Supplementary Appendix
Trust Me: Communication and Competition in Psychological Games

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This document contains supporting material for the document "Trust Me: Communication and Competition in Psychological Games," which herein we refer to as the "main document."

This document is structured as follows:

1. Derivations of Equilibria
2. Instructions for No-Competition treatment
3. Screenshots: Feedback in both treatments
4. Belief elicitation procedure
5. Additional analysis of experimental data

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1 Derivations of Equilibria

1.1 The Game without Competition

As we described in the manuscript, for any set of parameters there exists a pooling equilibrium in which messages sent by the Seller convey no information, and therefore, the Buyer chooses the same action regardless of the message. In this pooling equilibrium, the Buyer never buys the product and secures the payoff of 5.

However, the pooling equilibrium is not the only type of equilibrium that one can sustain in our psychological game. Under some restrictions on the game's primitives, there exist partially informative equilibria (PIE), in which some of the information about the product quality is conveyed in the communication stage between the Seller and the Buyer. In this section, we characterize the conditions that guarantee existence of PIEs.

Denote by $\bar{\omega}(m_i)$ the Buyer's type who is indifferent between purchasing and not purchasing the product after observing message m_i. This type is defined as

$$\bar{\omega}(m_i) = \frac{2b_B^1(m_i) - 1}{2b_B^1(m_i) \cdot (1 - b_B^1(m_i))}$$

where $b_B^1(m_i)$ denotes Buyer's belief that the message m_i came from the Seller with the high quality product.

Note, first, that the Sellers with the high quality good send the m_1 message irrespective of their psychological types (G, L) because lying is costly, $b_B^1(m_1) \geq b_B^1(m_0)$, and $\frac{\partial \bar{\omega}(m_i)}{\partial b_B^1(m_i)} > 0$, which implies that more Buyer types will choose to buy the product after observing message m_1 than message m_0. Thus, message m_0 necessarily comes from the Seller with a low quality product, which implies that $b_B^1(m_0) = b_S^2(m_0) = 0$, and no Buyer will ever purchase the product after observing message m_0.

We now consider the behavior of Sellers who own low quality goods. First, note that as long as there exists a psychological type of a Seller who does not suffer from guilt or lying aversion, i.e., $G = L = 0$, then there does not exist a fully informative equilibrium, because a Seller with $G = L = 0$ will necessarily lie in the communication stage and will send message m_1.

More generally, a Seller with low quality product and psychological type (G, L) prefers to lie and send message m_1 if and only if

$$5 \leq (1 - H[\bar{\omega}(m_1)]) \cdot (5 - L) + H[\bar{\omega}(m_1)] \cdot \big(21 - 10G \cdot b_S^2(m_1) \cdot \mathbb{E}[\omega | \omega \leq \bar{\omega}(m_1)] - L\big) \quad ...(1)$$

Otherwise, if inequality (1) is not satisfied, then the Seller with the low quality product and psychological type (G, L) will prefer to be truthful and send message m_0 in the communication stage. For a given set of parameters of the game, i.e., the distribution of disappointment sensitivity of the Buyer $H[\omega]$ as well as possible values of guilt G and lying sensitivity L of the Seller, the inequality (1) is easily verifiable for every psychological type of Seller with low quality product.

To state the general conditions for existence of a PIE, we will decompose the set of all possible psychological types of the Sellers into those who satisfy inequality (1) when they are endowed with low quality product, and those who do not. We denote by ψ the fraction of psychological types who satisfy inequality (1), i.e., those types that prefer to send message m_1 in the communication stage when the Seller has a low quality product. Then, in any equilibrium, beliefs must be correct, i.e.,

$$b_B^1(m_1) = b_S^2(m_1) = \frac{1-p}{1-p+p\cdot\psi}$$

Note also that a necessary condition for an existence of a PIE is that at least some types of Buyers purchase the product after observing message m_1, which implies that

$$b_B^1(m_1) > \frac{1}{2} \Leftrightarrow \frac{1-p}{1-p+p\cdot\psi} > \frac{1}{2} \Leftrightarrow \psi < \frac{1-p}{p}$$

In words, the proportion of Sellers with low quality product who lie in equilibrium must not be too high.

