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Naivety about hidden information: An experimental investigation[1]

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Abstract: The unravelling prediction of disclosure theory relies on the idea that strategic forces lead firms (information senders) to voluntarily disclose information about the quality of their products provided the information disclosed is verifiable and the costs of disclosure are negligible. This theoretical prediction requires that consumers (information receivers) hold correct beliefs about non-disclosed information and, in equilibrium, treat all non-disclosed information with extreme scepticism. Previous research finds that receivers are insufficiently sceptical, or in other words are naive, about non-disclosed information, which leads to the failure of unravelling. This paper examines the extent to which naivety responds systematically to features of the decision environment, namely the availability of opportunities to communicate with others (Consultation treatment) and the context of the experimental setting (Context treatment, based on hygiene ratings). We find that complete unravelling fails to occur in all our treatments. Receiver's beliefs and guesses about non-disclosed information are similar across the Consultation and Context treatments relative to the Baseline implying that naivety about hidden information is a robust phenomenon. We also find that senders are partly to blame for the lack of unravelling, as intermediate types would gain from disclosing more often given the observed receiver behaviour.

Keywords: Consultation, Context, Laboratory Experiment, Verifiable Information Disclosure

JEL classification: B49, C91, C92, D80

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The theory of voluntary disclosure of information predicts that firms will disclose the quality of their products provided that the information to be disclosed is verifiable, and the costs of disclosure are negligible (Viscusi, 1978; Grossman & Hart, 1980; Grossman, 1981; Milgrom, 1981; for a review see Milgrom, 2008). The intuition behind this idea is that, in any equilibrium, all firms that do not disclose information are treated in the same manner (according to the average quality of a non-disclosing firm) by consumers. This incentivises the higher quality firms to differentiate themselves by disclosing their information. When this logic is applied iteratively, it leads all firms to disclose their information, except possibly the lowest quality firm – which is indifferent between disclosing and withholding (see Dranove & Jin, 2010 for a review on quality disclosure and certification). This mechanism is known as *unravelling*. In equilibrium, consumers treat all non-disclosed information with extreme scepticism and conclude that the products of non-disclosing firms are of the lowest possible quality.[3] The logic behind unravelling rests on consumers' ability to make adverse inferences about non-disclosed information. One of the reasons unravelling can fail to occur is when consumers are too optimistic about non-disclosed information.[4] Recent papers have documented evidence of incomplete unravelling of information in voluntary disclosure settings (Jin and Leslie, 2003; Jin, 2005; Mathios, 2000; Benndorf et al., 2015; Luca and Smith, 2015) and insufficient scepticism about non-disclosed information, or as Jin et al. (2017) term it, '*strategic naivety*' (Brown et al., 2012; Sah and Read, 2017; Deversi et al., 2018).[5]

In this paper, we examine the extent to which naivety responds systematically to features of the decision environment, namely the availability of opportunities to communicate with others and the context of the experimental setting. In doing so, we aim to contribute to the literature in two broad ways. First, this investigation allows us to study the robustness of strategic naivety in face of naturalistic features that exist in field settings which could help markets to unravel. Second, this study allows us to investigate the nature and roots of strategic naivety by examining questions such as whether alleviating cognitive constraints by providing communication opportunities or a natural context attenuates strategic naivety.

Consulting with others can have consequences on the quality of decisions made - it can improve or worsen the decisions made by individuals and this has been explored in both the social psychology and the experimental economics literature (Schotter & Sopher, 2003; Chaudhuri et al., 2006; Schotter & Sopher, 2007; Iyengar and Schotter, 2008; Çelen et al., 2010; Charness et al., 2010; Bougheas et al., 2013; Charness et al., 2013; Isopi et al., 2014; Ambuehl et al., 2018). In strategic settings, Kocher et al. (2014) and Penczynski (2016) find that advice from peers improves performance more than learning from observation. Schotter

[3] The standard models in the cheap-talk literature such as Crawford and Sobel (1982) permit firms to lie about their private information. In contrast, models of verifiable disclosure of information require firms' messages about their private information to be truthful.
[4] Unravelling can fail to occur for other reasons such as firms' strategic and dynamic incentives like not disclosing favourable information today to avoid future disclosure when the information may turn out to be unfavourable (Grubb, 2011, Marinovic and Varas, 2016), or for countersignalling purposes in the presence of multiple quality dimensions (Feltovich et al., 2002).
[5] Theories by Eyster and Rabin (2005) (cursed-equilibrium concept), Mullainathan et al. (2008) (coarse thinking), Gabaix and Laibson (2006) and Heidhues et al. (2016) (shrouded attributes) predict that firms may not reveal their private information if consumers are 'naive' about the quality of non-disclosed information. A related notion of naivety is considered in Cartwright and Patel (2010).

(2003) claims that advising others or receiving advice from others makes decision-makers think about the problem at hand differently than in the absence of the advice. Iyengar and Schotter (2008), and Charness et al. (2010) also find that advice (or consultation) helps individuals overcome the conjunction fallacy in probabilistic judgement. In contrast, Isopi et al. (2014) find that consultation worsens individual decision-making in situations where the solution to a problem has low demonstrability.[6] We contribute to this literature by investigating the effect of consultation in a setting where individuals are required to make an inference from the fact that information was not disclosed.[7]

The potentially beneficial effects of consultation on decision-making can be attributed to differences in *beliefs* held by individuals who do and do not consult. We explore the role of beliefs because Chaudhuri et al. (2006) and Schotter and Sopher (2007) provide evidence suggesting individuals who consult construct different beliefs about the actions of the other player relative to the individuals who make decisions in isolation. Based on the literature, we conjecture that individuals who consult form better, i.e. more accurate, beliefs about the actions of the other player. This is because consulting and receiving advice from peers may help individuals realize that non-disclosure is bad news about quality.

The motivation to employ context in an analysis of strategic naivety stems from the fact that, in natural environments, individuals do not face strategic situations in an abstract and context-free setting, as is widely the norm in lab experiments, but within a certain relevant contextual setting. Providing a context to the game enables individuals to have a nuanced sense of the setting by influencing beliefs, motivations, and therefore, behaviour (Barr and Serra, 2009; Dufwenberg et al., 2011; for a review see Alekseev et al., 2017). Context can also highlight the essential features of an abstract game and thereby enhance subjects' understanding of the decision problem, especially in tasks that require sophisticated reasoning. The literature on “context-free” versus “in-context” presentation of experiments is largely divided with respect to the effect of context on behaviour. Alm et al. (1992), Abbink and Hennig-Schmidt (2006), Benndorf et al. (2015), and Banerjee (2016) examine behaviour in an ‘abstract/neutral’ treatment and a ‘loaded/framed’ treatment and find that context does not have a significant effect on the behaviour of subjects in these experiments. On the contrary, Krajcova and Ortmann (2008), Samuelson and Allison (1994), Cooper and Kagel (2003), Chou et al. (2009), and Dufwenberg et al. (2011) find an effect of context on subjects’ behaviour. In particular, Chou et al. (2009) attribute the reason for subjects’ failure to play a weakly dominant strategy in a guessing game to the abstractness of the game. They find that presenting the experiment in a familiar context confirms the ability of subjects to make strategic decisions.

[6] The solution to a problem has ‘low demonstrability’ if the solution cannot be identified by individuals using basic reasoning or conceptual system (ex: logic or mathematics).

[7] A subjects’ earnings depend only on her or his own choices in the consultation literature mentioned above. The literature on group decision-making differs from this because the earnings of group members depend on the decision of the group as a whole. The literature on group-decision making finds that groups are more strategic than individual decision-makers and are better at constructing realistic beliefs about the strategy of the other player (Robert and Carnevale, (1997); Bornstein et al., (2004); Cooper and Kagel, (2005); Kocher and Sutter, (2005); Charness et al., (2007); Kugler et al., (2007); Song, (2009); Sutter et al., (2013); for a review see Charness and Sutter, (2012)).

In the setting we investigate, we conjecture that adding a natural context to our experiment, regarding the disclosure of restaurant hygiene ratings, will generate unravelling. This is because making decisions in a natural context may elucidate the incentives and the motives for high quality restaurants (senders with high numbers) to disclose their hygiene rating (private number), and thereby, correct receivers' beliefs about the non-disclosed number. In addition, our setting minimises alternative reasons (such as receivers' unawareness or inattention) that may contribute to the lack of unravelling in corresponding field setting with restaurant hygiene ratings. Therefore, our experiment which introduces a natural context allows us to isolate and examine the effect of strategic naivety on information unravelling.

To investigate our question, we design an experiment with a 'Baseline', a 'Consultation treatment', and a 'Context treatment' built on the experimental disclosure game proposed by Jin et al. (2017). The setup of our experiment is as follows: There are three players - one information sender and two information receivers. The sender obtains a private number (for example, this could be the firm's quality level in field settings) randomly drawn from a uniformly distributed set of numbers. He then decides whether to reveal this number to the receivers or stay silent. After observing the sender's decision to reveal or not, each receiver must make a report about the private number. If the sender has revealed the number, he cannot misreport it (mimics legal regulations relating to, for example, truth-in-advertising laws), and both receivers know the number with certainty. Else, the receivers must make a guess about the true number based on the sender's decision not to reveal the number, and on the probability distribution of the numbers, which is common knowledge.

In our Baseline, the two receivers do not have the opportunity to consult with each other before entering their reports individually, and the instructions are framed in an abstract/neutral manner. In our Consultation treatment, which is also neutrally framed, the two receivers are given the opportunity to consult with each other before entering their reports individually. The Context treatment varies from the Baseline in the way the instructions are framed, in particular, in the labelling that is used to convey the key features of the game. We provide a context of the restaurant owner's (sender's) decision to display the restaurant hygiene rating. We frame the role of the sender as the "Restaurant owner" and the receivers as "Restaurant Customer 1" or "Restaurant Customer 2". We refer to the draw as the "Food hygiene rating" of the restaurant. We present a more detailed discussion of the experimental design later in this paper.

The sender and the receivers have a conflict of interest as the sender gets a higher payoff if each of the receivers reports a higher number, and each of the receivers gets a higher payoff when her individual report is closer to the true number. The payoff structure of the sender and the receivers is such that in every sequential equilibrium of the game, senders always reveal their information, with the possible exception of the sender with the lowest number (who is indifferent between revealing or not), and the receivers make adverse inferences upon observing non-disclosure, and thereby, guess the lowest possible number.

We find that complete unravelling fails to occur in all our treatments. That is, a large proportion of senders with a number higher than the lowest possible number choose not to reveal information to the receivers. We also find that there is no statistically significant difference between the guesses of the receivers in the Consultation and Context treatment relative to those in the Baseline. Regarding beliefs that we elicit in the experiment, we observe that receivers' beliefs about the non-disclosed number are significantly higher relative to the average actual non-disclosed number by senders in all treatments. We find that context leads senders to hold lower beliefs about the receivers' guess of the non-disclosed number; yet this does not appear to affect senders' overall disclosure behaviour. In general, we find that consultation neither leads to lower reports nor reduces naivety (or in other words, increases scepticism) about non-disclosed information, and 'context-free' experiments and 'in-context' experiments yield similar results in our setting. Therefore, strategic naivety is a robust phenomenon.

These results suggest that strategic naivety about non-disclosed information may be a strong contributor to the failure of complete unravelling of information in field settings. The robustness of strategic naivety among information receivers brings the policy of voluntary disclosure of information under scrutiny. This is because the strength of the policy is based on the intuition that it can solve asymmetric information problems between senders and receivers of information and restore efficiency in markets.

The rest of this paper is organised as follows. Section 2 presents the experimental design and highlights differences between treatments. In Section 3, we outline the main results, and Section 4 examines the effect of consultation and context on the beliefs that subjects hold. In section 5, we discuss our results and offer concluding remarks.

2. Experimental Design

Our experiment consists of a Baseline, a Consultation treatment, and a Context treatment. We call the treatment where receivers were not given the opportunity to consult, and where the instructions are abstract and context-free as the 'Baseline'.[8] The treatment where receivers were given the opportunity to consult is called the 'Consultation' treatment, and the treatment with a context provided in the instructions is called the 'Context' treatment. In all treatments, subjects complete 30 rounds (divided into 6 blocks with 5 rounds in each block) of a three-player disclosure game between one information sender and two information receivers. At the beginning of the experiment, the experimental instructions are read aloud publicly to ensure common knowledge. After the brief instruction period (see Appendix B), the subjects answer control questions that gauge their understanding of the main features of the game. Subjects are then assigned to be either information senders or information receivers, and they remain in these roles for the entire duration of the experiment. Two receivers are paired together, and these pairs remain fixed for the entire duration of the experiment. Each receiver pair is randomly matched with a different sender in each round to maintain the one-shot nature of the game, and to minimise any reputation effects that might affect disclosure decisions. We pair two receivers together in all treatments to ensure that all other elements of the experiment are kept constant across the treatments.

[8] The 'Baseline' is a conceptual replication of the 'No Feedback and Fixed Role' treatment in Jin et al. (2017).

In each round, and for every matching of a sender with a pair of receivers, the computer program generates a ‘private number’ from the set $\{1, 2, 3, 4, 5\}$.[9] Each of these numbers have an equal probability of being drawn. Both senders and receivers know the probability distribution over the set of private numbers. The computer program then sends the private number to the sender. After receiving this number, the sender decides between ‘Reveal’ and ‘Do not reveal’ the private number to the receivers. If the sender chooses to ‘Reveal’ the private number, the receivers see this message: “The number I received is:” and then the actual private number. If the sender decides ‘Do not reveal’, the receivers see a blank in the message space and they are aware that the sender chose not to reveal the private number.[10] After observing the message from the sender or a blank, the receivers report (or guess, in the event of non-disclosure by the sender) the value of the private number.

In the Consultation treatment, before the receivers report the value of the private number, they see a computerised chat program to consult with the other receiver. We inform receivers that they can use the chat program to get help from or offer help to the other receiver about the report they want to submit. Receivers are given 60 seconds to chat with each other but can leave the chat program by clicking on the ‘Leave chat’ button if they wish to proceed to the decision-making stage before the 60 seconds lapse.

The receivers then enter their reports about the value of the private number individually, i.e. receivers do not have to agree on a report to submit jointly. Receivers can report any number from the following $\{1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5\}$. Note that receivers can report numbers that are not in the actual set of private numbers (i.e., 1.5, 2.5, 3.5 and 4.5). These numbers have been added to the action space to make it sufficiently rich so that the sequential equilibrium involves complete unravelling[11], i.e. unravelling of all numbers with the possible exception of the lowest number, i.e. 1. We inform receivers of the richness of the action space by telling them that they can use the numbers $\{1.5, 2.5, 3.5, 4.5\}$, for example, if they are unsure about the value of the private number.

The payoffs in the experiment are derived using the following payoff functions. The sender’s payoff is given by the following function:

$$U_s = \frac{(110 - 20\,|5 - \text{receiver 1's report}|^{1.4}) + (110 - 20\,|5 - \text{receiver 2's report}|^{1.4})}{2}$$

[9] We randomly generated a series of 30 private numbers corresponding to the 30 rounds of the game for each sender in a session and kept the series constant across all sessions to enhance comparability. The average realised draw in the Baseline was 2.837, in the Consultation treatment was 2.843, and in the Context treatment was 2.833. The difference in the average realised draw across Baseline and the Context treatments was due to fewer subjects in the Context treatment. The difference between the Baseline and the Consultation treatment was due to slightly different draws in one session.

[10] These design features (“The number I received is:”, type space, payoffs, private number) are borrowed from Jin et al. (2017) and from the cheap-talk literature Cai and Wang (2006) and Wang et al. (2010).

