs of both senders about being the High Performer add up to one, $\hat{\eta}_i = \eta_i = 1 - \eta_{-i} = 1 - \hat{\eta}_{-i}$, there exist two candidate equilibria.

(1) Separating equilibrium where Sender i with $\hat{\eta}_i > N_c$ forwards his signal, Sender $-i$ with $\hat{\eta}_{-i} < N_c$ does not forward his signal, and the Receiver believes that the observed signal coincides with the true state with probability $\mu = 0.5 \cdot \hat{\eta}_i + 0.5$.

(2) Pooling equilibrium where both senders forward their signals and the Receiver believes that the randomly selected signal that she observes coincides with the true state with with probability $\mu = 0.75$.

Figure 1 shows the equilibrium strategies of the Sender whose belief about being the High Performer is less than 0.5. The strategy to forward the signal depends on the ratio of rewards Y/X and the Sender i's belief about being the High Performer $\hat{\eta}_i$. The vertical lines represent the areas with separating equilibrium (1), whereas the horizontal lines represent the areas with pooling equilibrium (2). For example, if the ratio of rewards is fixed at $Y/X = 0.25$ as in the experiment and the Sender i's belief about being the High Performer is $\eta_i = 0.15$, than the Sender i's optimal strategy is not to forward his signal, whereas the Sender $-i$ with belief $\eta_{-i} = 0.85$ should forward his signal, and the Receiver should report her belief $\mu = 0.925$. Alternatively, if the ratio of rewards is still fixed at $Y/X = 0.25$, but the Sender i's belief about being the High Performer is now $\eta_i = 0.4$, than the Sender i's optimal strategy is to forward his signal, Sender $-i$ with $\eta_{-i} = 0.6$ should forward his signal as well, and the Receiver should report her belief $\mu = 0.75$.

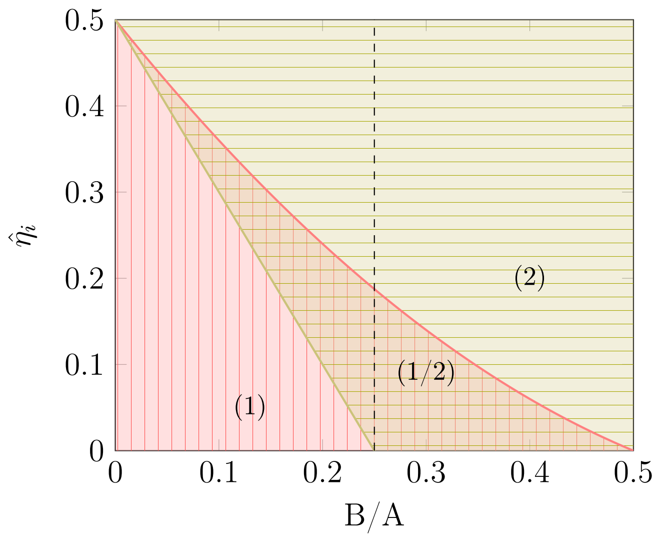

Figure 1: Equilibrium strategies.

The check pattern of the Figure 1 represents areas of multiple equilibria (1/2). In this areas, the Sender's decision to forward the signal is based not only on the ratio of the rewards and his belief about being the High Performer, but also on his beliefs about what other participants will do. Thus, the coordination problem of participants becomes more complex.

Experiment. To study the effect of the competition for the attention of the receivers, I compare the results of the Reward treatment, where the Sender receives an additional reward Y when his signal is transmitted to the Receiver, with the results of the Hard treatment. The Hard treatment is similar to the Reward treatment, except that it does not include the reward Y.

My third set of hypotheses test how the competition for the attention of the receivers influences the actions of senders and how the receivers evaluate the accuracy of the messages that result from these actions. The logic behind these hypotheses is that individuals who compete for the attention are more likely to forward their signals and that the listeners should expect this effect.

H_2^S (H vs R): *Competition for the attention of the receivers will lead to a higher fraction of senders forwarding their messages.*

H_2^R (H vs R): *Receivers expect less informative messages in the Reward treatment than in the Hard treatment.*

3.5 Feedback

I investigate how feedback about the relative performance of senders influence their decisions for forward their signals and how it affects the report of listeners.

Strategy of the Sender. If senders get feedback about their relative performance, the equilibrium strategy is straightforward. Sender i should forward his signal if he is the High Performer, $\hat{\eta}_i = 1$, and does not forward his signal otherwise, $\hat{\eta}_i = 0$.

Experiment. In the experiment, I study the effect of the feedback to the senders by comparing the results of the Feedback treatment to those in the Hard treatment.

My fourth set of hypotheses test if feedback improves coordination of senders. In particular, if High Performers forward their signals and Low Performers do not. Moreover, I examine if receivers expect this and adjust their reports upwards.

H_3^S (H vs F): *Providing feedback about one's own relative performance will lead to a higher fraction of sender pairs who successfully coordinate the forwarding of signals.*

H_3^R (H vs F): *Receivers expect more informative messages in the Feedback treatment than in the Hard treatment.*

4 Results

The main objective of my treatment manipulation is to exogenously shift participants' beliefs about their relative performance in the reasoning task. Figure 2 shows that there is a significant difference in the experts' average confidence between the Hard treatment and the Easy treatment, where confidence refers to the experts' stated probability of being the High Performer (t-test, $p < 0.01$).

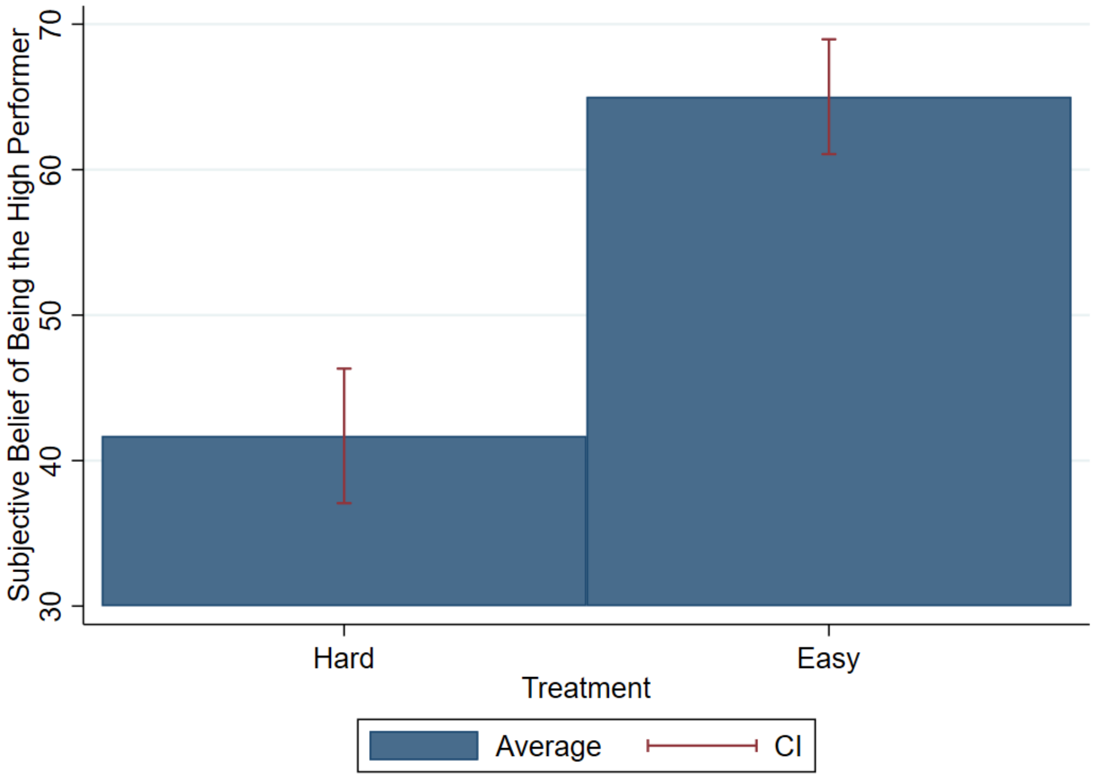

Figure 2: Average subjective beliefs of experts by treatment.

Result 1. In line with the previous hard-easy effect literature, reducing the difficulty level of the reasoning task increases the average confidence of participants in their own relative performance.