To summarize, the game without competition admits a PIE if and only if $\psi < \frac{1-p}{p}$ where ψ is the fraction of psychological types of the Sellers who satisfy inequality (1) described above, in which $b_B^1(m_1) = b_S^2(m_1) = \frac{1-p}{1-p+p\cdot\psi}$ and $\bar{\omega}(m_1) = \frac{2b_B^1(m_1)-1}{2b_B^1(m_1)\cdot(1-b_B^1(m_1))}$. The exact type of PIE will, of course, depend on the exact parameters.

1.2 The Game with Competition

The symmetric equilibrium of the game with competition consists of specifying a communication strategy for both Sellers, s^S, indicating the probability distribution over messages for each Seller's type, the selection function of the Buyer which selects one of the Sellers given the two of messages that the Buyer receives in the communication stage, where we denote by m^{winner} the message from the selected Seller, a buying strategy for the Buyer, s^B, indicating the probability that the Buyer purchases the product for each message (m_0, m_1) received from the selected Seller, and the system of beliefs for the Buyer and the Sellers (b_B^1, b_S^2) such that

(1) **Buyer's actions are optimal**

$$s^{B^*}(\omega, m^{\text{winner}}) = \arg\max_{s^B\in[0,1]} \mathbb{E}\Pi^{\text{Buyer}}\left(m^{\text{winner}}, s^{S^*}\right) \quad \forall(\omega, m^{\text{winner}}) \in T^{\text{Buyer}} \times M$$

and

$$m^{\text{winner}}(m_{S_1}, m_{S_2}) = \arg \max_{m \in \{m_{S_1}, m_{S_2}\}} \mathbb{E}\Pi^{\text{Buyer}}\left(m, s^{S^*}\right)$$

where m_{S_1} (m_{S_2}) denotes the message sent by Seller 1 (Seller 2)

(2) **Seller's messages are optimal**

$$s^{S^*}(q, G, L) = \arg \max_{m_i \in M} \mathbb{E}\Pi^{\text{Seller}}\left(m_i, s^{B^*}\right) \quad \forall (q, G, L) \in T^{\text{Seller}}$$

(3) **Beliefs are correct**

$$b_B^1(m_i) = b_S^2(m_i) = \Pr[q = q_H | s^S(q, G, L) = m_i] \quad \forall m_i \in M$$

In words, just like in the game without competition, in equilibrium (1) actions of both players maximize their expected payoffs conditional on beliefs they hold regarding actions of other players, (2) no Seller type wants to mimic another type in terms of communication strategy used, and (3) beliefs are 'correct', i.e., the first-order and the second-order beliefs of players coincide with the expected frequency of Buyer choosing to purchase the product conditional on the message received from the selected Seller.

As in the game without competition, when we introduce competition between Sellers we focus on equilibria in which $b_B^1(m_0) = b_S^2(m_0) \leq b_B^1(m_1) = b_S^2(m_1)$, which is a natural restriction that respects the meaning of the messages.

As in any cheap talk game, the game with competition admits a non-informative babbling equilibrium in which messages sent by Sellers convey no information, and, therefore, the Buyer randomly selects one of the Sellers and never purchases the product in the equilibrium. This is the unique pooling equilibrium (no-trade equilibrium) in which the Buyer secures the payoff of 5.

In addition, under some restrictions on the parameters of the game there exists a PIE, in which some of the information about the product qualities owned by the Sellers is conveyed in the communication stage. As in the game without competition, in any PIE, message m_0 necessarily comes from a Seller with low quality product, which means that $b_B^1(m_0) = b_S^2(m_0) = 0$.[1]

First, we specify selection function for the Buyer in any PIE. If Buyer observes two different messages, then she necessarily selects a Seller who sent message m_1. If, however, the Buyer observes two identical messages, then she selects one Seller at random.

[1] Just like in the game without competition, as long as there exists a psychological type of a Seller who does not suffer from guilt or lying aversion, i.e., $G = L = 0$, then there does not exists a fully informative equilibrium, because a Seller with $G = L = 0$ will necessarily lie in the communication stage and will send message m_1.