[11] Receiver payoffs are such that, if the private number is equally likely to be 1 or 2, both guesses give the same payoff to the receiver. If guessing 1.5 was not possible, there would be an additional sequential equilibrium of the game such that senders with private numbers 1 and 2 both conceal the number, and the receiver guesses 2 when the sender conceals.

The function is concave, independent of the actual private number, and monotonically increasing in the report of receiver 1 and receiver 2. The payoff of receiver 1 and receiver 2 is given by the following function, where *i* = 1 or 2:

$$U_{Ri} = 110 - 20\,|\text{actual private number} - \text{receiver } i\text{'s report}|^{1.4}$$

This function is concave in the receiver's own action and reaches its peak when the receiver's report is equal to the true private number. The payoffs are such that there is a conflict of interest between the sender and the receivers when the state is low, i.e. the sender obtains a higher payoff when each of the receivers reports a higher number, whereas each of the receivers obtains a higher payoff when her report is closer to the true private number irrespective of the report of the other receiver. These specifications are akin to the ones used by Jin et al. (2017), except that the sender's payoff is adjusted to take into account that the sender is paired with two receivers. Subjects did not have to know how to interpret the functional forms because the payoffs were shown in two tables (see Table 11 in Appendix A).

We do not provide any feedback to senders or receivers after each round, i.e. senders learn nothing about the reports of the receivers and receivers learn only the disclosed number or that the sender did not disclose the number. This is equivalent to the 'No feedback and fixed role' treatment in Jin et al. (2017). Besides pairing one sender with two receivers as required by our design, we depart from Jin et al. (2017) by eliciting beliefs every 5 rounds instead of eliciting them only once at the end of the 30 rounds. We also elicit beliefs in an incentivised manner.

At the end of each block, senders (receivers) are asked to state their beliefs about the actions of the receivers (senders). We ask senders what percentage of receivers they think guessed 1 or 1.5, 2 or 2.5, 3 or 3.5, 4 or 4.5, and 5 when a number was not disclosed. We ask receivers what percentage of senders they think revealed when the true number was 1, 2, 3, 4, and 5.[12] To incentivise the belief elicitation questions, we adopt a linear scoring rule similar to the one used by Kugler et al. (2007).[13] Using responses of the receivers to these belief questions, and applying Bayes' rule, we infer what the receivers should have guessed based on the beliefs they hold about the sender's strategy. Similarly, using the sender's responses to these questions, we infer what they believe the receivers would guess upon observing non-disclosure. This allows us to examine whether subjects hold correct beliefs about the action of the other player, and whether they best respond to their beliefs.

At the end of the final block, two out of six blocks are chosen at random for payment. Subjects are paid for the decision-making stage of one of the blocks, and for the accuracy of their beliefs about the actions of the other player in the other block. The reason we do not pay the same blocks for both the decision-making stage as well as the accuracy of the belief is to avoid hedging actions with responses to the belief questions. Subjects answer a socio-demographic questionnaire at the end of the final block and questions about reciprocity, risk and cognitive abilities. We use questions from Falk et al. (2016) to elicit risk preferences, and

[12] The belief elicitation questions are relegated to the experimental instructions in Appendix B.

[13] Each belief question at the end of the block was incentivised using the following rule: $70 - |\text{Correct Answer} - \text{Subject's Answer}|$. We use this rule because it is simple and less time consuming to explain to the subjects.

positive and negative reciprocity. We also use the Cognitive Reflection Task questions (Frederick, 2005) in the post-experimental questionnaire.

In the Context treatment, we frame the instructions to provide a natural setting to the game, i.e. of a Food Hygiene Rating of a restaurant. We do this by providing a context of a restaurant owner's (sender's) decision to display or withhold the food hygiene rating of the restaurant (private number), and restaurant customers' (receivers') decision to note down or guess the hygiene rating based on the restaurant owner's decision to display or withhold it. We use the context of a restaurant hygiene rating as we run the experiment with student subjects in the United Kingdom and food hygiene ratings are commonly seen at restaurants and eateries that students often visit.

The Food Hygiene Ratings are issued by the Food Standards Agency, which is an independent government department operating in England, Wales and Northern Ireland in partnership with local authorities. The FSA runs a scheme called the Food Hygiene Rating Scheme as part of their agenda to protect public health by ensuring food safety. This scheme gives restaurants and businesses that deal with food a Food Hygiene Rating between {0, 1, 2, 3, 4, 5}, where 0 implies that the business is required to make urgent improvements to their hygiene standards and 5 implies very good hygiene standards. Displaying these ratings is mandated by law in Wales and Northern Ireland but is on a voluntary basis in England, i.e. restaurants and other food businesses can choose whether to display their rating ("Food Standards Agency," 2018).

In our experiment, we use a modified version of the food hygiene rating card, one which closely resembles the food hygiene rating cards issued by the FSA. This ensures that the experiment closely resembles a natural setting. In Figure 1, Panel A shows the actual hygiene rating card issued by the FSA and Panel B shows the modified hygiene rating card used in the experiment.

Table 1 provides a summary of the key differences in the terminology used in the instructions of the Context treatment and the No Context treatment. The instructions for the treatments are presented in Appendix B.

Panel A: Actual Hygiene Rating Card (FSA)

Panel B: Modified Hygiene Rating Card (Experiment)

Figure 1: Food hygiene rating cards

Table 1: Framing used in the Context treatment

Baseline	Context treatment
S Player	Restaurant Owner
R Player 1	Restaurant Customer 1
R Player 2	Restaurant Customer 2
Private number	Food Hygiene Rating
Reveal	Display
Do not reveal	Do not display
Report the private number	Note down the hygiene rating

We used a between-subjects design and ran the experiment at the Centre for Decision Research and Experimental Economics laboratory at the University of Nottingham. Subjects were recruited using ORSEE (Greiner, 2015) and the sessions were run on z-Tree (Fischbacher, 2007).[14] Table 2 provides an overview of the treatments. The average payment was £13 (converted at the rate of 75 points = £1) which comprised of a fixed participation fee of £4, and an additional amount based on the decisions in the blocks chosen for payment.

Table 2: Overview of treatments

	Baseline	Consultation	Context
Number of sessions*	6	6	6
Number of senders	34	34	33
Number of receiver pairs	34	34	33
Number of rounds	30	30	30
Average minutes per session	70	90	70
Total number of subjects	102	102	99

*Note: Each session comprised of 15-18 subjects and was one matching group.

3. Results

3.1. Analysis of senders' behaviour

Panel A in Table 3 summarises the revealing rates by senders in all treatments. In general, we see that senders are more likely to reveal higher draws. When the draw is 4 or 5, the revealing rate is over 80% in all treatments. The revealing rate drops below 70% when the draws are 2 and 3 and the percentage of disclosure is nowhere close to the equilibrium prediction of full unravelling. We perform a non-parametric test on the average revealing rate of each sender (excluding private number 1 from the test because the senders with draw 1 are indifferent between revealing and not revealing in equilibrium). We find that there is a stark deviation from the theoretical prediction of full unravelling in the Baseline, Consultation treatment, and Context treatment even when we allow for a 10% error rate from the equilibrium prediction (Binomial test $p<0.001$ for all comparisons).[15]

[14] The sample summary statistics are relegated to Table 10 in Appendix A.

[15] We did not provide any feedback to senders between rounds in the experiment. Therefore, we consider each sender as an independent unit of observation and run all tests at the subject level for the senders. Receivers observed the sender's decision and they were randomly re-matched with a different sender after each round. Therefore, we conduct all tests for receivers at the session level. The paired tests conducted to compare the treatment averages of receivers with senders also consider each session as the independent unit of observation (for example: comparing the average non-disclosed number with the average guess of the non-disclosed number across treatments).

Table 3: Summary of senders' disclosure decisions

	Panel A					
Variables	**Baseline**		**Consultation**		**Context**	
	N	**% revealed**	**N**	**% revealed**	**N**	**% revealed**
Draw = 1	214	8.41	214	6.54	207	2.90
Draw = 2	266	27.44	263	33.08	261	32.18
Draw = 3	186	63.44	186	69.35	180	63.33
Draw = 4	180	83.89	183	84.15	174	92.53
Draw = 5	174	90.23	174	87.36	168	95.24

	Panel B		
	Baseline	**Consultation**	**Context**
Total non-revealed draws	503	484	465
Average non-revealed draw	1.962	1.960	1.817

Note: In Panel A, the column "% revealed" reports the average revealing rate across all senders when they observed that draw. In Panel B, we report the total number of non-revealed draws and the average draw when senders did not disclose the draw in the respective treatments.

Figure 2 shows the average revealing rate of senders across blocks by draw in both treatments. The revealing rates for none of the draws are significantly different across the Baseline and the Consultation treatment. Between the Baseline and the Context treatments, the revealing rate of draw 1 is lower in the Context treatment and this is marginally significant (Wilcoxon rank-sum test p=0.086). The average non-disclosed number is, therefore, strikingly similar across treatments, i.e. 1.962 in the Baseline, 1.960 in the Consultation treatment, and 1.817 in the Context treatment, as also shown in Panel B in Table 3 (Wilcoxon rank-sum test p=0.564 between Baseline and Consultation treatment, and Wilcoxon rank-sum test p=0.651 between Baseline and Context treatment). The average revealing rate of senders across treatments is also not significantly different (Wilcoxon rank-sum test p=0.475).[16]

We also analyse the differences in revealing behaviour of senders across the Baseline and Consultation treatment, and Baseline and Context treatment using regression analysis. Table 4 presents the marginal effects from probit estimations with standard errors clustered at the subject level, which is an independent unit of observation. The dependent variable takes values 1 if the sender's decision is to reveal, and 0 otherwise. The independent variables of interest are the Consultation treatment dummy which takes the value of 1 for senders in the Consultation treatment, and 0 for senders in the Baseline. The Context treatment dummy takes the value of 1 for senders in the Context treatment, and 0 for the senders in the Baseline.

[16] Because the realized distribution of draws is not exactly uniform, we construct a "theoretical" average non-disclosed number in the following way. Suppose the probability of disclosing each draw is equal to the frequency observed in the experiment. Then the theoretical average non-disclosed number can be calculated as the expectation of the draw conditional on non-disclosure. For example in Baseline using the % revealed from Table 3 we find that the theoretical average non-disclosed number would be $\frac{[100-8.41]\times 1+[100-27.44]\times 2+[100-63.44]\times 3+[100-83.89]\times 4+[100-90.23]\times 5}{100-8.41+100-27.44+100-63.44+100-83.89+100-90.23} = 2.03$. This value is slightly higher than the realized average nondisclosed number. The corresponding values for Consultation and Context are 2.03 and 1.85 respectively. As with the realized average non-disclosed number, there is no significant difference between treatments.

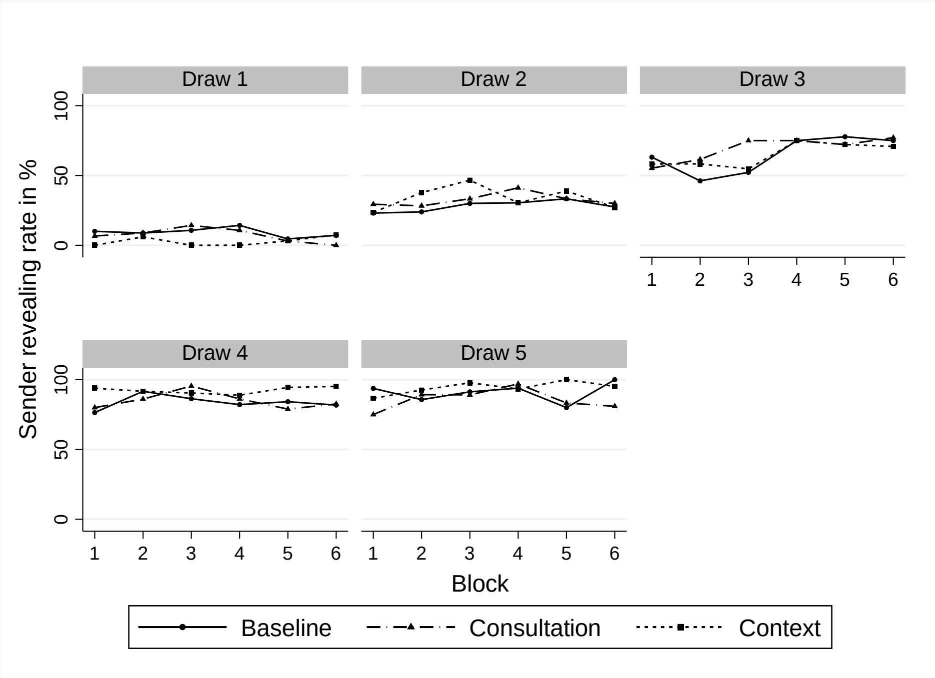

Figure 2: Sender revealing rate by draw across blocks

The regressions are estimated with socio-demographic controls such as sex, field of study (Economics), being a native English speaker, having a friend in the session, risk aversion, and cognitive ability.[17] We control for the subject's field of study being Economics because these subjects might be familiar with equilibrium concepts in games such as ours. Controlling for the cognitive ability of a subject helps us examine whether subjects with a higher cognitive ability (as measured by three questions of the Cognitive Reflection Task (Frederick, 2005) who might understand the game better than others, tend to reveal more compared to subjects with a lower score on those questions.[18] We control for subjects' risk preferences which might influence revealing behaviour, i.e. risk-averse subjects might reveal more to avoid a low payoff from receivers' low guess of a non-disclosed draw.[19]

Model I (column I) regresses sender's decision to reveal the draw on the treatment dummy, the individual draw dummies, the number of the round, and the socio-demographic controls. The main result is that the revealing rate of senders in the Consultation treatment and the Context treatment is not significantly different from the revealing rate of senders in the Baseline (p=0.817 for Consultation treatment dummy, and p=0.931 for Context treatment dummy). The estimates for the draw coefficients are statistically significant which implies that senders reveal higher draws significantly more than draw 1 (p=0.000 for all 'Draw' coefficients). We see that senders reveal more over rounds, although the effect size is small

[17] The post-experimental questionnaire used to measure the controls is provided in Appendix C. Being a native English speaker, and having a friend in the session are included in the regression to replicate the analysis in Jin et al. (2017) who include these terms in their regressions.
[18] The control variable for cognitive ability takes a value between 0 and 3 denoting the number of Cognitive Reflection Task questions (Frederick, 2005) correctly answered by a subject.
[19] The risk preference variable takes a value between 0 and 10, where 0 corresponds to extremely risk averse and 10 corresponds to risk seeking (Falk et al. 2016, see also Appendix C).

(p=0.045). The term identifying a native English speaker is positive and statistically significant which implies that the probability of a native English speaker revealing the draw is 7% higher compared to a non-native English speaker (p=0.020). The dummy identifying subjects with an Economics background is also positive and marginally significant implying that subjects studying Economics reveal 9% more than other subjects in the experiment (p=0.081). All other controls are insignificant.

Table 4: Regressions on senders' behaviour

	Sender reveals? (0/1)	
Variables	**I**	**II**
Consultation treatment	0.008	0.011
	(0.038)	(0.036)
Context treatment	-0.003	-0.012
	(0.038)	(0.036)
Draw=2	0.243***	0.224***
	(0.030)	(0.029)
Draw=3	0.591***	0.520***
	(0.038)	(0.047)
Draw=4	0.803***	0.719***
	(0.032)	(0.048)
Draw=5	0.845***	0.769***
	(0.031)	(0.044)
Round	0.001**	0.001*
	(0.0008)	(0.0008)
Dummy=1 if believed guess is below the actual number		0.100***
		(0.031)
Controls	Yes	Yes
Observations	3,030	3,030
(Pseudo) R-squared	0.372	0.378

Note: Probit for senders. Robust standard errors in parentheses (clustered at the subject level). Controls include sex, field of study (Economics), native English speaker, having a friend in the session, risk aversion, cognitive ability. ***p<0.01, **p<0.05, *p<0.1.