Next, I present evidence on whether the increase in confidence translates into a higher fraction of experts who forward their signals. Figure 3 confirms that experts forward their signals significantly more often in the Easy treatment than in the Hard treatment (diff. = 33 pp; t-test, $p < 0.01$). The first two columns of Table 2 show that this result is unaffected by gender of experts. The first and the third columns of Table 1 show that the result is slightly affected by the coefficient of risk aversion. Less risk-averse experts forward their signals significantly more often.

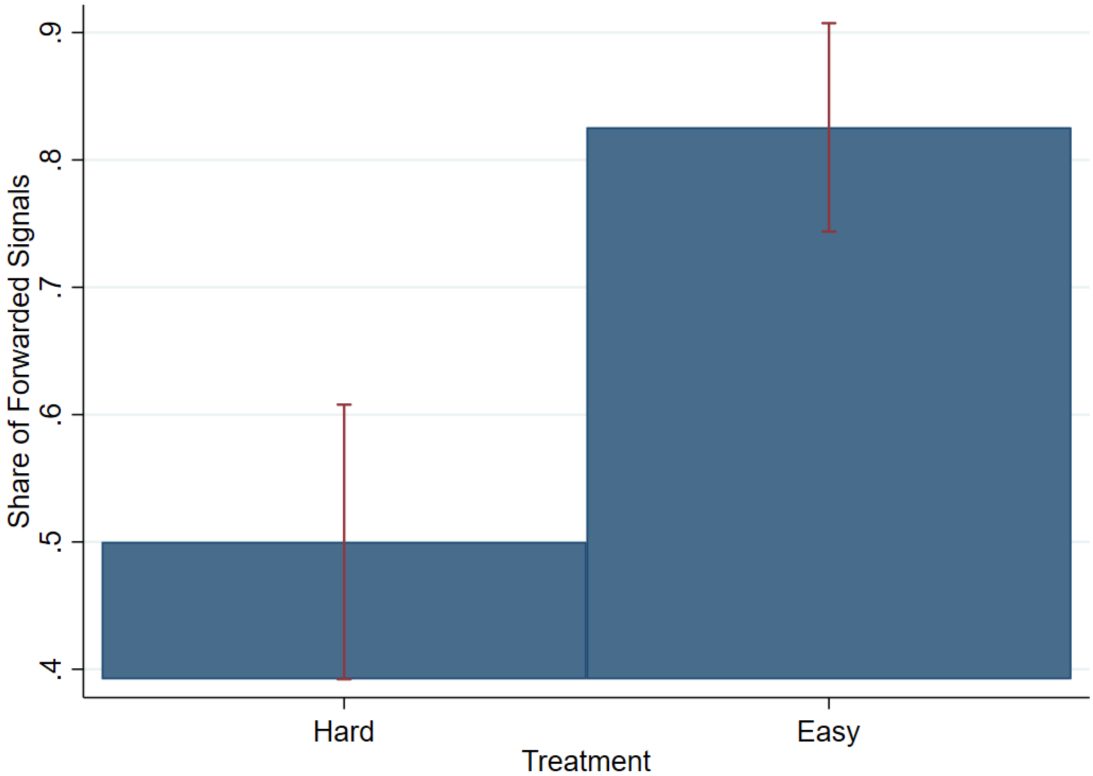

Figure 3: Share of forwarded signals by treatment.

Result 2. An exogenous increase in confidence leads to a higher fraction of experts forwarding their signals.

Table 2: OLS

	(1) OLS 1	(2) OLS 2	(3) OLS 3	(4) OLS 4	(5) IV 1	(6) IV 2
Treatment (Easy = 1)	0.3256***	0.3270***	0.2970***			
	(0.0681)	(0.0680)	(0.0690)			
Female		0.0307				
		(0.0689)				
Risk aversion			0.0512***			0.0202
			(0.0180)			(0.0182)
Subjective belief				1.1705***	1.3965***	1.3481***
				(0.1077)	(0.2560)	(0.2780)
Constant	0.5000***	0.4878***	0.2268**	0.0383	-0.0823	-0.1700
	(0.0542)	(0.0609)	(0.1087)	(0.0750)	(0.1433)	(0.1248)
Number of observations	172	172	172	172	172	172
R-squared	0.1186	0.1196	0.1571	0.3269	0.3147	0.3255

In addition to documenting the treatment effect on choices, it is informative to provide more direct evidence on whether this treatment effect operated via beliefs. To do this, Column 4 of Table 2 shows that the experts' reported beliefs about being the High Performer are highly predictive of their choice to forward their signal - a 1 percentage point (pp) increase in a expert's belief is associated with forwarding the signal 1.17 pp more often. However, this relationship may be endogenous. A nice feature of the experimental design is that I can use the treatment variation as an instrument for beliefs. Columns 5 and 6 report the results from this exercise, showing that the exogenous shift in beliefs does indeed translate directly into a change in choices to forward the signal.

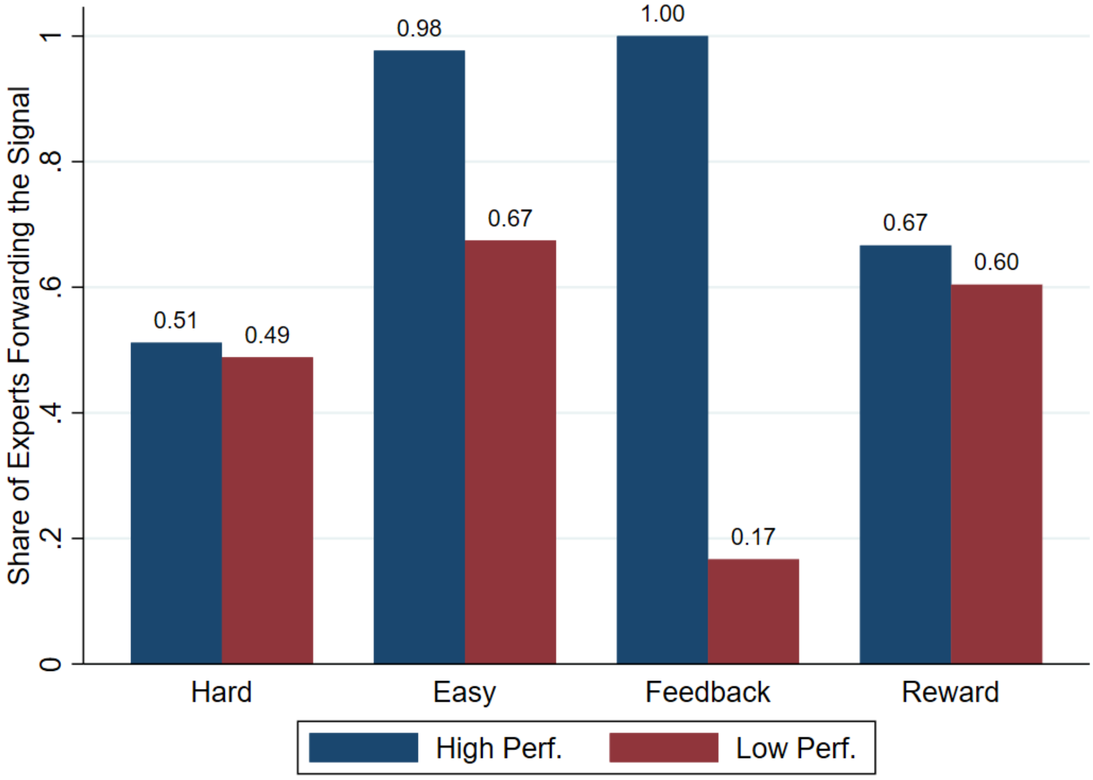

Figure 4: Share of forwarded signals by treatment and relative performance of experts.

Figure 4 shows the share of forwarded signals by relative performance of experts in each of the four treatments. In the Feedback treatment, the behavior of experts is the closest to the theoretical prediction: 100 % of High Performers and 17 % of Low Performers forward their signals compared to 100 % and 0 % in theory. In the Easy treatment, the share of High Performers forwarding their signals remains high (98 %). However, a large share of Low Performers forward their signals as well (67 %). The decrease in confidence observed in the Hard treatment leads to a lower share of forwarded signals. Compared to the Easy treatment, the share of Low Performers forwarding their signals decreases by 18 pp. However, the share of High Performers forwarding their signals decreases even more significantly by 47 pp. In the Reward treatment, the share of forwarded signals increases. Additional reward for being visible increases the shares of signals forwarded by High Performers (16 pp) and Low Performers (11 pp) compared to those in the Hard treatment.