We will use the previous section notation and will denote by $\bar{\omega}(m_i)$ the type of the Buyer who is indifferent between purchasing the product and not purchasing it after observing message m_i from the selected Seller

$$\bar{\omega}(m_1) = \frac{2b_B^1(m_1) - 1}{2b_B^1(m_1) \cdot (1 - b_B^1(m_1))}$$

Then, a Seller i with low quality product and a psychological type (G, L) will prefer to send message m_1 over message m_0 in the communication stage if and only if

$$\begin{aligned} 5 \leq & \left(\frac{1}{2}\Pr[m_j = m_1] + \Pr[m_j = m_0]\right) \cdot (1 - H[\bar{\omega}(m_1)]) \cdot (5 - L) + \\ & + H[\bar{\omega}(m_1)] \cdot \big(21 - 10G \cdot b_S^2(m_1) \cdot \mathbb{E}[\omega | \omega \leq \bar{\omega}(m_1)] - L\big) \end{aligned} \quad ...(2)$$

where m_j denotes the message sent by Seller j. Otherwise, a Seller i with low quality product and a psychological type (G, L) will prefer to be truthful and send message m_0. Inequality (2) is easily verifiable for all possible psychological types of the Sellers.

Denote by ψ' the fraction of psychological types of the Sellers who satisfy inequality (2). Then, in any equilibrium, beliefs must be correct, i.e.,

$$b_B^1(m_1) = b_S^2(m_1) = \frac{1 - p}{1 - p + p \cdot \psi'}$$

Also the proportion of Sellers with low quality product who lie in equilibrium cannot be too high, otherwise, no types of Buyers will purchase the product even if they selected to play the tree game with a Seller who sent message m_1, i.e., $b_B^1(m_1) > \frac{1}{2}$.

To summarize, the game with competition admits a PIE if and only if $\psi' < \frac{1-p}{p}$ where ψ' the fraction of psychological types of the Sellers who satisfy inequality (2) in which $b_B^1(m_1) = b_S^2(m_1) = \frac{1-p}{1-p+p\cdot\psi'}$ and $\bar{\omega}(m_1) = \frac{2b_B^1(m_1)-1}{2b_B^1(m_1)\cdot(1-b_B^1(m_1))}$.

2 Instructions for No-Competition treatment

General. Welcome to todayÕs experiment. This is an experiment in decision making which will provide you an opportunity to earn money. You will participate in two unrelated tasks. The instruction for the first task is given below. The instruction for the second task will be given to you after you have completed task 1.

Instructions for Task 1. The amount of money you earn depends partly on your decisions, partly on decisions of others and partly on chance. Various research organizations have provided funds for this experiment and if you make good decisions you may be able to receive a good payment, which will be paid to you at the end of the session. Please do not talk to each other during the experiment and put away all of your electronic devices and shut of your cell phone during the experiment.

At the beginning of the experiment you will be randomly assigned one of the two roles: a buyer or a seller. Your role will remain fixed throughout the experiment.

The experiment consists of 10 blocks with several rounds within each block. Before the beginning of each block, you will be randomly matched with another participant in this room who was assigned a different role than you are. That is, if you are a buyer you will be matched with a seller, and if you are a seller you will be matched with a buyer. This matching remains fixed for the duration of the block. Once the block is over, you will be re-matched with another participant who was assigned a different role than you are, and so forth. Note, that it is impossible to track participants between blocks because of the random assignments, and you will not know the real identity of participants you are matched with, either during or after the experiment.

The Buyer-Seller Game

In this experiment, each seller has a product that he wants to sell to the buyer. The product is either of low quality or of high quality. There is 40% chance that the product has high quality and 60% chance that it is low quality. The buyer prefers to buy the high quality product. Each seller can send a message to the buyer he is matched with to convince him to buy the product. The seller always knows the quality of his/her product but the buyer does not until s/he buys it. The buyer has to decide whether to buy it or not based on the message s/he receives and the additional details as described below.

The seller can send one of the two messages to the buyer:

Message m1 is"The product is really of high quality"

Message m0 is "The product is of low quality"

It is up to the seller whether he wants to lie and misrepresent the quality of the product or not. However, if the seller lies about the quality of the commodity he will incur a cost L that will reduce his payoff in the experiment. Further, if the seller lies and convinces the buyer to buy the low quality product s/he may incur additional penalty G for misleading the buyer, which will depend on how disappointed the buyer will be about ending up with a low quality product. We will talk about buyersÕ sensitivity to disappointment later. The sellerÕs cost of lying (L) and the penalty for misleading (G) can be different for each seller. He might incur no cost of lying or high costs from lying. Similarly, he might pay no penalty for misleading the buyer or high penalty from misleading the buyer. In the experiment, the seller can be one of the four types:

Type S1 - (L=0, G=0)

Type S2 - (L=0, G=6)

Type S3 - (L=20, G=0)

Type S4 - (L=20, G=6)

There is a 25% chance that the seller is one of these four types. Note that some sellers will incur no costs from lying or misleading (the L=0, G=0 types) while others will pay a high cost from lying and misleading (the L=20, G=6 types). Some are going to be of mixed types and will not incur costs from lying but will pay the penalty for misleading (L=0, G=6); some will pay a cost for lying but will not incur additional penalty from misleading (L=20, G=0).