Model II (column II) includes socio-demographic controls and a variable capturing senders' belief about the receivers' guess conditional on non-disclosure. We use senders' responses to the belief questions to infer what they believe the receivers would guess, on average, upon observing non-disclosure. We call this the *'believed guess'* of the sender. We calculate the believed guess for each sender and for every block as follows: For example, if the sender believes that 30% receivers who observe non-disclosure guess 1 or 1.5 as the private number, 25% guess 2 or 2.5, 20% guess 3 or 3.5, 15% guess 4 or 4,5, 10% guess 5, then the 'believed guess' of the sender is calculated using the lower numbers in the formula as follows:[20]

$$\frac{[(30) * 1 + (25) * 2 + (20) * 3 + (15) * 4 + (10) * 5]}{100} = 2.50$$

[20] We also calculate the believed guess of the sender by taking 1.5 (instead of 1), 2.5 (instead of 2), 3.5 (instead of 3), 4.5 (instead of 4) and 5 as the guess of the receiver. The dummy calculated in this way is also significant in Model II of Table 4.

We include a dummy variable in the regression which takes values 1 if the draw in a given round is higher than senders' believed guess elicited at the end of that block, and the dummy takes the value of 0 otherwise. This dummy gives us insights into whether senders' revealing behaviour is influenced by their beliefs about the actions of the receivers. The believed guess dummy is highly significant implying that the probability of a sender revealing a draw is 10% higher if their believed guess is below the actual draw they observe (p=0.001). The probability of a native English speaker revealing the draw is 6% higher compared to a non-native English speaker (p=0.043). The treatment dummies and other control variables remain statistically insignificant.

Result 1: Sender's revealing behaviour is not significantly different between treatments and is far from the unravelling prediction.

3.2. Analysis of receivers' behaviour

Table 5 presents the average receiver report by treatment when the sender reveals private number 1, 2, 3, 4, 5, and when he does not reveal the number, i.e. blank. The data in the 'Consultation' column come from a pooled sample of those in the Consultation treatment who consult as well as those who did not consult when they were given the opportunity to do so.[21] On average, receivers' reports when the draws are revealed are accurate. Figure 3 shows the average guess of non-disclosed numbers across blocks by receivers in all treatments. The average guess of a non-disclosed number is 2.263, 2.232, and 2.189 in the Baseline, Consultation treatment, and Context treatment respectively and the difference between Baseline and Consultation treatment and Baseline and Context treatment is not statistically significant (Wilcoxon rank-sum test p=0.990, and p=0.423 respectively).

We calculate the difference between the average non-disclosed number by senders and the average guess of the non-disclosed number by receivers in all treatments to calculate how accurate receivers' guesses are about the non-disclosed number. We find that, in the Baseline this difference is 0.301, it is 0.272 in the Consultation treatment, and 0.372 in the Context treatment implying that the average guess of the non-disclosed draw is significantly above the average non-disclosed number in all treatments (Wilcoxon signed-rank test p=0.027 for Baseline, p=0.046 for the Consultation treatment, and p=0.027 in the Context treatment).[22]

[21] Consulting or not was a choice given to receivers in the Consultation treatment, and some receivers did not consult during the experiment. Overall, out of 34 pairs of receivers in the Consultation treatment, 31 pairs of receivers sent a message in at least one round of the experiment. Out of 1,020 rounds, receivers sent messages in 444 rounds, i.e. in 43.52% of all rounds.

[22] As the realised distribution of the numbers was not exactly uniform, we calculate the theoretical average non-disclosed number for each session given the actual sender revealing rate. This is 1.995, 2.015, and 1.839 in the Baseline, Consultation, and Context treatments respectively. We compared the difference between the average guess of the non-disclosed number and the theoretical average non-disclosed number, and this is 0.255, 0.214, and 0.336 in the Baseline, Consultation and Context treatments respectively. This difference is statistically significant in the Baseline and Context treatment but not statistically significant in the Consultation treatment

Table 5: Summary of receivers' reports

Variables	Baseline		Consultation		Context	
	N	**Mean**	**N**	**Mean**	**N**	**Mean**
Report (reveal=1)	36	1.04	28	1.25	12	1.12
Report (reveal=2)	146	2.00	174	2.10	168	1.99
Report (reveal=3)	236	3.00	258	3.02	228	3.00
Report (reveal=4)	302	4.00	308	4.00	322	4.01
Report (reveal=5)	314	4.98	304	4.95	320	4.99
Guess (reveal = blank)	1006	2.263	968	2.232	930	2.189
Guess - draw (not revealed)	1006	0.301	968	0.272	930	0.372

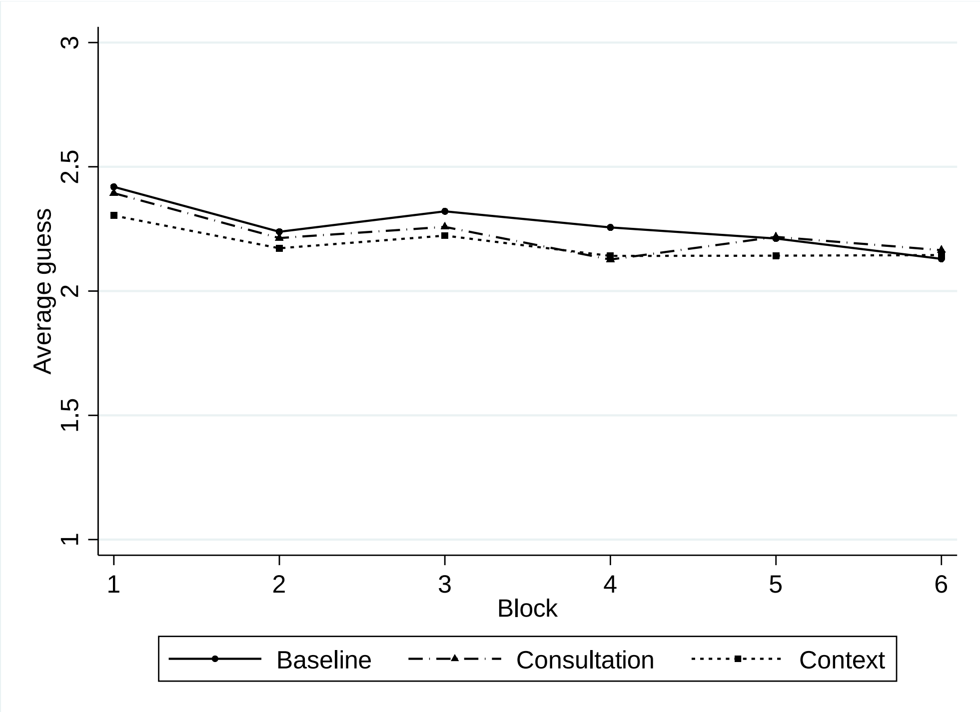

Figure 3: Average guess of non-disclosed numbers by receivers

Results from a regression analysis are presented in Table 6. We estimate two models to examine receivers' guess of a non-disclosed number. We estimate our regressions using the Ordinary Least Squares Method (OLS) with standard errors clustered at the session level as each session, which is a matching group, is an independent unit of observation. This is because receiver pairs received indirect feedback and were re-matched with a different sender in each round. The regressions include socio-demographic controls like the ones used in the sender regressions - sex, field of study (Economics), being a native English speaker, having a friend in the session, risk aversion, and cognitive ability. We include these terms for similar reasons mentioned earlier. We also include additional controls for the receiver regressions such as negative reciprocity and general reciprocity as a measure of subjects' social preferences because we

(Wilcoxon signed-rank test p=0.046 for Baseline, p=0.173 for the Consultation treatment, and p=0.027 in the Context treatment).

conjecture that reciprocal receivers might guess lower upon observing non-disclosure to punish the sender for not disclosing the draw.[23]

Model I (column I) compares the guesses of receivers across treatments. Our independent variables of interest are the treatment dummies. The Consultation treatment dummy and Context treatment dummies are coded 1 if the receiver is in the Consultation treatment or the Context treatment respectively, and 0 for the receivers in the Baseline. The coefficient of neither the Consultation treatment dummy nor the Context treatment dummy is statistically significant (p=0.624, p=0.455 respectively). This implies that guesses of receivers do not differ significantly between the Baseline and the Consultation treatment, or Baseline and the Context treatment. The round variable is negative and significant implying that receivers guess lower over rounds (p=0.000). We also find that receivers with a higher cognitive ability as measured by the cognitive ability questions guess 0.081 lower and this is statistically significant (p=0.021). All other controls are statistically insignificant.

Table 6: Regressions on receivers' behaviour

Variables	**Receiver guess of non-disclosed numbers**	
	I	**II**
Consultation treatment	-0.043	-0.011
	(0.087)	(0.066)
Context treatment	-0.084	-0.431
	(0.110)	(0.088)
Round	-0.007***	-0.001
	(0.001)	(0.001)
Implied guess calculated using receiver's stated beliefs		0.705***
		(0.050)
Constant	3.075***	1.014***
	(0.364)	(0.257)
Controls	Yes	Yes
Observations	2,904	2,904
R-squared	0.059	0.294

Note: OLS for receivers. Robust standard errors in parentheses (clustered at the session level). Controls include sex, field of study (Economics), native English speaker, having a friend in the session, risk aversion, cognitive ability, negative reciprocity, and reciprocity. ***p<0.01, **p<0.05, *p<0.1.

Model II (column II) builds on Model I (column I) by including a variable that measures receivers' beliefs about the non-disclosed number. We calculate what the receivers should have guessed based on the beliefs they held using responses to belief questions and applying Bayes' rule. We refer to this calculated number as the *'implied guess'* of the receiver following the terminology of Jin et al. (2017). The implied guess is calculated for each receiver and for every block as follows: For example, if the receiver believes that the sender revealing rate is 10% for

[23] The reciprocity controls included in the regression take values between 0 and 10, where 0 indicates a non-reciprocal person and 10 indicates a reciprocal person (Falk et al. 2016, see Appendix C).

a private number of 1, 40% for 2, 70% for 3, 90% for 4, and 95% for 5, then the implied guess of this receiver conditional on non-disclosure is:

$$\frac{[(100-10)*1+(100-40)*2+(100-70)*3+(100-90)*4+(100-95)*5]}{[(100-10)+(100-40)+(100-70)+(100-90)+(100-95)]}=1.871$$

We compare receivers' guess of the non-disclosed number in a given round with their implied guess elicited at the end of that block. We estimate Model II to examine whether guesses are influenced by the beliefs receivers hold about the non-disclosed number. The coefficient on receivers' belief is positive and significant (p=0.000). This suggests that receivers' guess of the non-disclosed number increases by 0.70 with a one-point increase in their implied guess. The subjects with an Economics background guess lower by 0.17 relative to all other subjects in the experiment (p=0.049). The treatment dummies all other controls are statistically insignificant.

Result 2: Receivers in the Consultation treatment and Context treatment do not guess significantly lower upon observing non-disclosure compared to the receivers' in the Baseline. In all treatments, receivers' guesses are significantly above the non-disclosed draw.

3.3. Analysis of the chat content

In this sub-section, we analyse the chat content of receivers in the Consultation treatment. To do this, we first assign the messages to one of the following four categories:

Receiver's action: Messages where receivers chat about own action or the action of the other receiver. For example, "What will you report?", "I will choose 2."

Sender's action: Messages where receivers chat about the sender's action, or what they think a non-disclosed number is. For example, "...well but he [sender] revealed 2 previously".

Equilibrium (like) reasoning: Messages where receivers provide a plausible reasoning for senders not disclosing the number. This reasoning may be close to or be the actual equilibrium reasoning. For example, "He [sender] didn't reveal it, probably means its low", "He'd [sender] definitely reveal if its 3, 4, 5."

Payoffs: Messages where receivers chat about the payoffs they would earn or the payoffs the senders would earn, for instance, from reporting a given number. For example, "He (sender) will lose 14.5 points if we report 1."

In total, based on the inspection of all messages, we manually code 837 messages out of 2,302 messages into one of the four categories mentioned above.[24] The remaining messages comprised of content such as exchanging greetings and game-irrelevant chats. Each message falls under one category only, i.e. categories are mutually exclusive. Table 7 below presents the categorisation of messages.

Table 7: Categorisation of messages

Variable	*Receiver's action*	*Sender's action*	*Equilibrium (like) reasoning*	*Payoffs*
Number of messages	611	85	70	71
% out of all messages sent	26.54%	3.69%	3.04%	3.08%
% of receiver pairs who send at least one message	79.41%	50%	55.88%	47.05%

After categorising the relevant chats into the aforementioned categories, we estimate a regression with the receivers' guess of the non-disclosed number as the dependent variable and the frequency of a given chat category for a receiver pair as the independent variable. The regression includes observations from the Consultation treatment, and from the Baseline where the dummies identifying the chat categories are all 0. We conjecture that receivers who message about the equilibrium reasoning will guess lower compared to the receivers who do not message about this or do not chat at all. We present the results from the regression analysis in Table 8.

Table 8: Regression of receivers' guess on the number of messages in a chat category

Variables	**Receiver guess of non-disclosed numbers**
	OLS
Receiver's action	0.005*
	(0.002)
Sender's action	-0.045*
	(0.021)
Equilibrium (like) reasoning	-0.036**
	(0.011)
Payoffs	0.002
	(0.005)
Constant	2.294***
	(0.050)
Observations	1,974
R-squared	0.037

Note: OLS for receivers. Robust standard errors in parentheses (clustered at the session level). ***p<0.01, **p<0.05, *p<0.1.

[24] When subjects hit "Enter" on the keyboard to send a message during the chat stage, we record it as one message in our dataset. Subjects could send as many messages as they wished in each round of the experiment within the 60 seconds of the chat stage. Examples of chat transcripts are included in Appendix 2.E.

We find that receivers who send messages about their own action or the action of the other receiver in the pair tend to guess higher than those who either do not send messages at all in either of the treatments or send messages about different things in the Consultation treatment (p=0.071). We find that receivers who message about the sender's action guess lower upon observing a non-disclosed number and this is marginally significant (p=0.060). In line with our conjecture, we find that receivers who message about the equilibrium (like) reasoning guess lower upon observing a non-disclosed number and this is statistically significant (p=0.010). However, these types of messages are rather infrequently observed in our data. Finally, we find that messaging about payoffs (either their own or of the senders) does not affect receivers' guesses of the non-disclosed number. In general, we find that pairs who consulted guessed lower on average than pairs who did not consult.

Result 3: In the Consultation treatment, receivers who send messages about sender's action and about equilibrium (like) reasoning guess lower upon observing non-disclosure, although such messages are infrequently observed in our dataset. In general, pairs who consulted guessed lower on average than pairs who did not.

4. Beliefs

4.1. Sender's beliefs

In this section, we explore the role of beliefs in driving senders' revealing decision, and receivers' guesses. We first compare senders' believed guess across treatments. The average believed guess is 2.291 in the Baseline, 2.328 in the Consultation treatment, and 1.886 in the Context treatment. We find that the difference between senders' believed guess across the Baseline and the Consultation treatment is not statistically significant (Wilcoxon rank-sum test p=0.917) while it is statistically significant across the Baseline and the Context treatment (Wilcoxon rank-sum test p=0.008). This implies that senders in the Context treatment believe that receivers will guess lower upon observing non-disclosure compared to the senders in the Baseline. Note that the effect on believed guesses in the Context treatment does not alter senders' overall revealing behaviour as discussed earlier.