Result 3. Providing feedback about experts' relative performance leads to a higher fraction of expert pairs who successfully coordinate the forwarding of signals. Among the four treatments, the results of the Feedback treatment are the closest to the theoretically optimal results: all High Performers and only a small fraction (17 %) of Low Performers forward their signals compared to 100 % of High Performers and 0 % Low Performers predicted by the model.

Result 4. Introducing additional reward for experts whose signals were observed by decision makers leads to a higher fraction of experts forwarding their signals. In the Reward treatment, the share of forwarded signals is higher than in the Hard treatment (64 % vs 50 %). This result hold for both High Performers and Low Performers.

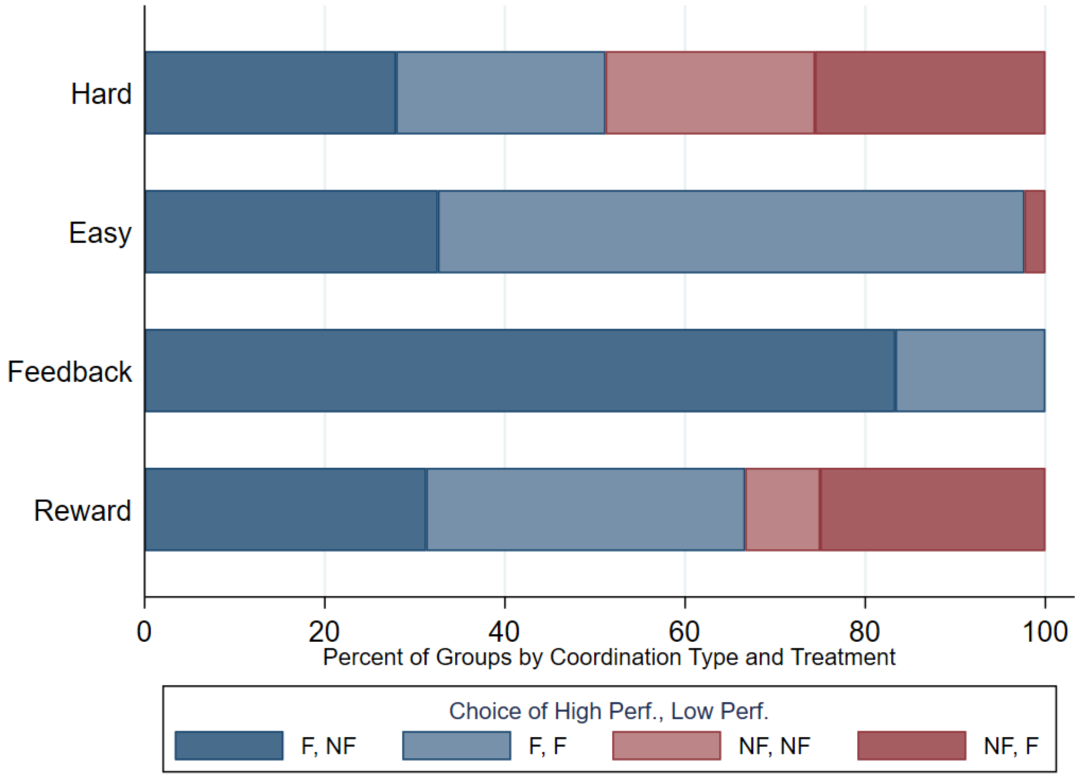

Figure 5: Coordination of experts.

Figure 5 provides further details on coordination of experts. I distinguish four coordination types. Each type is described by the pair of choices a_H, a_L of the High Performer and the Low Performer to forward or not to forward their signals: $a_H, a_L \in \{\text{F, NF}\}$.

The best coordination type is F, NF. It describes the situation when the High Performer forwards his signal and the Low Performer does not. In this case, both advice informativeness and the expected total welfare of all participants in the group are the highest. The largest share of groups with this coordination type is in the Feedback treatment: in 83 % of groups experts coordinate correctly on who should talk and who should stay silent. In three other treatments this type of coordination is achieved in about 30 % of groups: 28 % in the Hard treatment, 33 % in the Easy treatment, and 31 % in the Reward treatment.

The second coordination type is F, F when both experts forward their signals. It is characterized by lower advice informativeness and lower expected total welfare compared to the F, NF type. The second coordination type is mostly present in the Easy treatment: in 65 % of groups both experts forward their signals.

The third coordination type - NF, NF - is equivalent to the second coordination type F, F in terms of advice informativeness and expected total welfare. It is present in the Hard treatment (23 %) and in the Reward treatment (8 %). Since the second and the third coordination types are equivalent in terms of advice informativeness, it might be useful to combine them. In this case, the combined type describes 47 % of groups in the Hard Treatment and 44 % of groups in the Reward Treatment.

The last coordination type is NF, F. It describes the situation when the High Performer does not forward his signal and the Low Performer does. In this case, both advice informativeness and the expected total welfare of all participants in the group are the lowest. This type is present mostly in the Hard treatment (26 %) and in the Reward treatment (25 %).

The lack of coordination in the Hard and the Reward treatments can be explained by underconfidence of High Performers. Figure 6 summarizes the data on the confidence bias of experts by their relative performance.[8] The negative (positive) confidence bias stands for underconfidence (overconfidence) of experts. For all treatments, it holds that High Performers are on average less confident than Low Performers. Moreover, High Performers

[8] The confidence bias is measured as the difference between the expert's subjective belief about being the High Performer and the actual percentile rank of the expert's performance.

are on average less confident in the Hard and the Reward treatments compared to those in the Easy treatment (-18 pp and -26 pp vs 8 pp). The median High Performer in the Hard and the Reward treatments underestimates his relative performance by 16 pp and 24 pp respectively, whereas the median High Performer in the Easy treatment provides a much better estimate - the expert overestimates his relative performance by only 6 pp.

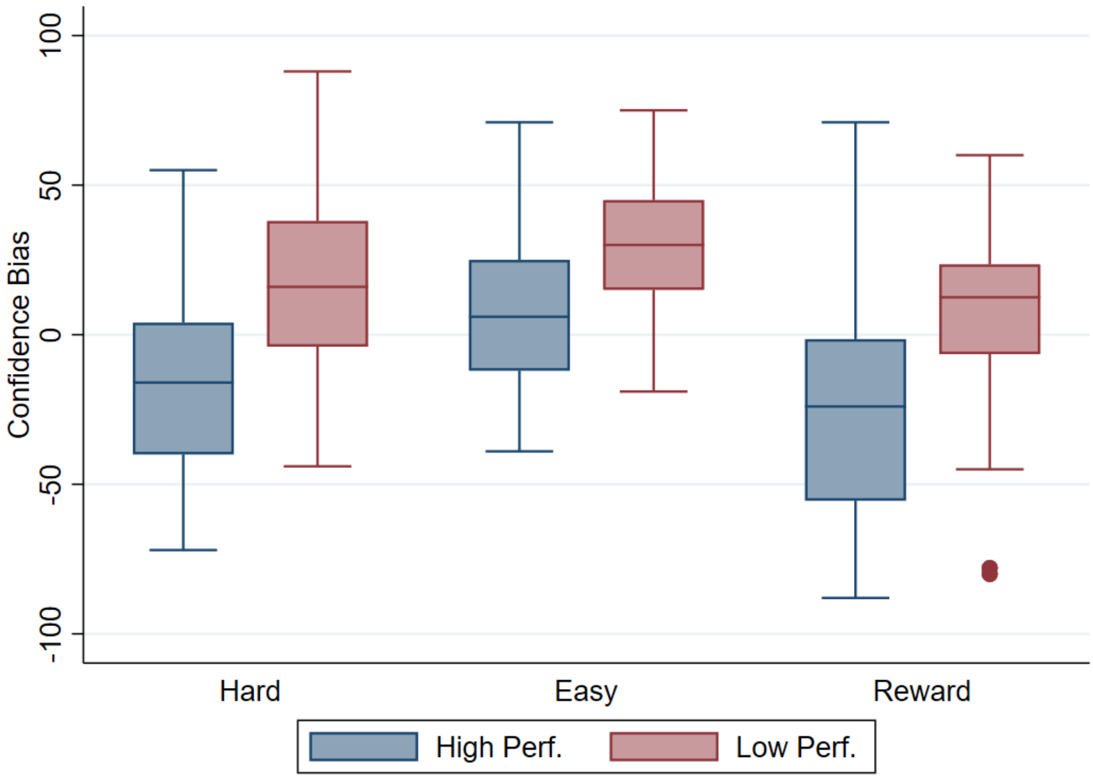

Figure 6: Confidence bias of experts by their relative performance.