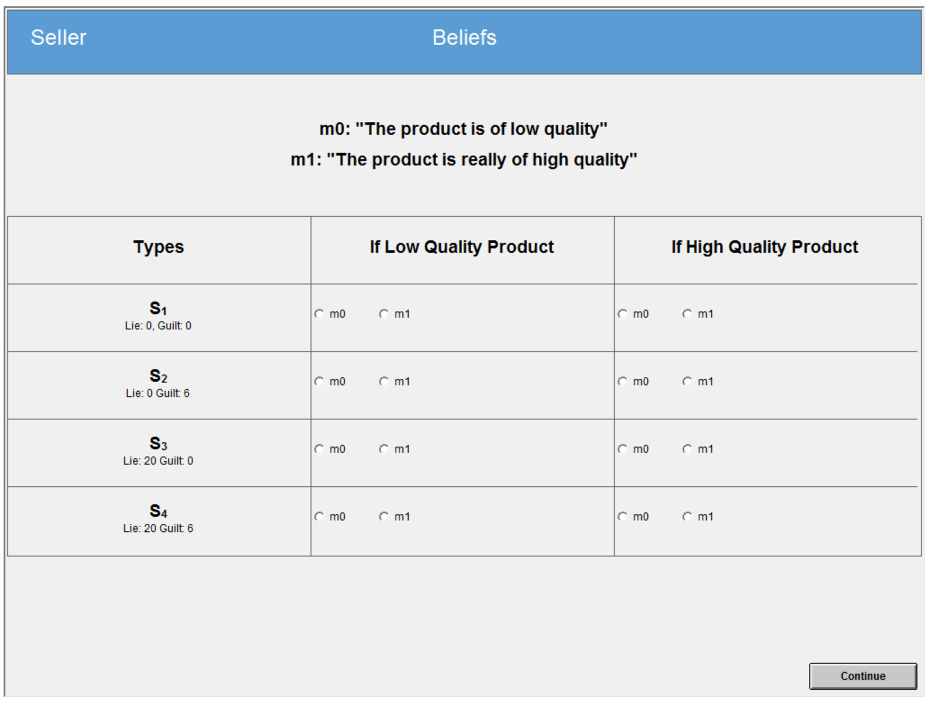
The buyers differ in their sensitivity to being disappointed. Disappointment comes from being misled by the seller into buying a low quality product while expecting it to be a high quality. For example, if the seller with a low quality product sends the message “the product is really of high quality” and the buyer buys the product believing the lie only to find out its actually low quality, then the buyerÕs payoff will go down due to his disappointment. By how much the payoff will go down depends on the buyerÕs “disappointment sensitivity” parameter D, which can take a value between 0 and 1 with equal likelihood. That is, value 0.16 is as likely to occur as value 0.79 or any other value between 0 and 1 inclusive. Hence a buyer is as likely to be very sensitive to disappointment and have a high value for D, as he is to be very *little sensitive* and have low values for D. Only the buyer will know the true sensitivity value.

What happens in each block. Each block consists of 10 rounds of play between a buyer and a seller. Remember, that buyers and sellers are randomly matched for the duration of a block, and re-matched once the block is over.

At the beginning of each block, a buyer and a seller will specify their strategies, which will be used to play 10 repetitions of the game. We will call these repetitions rounds. For each round, the computer will randomly select the disappointment parameter for the buyer, D, which takes values between 0 and 1 with each number being equally likely. In addition, for each round, the computer also randomly selects the quality of the product for the seller (40% chance of high quality and 60% chance of low quality) as well as sellerÕs lying and misleading parameters L and G (each of the four types S1, S2, S3 and S4 are equally likely to be selected for both high and low quality products).