We also compare the believed guess with the actual guess by receivers in all treatments. We find that the difference between the believed guess and the actual guess is not statistically significant in the Baseline and the Consultation treatments (Wilcoxon signed-rank test p=0.463 for Baseline, and p=0.345 for the Consultation treatment). This implies that senders in both these treatments form accurate beliefs about the receivers' guess conditional on non-disclosure. On the contrary, the difference between the believed guess and the actual guess in the Context treatment is statistically significant (Wilcoxon signed-rank test p=0.027) implying that believed guess in the Context treatment is not accurate, i.e. lower, given the receivers' actual guess of the non-disclosed number.[25]

We further analyse the consistency of senders' actions in a block with their elicited beliefs in that block in all treatments and present these numbers in Table 9. When the believed guess is lower than the actual draw in a given round of the experiment, we find that senders reveal optimally 75.17% in the Baseline, 76.92% in the Consultation treatment, and 73.39% in the Context treatment. When the believed guess is higher or equal to the actual draw in a given round of the experiment, we find that senders did not reveal the draw 83.18% in the Baseline, 80.23% in the Consultation treatment and 89.41% in the Context treatment. We find that there is no significant difference between treatments when we compare the overall percentage of times senders best respond to their beliefs (Wilcoxon rank-sum test p=0.980 between Baseline and Consultation treatment and p=0.959 between Baseline and Context treatment). Senders in none of the treatments best respond to their beliefs even when we allow for a 10% error rate (Binomial test p<0.001). The numbers in Table 9 are similar to those in Jin et al. (2017).

Table 9: Consistency between sender beliefs and actions

	Baseline	**Consultation**	**Context**
% of observations revealed when believed guess < draw	**75.17**	**76.92**	**73.39**
Rounds 1-10	70.30	70.59	69.09
Rounds 11-20	73.93	83.82	74.15
Rounds 21-30	82.12	75.77	77.00
% of observations not revealed when believed guess >= draw	**83.18**	**80.23**	**89.41**
Rounds 1-10	84.78	77.78	85.45
Rounds 11-20	78.29	74.26	92.55
Rounds 21-30	85.71	88.36	90.60

Result 4: There is no significant difference between the believed guesses of senders between Baseline and Consultation treatments. Senders in the Context treatment hold a lower believed guess than the senders in the Baseline. Senders in none of the treatments best respond to their beliefs even when we allow for a 10% error rate.

4.2. Receiver's beliefs

We next analyse the average implied guess of receivers across treatments. The implied guess is calculated using receivers' stated beliefs and applying Bayes' rule as explained before, and

[25] We also calculate the believed guess of the sender as explained in sub-section 3.1 by taking 1.5 (instead of 1), 2.5 (instead of 2), 3.5 (instead of 3), 4.5 (instead of 4) and 5 as the guess of the receiver and present results similar to the ones in Table 9 in Table 12 (Appendix A). We test whether the believed guess, calculated using the higher numbers of the interval, is significantly different from the actual guess in all treatments. We find that the believed guess and actual guess are significantly different in the Baseline and Consultation treatments (Wilcoxon signed-rank test p=0.027 for both treatments) but not significantly different in the Context treatment (Wilcoxon signed-rank test p=0.115).

on average, it is 2.186 in the Baseline, 2.139 in the Consultation treatment, and 2.108 in the Context treatment. This difference is not statistically significant (Wilcoxon rank-sum test p=0.748 between Baseline and Consultation treatment, and p=0.423 between Baseline and Context treatment). The average implied guess is not significantly different from the average actual guess in the Baseline and Context treatment but the difference is statistically significant in the Consultation treatment (Wilcoxon signed-rank test p=0.115, p=0.463, and p=0.074 respectively). The difference between the implied guess and the actual non-disclosed number in the Baseline, Consultation treatment and Context treatment is statistically significant (Wilcoxon signed-rank test p=0.027, p=0.074, and p=0.027 respectively). We use the term 'strategic naivety' to refer to the difference between the implied guess and the actual non-disclosed number following the terminology of Jin et al. (2017). This implies that receivers in all the treatments form incorrect beliefs about senders' revealing behaviour and they best respond to these incorrect beliefs about sender's behaviour.

Figure 4 shows the actual revealing rate of each draw by senders in both treatments and the receivers' belief about the senders' revealing rate, which we elicit during the experiment. We find that receivers hold accurate beliefs about the revealing behaviour of senders with low draws. However, receivers have miscalibrated beliefs about the senders' revealing rates when the draws are intermediate and high. In other words, receivers incorrectly believe that senders with intermediate and high draws are not disclosing as often as they do, while they are sufficiently pessimistic about the senders' revealing behaviour of low draws. This implies that receivers are too optimistic about the non-disclosed draw given senders' revealing behaviour and this is similarly seen in Jin et al. (2017).

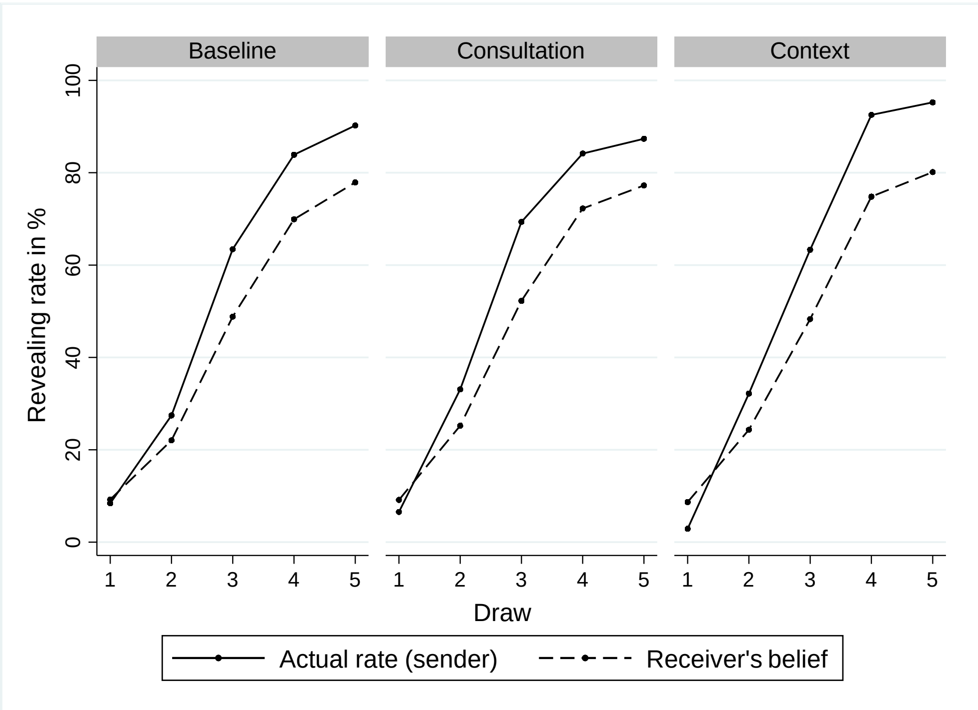

Figure 4: Actual revealing rate and receivers' belief about revealing rate

Result 5: The difference between the implied guess across treatments is not statistically significant. The difference between the implied guess and the actual non-disclosed number is statistically significant in all treatments implying that strategic naivety is robust under consultation and contextual setting. This result is driven by receivers underestimating the rate of disclosure of high draws.

Even though our focus is on strategic naivety on the part of the receiver, it is worth noting that senders are disclosing too seldom, not only compared to the equilibrium prediction but also compared with the best response to receivers' behaviour (see Appendix F). Therefore, both senders' behaviour as well as receiver's naivety about non-disclosed information contributes towards incomplete unravelling.

4.3. Evolution of receiver's beliefs

In Figure 5, we examine the evolution of receiver's beliefs and the actual non-disclosed number over blocks. Receiver's beliefs do not evolve sufficiently over time and the difference between their beliefs and the actual non-disclosed number remains statistically significant in all treatments (Wilcoxon signed-rank test p<0.001 in all treatments).

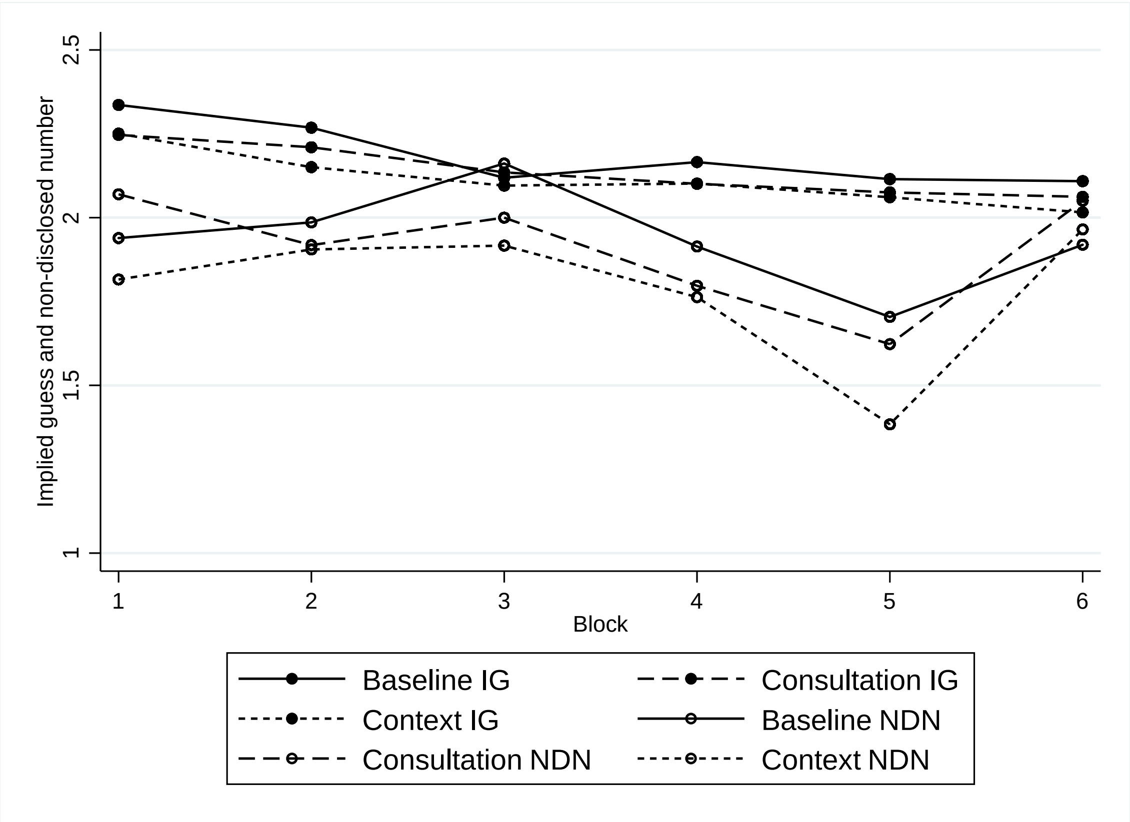

Figure 5: Evolution of receiver's beliefs and the non-disclosed number

Result 6: The difference between receiver's implied guess and the actual non-disclosed number is statistically significant over rounds in all treatments. This implies that receiver's naivety is persistent over time.

5. Discussion and conclusion

This paper examines whether naivety varies with systematic manipulations of the decision environment, namely with the opportunity to consult and with contextual presentation of information. Overall, we find that complete unravelling fails to occur in all our treatments. Contrary to our conjecture, we find that allowing receivers to consult with another subject before making decisions or adding context to the experiment does not change subjects' behaviour. The revealing rate by senders does not differ significantly across treatments even though senders believe receiver guesses will be lower in the Context treatment. In conclusion, we conclude that strategic naivety is robust to manipulations of the decision environment.

Our results regarding the average revealing rate by senders and the average guess of non-disclosed numbers by receivers are qualitatively similar to those in Jin et al. (2017), although we find that sender behaviour is at least as noisy as receiver behaviour (see Appendix F2.1). Our finding regarding the revealing rate of each of the numbers by senders is similar to the results in Mathios (2000) who studies disclosure of fat content in salad dressings using field data. He finds that fat content in salad dressings is disclosed almost always when it is low (i.e. when it is of high quality, similar to the 4s and 5s in our experiment), medium fat content in salad dressings is disclosed about 60% of the time (similar to the 3s), and high fat content is disclosed about 9% of the times (similar to the revealing rate of 1s in our experiment). This suggests the generalisability of our results to natural settings and in addition, provides further insights about the nature of strategic naivety about non-disclosed information.

Charness et al. (2010) remark that merely deliberating alternative courses of action improves understanding of the problem and leads to accurate responses by subjects. The main result of our study departs from theirs, and there are two reasons that might explain this. First, Charness et al. (2010) study an individual decision-making problem which requires subjects to undertake basic reasoning to overcome a decision anomaly (the conjunction fallacy in their setup). Consultation helps in this case as the solution to the problem is easily demonstrable once one of the subjects identifies the solution to the problem and communicates it to the other subject. In contrast, we examine behaviour in a strategic setting where receivers need to anticipate senders' behaviour, and there is strategic uncertainty about the senders' decision-making ability. Second, even if a receiver conveys the equilibrium reasoning to the other receiver during the chat stage, there is no direct way to verify whether the reasoning led to a more accurate guess of the non-disclosed number relative to previous rounds, except by observing what numbers were revealed earlier. Since many natural settings are characterised by a lack of direct and immediate feedback, we do not expect consultation in the real-world to improve receivers' inference about non-disclosed information.

We believe that the 'context-free' experiment communicates the structure of the game clearly such that providing a context to the game does not change subjects' behaviour. That is, essential features of the game, like the conflict-of-interest between the sender and the receivers, are clearly highlighted in the instructions of the 'context-free' treatment. Hence, subjects may have "transcended the frame" in the 'in-context' treatment and therefore, we observed actions and beliefs (of receivers) similar to those in the 'context-free' treatment (Chatterjee et al., 2000). This suggests that future research should examine not only whether context affects behaviour but also the conditions under which we are likely to see an effect of context on the behaviour of subjects.

Our results are also in contrast to the results in Benndorf et al. (2015) who find less revelation in a contextualised setting. We conjecture that the difference between our results may be due to the nature of information that subjects (workers) had to reveal, i.e. in their experiment, information is personal and sensitive (about health status) which is not the case in our experiment. A fruitful area for future research could be to further examine why strategic naivety exists, i.e. why don't individuals infer non-disclosure is bad news.