Figure 7 shows choices of experts according to their subjective belief about being the High Performer. In the Hard and the Easy treatments, experts who forward their signals have on average higher subjective beliefs compared to those who do not forward their signals. This result supports theoretical prediction: in case when the reward for being visible is absent, $B = 0$, experts forward their signals if their beliefs about being the High Performer is higher than a certain threshold and do not forward their signal otherwise. Thus, there is an evidence for a separating equilibrium for these two treatments.

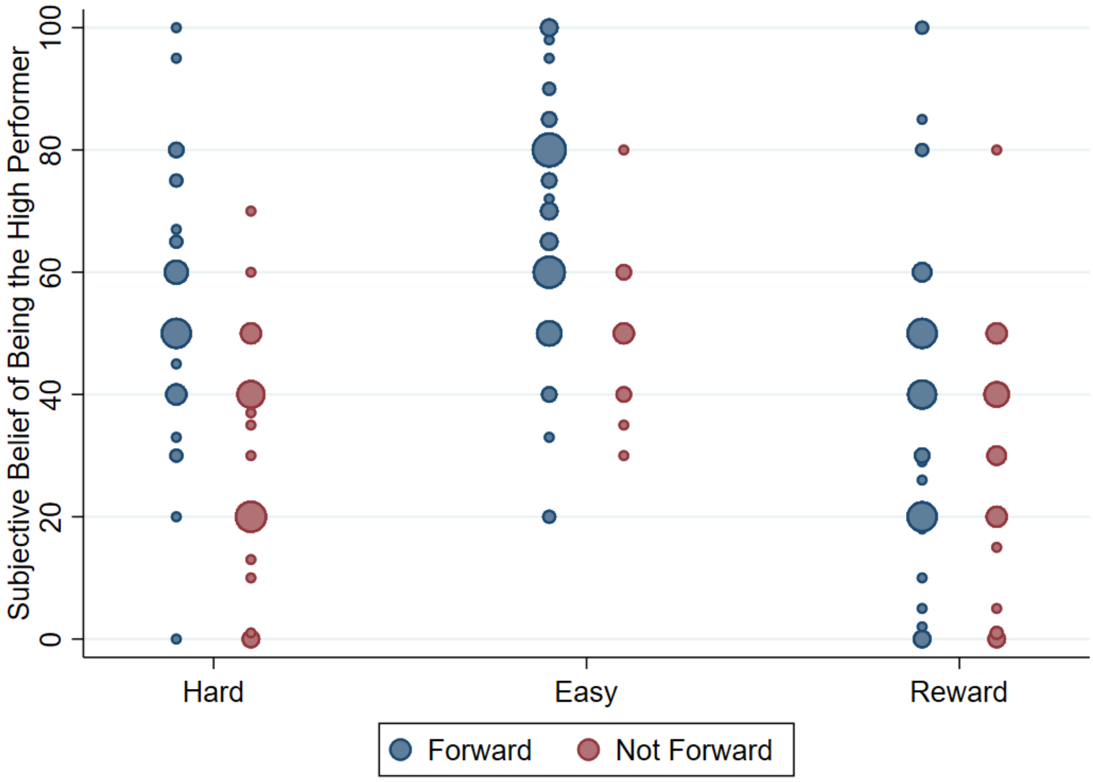

Figure 7: Choices of experts according to their subjective beliefs.

In the Reward treatment where experts earn additional reward for being visible, $B = 2$, the model predicts multiple equilibria. If expert's subjective belief is lower than 20 %, the decision to forward his signal depends on the expert's belief about what other participants will do. Thus, both pooling and separating equilibrium is possible. Figure 7 shows that in the Reward treatment, experts' choices depend to a lower extent on experts' subjective beliefs compared to those in the other two treatments. Thus, presence of multiple equilibria enhances coordination problem.

Decision makers perform relatively well in assessing the informativeness of experts' advice. Figure 8 shows the average advice informativeness by treatments. Decision makers' beliefs about advice informativeness are close to the actual advice informativeness in the Hard, the Easy and the Rewards treatments on average. In the Feedback treatment, decision makers expect higher advice informativeness; however, they underestimate it compared to the actual one (diff. = 7.7 pp; t-test, p = 0.08).

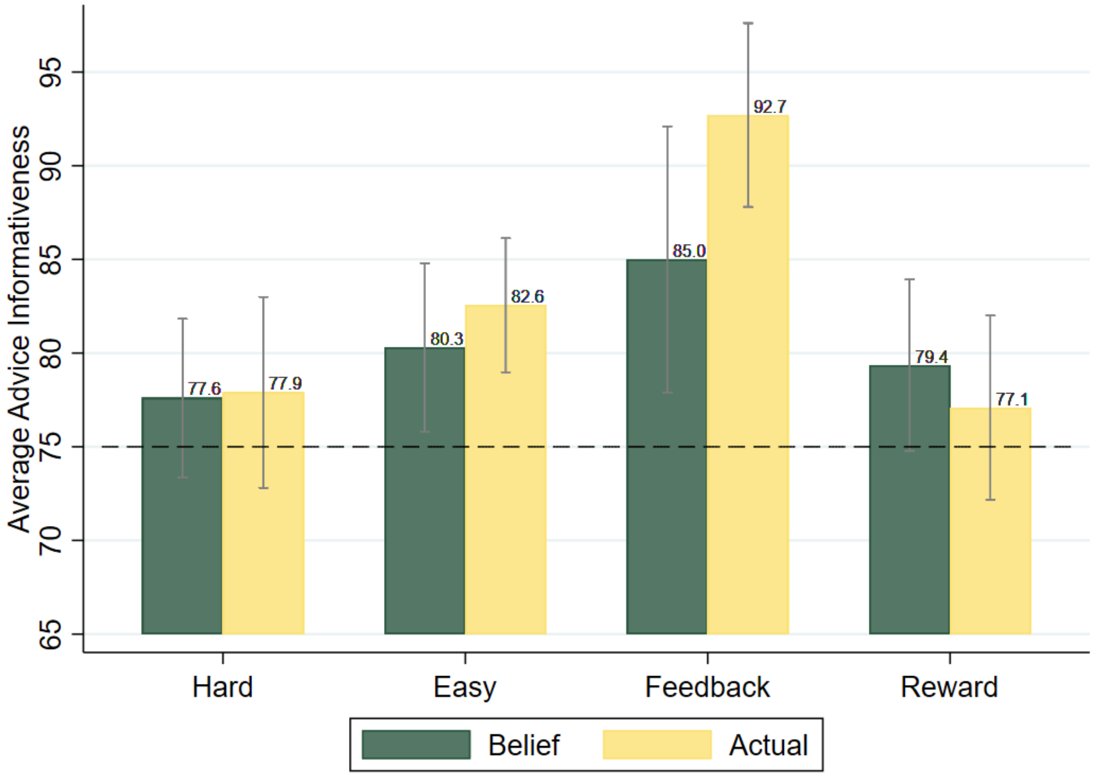

Figure 8: Advice informativeness.

Results 5-7. On average, decision makers expect lower advice informativeness in the Hard treatment compared to that in three other treatments.

5 Conclusion

In this paper, I show that the exogenous shift in confidence about one's own relative ability causally influences the decision to talk.

This study contributes to developing a better understanding of why people talk and if they talk when they should. If questions are easy, the relative confidence about being well-informed is high. More talking takes place and there is a higher chance to hear the truth. However, if questions are difficult, less talking happens. A large share of talkers overestimate the reliability of their information. Thus, listeners could be easier misled on more difficult questions. If talkers get a positive utility from being visible, they talk more often. However, it does not improve the average informativeness of messages.

References

Barron, K. and C. Gravert (2022): "Confidence and career choices: An experiment," *The Scandinavian Journal of Economics*, 124, 35–68.

Battaglini, M. (2002): "Multiple referrals and multidimensional cheap talk," *Econometrica*, 70, 1379–1401.

Blume, A., D. V. DeJong, Y.-G. Kim, and G. B. Sprinkle (1998): "Experimental evidence on the evolution of meaning of messages in sender-receiver games," *The American Economic Review*, 88, 1323–1340.

Bordalo, P., K. Coffman, N. Gennaioli, and A. Shleifer (2019): "Beliefs about gender," *American Economic Review*, 109, 739–73.