The Task of the Seller

If you were assigned the role of a seller, then at the beginning of each block, you will have to decide the message you want to send to the buyer for each of the two types of products and each combinations of lying and misleading parameters L and G that you might be assigned. Specifically, you will be asked to fill out the following table:


Seller Beliefs

m0: "The product is of low quality"
m1: "The product is really of high quality"

Types	If Low Quality Product	If High Quality Product
S_1 Lie: 0, Guilt: 0	m0 m1	m0 m1
S_2 Lie: 0 Guilt: 6	m0 m1	m0 m1
S_3 Lie: 20 Guilt: 0	m0 m1	m0 m1
S_4 Lie: 20 Guilt: 6	m0 m1	m0 m1

Continue

In this table, each cell in columns 2 and 3 represents the combination of the quality of the product you might have and lying and misleading parameters L and G. For each cell in this table, you have to choose which of the two messages (m0 or m1) you will send to the buyer. For instance, on the top right of the table is the situation in which you are of type S1 and you have a high quality product to sell. Your task is to decide which message you want to send to the buyer in this situation: message m1 = “The product is really of high quality” or message m0 = “The product is of low quality”. You will be prompted to make such choice in each of the 8 situations in the table above.

Once you have entered all your choices at the beginning of a block, the computer will play out your specified strategies for you over the 10 rounds in that block. So the computer will first assign a high quality or a low quality product to you with high quality product occurring with 40% chance. Then, the computer will assign you one of the four types S1, S2, S3 and S4 with 25% chance in each round. And then the computer will send message to the buyer, which you have specified for this type and this product quality in the table above. Once the next round starts, the computer will select product quality and your type again, and use message you specified for that type, and so on.

Guesses about buyers:

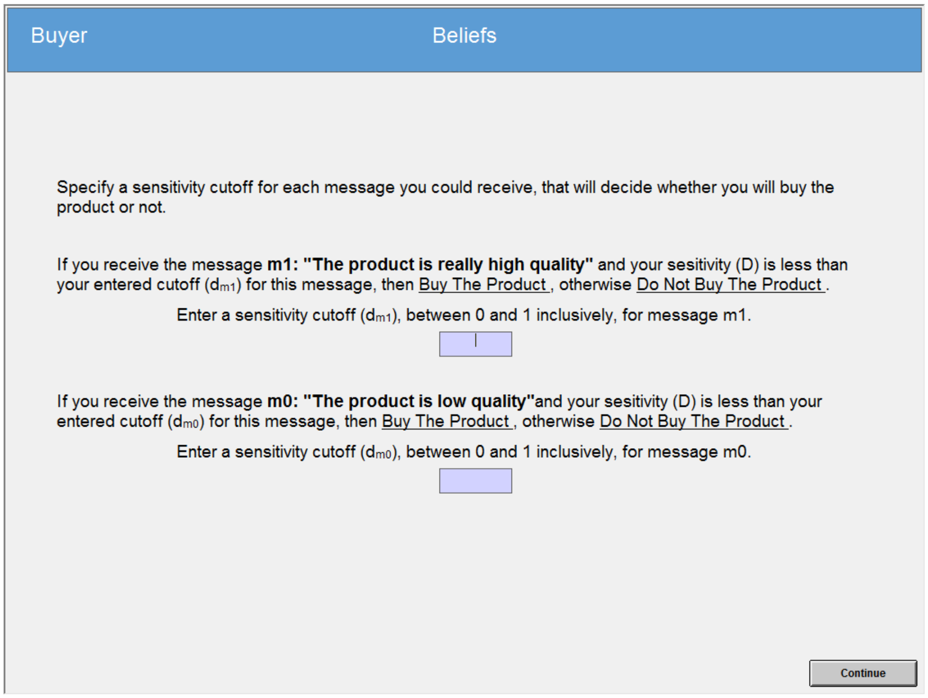
In addition to the strategies you choose in each block, you will be asked to specify your guess about the buyerÕs behavior before the start of each block. In particular, you will be asked to give your best guess about how credible the buyer thinks your message about the quality of the product is, for each message s/he receives from you. In other words, you need to specify what you think the buyer thinks about the chance of receiving a high quality product, after receiving either of the messages from you. We will also ask buyers to specify what they think about the chance of the product being high quality based on the message they receive from you.

The Task of the Buyer

If you are assigned the role of a buyer, you have to provide your buying strategy for each round, based on the messages you will receive from the seller, and your sensitivity to disappointment in case seller misguides you to buy a low quality product. Remember that sensitivity to disappointment is measured by a fraction between 0 and 1 determined by the computer with equal chances. Note that smaller the sensitivity parameter D, the less is your loss in payoff in case you end up buying the low quality product believing it to be of a high quality.