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Appendix A

Table 10: Summary statistics

Variables	N	Mean	Standard deviation
Consultation treatment (dummy)	6120	0.500	0.500
Context treatment (dummy)	6030	0.492	0.499
Economics (dummy)	9090	0.141	0.348
Male (dummy)	9090	0.386	0.486
Native English (dummy)	9090	0.488	0.499
Friend in the session (dummy)	9090	0.191	0.393
Cognitive ability	9090	1.297	1.101
Age	9090	21.468	3.464

Table 11: Payoff tables of the game

Points S, **R1**	**R 1's report: 1**	**R 1's report: 1.5**	**R 1's report: 2**	**R 1's report: 2.5**	**R 1's report: 3**	**R 1's report: 3.5**	**R 1's report: 4**	**R 1's report: 4.5**	**R 1's report: 5**
Private number 1	-14.5, 110	-3, 102	8.5, 90	19, 75	28.5, 57	37.5, 38	45, 17	51, -6	55, -29
Private number 2	-14.5, 90	-3, 102	8.5, 110	19, 102	28.5, 90	37.5, 75	45, 57	51, 38	55, 17
Private number 3	-14.5, 57	-3, 75	8.5, 90	19, 102	28.5, 110	37.5, 102	45, 90	51, 75	55, 57
Private number 4	-14.5, 17	-3, 38	8.5, 57	19, 75	28.5, 90	37.5, 102	45, 110	51, 102	55, 90
Private number 5	-14.5, -29	-3, -6	8.5, 17	19, 38	28.5, 57	37.5, 75	45, 90	51, 102	55, 110

Points S, **R2**	**R 2's report: 1**	**R 2's report: 1.5**	**R 2's report: 2**	**R 2's report: 2.5**	**R 2's report: 3**	**R 2's report: 3.5**	**R 2's report: 4**	**R 2's report: 4.5**	**R 2's report: 5**
Private number 1	-14.5, 110	-3, 102	8.5, 90	19, 75	28.5, 57	37.5, 38	45, 17	51, -6	55, -29
Private number 2	-14.5, 90	-3, 102	8.5, 110	19, 102	28.5, 90	37.5, 75	45, 57	51, 38	55, 17
Private number 3	-14.5, 57	-3, 75	8.5, 90	19, 102	28.5, 110	37.5, 102	45, 90	51, 75	55, 57
Private number 4	-14.5, 17	-3, 38	8.5, 57	19, 75	28.5, 90	37.5, 102	45, 110	51, 102	55, 90
Private number 5	-14.5, -29	-3, -6	8.5, 17	19, 38	28.5, 57	37.5, 75	45, 90	51, 102	55, 110

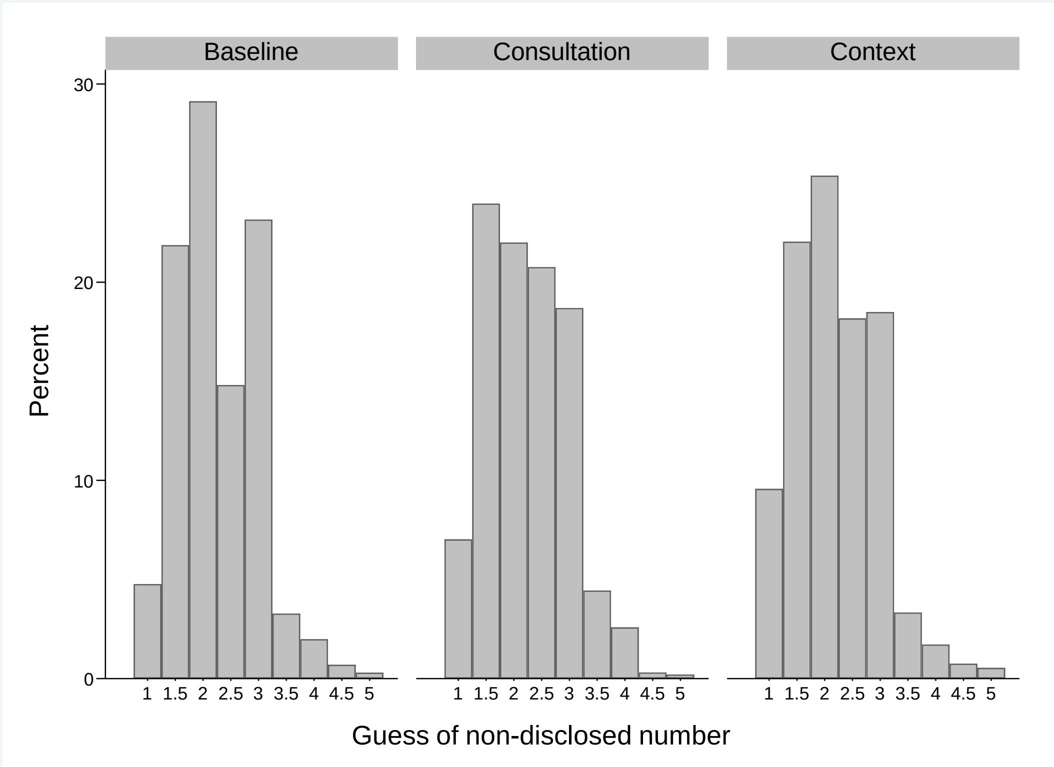


Figure 6: Distribution of guesses of non-disclosed numbers

Table 12: Consistency between sender beliefs and actions

	Baseline	**Consultation**	**Context**
% of observations revealed when believed guess < draw	**84.90**	**82.39**	**82.16**
Rounds 1-10	82.35	76.10	77.65
Rounds 11-20	73.93	88.70	82.29
Rounds 21-30	87.65	81.65	86.41
% of observations not revealed when believed guess >= draw	**83.18**	**75.48**	**84.14**
Rounds 1-10	80.21	75.14	80.79
Rounds 11-20	78.18	69.94	82.61
Rounds 21-30	84.27	80.77	89.04

Note: The believed guess is calculated taking the higher point of the interval (**Error! Reference source not found.** is calculated taking the lowest point of the interval).

Appendix B

B1. Experimental Instructions – Baseline and Consultation

Welcome

Thank you for taking part in this experiment on decision-making. For participating in this experiment, you will be paid a £4 show up fee. Moreover, you will be paid an additional amount of money that will depend on yours and other participants' decision, and on chance. You will be paid in cash, privately at the end of the experiment.

Please silence and put away your mobile phones now.

The entire session will take place through your computer terminal. Please do not talk with other participants during the session.

During this experiment we will calculate your earnings using points. For your final payment, your earnings will be converted into Pounds at the ratio of 75:1 (75 points=£1). Any negative earnings you may make during the experiment will be subtracted from your show-up fee of £4.

We will start with a brief instruction period. During the instruction period you will be given a description of the main features of the experiment. If you have any questions during this period, please raise your hand and the experimenter will come to you to answer your question.

Instructions

The experiment consists of 6 blocks with 5 rounds in each block, making it a total of 30 rounds. At the end of each block, you will be asked to answer 5 questions, and at the end of the final block, you will be asked to fill out a questionnaire.

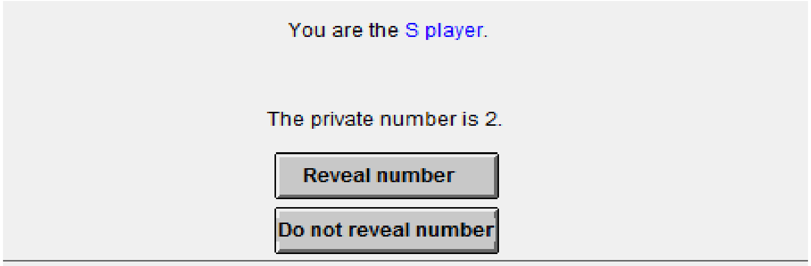
At the beginning of block 1, some of you will be randomly assigned to be the S Player and the others to be the R Player. If you are assigned to be the R Player, you will further be assigned to be either R Player 1 or R Player 2. You will remain in these roles for the entire duration of this experiment. The computer will randomly pair one R Player 1 with one R Player 2 and you will remain in these pairs for the entire duration of this experiment.

Decision making stage

In each round, one S Player will be randomly matched with a pair of R Players and in each new round, the S Player will be matched with a new pair of R players. You will not learn the identity of the other participants you are matched with, nor will the other participants learn your identity.

For every matching of an S Player with a pair of R Players, the computer program will generate a private number that is randomly drawn from the set {1, 2, 3, 4, 5}. Each of these numbers is equally likely to be generated. The computer will then send the private number to the S Player. After receiving this number, the S Player will choose whether or not to reveal the private number to both the R Players. If the S Player chooses to reveal the number, both the R Players will receive this message from the S Player: "The number I received is:" followed by the actual private number. Otherwise, both the R Players will receive no message.

This is a screenshot of the S Player's screen. As you can see, the S Player **cannot lie or misreport** the true private number.



After seeing the message from the S Player, each of the two R Players will independently report the value of the private number revealed by the S Player. If the private number is not revealed by the S Player, the R Players will guess the value of the private number. R Players can report the following numbers {1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5}. The numbers {1.5, 2.5, 3.5, 4.5} can be used, for example, when the R Players are unsure about the true value of the private number.

Earnings for the decision-making stage

The S Player will earn the sum of the points that result from the reports of both the R Players. The R Players will earn points based on their own report and the true value of the private number. The specific earnings are shown in the two tables below, which are displayed again before the S Player and the R Players make their decisions. In each cell of the two tables, the points for the S Player are on the left, and the points for the R Players are on the right. As you can see from the tables, the S Player earns more when the R Players make a higher report, and each of the R Players earns more when their report is closer to the true private number. The two tables are identical for both the R Players and the S Player.

The tables show the earnings in points for the **S Player** and **R Player 1**.

Points **S, R1**	**R 1's report: 1**	**R 1's report: 1.5**	**R 1's report: 2**	**R 1's report: 2.5**	**R 1's report: 3**	**R 1's report: 3.5**	**R 1's report: 4**	**R 1's report: 4.5**	**R 1's report: 5**
Private number 1	-14.5, 110	-3, 102	8.5, 90	19, 75	28.5, 57	37.5, 38	45, 17	51, -6	55, -29
Private number 2	-14.5, 90	-3, 102	8.5, 110	19, 102	28.5, 90	37.5, 75	45, 57	51, 38	55, 17
Private number 3	-14.5, 57	-3, 75	8.5, 90	19, 102	28.5, 110	37.5, 102	45, 90	51, 75	55, 57
Private number 4	-14.5, 17	-3, 38	8.5, 57	19, 75	28.5, 90	37.5, 102	45, 110	51, 102	55, 90
Private number 5	-14.5, -29	-3, -6	8.5, 17	19, 38	28.5, 57	37.5, 75	45, 90	51, 102	55, 110

The table shows the earnings in points for the **S Player** and **R Player 2**.

Points **S, R2**	**R 2's report: 1**	**R 2's report: 1.5**	**R 2's report: 2**	**R 2's report: 2.5**	**R 2's report: 3**	**R 2's report: 3.5**	**R 2's report: 4**	**R 2's report: 4.5**	**R 2's report: 5**
Private number 1	-14.5, 110	-3, 102	8.5, 90	19, 75	28.5, 57	37.5, 38	45, 17	51, -6	55, -29
Private number 2	-14.5, 90	-3, 102	8.5, 110	19, 102	28.5, 90	37.5, 75	45, 57	51, 38	55, 17
Private number 3	-14.5, 57	-3, 75	8.5, 90	19, 102	28.5, 110	37.5, 102	45, 90	51, 75	55, 57
Private number 4	-14.5, 17	-3, 38	8.5, 57	19, 75	28.5, 90	37.5, 102	45, 110	51, 102	55, 90
Private number 5	-14.5, -29	-3, -6	8.5, 17	19, 38	28.5, 57	37.5, 75	45, 90	51, 102	55, 110

Example – Earnings for a decision-making stage

Suppose in Round 18 of the experiment:

The computer program generates a private number: **3** and sends it to the S Player.

The S Player chooses not to reveal the private number to the R Players.

Hence, both the R Players see no message on their screen

R Player 1 guesses the value of the private number as: **4**

R Player 2 guesses the value of the private number as: **2.5**

Therefore,

S Player earns = Points resulting from R Player 1's guess + Points resulting from R Player 2's guess

= 45 + 19

= **64 points** (for Round 18)

R Player 1 earns = **90 points**

R Player 2 earns = **102 points**

Now please answer the following questions. After you have finished answering all the questions, please raise your hand and the experimenter will come to you to check your answers.

1. Suppose you are R Player 1 and the S Player sends the following message to you: *"The number I received is: 3"*. Which number that you report will earn you the highest points? ______

2. Suppose you are R Player 2 and the S Player sends the following message to you: *"The number I received is: 3"*. Which number that you report will earn you the highest points? ______

3. Suppose you are the S Player and you send the following message to the R Players: *"The number I received is: 2"*. Which number that R Player 1 or R Player 2 reports will earn you the highest points? ______

4. Suppose the S Player did not reveal the private number 4. R Player 1 guesses 2.5 and R Player 2 guesses 3. What would be:

    a) S Player's earnings: _____

    b) R Player 1's earnings: _____

    c) R Player 2's earnings: _____

[Discussion Stage - *Only Consultation treatment*

Before the R Players submit their own report about the value of the private number, they will have **60 seconds** to use a computerised chat program to get help from or offer help to the other R Player about the report they want to submit. Messages will be shared only among the two R Players that are paired together. That is, a pair of R Players will not be able to see the messages exchanged between another pair of R Players. The S Players cannot see any messages that are shared between any pair of R Players. If both the R Players have finished discussing before the 60 seconds lapse, they can click on the **"Leave chat"** button on the chat window to enter their reports for that round.

Except for the following restrictions, R Players can type whatever they want in the chat window.

Restrictions on messages:

1. You must not identify yourself or send any information that could be used to identify you.

2. You must not make any threats, insult or use any obscene or offensive language.

If you violate these rules, your payment will be forfeited.]

Questions at the end of each block

At the end of each block, S Players will answer the following 5 questions:

Think about the last 5 rounds. When the S Players did not reveal the private number, what percentage of R Players in this room do you think reported the number:

a) 1 or 1.5:

b) 2 or 2.5:

c) 3 or 3.5:

d) 4 or 4.5:

e) 5:

In a block, if all S Players have revealed the private number the earnings for that block will be determined at random for the S Players.

At the end of each block, R Players will answer the following 5 questions:

What percentage of S Players do you think revealed the private number:

a) When the true private number was 1:

b) When the true private number was 2:

c) When the true private number was 3:

d) When the true private number was 4:

e) When the true private number was 5:

The following rule will be used to calculate your earnings for the answers to each of the 5 questions:

70 - (Your answer - Correct answer), if your answer is higher than the correct answer of that question

Or

70 - (Correct answer - Your answer), if your answer is lower than the correct answer of that question

Example – Earnings for the questions at the end of each block

Suppose you are the **S Player**. You answer the following question:

Think about the last 5 rounds. When the S Players did not reveal the private number, what percentage of R Players in this room do you think reported the number:

a) 1 or 1.5: ____

If your answer is: **30**

But the correct answer is: **50**

Your answer is lower than the correct answer. Therefore, we will use the following rule to determine your earnings for that question:

Your earnings = 70 - (Correct answer - Your answer)

= 70 - (50 - 30)

= 70 - 20

= **50 points**

Suppose you are one of the two **R Players**. You answer the following question:

What percentage of S Players do you think revealed the private number:

a) When the true private number was 1:

If your answer is: **45**

But the correct answer is: **30**

Your answer is higher than the correct answer. Therefore, we will use the following rule to determine your earnings for that question:

Your earnings = 70 - (Your answer - Correct answer)

= 70 - (45 - 30)

= 70 - 15

= **55 points**

Now please answer the following questions. After you have finished answering all the questions, please raise your hand and the experimenter will come to you to check your answers.

1. Suppose you are the S Player. If your answer to any one of the 5 questions above is **55** but the correct answer is **50**, what would be your earnings in points for that question? ______

2. Suppose you are R Player 1. If your answer to any one of the 5 questions above is **25** but the correct answer is **40**, what would be your earnings in points for that question? ______

Payment

At the end of the experiment, the experimenter will call two participants to roll two six-sided dice one after another. The number rolled on the two dice will determine the two blocks that all participants will be paid for. You will be paid the total earnings accumulated for the 5 rounds in the decision making stage for the block determined by the first die roll. For example, if the number rolled on the first die is 1, you will be paid the total amount you have accumulated in the 5 rounds in the decision making stage in block 1. You will be paid for the accuracy of your answers to the 5 questions at the end of the block determined by the second die roll. For example, if the number rolled on the second die is 2, you will be paid for the accuracy of your answers to the 5 questions in block 2. If the number rolled on the second die is the same as the number rolled on the first die, the second die will be rolled again. In other words, you will be paid once for the total amount you have accumulated in the 5 rounds in the decision making stage of one of the blocks, and once for the accuracy of your answers to the 5 questions in a different block.