Cain, D. M., D. A. Moore, and U. Haran (2015): "Making sense of overconfidence in market entry," *Strategic Management Journal*, 36, 1–18.

Charness, G., A. Rustichini, and J. Van de Ven (2018): "Self-confidence and strategic behavior," *Experimental Economics*, 21, 72–98.

Chen, Q. and W. Jiang (2006): "Analystsâ weighting of private and public information," *The Review of financial studies*, 19, 319–355.

Coffman, K. B. (2014): "Evidence on self-stereotyping and the contribution of ideas," *The Quarterly Journal of Economics*, 129, 1625–1660.

Crawford, V. P. and J. Sobel (1982): "Strategic Information Transmission," *Econometrica*, 50, 1431–1451.

Daniel, K. and D. Hirshleifer (2015): "Overconfident investors, predictable returns, and excessive trading," *Journal of Economic Perspectives*, 29, 61–88.

Elsner, B., I. E. Isphording, and U. Zölitz (2021): "Achievement rank affects performance and major choices in college," *The Economic Journal*, 131, 3182–3206.

Enke, B., T. Graeber, and R. Oprea (2023): "Confidence, self-selection, and bias in the aggregate," *American Economic Review*, 113, 1933–1966.

Fehrler, S., U. Fischbacher, and M. T. Schneider (2020): "Honesty and self-selection into cheap talk," *The Economic Journal*, 130, 2468–2496.

Goodman-Delahunty, J., P. A. Granhag, M. Hartwig, and E. F. Loftus (2010): "Insightful or wishful: Lawyers' ability to predict case outcomes." *Psychology, Public Policy, and Law*, 16, 133.

Hossain, T. and R. Okui (2013): "The binarized scoring rule," *Review of Economic Studies*, 80, 984–1001.

Huffman, D., C. Raymond, and J. Shvets (2022): "Persistent overconfidence and biased memory: Evidence from managers," *American Economic Review*, 112, 3141–75.

Kawamura, K. (2015): "Confidence and competence in communication," *Theory and Decision*, 78, 233–259.

Kruger, J. and D. Dunning (1999): "Unskilled and unaware of it: how difficulties in recognizing one's own incompetence lead to inflated self-assessments." *Journal of personality and social psychology*, 77, 1121.

Li, Z., H. Rantakari, and H. Yang (2016): "Competitive cheap talk," *Games and Economic Behavior*, 96, 65–89.

Madarász, K. (2012): "Information projection: Model and applications," *The Review of Economic Studies*, 79, 961–985.

Mondak, J. J. and M. R. Anderson (2004): "The knowledge gap: A reexamination of gender-based differences in political knowledge," *The Journal of Politics*, 66, 492–512.

Moore, D. A. and P. J. Healy (2008): "The trouble with overconfidence." *Psychological review*, 115, 502.

Murphy, R. and F. Weinhardt (2020): "Top of the class: The importance of ordinal rank," *The Review of Economic Studies*, 87, 2777–2826.

Raven, J. C. (2000): *Raven's Advanced Progressive Matrices (APM)*, Upper Saddle River: Pearson.

Schwardmann, P. and J. Van der Weele (2019): "Deception and self-deception," *Nature human behaviour*, 3, 1055–1061.

Vespa, E. and G. Weizsaecker (2023): "Do we talk too much?" *Working Paper.*

Vespa, E. and A. J. Wilson (2016): "Communication with multiple senders: An experiment," *Quantitative Economics*, 7, 1–36.

Wilson, A. and E. Vespa (2018): "Paired-uniform scoring: Implementing a binarized scoring rule with non-mathematical language," Tech. rep., Working paper.

A Appendix: Instructions

The instructions below are translated from German. The treatment-specific text is shown in square brackets: [**H**: ...] - the Hard treatment, [**E**: ...] - the Easy treatment, [**F**: ...] - the Feedback treatment, [**R**: ...] - the Reward treatment. The text of the Hard treatment is also relevant for the Feedback and the Reward treatment. Comments are shown as [Comment: ...].

General Instructions

Welcome

Thank you for participating in our experiment.

In this experiment you have the opportunity to earn money. Your payoff may depend on your answers, choices and luck. Therefore, it is in your interest to pay attention to the instructions and make careful choices.

The experiment will last up to 60 minutes and consists of three parts: Part 1, Part 2 and Questionnaire.

When all participants have completed the experiment, your payment will be calculated and displayed to you. In addition to a show-up fee of 7 euro, you can earn more for your choices during the experiment. You will be paid directly after the experiment. We ask you to remain seated until you are invited to receive the payment.

Anonymity

Your answers and choices are anonymous and will be kept confidential and used for scientific purposes only.

Rules of conduct

In order for the data of the experiment to be reliable, certain rules must be adhered to during the experiment. Thus, we would like to ask you to switch your mobile phone on completely silent and put them out of reach. In addition, during the experiment, we ask you to use only the computer functions necessary for the experiment and otherwise refrain from using other electronic devices.

Please limit your communication to questions about the experiment and direct these questions to the experimenters only. If you have any questions after you have read the instructions, please communicate quietly by raising your hand. Your questions will then be answered personally and quietly. If a question is relevant to all participants, the question will be repeated loudly and answered by the experimenter.

Anyone disrupting the experiment or violating the above rules may be excluded from the experiment. In this case the participant will forfeit any earnings.

Good luck with this experiment!

Set-up of the experiment

The experiment consists of three parts.

In the first part, all participants will work on a computer task.

In the second part, participants will interact in groups of three people. Before making their decisions in this part, some of the participants will get additional information. The accuracy of this information is related to the first part of the experiment.

The third part is a questionnaire.

At the beginning of each part you will receive further instructions about your tasks. You will get paid after you have completed all three parts of the experiment.

Part 1: Instructions

In the first part of the experiment, you are asked to complete a short reasoning task consisting of 14 questions. Questions like these are sometimes used to measure a person's intelligence quotient (IQ). The 14 questions for this experiment were chosen from the [**E:** easy and moderate] [**H:** moderate and hard] difficulty levels of such a test.

You have 7 minutes to answer as many of the questions numbered 1 to 14 as possible. Each correct answer is worth 0.20 euro and each incorrect or incomplete question is worth 0.00 euro.

For each question, there is a pattern with a piece missing. Below the pattern, there are eight options to replace the missing piece. You have to choose which of the pieces below is the correct one to complete the pattern. In each case, one and only one of these pieces is the correct one. Figure A1 shows an example question and its answer.

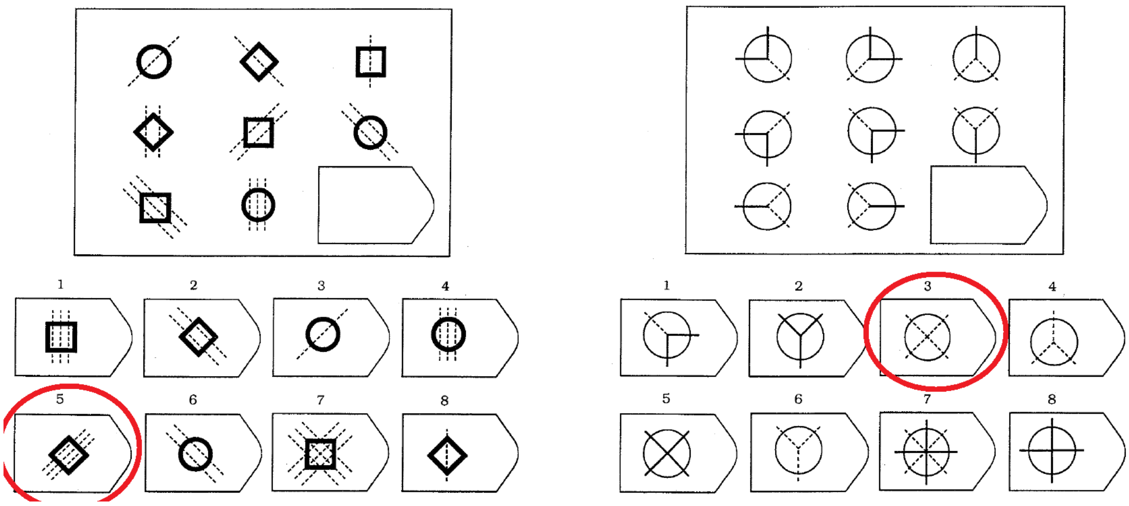

Figure A1: Example question.