You will be asked to provide two cutoff values of the sensitivity parameter; one in the case you receive the message m0, and one in the case you receive the message m1. The computer will use these two cutoff values to decide whether you end up buying the product or not. Specifically, say you receive the message “the product is really of high quality”. Then, if the computer draws a sensitivity parameter lower than your specified high cutoff, then you will buy the product. On the other hand, you will not buy the product if the computer draws a sensitivity number higher than your high cutoff. Similarly, say you receive the message “the product is of low quality.” Then, if the computer draws sensitivity number lower than your specified low cutoff, then you will buy the product, while you will not buy the product if the computer draws sensitivity number higher than your low cutoff.

The BuyerÕs screen will look as follows:



Guesses about sellers:

In addition to the choices you make in each block, you will need to specify your guesses about the sellerÕs behavior before the start of each block. In particular, you have to guess the probability that the seller matched with you is likely to have a high quality product when he sends you the message m1 = Òthe product is really of high qualityÓ as well as when he sends you the message m0 = Òthe product is of low qualityÓ. In other words, you have to specify two probability numbers (each between 0 and 100): one representing the guess that if you receive the message ÒThe product is really of high qualityÓ then the product is actually of high quality and another if you receive a message ÒThe product is of low qualityÓ then the product is still of high quality.

Payoff Determination in the Experiment

We will determine your final payoff in the experiment as follows. First we will calculate the payoff you received from reporting your guesses in each block as described below. Next we will determine your payoff from playing the game in each block of the experiment as described below. We will then choose a block at random first, and then for each of the 10 rounds in that block pay with equal chances either the amount of money you earned by reporting your guesses or by playing the game over. In other words, in a chosen block you have equal chances of getting your belief payoff or your game payoff for each of the 10 rounds.

Finally, note that in the experiment both for your guessing task and for the game you will be paid in a currency called Experimental Currency Units or ECUÕs. At the end of the experiment we will convert your ECU payment into US dollars at the rate of 1ECU = \$0.06 if you are a Buyer and at the rate of 1 ECU = \$0.008 if you are a Seller.

Payoff Calculation for Guesses

We will pay you for the guesses you enter in the computer in a manner that gives you a large incentive to report your true guesses. We will do this by giving you a fixed amount of money, which is yours to keep, but from which we will subtract an amount of money that will depend on how inaccurate your guesses are. Suppose you are a seller and you need to guess how likely it is that the buyer will buy the product expecting it to be of high quality when she receives the message Òthe product is really of high quality.Ó Note, the buyer will either buy the product or not when the round is played out and we will know the outcome with probability 100%. If you (seller) reported that there was only a 60% probability that the buyer buys it facing specified message, then you will be making a mistake of 40% in correctly predicting the buyerÕs behavior, and in the formula we use to pay you for your guesses we will penalize you for that mistake by taking that 40%, squaring it, and multiplying it by a constant and subtracting that amount from your fixed payment. The same is true for the mistake you make by placing a positive probability on the chance that the Buyer will buy if in fact he did not.

The exact formula we will use to pay you is available for you to inspect and we will hand you an explanation of it if you request it after the experiment. For the sake of brevity we will not explain it further here. However, there are two important things for you to understand about how we pay you for your beliefs:

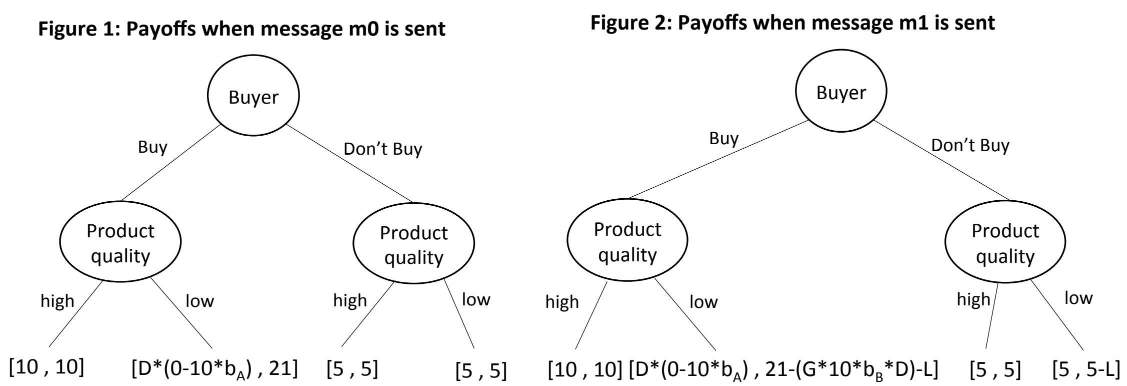
1. First, if your objective is to maximize the amount of money you are paid in the experiment then a good way to do that is to enter your true beliefs into the computer when asked. In other words, one can seldom do better than reporting beliefs truthfully in the game.