Please raise your hand if you have any questions.

B2. Experimental Instructions – Context

Welcome

Thank you for taking part in this experiment on decision-making. For participating in this experiment, you will be paid a £4 show up fee. Moreover, you will be paid an additional amount of money that will depend on yours and other participants' decision, and on chance. You will be paid in cash, privately at the end of the experiment.

Please silence and put away your mobile phones now.

The entire session will take place through your computer terminal. Please do not talk with other participants during the session.

During this experiment we will calculate your earnings using points. For your final payment, your earnings will be converted into Pounds at the ratio of 75:1 (75 points=£1). Any negative earnings you may make during the experiment will be subtracted from your show-up fee of £4.

We will start with a brief instruction period. During the instruction period you will be given a description of the main features of the experiment. If you have any questions during this period, please raise your hand and the experimenter will come to you to answer your question.

Instructions

The experiment consists of 6 blocks with 5 rounds in each block, making it a total of 30 rounds. At the end of each block, you will be asked to answer 5 questions, and at the end of the final block, you will be asked to fill out a questionnaire.

At the beginning of block 1, some of you will be randomly assigned to be the Restaurant Owner and the others to be the Restaurant Customers. If you are assigned to be the Restaurant Customers, you will further be assigned to be either Restaurant Customer 1 or Restaurant Customer 2. You will remain in these roles for the entire duration of this experiment. The computer will randomly pair one Restaurant Customer 1 with one Restaurant Customer 2 and you will remain in these pairs for the entire duration of this experiment.

Decision making stage

In each round, one Restaurant Owner will be randomly matched with a pair of Restaurant Customers and in each new round, the Restaurant Owner will be matched with a new pair of Restaurant Customers. You will not learn the identity of the other participants you are matched with, nor will the other participants learn your identity.

For every matching of a Restaurant Owner with a pair of Restaurant Customers, the computer program, which will act like the Food Standards Agency, will generate a food hygiene rating for the **Restaurant Owner**. This hygiene rating will be drawn from the set {1, 2, 3, 4, 5}. Each of these hygiene ratings is equally likely to be generated. The Food Standard Agency will then send the hygiene rating to the Restaurant Owner. After receiving this hygiene rating, the Restaurant Owner will choose whether or not to display the hygiene rating to both the Restaurant Customers. If the Restaurant Owner chooses to display the hygiene rating, both the Restaurant Customers will receive this message from the Restaurant Owner: "The food hygiene rating I received is:" followed by the actual hygiene rating. Otherwise, both the Restaurant Customers will receive no message.

This is a screenshot of the Restaurant Owner's screen. As you can see, the Restaurant Owner **cannot lie or misreport** the true hygiene rating.

After seeing the message from the Restaurant Owner, each of the two Restaurant Customers will independently report the hygiene rating displayed by the Restaurant Owner. This can be thought of as noting down the hygiene rating of a Restaurant Owner for future restaurant visit decisions. If the hygiene rating is not displayed by the Restaurant Owner, the Restaurant Customers will guess the value of the hygiene rating. Restaurant Customers can report the following hygiene ratings {1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5}. The hygiene ratings {1.5, 2.5, 3.5, 4.5} can be used, for example, when the Restaurant Customers are unsure about the true value of the hygiene rating.

Earnings for the decision-making stage

The Restaurant Owner will earn the sum of the points that result from the report of both the Restaurant Customers. The Restaurant Customers will earn points based on their own report and the true value of the hygiene rating. The specific earnings are shown in the two tables below, which are displayed again before the Restaurant Owner and the Restaurant Customers make their decisions. In each cell of the two tables, the points for the Restaurant Owner are on the left, and the points for the Restaurant Customers are on the right. As you can see from the tables, the Restaurant Owner earns more when the Restaurant Customers make a higher report, and each of the Restaurant Customers earns more when their report is closer to the true hygiene rating. The two tables are identical for both the Restaurant Customers and the Restaurant Owner.

The tables show the earnings in points for the **Restaurant Owner** and **Restaurant Customer 1**.

Points **O, C1**	**C 1's report: 1**	**C 1's report: 1.5**	**C 1's report: 2**	**C 1's report: 2.5**	**C 1's report: 3**	**C 1's report: 3.5**	**C 1's report: 4**	**C 1's report: 4.5**	**C 1's report : 5**
Food hygiene rating 1	-14.5, 110	-3, 102	8.5, 90	19, 75	28.5, 57	37.5, 38	45, 17	51, -6	55, -29
Food hygiene rating 2	-14.5, 90	-3, 102	8.5, 110	19, 102	28.5, 90	37.5, 75	45, 57	51, 38	55, 17
Food hygiene rating 3	-14.5, 57	-3, 75	8.5, 90	19, 102	28.5, 110	37.5, 102	45, 90	51, 75	55, 57
Food hygiene rating 4	-14.5, 17	-3, 38	8.5, 57	19, 75	28.5, 90	37.5, 102	45, 110	51, 102	55, 90
Food hygiene rating 5	-14.5, -29	-3, -6	8.5, 17	19, 38	28.5, 57	37.5, 75	45, 90	51, 102	55, 110

The table shows the earnings in points for the **Restaurant Owner** and **Restaurant Customer 2**.

Points **O, C2**	**C 2's report: 1**	**C 2's report: 1.5**	**C 2's report: 2**	**C 2's report: 2.5**	**C 2's report: 3**	**C 2's report: 3.5**	**C 2's report: 4**	**C 2's report: 4.5**	**C 1's report: 5**
Food hygiene rating 1	-14.5, 110	-3, 102	8.5, 90	19, 75	28.5, 57	37.5, 38	45, 17	51, -6	55, -29
Food hygiene rating 2	-14.5, 90	-3, 102	8.5, 110	19, 102	28.5, 90	37.5, 75	45, 57	51, 38	55, 17
Food hygiene rating 3	-14.5, 57	-3, 75	8.5, 90	19, 102	28.5, 110	37.5, 102	45, 90	51, 75	55, 57
Food hygiene rating 4	-14.5, 17	-3, 38	8.5, 57	19, 75	28.5, 90	37.5, 102	45, 110	51, 102	55, 90
Food hygiene rating 5	-14.5, -29	-3, -6	8.5, 17	19, 38	28.5, 57	37.5, 75	45, 90	51, 102	55, 110

Example – Earnings for a decision making stage

Suppose in Round 18 of the experiment:

The Food Standards Agency generates a hygiene rating: **3** for the Restaurant Owner.

The Restaurant Owner chooses not to display the hygiene rating to the Restaurant Customers.

Hence, both the Restaurant Customers see no message on their screen

Restaurant Customer 1 guesses the value of the hygiene rating as: **4**

Restaurant Customer 2 guesses the value of the hygiene rating as: **2.5**

Therefore,

Restaurant Owner earns = Points resulting from Restaurant Customer 1's guess + Points resulting from Restaurant Customer 2's guess

= 45 + 19

= **64 points** (for Round 18)

Restaurant Customer 1 earns = **90 points**

Restaurant Customer 2 earns = **102 points**

Now please answer the following questions. After you have finished answering all the questions, please raise your hand and the experimenter will come to you to check your answers.

1) Suppose you are Restaurant Customer 1 and the Restaurant Owner sends the following message to you: *"The food hygiene rating I received is: 3"*. Which hygiene rating that you report will earn you the highest points? ______

2) Suppose you are Restaurant Customer 2 and the Restaurant Owner sends the following message to you: *"The food hygiene rating I received is: 3"*. Which hygiene rating that you report will earn you the highest points? ______

3) Suppose you are the Restaurant Owner and you send the following message to the Restaurant Customers: *"The food hygiene rating I received is: 2"*. Which number that Restaurant Customer 1 or Restaurant Customer 2 reports will earn you the highest points? ______

4) Suppose the Restaurant Owner did not display the hygiene rating 4. Restaurant Customer 1 guesses 2.5 and Restaurant Customer 2 guesses 3. What would be:

a) Restaurant Owner's earnings: _____

b) Restaurant Customer 1's earnings: _____

c) Restaurant Customer 2's earnings: _____

Questions at the end of each block

At the end of each block, Restaurant Owners will answer the following 5 questions:

Think about the last 5 rounds. When the Restaurant Owners did not display the food hygiene rating, what percentage of Restaurant Customers in this room do you think reported the food hygiene rating:

a) 1 or 1.5:

b) 2 or 2.5:

c) 3 or 3.5:

d) 4 or 4.5:

e) 5:

In a block, if all Restaurant Owners have displayed the hygiene rating, the earnings for the questions in that block will be determined at random for the Restaurant Owners.

At the end of each block, Restaurant Customers will answer the following 5 questions:

Think about the last 5 rounds. What percentage of Restaurant Owners do you think displayed the food hygiene rating:

a) When the true food hygiene rating was 1:

b) When the true food hygiene rating was 2:

c) When the true food hygiene rating was 3:

d) When the true food hygiene rating was 4:

e) When the true food hygiene rating was 5:

The following rule will be used to calculate your earnings for the answers to each of the 5 questions:

70 - (Your answer - Correct answer), if your answer is higher than the correct answer of that question

Or

70 - (Correct answer - Your answer), if your answer is lower than the correct answer of that question

Example – Earnings for the questions at the end of each block

Suppose you are the **Restaurant Owner**. You answer the following question:

Think about the last 5 rounds. When the Restaurant Owners did not display the food hygiene rating, what percentage of Restaurant Customers in this room do you think reported the food hygiene rating:

a) 1 or 1.5: ____

If your answer is: **30**

But the correct answer is: **50**

Your answer is lower than the correct answer. Therefore, we will use the following rule to determine your earnings for that question:

Your earnings = 70 - (Correct answer - Your answer)

= 70 - (50 - 30)

= 70 - 20

= **50 points**

Suppose you are one of the two **Restaurant Customers**. You answer the following question:

Think about the last 5 rounds. What percentage of Restaurant Owners do you think displayed the food hygiene rating:

a) When the true food hygiene rating was 1:

If your answer is: **45**

But the correct answer is: **30**

Your answer is higher than the correct answer. Therefore, we will use the following rule to determine your earnings for that question:

Your earnings = 70 - (Your answer - Correct answer)

= 70 - (45 - 30)

= 70 - 15

= **55 points**

Now please answer the following questions. After you have finished answering all the questions, please raise your hand and the experimenter will come to you to check your answers.

1. Suppose you are the Restaurant Owner. If your answer to any one of the 5 questions above is **55** but the correct answer is **50**, what would be your earnings in points for that question? ______

2. Suppose you are Restaurant Customer 1. If your answer to any one of the 5 questions above is **25** but the correct answer is **40**, what would be your earnings in points for that question? ______

Payment

At the end of the experiment, the experimenter will call two participants to roll two six-sided dice one after another. The number rolled on the two dice will determine the two blocks that all participants will be paid for. You will be paid the total earnings accumulated for the 5 rounds in the decision making stage for the block determined by the first die roll. For example, if the number rolled on the first die is 1, you will be paid the total amount you have accumulated in the 5 rounds in the decision making stage in block 1. You will be paid for the accuracy of your answers to the 5 questions at the end of the block determined by the second die roll. For example, if the number rolled on the second die is 2, you will be paid for the accuracy of your answers to the 5 questions in block 2. If the number rolled on the second die is the same as the number rolled on the first die, the second die will be rolled again. In other words, you will be paid once for the total amount you have accumulated in the 5 rounds in the decision making stage of one of the blocks, and once for the accuracy of your answers to the 5 questions in a different block.

Please raise your hand if you have any questions.

Appendix C

Post-experimental questionnaire

General questions:

1. What is your gender?
2. Is English your first or native language?
3. How old are you?
4. Do you have a friend participating in the session today?
5. What advice would you give to a friend if they were going to take your spot in this experiment?
6. Answer if you were an S Player. How did you decide whether or not to reveal the private number?
7. Answer if you were an R Player. How did you decide which number to report or guess?
8. What is your academic major or your planned academic major?

Cognitive ability questions:

9. A bat and a ball cost £1.10 in total. The bat costs £1 more than the ball. How much does the ball cost? ______ pence
10. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets? _____ minutes
11. In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half the lake? ______ days

Risk preference:

12. Please tell me, in general, how willing or unwilling you are to take risks. Please use a scale from 0 to 10, where 0 means you are "completely unwilling to take risks" and a 10 means you are "very willing to take risks". You can also use any numbers between 0 and 10 to indicate where you fall on the scale.

Negative Reciprocity:

13. On a scale from 0 to 10, where 0 means you are "completely unwilling to do so" and a 10 means you are "very willing to do so", how willing are you to punish someone who treats YOU unfairly, even if there may be costs for you?

General reciprocity:

14. How well does the following statement describe you as a person? Please indicate your answer on a scale from 0 to 10, where 0 means "does not describe me at all" and a 10 means "describes me perfectly".

    When someone does me a favour I am willing to return it.

Positive reciprocity:

15. Please think about what you would do in the following situation. You are in an area you are not familiar with, and you realise that you lost your way. You ask a stranger for directions. The stranger offers to take you to your destination. Helping you costs the stranger about 20 Pounds in total. However, the stranger says he or she does not want any money from you. You have 6 presents with you. The cheapest present costs 5 Pounds, the most expensive one costs 30 Pounds. Do you give one of the presents to the stranger as a "thank-you"-gift? If so, which present do you give to the stranger?