Once you start the reasoning task, you can enter your answers on the right side of your computer screen. You can switch back and forth between the 14 questions and change your previous answers. Your respective answer will be saved only when you click on the "Next" or "Back" button. In the upper right corner of the screen, the remaining time (in seconds) is displayed.

Before we start Part 1, please raise your hand if you have any questions.

[Comment: the reasoning task takes place. The questions are displayed in the same order for all participants.]

Part 1: Estimates

Thank you for completing the reasoning task.

From now on, all participants will be randomly assigned to groups of three people. You will only interact with the participants in your group. Your group will remain for the rest of the experiment.

Before you begin the second part of the experiment, we ask you to make some estimates about how you and another randomly selected participant in your group performed on the reasoning task in Part 1.

More precisely, the computer will now randomly match you with one of the other two participants in your group. Your score in the reasoning task of Part 1 will be compared with the score of this other person. If you scored higher than the other person, you are the High Performer. If you scored less than the other person, you are the Low Performer. If your score is the same, the computer flips a coin to randomly determine if you are the High Performer or the Low Performer.

Estimate 1: What do you think is the probability that you are the High Performer in the sense of the previous paragraph?

You can use the following rough guideline to answer this question, but any number between 0 and 100 is possible.

- 100 - I am sure that I scored better than the other person
- 80 - It is very likely that I have scored better than the other person
- 60 - It is somewhat likely that I have scored better than the other person
- 50 - It is equally likely that I scored better or worse than the other person
- 40 - It is somewhat likely that I have scored worse than the other person
- 20 - It is very likely that I have scored worse than the other person
- 0 - I am sure that I scored worse than the other person

The accuracy of your answer contributes to your earnings. Your payment for the estimate is calculated using a rule called the Binarized Scoring Rule. According to this rule, you can receive 2 euro. The probability of earning this payment of 2 euro increases depending on how close your estimate is to your actual relative performance. If you are actually the High Performer, you should report a high number as your estimate in order to have a higher probability of receiving the payment. On the other hand, if you are the Low Performer, you should report a low number.

Although you don't need to understand the exact mechanism of the "Binarized Scoring Rule", you can find the full description below in the section "Part 1: BSR". All you need to know is that the rule makes it optimal for all participants to to state their true beliefs in response to this question.

The following estimate has no direct impact on your payout. Nevertheless, please provide it as best as you can.

Estimate 2: What is your best estimate for how many points you scored in the reasoning task? Please enter a score between 0 and 14.

Part 1: Binarized Scoring Rule

This section describes the payment rule for the question about your relative performance in the reasoning task. In this question, as described, you indicate the probability that you scored higher than another person on a scale from 0 to 100.

The expected payment increases with the accuracy of your answer. The measure of the realized error in the reported answer (hereafter called l) is calculated as follows: $l = ((x - t)/100)^2$, where x is your estimate, and t is the actual relative performance. In particular, t can take one of two values: $t = 100$ if you are the High Performer or $t = 0$ if you are the Low Performer.

The payment is calculated as follows. For each participant, the computer draws a random integer z between 0 and 100, with equal probability for each integer. If the error measure l is strictly smaller than $z/100$ ($l < z/100$), participant receives 2 euro. If l is greater than or equal to $z/100$ ($l \geq z/100$), the participant receives nothing. This mechanism ensures that the probability of getting a payment is strictly proportional to the accuracy of the estimate.

It follows from this rule that it is optimal for you to enter a relatively high number x (close to 100) if you think that your relative performance t is high. Conversely, it is optimal to enter a relatively small number if you think that your relative performance is low. In this way, you maximize the probability of receiving 2 euro for every possible realization of the integer z. Please note: how large or small the optimal x is, depends on your precise assessment of how likely you think it is that you are the High Performer.

With this in mind, the Binarized Scoring Rule implies that it is always optimal for the participants to truthfully state their own belief. This has been demonstrated by Hossain and Okui (2013) in a formal analysis and under very general conditions.[9]

Part 2: Instructions

Please read the instructions carefully so that you fully understand all tasks and questions.

[9] Tanjim Hossain, Ryo Okui; The Binarized Scoring Rule, *The Review of Economic Studies*, Volume 80, Issue 3, 1 July 2013, Pages 984â1001.

At the end of the instructions you will be asked a few questions to make sure you understand the experiment. If you answer a question incorrectly, the relevant text passages from the instructions will appear in a separate window. Please read these passages again carefully and try to answer the question again.

Introduction

In the second part of the experiment, you will continue to interact with participants in your group.

Each group of participants consists of two experts and one decision maker. Your role (Expert A, Expert B or Decision Maker)[10] will be randomly assigned and announced to you at the beginning of the payoff-relevant stage of Part 2. Your role remains the same for the rest of the experiment.

Short summary of the interaction

The Decision Maker would like to answer a question. The question has two possible answers (a or b), one of which is correct. The Decision Maker does not know the correct answer, but can get advice from an expert.

Each of the two experts receives a signal (a or b) â a suggested answer to the question that the Decision Maker is interested in. One of the two experts receives the correct signal, i.e., the correct answer to the question. The other expert receives a random signal, i.e., it is equally likely that the answer is correct or incorrect.

The quality of experts' signals depends on their performance in the Part 1 of the experiment. Whether Expert A or Expert B receives the correct signal (rather than the random signal) depends on their performance in Part 1. The High Performer with the higher number of correctly answered questions receives the correct signal, the Low Performer receives the random signal.

Each expert has to decide whether to forward his signal to the Decision Maker and thereby advise the decision maker. [**F:** Before he has to decide, he receives feedback as to whether he is the High Performer or the Low Performer in his group.]

Upon observing the advice from *one* expert, the Decision Maker has to evaluate its reli-

[10]For the sake of simplicity the masculine form is used throughout this document, but should be taken to refer to persons of both genders.

ability. The Decision Maker needs to assess how likely it is that the advice is the correct answer to his question.

The answer of the Decision Maker determines the payment in Part 2. All three participants receive the same payment which increases with the accuracy of the Decision Maker's assessment. Thus, in order to earn the highest possible payment, (1) experts should inform the Decision Maker as best they can, (2) the Decision Maker should be able to correctly assess how well advised he is.

What comes next?

Below are the detailed instructions of the interaction. The average reading time for these instructions is 6 minutes.

After everyone has read the instructions, you will answer a questionnaire with several comprehension questions to test your knowledge of the instructions.

After filling out the questionnaire, the payoff-relevant stage of Part 2 begins.

Initialization of the interaction

Before the interaction begins, your role (Expert A, Expert B or Decision Maker) will be randomly assigned and announced to you.

Next, the computer determines the correct answer to the question that the Decision Maker has to answer. Each possible answer (a or b) is equally likely to be correct.

To illustrate this step, imagine that there is a Question 15 in the reasoning task, with two possible answers (a and b), both equally likely as shown in Figure A2. The computer considers this question and finds the correct answer. The Decision Maker does not know the answer and waits for an expert's advice.

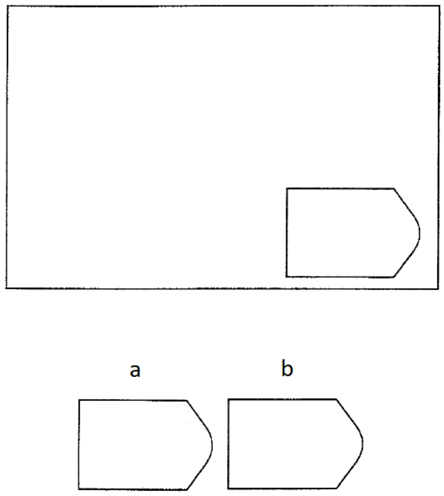

Figure A2: Question 15

Task of the experts

Each expert receives one signal (a or b) that can be either the correct or the random answer to the Question 15 described above.

The experts cannot know the accuracy of their signals with certainty. This accuracy depends on who is the High Performer in the reasoning task of Part 1.

Among the two experts, the expert who answered more questions correctly observes the correct signal. Thus, if the correct answer to Question 15 is a, the expert observes the signal a, and if the correct answer is b, the expert observes the signal b.

The other expert, who answered fewer quiz questions correctly, receives a signal that is selected at random, i.e., the signal shown to the expert is determined by a (computerized) coin flip. If the coin lands on heads, the expert receives the signal a, whereas if the coin lands on tails, the expert receives the signal b.