2. Second, as we will describe below, in addition to paying you for your reported guesses, we will also pay you for how you play the buyer-seller game. As you will see there the guesses you report will also affect your payoffs in the game. **We have set the payoffs you receive to be such that if you want to maximize the money payoff you receive in the entire experiment it will be best again for you to report your guesses truthfully and the play the game using these reported guesses.** In other words, it will not benefit you to report false guesses purposefully if you feel that will increase your payoffs in the game. This fact is reinforced by the fact that when we pay you we will flip a coin and with probability $\frac{1}{2}$ pay you either for the guesses you report

or the payoffs you receive in the game. This makes it even more imperative that your report your beliefs truthfully.

Payoff Calculation For the Buyer-Seller Game

In order to explain your payoffs in the Buyer-Seller game, consider the following two simple figures.



These figures describe how your payoffs are determined depending on the message sent by the Seller, whether the product is of high or low quality, and whether the Buyer decides to buy or not. At the bottom of the figure are the payoffs to the Buyer and Seller with the BuyerÕs payoff listed first and the SellerÕs listed second.

Let is start with the Figure 1 on the left. This figure describes the payoffs in the Buyer-Seller game when the Seller sends the message m0 indicating that ÒThe product is of low qualityÓ. Given this message, if the Buyer decides not to buy, then no matter whether the product is high quality or not both the Buyer and the Seller will receive a payoff of 5. However, if after being told the good is of low quality the Buyer decides to buy, then everyoneÕs payoff will depend on whether the product is actually of low or high quality. If it is of low quality, the Buyer will get a payoff of D*(0-10*bA) and the Seller will get a payoff of 21 (he got rid of a low quality product).

LetÕs talk about the Buyers payoff first D*(0-10?bA). This payoff indicates that the Buyer is disappointed since, given his belief that the good would be of high quality, bA, he expected to get a payoff of 10*bA, (i.e., he expected to get a payoff of 10 with a probability bA and hence his expected payoff is 10*bA). Since the good was actually of low quality, his payoff was 0 and so his disappointment was (0-10*bA) = -10*bA. How strongly the Buyer feels this disappointment depends on his sensitivity to disappointment, D. This is a number between 0 and 1 so if D = 0 the Buyer will not feel disappointed at all and his payoff will be 0. However, if he is very sensitive, then D = 1 and he will feel the full brunt of his disappointment which is -10. Importantly, although the Buyer is disappointed here, there are no guilt or disappointment penalties for the Seller since he warned the Buyer of the goodÕs quality. Also, if the product is of high quality, then both the Buyer and Seller get a payoff of 10. The important thing to point out is that if the Seller sends the m0 message, then he is absolved from lying or guilt-disappointment penalties no matter what the quality of the product is.

The situation changes when the Seller sends message m1 stating that, ÒThe product is really of high qualityÓ. This is what we show in Figure 2. Look first at the right hand branch of the figure indicating that the Buyer did not buy the product. Here if the product was in fact of high quality, both the Buyer and Seller will receive a payoff of 5. However, if the product is of low quality then since the Seller lied by sending message m1 he will pay a penalty of L for his lie. Remember that L can take on a value of either 0 or 20 so when its value is 20 the lying penalty will be substantial.

Finally look at the lower left hand part of Figure 2. Here the Buyer buys after receiving the m1 message and hence the payoffs for both subjects will depend on whether the product is of high or low quality. If the good is of high quality (bottom left hand corner of Figure 2) then both the Buyer and Seller will get a payoff of 10 since no one lied and no one was disappointed. However, if the Buyer buys after receiving the m1 message and the product was actually of a low quality, then the situation becomes a bit more complicated. BuyerÕs payoff is D*(0-10*bA), where bA indicates BuyerÕs belief that product is of high quality after getting message m1. To illustrate how this payoff may vary, say that the Buyer guesses that the message m1 indicates that the chance that the good is of high quality is 70% (bA = 0.7) and his sensitivity parameter D = 0.5. This indicates that the Buyer is relatively trusting that the message is not a lie and he is somewhat sensitive to disappointment. If the product turns out to be of high quality his payoff, as we saw above, will be 10. However, if the product turns out to be of low quality, his payoff will be -10*0.7*0.5 = -3.5. Obviously, this payoff will differ depending on the BuyerÕs guesses and his sensitivity to disappointment. However, the range of payoff will be somewhere between 0 and -10 when the product is of low quality. If the product turns out to be of high quality after the message m1 is sent, then the payoff for the Buyer will always be 10. Hence, the decision to buy will depend on how trusting the Buyer is of the message sent, his bA, and his sensitivity to disappointment, D.