    No present
    The present worth 5 Pounds
    The present worth 10 Pounds
    The present worth 15 Pounds
    The present worth 20 Pounds
    The present worth 25 Pounds
    The present worth 30 Pounds

Appendix D

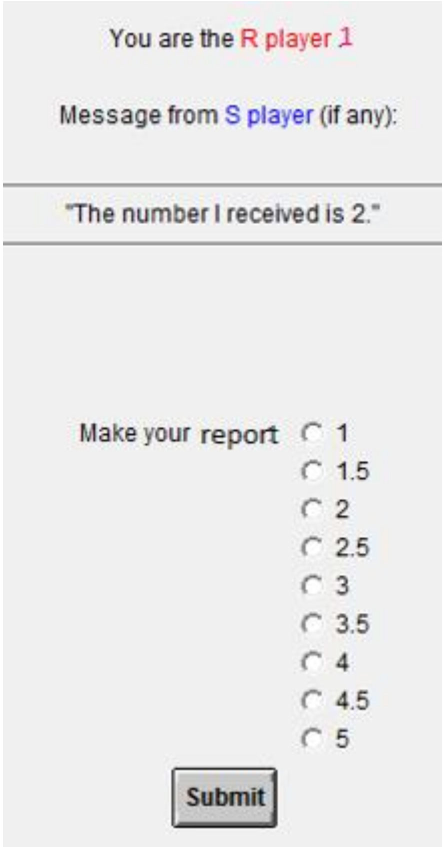
Screenshots of players' screen

Senders' screen – Baseline and Consultation treatment

Senders' screen – Context treatment

Receivers' chat screen – Consultation treatment (1)

Receivers' screen - Baseline and Consultation treatment (2)



Receivers' screen – Context treatment

Appendix E

Examples of chat message categorisation

1. Receiver's action

Round	Chat	SubjectID	GroupID
1	What number are you going to choose?	713	5
1	3?	714	5
1	yeah me too I think	713	5
4	so go for 4?	711	4
4	4 for this one	710	4
4	yesss	711	4
4	i will try 3.5 this time	714	5
4	i might try 2.5	713	5
6	im gonna do 2.5	716	6
6	ill go 3,5	717	6
6	great	716	6
7	im thinking 3	701	1
7	im thinking below 2	702	1
7	cos its is an average	701	1
7	i think i will try 2,5	717	6
7	same	716	6

2. Sender's action

Round	Chat	SubjectID	GroupID
3	so what do you think the number is??	716	6
3	he hadnt reveal	717	6
3	yeah well but he revealed 2 previously	716	6
5	i guess its 1?	716	6
5	me too	717	6
6	its a different player now, so it may not be 1	716	6
9	the s player is quite conservative dont you think??	716	6
2	why isnt he revealing	805	2
2	It's v annoying that he isn't revealing	804	2
6	id say he has either 1, 2, 3	816	6
6	most likerly between 1, 2	816	6
7	they got a 1 :')	811	4
8	you knot it could have been a 5 just now..	810	4
8	either this guy keeps getting low numbers or he is a moron	816	6
8	lets hop he keeps getting low numbers	816	6

3. *Equilibrium (like) reasoning*

Round	Chat	SubjectID	GroupID
1	if they didnt say it that probably means low	807	3
1	if he doesnt report a number we can assume he has a low number. If he had a high number he would report it	816	6
2	Must be a low number again?	817	6
3	haha, maybe they are just getting all low numbers. Surely they would reveal it if it were 4 or 5	817	6
5	must be 1 or 2 because they would reveal it again if it was 3	817	6
5	yeah id say so	816	6
2	i think its likely to be a lower number seen as they didnt reveal it this time	1008	3
2	yeah i agree	1007	3
6	I'm assuming that if they don't reveal the value then it's probably <3 and I'm not sure that's the right way to go about it	1014	5
10	i think private number must be 1 or 2. If it was 3 they would have reported it	1004	2
17	Anything 3 or above will be revealed I feel	1005	2
22	Yeah I do think most people report 2	1005	2
22	yeah i think people do	1004	2
23	this must be 1 then. They would report 2	1004	2

4. *Payoffs*

Round	Chat	SubjectID	GroupID
20	they are going to lose -14.5 points	613	5
20	so -29	613	5
9	we both report 1, get 110 each, and they get negative points	710	4
11	110 points guarunteed	710	4
13	we are on full points this round	710	4
13	hopefully this one is chosen by the dice	710	4
13	we get 90 each	1117	6
13	he gets 17	1117	6
19	why dont we choose 4, we can get 110	1205	2

Appendix F

F1. Robustness check for receivers

Receivers in the Consultation treatment were given the option to consult and therefore, they could choose not to consult with the other receiver during the experiment. We estimate a regression on receivers' guess of non-disclosed numbers using only the observations (rounds) in the Consultation treatment where chat actually did occur and the rounds thereafter, and with all observations (rounds) in the No Consultation treatment. We present the results in Table 13 below and include the same socio-demographic controls as in earlier regressions on receivers' behaviour for comparability.

Table 13: Robustness regression on receivers' behaviour

Variables	**Receiver guess of non-disclosed numbers**
	OLS
Consultation and Chat	-0.038
	(0.103)
Round	-0.007***
	(0.002)
Constant	2.479***
	(0.317)
Controls	Yes
Observations	1,840
R-squared	0.047

Note: OLS for receivers. Robust standard errors in parentheses (clustered at the session level). 'Consultation and Chat' dummy = 1 for all rounds after which a receiver first chats in the Consultation treatment, and 0 for all rounds in the No Consultation treatment. Controls include sex, field of study (Economics), native English speaker, having a friend in the session, risk aversion, cognitive ability, negative reciprocity, and reciprocity. ***p<0.01, **p<0.05, *p<0.1.

We estimate this regression because we intended to treat all receiver observations (i.e. all receivers and in all 30 rounds) in the Consultation treatment but couldn't, i.e. in a few initial rounds, some receivers did not chat and there were also some receivers who never chatted in the experiment. Therefore, our independent variable of interest is the 'Consultation and Chat' dummy which we code as 1 if the receiver in the Consultation treatment chats in a given round, and for all subsequent rounds after the chat occurs, and 0 in all rounds for the receivers in the Baseline. We code the 'Consultation and Chat' dummy = 1 for all rounds after the round in which receiver chats for the first time to account for spill-over effects of consultation. We reason that once the receiver consults to clarify a feature of the game or suggests a reason for his/her guess or anticipation of the sender's strategy, they may not need to chat again, but the effect of that chat lasts for all subsequent rounds of the experiment.

The coefficient of the 'Consultation and Chat' dummy is not statistically significant (p=0.715). This implies that guesses in rounds where chat occurs and the guesses thereafter in the Consultation treatment do not differ from the guesses of the receivers in the No

Consultation treatment. The round variable is statistically significant implying that receivers guess lower over rounds (p=0.008). None of the controls included are significant.[26, 27]

Result 7: Receivers' guesses after they chat do not differ significantly from receivers' guesses in the Baseline.

F2. Quantal response analysis

F2.1. Best response analysis

The quantal response analysis is motivated by the fact that neither senders nor receivers are acting optimally given the other players' behaviour. The figures below show the expected payoff from disclosure in each treatment, separately for each draw, given receivers' behaviour; the horizontal line corresponds to the expected payoff from nondisclosure given receivers' behaviour. Full unravelling is not a best response for the sender given receivers' actual behaviour; however, the sender has a lot to gain from revealing draws = 3, 4 and 5. This suggests that the lack of full unravelling is partly the sender's fault: had the sender played a best response to the receiver, the average nondisclosed number would be lower (1.5 in all treatments rather than 1.85-2.03).

Similarly, because senders' revealing behaviour is far from the unravelling prediction, it is not a best response for the receiver to guess 1 if the draw is not disclosed. The figures show that the best response in all treatments would be to guess 2 (lower than the observed average 2.19-2.26), though expected payoffs from guesses 1.5-2.5 are quite similar. The payoff for each of the receiver's guesses is calculated given the sender's empirical frequencies of disclosure for each draw, and assuming that each value of the draw is equally likely.

Interestingly, playing a best response to the empirically observed behaviour of the other player would lead to a greater adjustment in the sender's strategy (in terms of the average nondisclosed number) than the receiver's (in terms of the average guess of a nondisclosed number). The quantal response analysis below also suggests that sender's behaviour is further away from best response.

[26] We also compare receivers' guesses after chat occurs with receivers' guesses before chat occurs combined with guesses of receivers who never chat in the Consultation treatment. We find that receivers' guesses after chat occurs do not differ significantly from the guesses before chat occurs and guess of receivers who never chat.

[27] We investigate whether there is any selection into consulting based on the observed characteristics of receivers such as sex, field of study (Economics), having a friend in the session, being a native English speaker, risk aversion, and cognitive ability. For each receiver, we take the average of the Chat dummy across rounds in the Consultation treatment (the Chat dummy is coded as 1 if a receiver chats in a given round of the experiment and 1 for all rounds thereafter, and 0 before any chat occurs, or if no chat occurs). This average gives us a measure of how early (or how much quicker) a receiver decides to chat in the experiment and we regress this average on the characteristics of the receivers. We find that none of the characteristics are statistically significant and therefore, we conclude that we do not find any evidence for selection into chatting based on the characteristics of the receivers we observe in our data.

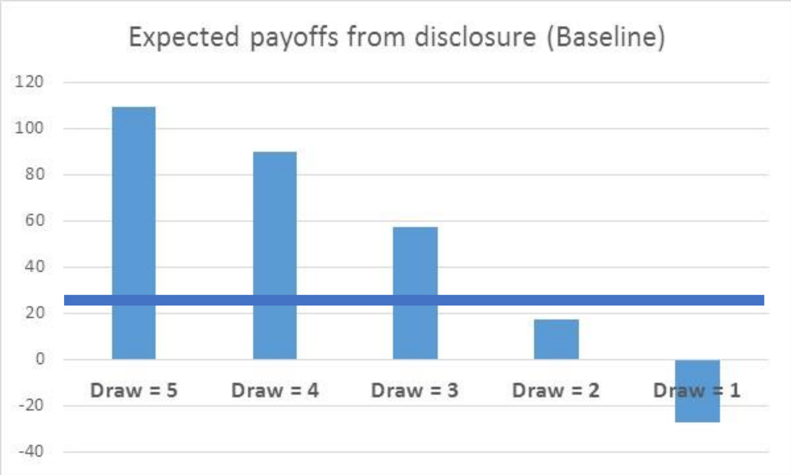


Figure 7: Sender's expected payoffs from disclosure in the Baseline

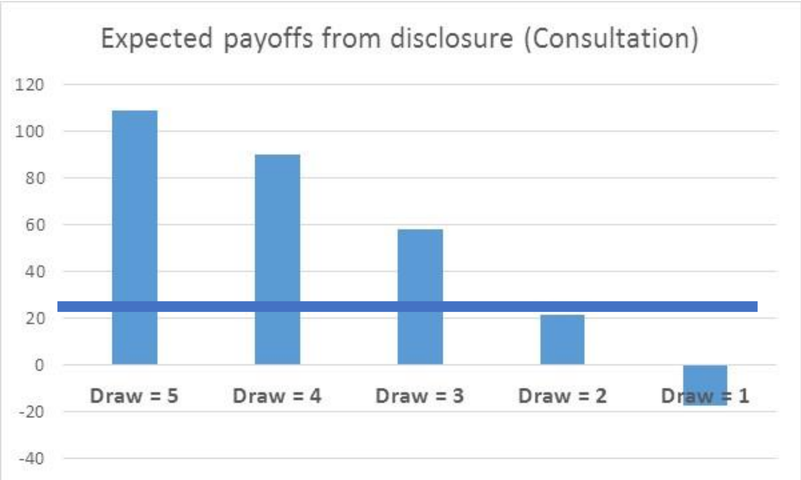


Figure 8: Sender's expected payoffs from disclosure in the Consultation treatment

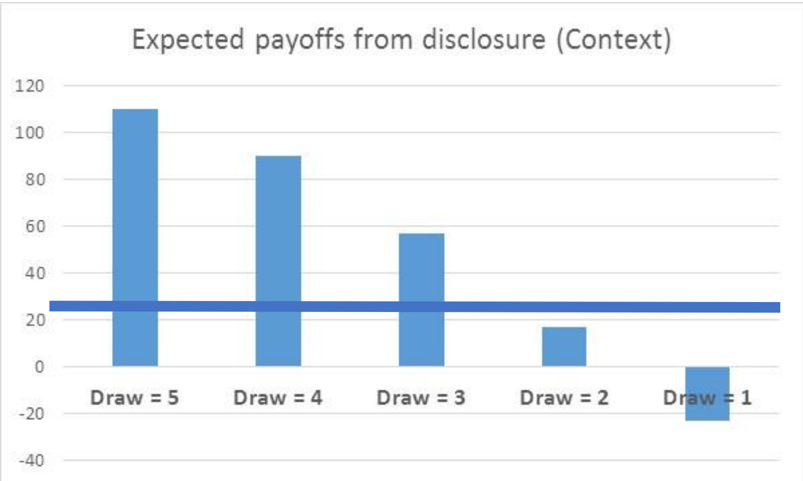


Figure 9: Sender's expected payoffs from disclosure in the Context treatment

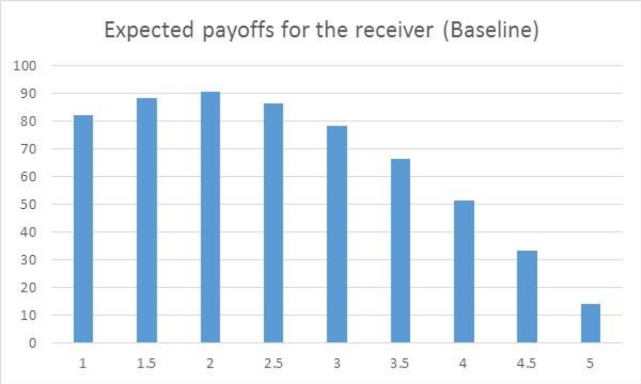


Figure 10: Receiver’s expected payoffs from each possible guess in the Baseline

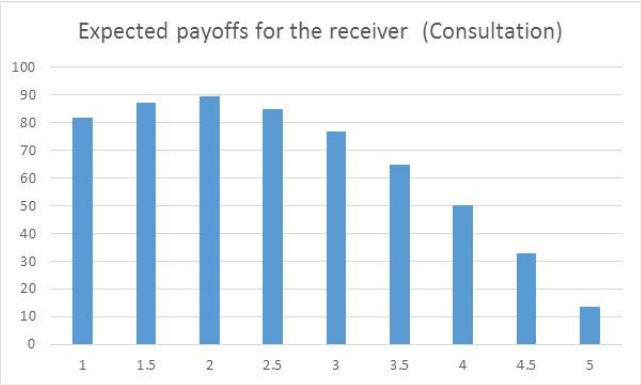


Figure 11: Receiver’s expected payoffs from each possible guess in the Consultation treatment

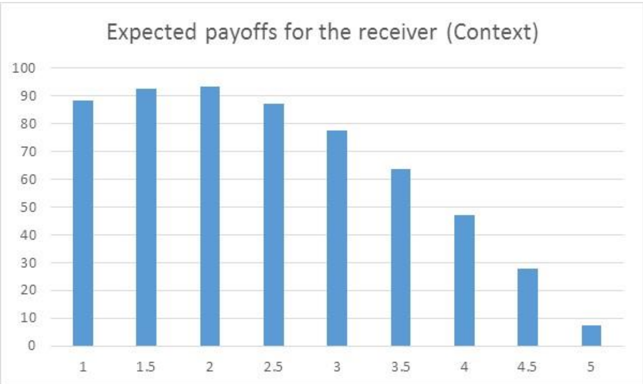


Figure 12: Receiver’s expected payoffs from each possible guess in the Context treatment

Quantal response models replace the concept of best response with that of better response. Strategies with higher payoffs are more likely to be played, but they are not necessarily played with certainty (Goeree et al., 2016). In other words, players make errors, but more costly errors are less likely. The most commonly used quantal response function is the logit quantal response function, which assumes that the probability of a strategy being played is proportional to $\exp(\lambda u_j)$, where u_j is the expected payoff of strategy j and λ is a precision parameter ($\lambda = 0$

corresponds to purely random behavior, while as $\lambda \to \infty$ the quantal response function converges to a best response).

We start by estimating the parameter λ in the quantal response function for senders and receivers separately, based on the empirically observed expected payoffs in the figures above. The figures suggest strong incentives for the sender to reveal draws 3, 4 and 5 and to withhold draw 1, while the receiver would not lose too much by reporting 2.5 instead of 2. Maximum likelihood estimates of λ confirm that sender's behaviour is noisier than receiver's behaviour, as reflected by the lower precision parameter.

Table 14: Maximum likelihood estimates for a quantal response model

Precision parameter	Baseline	Consultation	Context
$\hat{\lambda}_S$	0.0306	0.0306	0.0390
$\hat{\lambda}_R$	0.0632	0.0606	0.0490

Note: Maximum likelihood estimates for the precision parameter in a quantal response model, based on the empirical expected payoff of each strategy. For the sender, we assume the same precision parameter at all subgames. For the receiver, only cases in which the sender conceals the draw are included.

Result 8: Senders are further away from playing a best response than receivers.