Remember that if both experts have answered the same number of questions correctly, the High Performer is also determined by a coin toss. The expert selected as the High Performer will then also receive the correct signal in part 2. The other expert receives a random signal.

Table 1 summarizes the accuracy of an expert's signal depending on the performance in the reasoning task in Part 1. The table illustrates: providing more correct answers for the 14 questions in Part 1 increases probability of answering the 15th question correctly.

Table A1: Accuracy of signal depending on experts' performance in Part 1

Expert	Signal	Accuracy
scored HIGHER in the reasoning task	correct	100 %
scored LOWER in the reasoning task	random	50 %
scored SAME in the reasoning task	correct or random	100 % or 50 %

[**F:** Before deciding whether to forward the signal, each expert receives feedback on whether he is the High Performer or the Low Performer.] After both experts observe their signals [**F**: and feedback], each of them decides whether to forward the signal to the decision maker.

If none of the experts or both of the experts decide to forward their signals, one of the two experts is randomly selected by the computer and his signal is forwarded to the decision maker.

In all cases, the Decision Maker receives exactly one signal: either Expert A or Expert B (but not the other expert) forwards his signal, or one signal is selected at random.

The signal that the Decision Maker receives is called the advice.

Task of the Decision Maker

The Decision Maker observes the advice (a or b) and reports a number between 50 and 100 that indicates how likely it is that the observed advice is the correct answer to the Question 15.

Remember that the accuracy of the advice depends on the relative performance in Part 1 of the expert who forwarded it. Thus, the advice coincides with the true answer with a probability between 50 and 100 percent. Although the Decision Maker knows that the advice is more likely to be true than false (at least somewhat more likely), he should know as precisely as possible how likely the advice is true. This feature is implemented by the payment rule described next.

Payment

The number between 50 and 100 reported by the Decision Maker hereafter referred to as the the Decision Maker's belief determines the payment for all three participants: all three receive the same payment.

The payment is calculated using the "Binarized Scoring Rule" that has been explained to you in Part 1. However, here in Part 2 you can earn a reward of **8 euro**.

The logic of the rule is simple: the probability of earning 8 euros increases the more accurate the decision maker's expectation is about how likely the advisor's advice is true.

Note: knowing how likely the advice is true is the same as knowing how likely the true answer to question 15 a or b is. This yields another simple property of the "Binarized Scoring Rule": the payoff is higher when experts pass on the correct signal with higher probability. Just like the other properties of the "Binarized Scoring Rule", you do not need to check this property, you can just trust us. A full description of the rule can be found below in the section "Part 2: BSR".

In summary, the payoff in this experiment is higher when (1) the experts inform the decision maker as well as possible and (2) the Decision Maker shares an expectation that is the best estimate of how well informed he is.

[**R:** Forwarding the signal contributes to the expert's remuneration as well. The expert whose signal is shown to the Decision Maker receives an additional **2 euro**. For example, if Expert A forwards his signal to the Decision Maker and Expert B does not, Expert A receives 2 euro in addition. If none of the experts or both experts forward their signals, the experts whose signal is shown to the Decision Maker receives the 2 euros.]

Part 2: Binarized Scoring Rule

This section describes the payment rule for the communicated belief of the Decision Maker. This rule determines the payoff for all participants: all participants earn 8 euro or they earn nothing. The probability of each of these two possible outcomes depends on the Decision Maker's belief.

The expected payoff increases with the accuracy of the communicated belief. The measure of the realized error in the communicated belief (hereafter called l) is calculated as follows: $l = ((x - t)/100)^2$, where x is the belief of the Decision Maker about the accuracy of the advice, and t is the actual accuracy of the advice. In particular, t can take one of two values: $t = 100$ if the advice coincides with the correct answer to the Question 15 and $t = 0$ otherwise. Thus, l measures the distance between the belief of the decision maker and the actual accuracy of the advice.

The payment of all three group members is calculated as follows. For each group, the computer randomly draws an integer between 0 and 100 (hereafter called z). Each integer between 0 and 100 has the same probability of being drawn as the value of z. If the error measure l is strictly smaller than $z/100$ ($l < z/100$), participants get 8 euro. If l is greater than or equal to $z/100$ ($l \geq z/100$), participants get nothing in this part of the experiment.

It follows from this rule that it is optimal for the Decision Maker to enter a relatively high number x (close to 100) if he thinks that the actual accuracy of the advice t is high. Conversely, it is optimal for the Decision Maker to enter a relatively small number if he thinks that the actual accuracy of the advice is low. Overall, it is always optimal for decision makers to truthfully state their own expectation. This has been demonstrated by Hossain and Okui (2013).[11]

The other property mentioned in the payment section is that it is optimal if the advice is correct with the highest possible probability. It can be demonstrated using the expression for l mentioned above as follows. Since the accuracy of the advice can be either $t = 100$ or $t = 0$, it is relatively easy to calculate the expected payment for a given t. You do not need to check the formula, but the expected payment is proportional to

$$1 - Pr\big(t = 100\big)(100 - x)^2 - (1 - Pr\big(t = 100\big))x^2$$

where $Pr\big(t = 100\big)$ is the probability that t has the value 100. One can also verify that for any number x between 50 and 100, this expected payoff increases as long as $Pr\big(t = 100\big)$ increases. This means that increasing the probability $Pr\big(t = 100\big)$, i.e., the accuracy of the advice, increases the expected payoff of all participants.

Part 2: Comprehension questions

Please answer the following questions to test your understanding of the instructions. Your answers to these questions will not affect your payment.

Please note: Some of the questions describe specific situations. This is for illustration purposes only and does not indicate what will happen or be chosen in the course of the

[11] Tanjim Hossain, Ryo Okui; The Binarized Scoring Rule, *The Review of Economic Studies*, Volume 80, Issue 3, 1 July 2013, Pages 984â1001.

experiment.

[Comment: questions are displayed one by one. If a participant answers a question correctly, the next question appears. If the answer is wrong, then the participant gets to read a relevant section of instructions, and has a chance to answer again. If the second answer is wrong, the correct answer is displayed.]

1. How many experts are in your group?
   - Options: 0, 1, 2 [Correct: 2]
   - Help: "Each group of participants consists of two experts and one decision maker. Your role (Expert A, Expert B or Decision Maker) will be randomly assigned and announced to you at the beginning of the payoff-relevant stage of Part 2. Your role remains the same for the rest of the experiment."
2. How many signals can be observed by the Decision Maker?
   - Options: 0, 1, 2 [Correct: 1]
   - Help: "After both experts observe their signals, each of them decides whether to forward the signal to the decision maker. If none of the experts or both of the experts decide to forward their signals, one of the two experts is randomly selected by the computer and his signal is forwarded to the decision maker."
3. What is the accuracy of the High Performer's signal?
   - Options: 0 %, 50 %, 100 % [Correct: 100 %]
   - Help: Table A1.
4. What is the accuracy of the Low Performer's signal?
   - Options: 0 %, 50 %, 100 % [Correct: 50 %]
   - Help: Table A1.
5. Suppose the Decision Maker is sure that the advice comes from an expert who scored significantly *worse* in Part 1 than the other expert. How likely is it that this advice is the correct answer to Question 15?
   - Options: 0 %, 50 %, 100 % [Correct: 50 %]

- Help: Table A1.

6. Suppose the Decision Maker is sure that the advice comes from an expert who scored significantly *better* in Part 1 than the other expert. How likely is it that this advice is the correct answer to Question 15?
   - Options: 0 %, 50 %, 100 % [Correct: 100 %]
   - Help: Table A1.
7. Suppose the Decision Maker has revised his belief after a moment's thought and now reports a belief that is closer to the true value. Has the probability of getting a higher payoff for his group decreased, increased, or remained constant?
   - Options: decreased, increased, remained constant [Correct: increased]
   - Help: "Your answer was not correct. Please recall:" Last section in **Payment**.

Part 2: Expert

You are Expert A [B].

Your signal is a [b].

[**F:** You are the High [Low] Performer]

Would you like to forward this signal to the Decision Maker?

[FORWARD] [NOT FORWARD]

Part 2: Decision Maker

You are Decision Maker.

The advice forwarded to you is a [b].

Please indicate how likely it is that this advice is the correct answer to the Question 15.

You may wish to use the following rough guideline for answering this question, but any number between 50 and 100 is possible.

- 100 - I am certain that the advice is the right answer
- 80 - It is very likely that the advice is the right answer

- 70 - It is relatively likely that the advice is the correct answer
- 50 - It is equally likely that the advice is the right or wrong answer

Questionnaire

[Comment: gender, age, experience in economic experiments, highest degree obtainied, student status, area of studies, employment status, knowledge of German.]

Payment

Thank you for participating in this experiment!

Your payment consists of the following parts:

1. [?] euro for answering [?] questions in Part 1.
2. [0/2] euro for estimating your relative performance in the reasoning task.
3. [0 /8] euro for the accuracy of the Decision Maker's belief.

Your complete payment is therefore [?] euro including the show-up fee of 7 euro.

B Appendix: Equilibrium Strategies

B.1 Equilibrium Strategy of the Receiver

Receiver reports her belief μ that the observed signal s, $s \in \{a, b\}$, coincides with the true state of the world θ, $\theta \in \{a, b\}$: $\mu = P(\theta = s)$.

Without loss of generality, assume that the Receiver observes the advice $s = a$. If she follows the Bayes rule, she reports her belief as follows:

$$\begin{aligned}
\mu = P(\theta = s) &\overset{wlog}{=} P(\theta = a|s = a) \\
&= \frac{P(\theta = a) \cdot P(s = a|\theta = a)}{P(\theta = b) \cdot P(s = a|\theta = b) + P(\theta = a) \cdot P(s = a|\theta = a)} \\
&= \frac{P(s = a|\theta = a)}{P(s = a|\theta = b) + P(s = a|\theta = a)}
\end{aligned}$$

since $P(\theta = a) = P(\theta = b) = 0.5$.

The numerator becomes

$$\begin{aligned}
&P(s = a|\theta = a) \\
&= \underbrace{P(s = a|\theta = a, \eta = \overline{\eta})}_{=1} \cdot \underbrace{P(\eta = \overline{\eta}|\theta = a)}_{=P(\eta=\overline{\eta})} + \underbrace{P(s = a|\theta = a, \eta = \underline{\eta})}_{=0.5} \cdot \underbrace{P(\eta = \underline{\eta}|\theta = a)}_{=P(\eta=\underline{\eta})} \\
&= P(\eta = \overline{\eta}) + 0.5 \cdot P(\eta = \underline{\eta})
\end{aligned}$$

where $P(s = a|\theta = a, \eta = \overline{\eta})$ is the probability that the observed signal is forwarded by the High Performer (HP) and $P(s = a|\theta = a, \eta = \underline{\eta})$ is the probability that the observed signal is forwarded by the Low Performer (LP). Moreover, $P(\eta = \overline{\eta}|\theta) = P(\eta = \overline{\eta})$ and $P(\eta = \underline{\eta}|\theta) = P(\eta = \underline{\eta})$, since probabilities that the HP and the LP forward their signals are independent of the true state of the world.

The denominator becomes

$$
\begin{aligned}
&P(s=a|\theta=b)+P(s=a|\theta=a)\\
&=\underbrace{P(s=a|\theta=b,\eta=\overline{\eta})}_{=0}\cdot\underbrace{P(\eta=\overline{\eta}|\theta=b)}_{=P(\eta=\overline{\eta})}+\underbrace{P(s=a|\theta=b,\eta=\underline{\eta})}_{=0.5}\cdot\underbrace{P(\eta=\underline{\eta}|\theta=a)}_{=P(\eta=\underline{\eta})}\\
&+\underbrace{P(s=a|\theta=a,\eta=\overline{\eta})}_{=1}\cdot\underbrace{P(\eta=\overline{\eta}|\theta=a)}_{=P(\eta=\overline{\eta})}+\underbrace{P(s=a|\theta=a,\eta=\underline{\eta})}_{=0.5}\cdot\underbrace{P(\eta=\underline{\eta}|\theta=a)}_{=P(\eta=\underline{\eta})}\\
&=0.5\cdot P(\eta=\underline{\eta})+P(\eta=\overline{\eta})+0.5\cdot P(\eta=\underline{\eta})\\
&=P(\eta=\underline{\eta})+P(\eta=\overline{\eta})\\
&=1
\end{aligned}
$$

Therefore, the report of the Receiver can be expressed as

$$
\begin{aligned}
\mu=P(\theta=s)&\overset{wlog}{=}P(\theta=a|s=a)\\
&=P(\eta=\overline{\eta})+0.5\cdot P(\eta=\underline{\eta})\\
&=P(\eta=\overline{\eta})+0.5\cdot(1-P(\eta=\overline{\eta}))\\
&=0.5\cdot P(\eta=\overline{\eta})+0.5
\end{aligned}
$$

where $P(\eta=\overline{\eta})$ is the probability that the advice is forwarded by the HP or the probability that the accuracy of the advice is high.

In words, probability that the advice coincides with the true state is equal to the probability weighted sum of the accuracy of the advice times the probability of observing the advice with a given accuracy.

B.2 Properties of the BSR

Given the true belief $p=P(\theta=s)$ of the Receiver, the probability of receiving the reward X is given by:

$$\pi(p,\mu)=p\cdot(1-(1-\mu)^2)+(1-p)\cdot(1-\mu^2)$$

The Receiver chooses to report μ that maximizes the probability of receiving the reward X. Thus, the Receiver reports her true belief:

$$\pi'_{\mu}(p,\mu) = 2p(1-\mu) + (1-p)\cdot(-2\mu) = 2p - 2\mu \equiv 0 \Rightarrow \mu(p) = p$$

Moreover, the following holds:

$$\begin{aligned}
\pi'_{p}(p,\mu) &= (1-(1-\mu)^2) - (1-\mu^2) \\
&= 1 - (1 - 2\mu + \mu^2) - 1 + \mu^2 \\
&= 1 - 1 + 2\mu - \mu^2 - 1 + \mu^2 \\
&= 2\mu - 1 > 0 \text{ if } \mu > 0.5
\end{aligned}$$

If the report of the Receiver is restricted to $\mu > 0.5$, it holds that the probability of the receiving the reward X increases with actual probability that the advice coincides with the true state of the world. Consequently, it is always optimal for senders to provide the most accurate information to the Receiver.

B.3 Equilibrium Strategy of the Sender

Sender i forwards the signal if his expected payoff from forwarding it is larger than his expected payoff from not forwarding it.

If Sender i forwards his signal, his expected payoff is $XE[\pi_{s_i}]$, where $E[\pi_{s_i}]$ is:

$$\begin{aligned}
E[\pi_{s_i}] =& P(\theta = s_i|s_i)\cdot\big(1-(1-\mu)^2\big) + P(\theta \neq s_i|s_i)\cdot\big(1-\mu^2\big) \\
=& \big(\hat{\eta}_i + 0.5(1-\hat{\eta}_i)\big)\cdot\big(1-(1-\mu)^2\big) + \big(1-(\hat{\eta}_i + 0.5(1-\hat{\eta}_i))\big)\cdot\big(1-\mu^2\big) \\
=& (0.5\hat{\eta}_i + 0.5)(1-(1-2\mu+\mu^2)) + (1-(0.5\hat{\eta}_i+0.5))(1-\mu^2) \\
=& (0.5\hat{\eta}_i + 0.5)(2\mu - \mu^2) + (0.5 - 0.5\hat{\eta}_i)(1-\mu^2) \\
=& \mu\hat{\eta}_i - 0.5\mu^2\hat{\eta}_i + \mu - 0.5\mu^2 + 0.5 - 0.5\hat{\eta}_i - 0.5\mu^2 + 0.5\mu^2\hat{\eta}_i \\
=& \mu\hat{\eta}_i + \mu + 0.5 - 0.5\hat{\eta}_i - \mu^2
\end{aligned}$$

If Sender i does not forward his signal, his expected payoff is as if $\hat{\eta}_i = 0.5$, s.t.:

$$E[\pi_{s_i}|\hat{\eta}_i = 0.5] = 1.5\mu + 0.25 - \mu^2$$

Therefore, Sender i forwards s_i if his belief about being the HP is larger than 0.5.

$$\begin{aligned} X\big(E[\pi_{s_i}] - E[\pi_{s_i}|\hat{\eta}_i = 0.5]\big) &> 0 \\ \mu(\hat{\eta}_i - 0.5) - 0.5(\hat{\eta}_i - 0.5) &> 0 \\ (\mu - 0.5)(\hat{\eta}_i - 0.5) &> 0 \\ \hat{\eta}_i &> 0.5 \end{aligned}$$