F2.2. Estimating a quantal response equilibrium model

Our game is an extensive-form game, and consequently we take the agent quantal response equilibrium (AQRE) model (see Goeree et al., 2016, chapter 3).

From a qualitative point of view, sender's behavior is clearly consistent with regular quantal response. A qualitative feature of quantal response equilibrium in our game is that, for $\lambda > 0$, sender's disclosure probability is increasing in the draw. This is because receivers react more favorably to higher disclosed numbers for any $\lambda > 0$, thus senders with higher draws have more to gain (or less to lose) from revealing the draw, and this is reflected in an increasing disclosure probability as the draw increases. Receiver behavior cannot be fitted so closely because of receiver's overuse of round numbers (particularly in Baseline and Context). Note that the receiver expected payoff function will be single-peaked for any possible behavior of the sender, hence no regular quantal response model will be able to explain the frequencies observed in Baseline and Context, where the frequency of 2.5 is lower than that of both 2 and 3. Nevertheless, the quantal response equilibrium model may be able to replicate other qualitative features of receiver behavior. Specifically, it is not necessarily the case that quantal response equilibrium predicts too high guesses of non-disclosed numbers[28], but this will be the case for the value of λ that best fits our data.

The estimated AQRE model distinguishes between two types of subgames: subgames where the player's payoff depends only on their own action, and subgames where the payoffs depend also on the other player's action or on a move by nature. The first type of subgame occurs when the sender has revealed the draw. The receiver then knows the monetary payoffs from each of the actions. There are 5 subgames of this type, depending on what the draw is, and the precision parameter is assumed to be the same in all of them and denoted by λ_I. The second type of subgame includes decisions by the sender to reveal the draw or not (not knowing how the receiver will respond), and decisions by the receiver after observing that the draw was not revealed (not knowing the value of the draw). There are 6 subgames of this type, and the precision parameter is assumed to be the same in all of them and denoted by λ_U. We distinguish between these two kinds of subgames since, if we interpret AQRE as a model of errors, it makes sense to expect more noise in subgames where it is more difficult for players to estimate their best response.

Table 15: Estimates for the logit AQRE model

	Pooled data	Baseline	Consultation	Context
$\hat{\lambda}_I$	0.39	0.52	0.28	0.50
$\hat{\lambda}_U$	0.033	0.032	0.032	0.034
Loglikelihood (total)	-7779.87	-2515.93	-2876.79	-2300.01
Loglikelihood (average)	-0.8559	-0.8222	-0.9401	-0.7744

Table 15 suggests that there is indeed much less noise in subgames where the receiver knows the draw. It also confirms that there is very little difference between treatments.

The figures overleaf depict actual versus fitted strategies for senders and receivers, separately by treatment. Table 16 below summarizes two important features of the fitted strategies: the predicted value for the average nondisclosed number, and the predicted value for the receiver's average guess of a nondisclosed number. Note that, as in the actual data, average guesses are above average values.

[28] Intuitively, QRE is a model of noisy best response to the *actual* strategy of the other player rather than a model of mis-specified beliefs, hence there is no a priori reason to expect that guesses of non-disclosed numbers will be systematically above or below the actual averages. With our specific payoff functions, the average receiver guess of non-disclosed numbers may be above or below the true average in a logit AQRE depending on λ.

Table 16: Fitted QRE predictions by treatment

	Baseline	Consultation	Context
Fitted average nondisclosed number	1.906	1.915	1.840
Fitted average guess of nondisclosed number	2.267	2.273	2.200

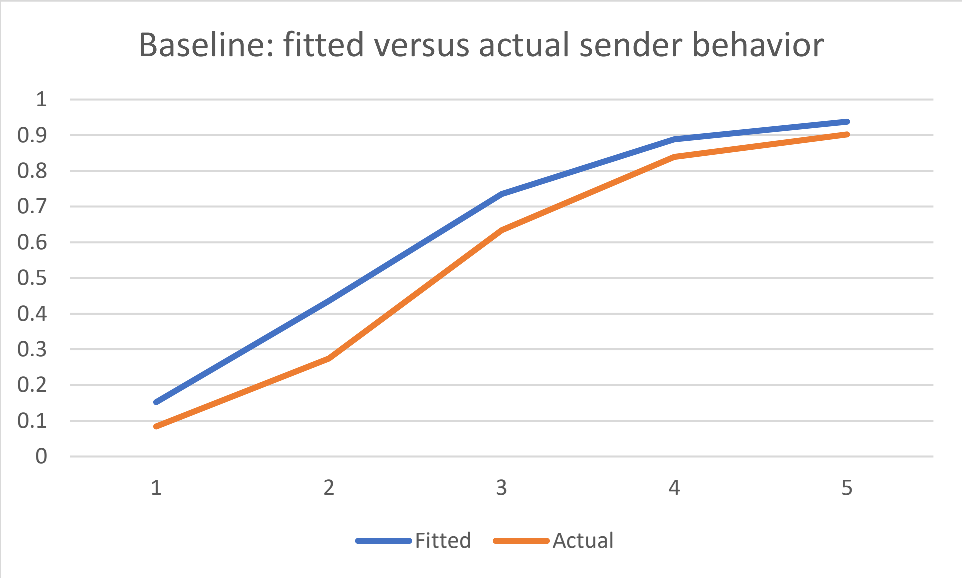


Figure 13: Fitted versus actual sender disclosure rates in the Baseline

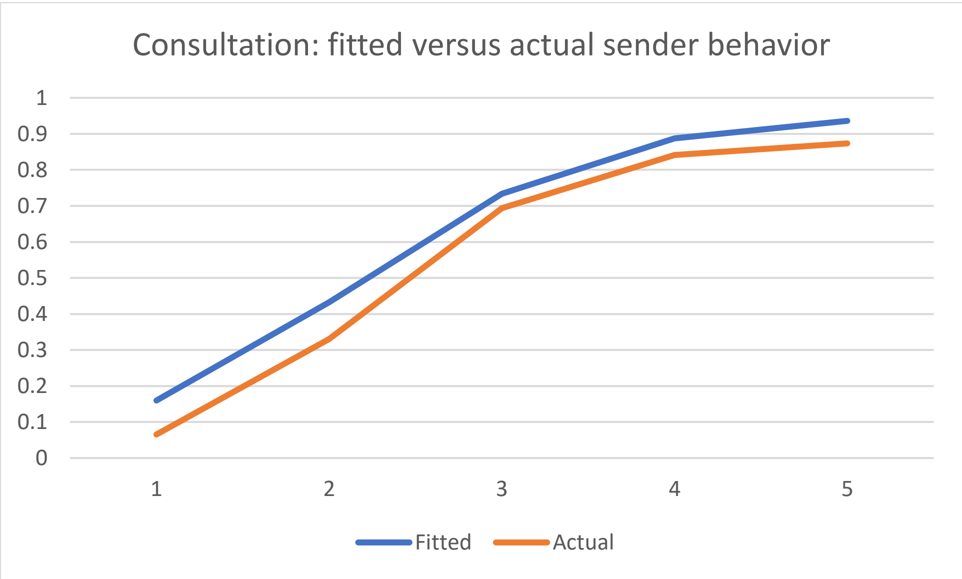


Figure 14: Fitted versus actual sender disclosure rates in the Consultation treatment

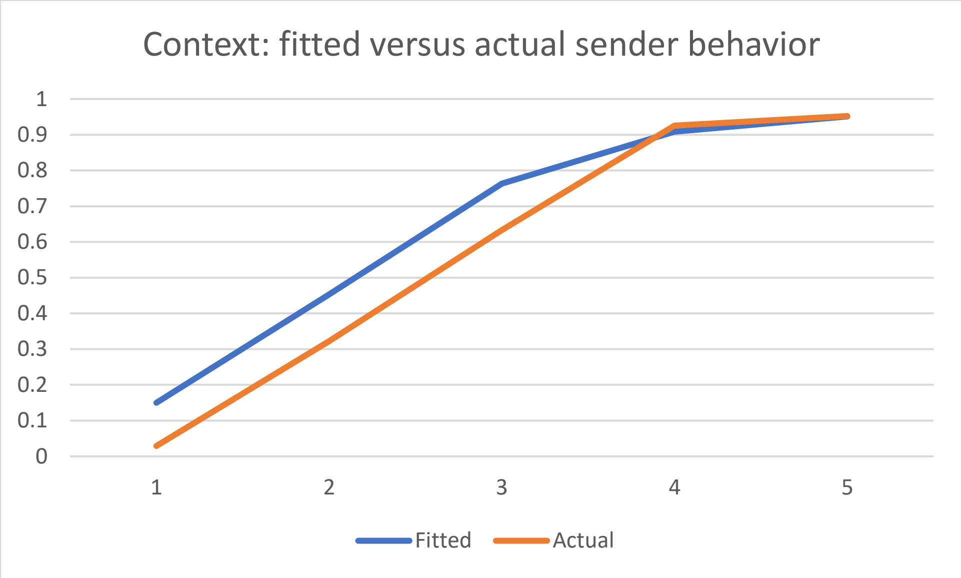


Figure 15: Fitted versus actual sender disclosure rates in the Context treatment

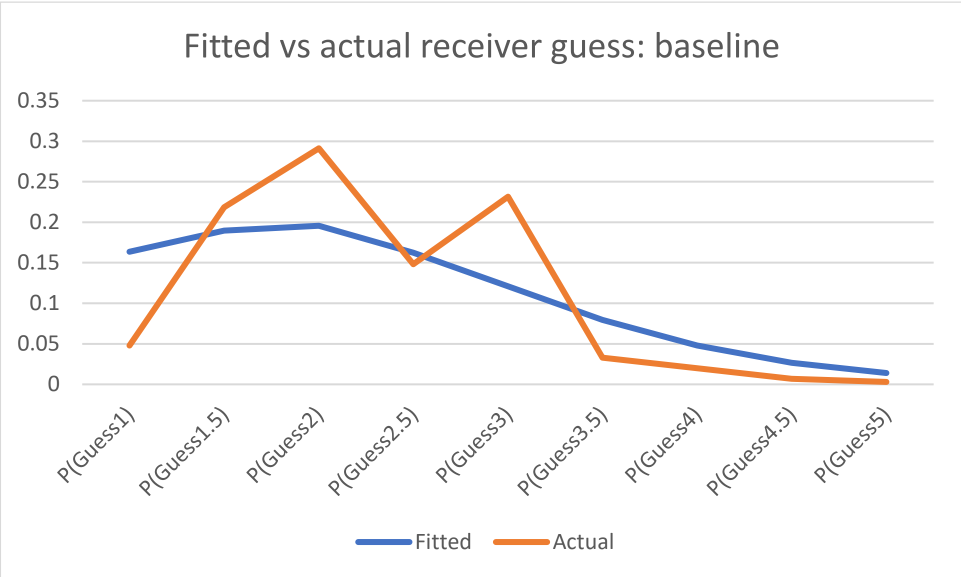


Figure 16: Fitted versus actual frequencies of the receiver guess in the Baseline

As expected, a feature of the data that cannot be explained by the model is the high frequency of some receiver guesses (3 in particular) compared to others (such as 2.5). The expected payoff of guessing 2.5 exceeds the expected payoff of guessing 3 in Baseline and Context (and this is true irrespective of whether we calculate it on the basis of the fitted sender behavior or the actual sender behavior), but 3 is chosen much more often than 2.5.

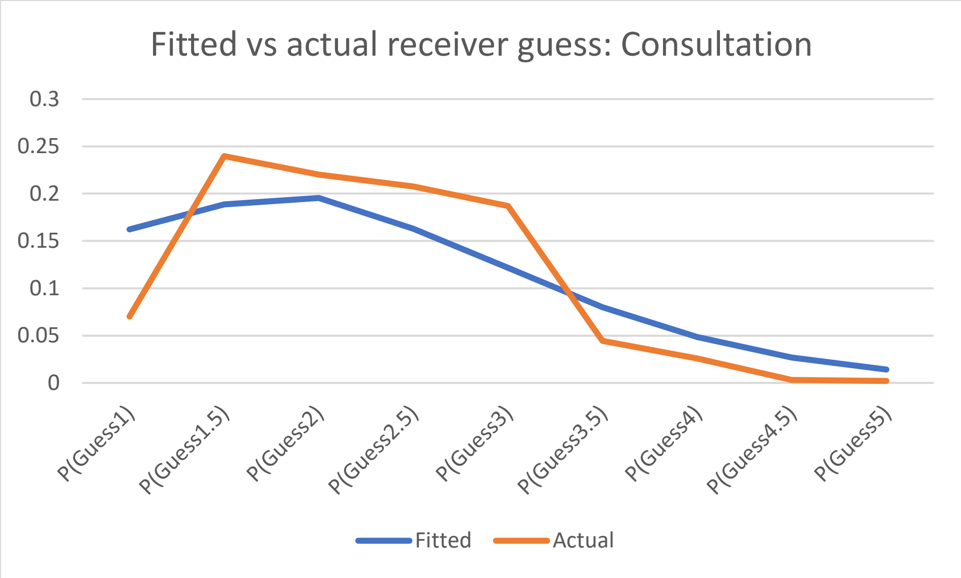


Figure 17: Fitted versus actual frequencies of the receiver guess in the Consultation treatment

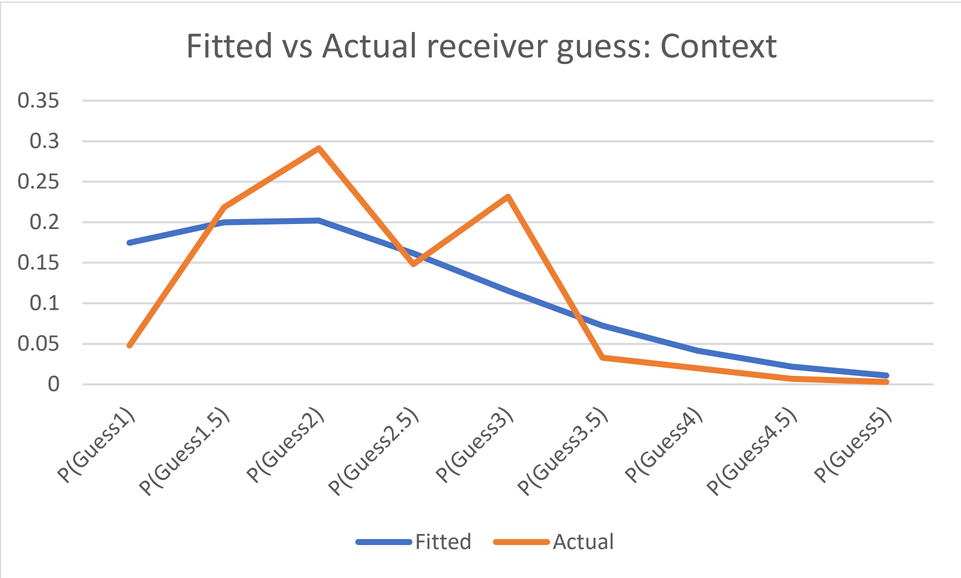


Figure 18: Fitted versus actual frequencies of the receiver guess in the Context treatment

The fitted QRE prediction replicates several relevant qualitative features of the data. For example, given actual sender's behavior, the best response for the receiver if the number is not disclosed is to guess 2, with 1.5 being almost as good a guess. This is also true of the best response to the fitted behavior of the sender. Likewise, given actual receiver behavior, it is a best response for the sender to reveal the draw if it is 3-5 but conceal it if it is 1-2 in all treatments. This is also true in the fitted model. Finally (Table 16), QRE predicts receiver guesses systematically above the actual average nondisclosed number.

Result 9: The fitted QRE prediction replicates several qualitative features of the data, including receiver guesses being on average above the actual values.