Finally consider the payoff for the Seller when, knowing the product is of low quality, he sends message m1 and the Buyer buys the good.

Here his payoff is denoted by 21-(G*10*bB*D) - L. This payoff has three parts. The first, 21, is simply the payoff the Seller gets from unloading a low quality product on the Buyer. However, since he lied in doing so and said the product was of high quality knowing it was of low quality, we subtract L for his lie. This leaves the middle term G*10*bB*D. This term basically measures how guilty the Seller is about disappointing the Buyer. When the Buyer receives the m1 message he tends to believe the product is of high quality. The SellerÕs guesses that the Buyer expected the good will be of high quality when he hears the m1 message is given by bB. How much the Seller cares about this depends on his guilt parameter G, which can take only two values, either G = 0 or G = 5. When G = 0, the Seller does not care at all about disappointing the Buyer and hence this middle term will be zero. If he cares a lot (G=5), this middle term will be negative and will be subtracted from 21. For the Buyer, since the good is of low quality, his payoff is 0 and hence his disappointment is (0-10*bB*D). LetÕs take an example: suppose the Seller cares a lot about guilt (G=5) and believes that the Buyer will really trust him after hearing message m1 i.e., BuyerÕs bB =0.9. Further, the BuyerÕs sensitivity to disappointment is D = 0.7. Then the SellerÕs disappointment payoff will be 5*10*0.9*0.7 = -31.5 and his total payoff will be 21-31.5 - L = -10.5 - L. If L=0 then the SellerÕs total payoff will be -10.5 while if L=20, it will be -30.5.

Also because your payoffs in the game can be complicated in the situation where the Seller sends the m1 message knowing that the good if of low quality, (the payoffs in all other situations can easily be read off from the figures above) we are providing you with a calculator that will help you evaluate what your payoff in this circumstance will be depending on the assumptions you make.

For example, for the Buyer, if you receive the m1 message then your payoff will depend on the guess bA you entered in the guessing exercise you engaged in and on your random disappointment sensitivity parameter, D. However, since you have already entered your belief in the guessing exercise, the calculator will allow you to see how your payoff varies when the computer assigns you the various Ds over the range 0 to 1 and you decide to buy or not. So, knowing the guess you already entered, you can enter different hypothetical Ds into the calculator and see the expected payoff you would get if you decided to buy or not.

If you are a Seller your payoff will depend on the value of G, L, D and your guess (bB) about the BuyerÕs guess about you. So in your calculator, given the belief bB you previously entered, the calculator will allow you to enter values for G, L, and D (which is how sensitive you think the Buyer is to being disappointed). Remember G can take on only values of 0 and 5 while L can take on values of only 0 and 20 while D can take on values between 0 and 1. If you enter hypothetical values for these numbers into the calculator and hit enter, the calculator will present you with your payoff if the buyer buys or not.

Summary

While the payoffs described above may be complicated the experiment itself is not. It can be summarized as follows:

1. There is a buyer and a seller.

2. The seller is selling a good that can be either of high or low quality and knows what the quality is before sending a message to the buyer telling him what that quality is (m0 or m1).

3. If he sends a message that the good is of high quality knowing while knowing it is of low quality, then he is lying and he may experience a cost of lying.

4. The seller may also feel bad that he misled the Buyer if the buyer relies on his message and buys a low quality good expecting it to be of high quality.

5. How sensitive the seller is to lying and misleading the Buyer depends on his type which is randomly determined.

6. He may not care at all about lying and misleading or he may care a lot. He may care about one and not the other.

7. How disappointed the buyer is by being misled is also randomly determined.

8. The task for the Seller is to determine what message to send for each type of Seller he may turn out to be (for each pair of lying and misleading costs).

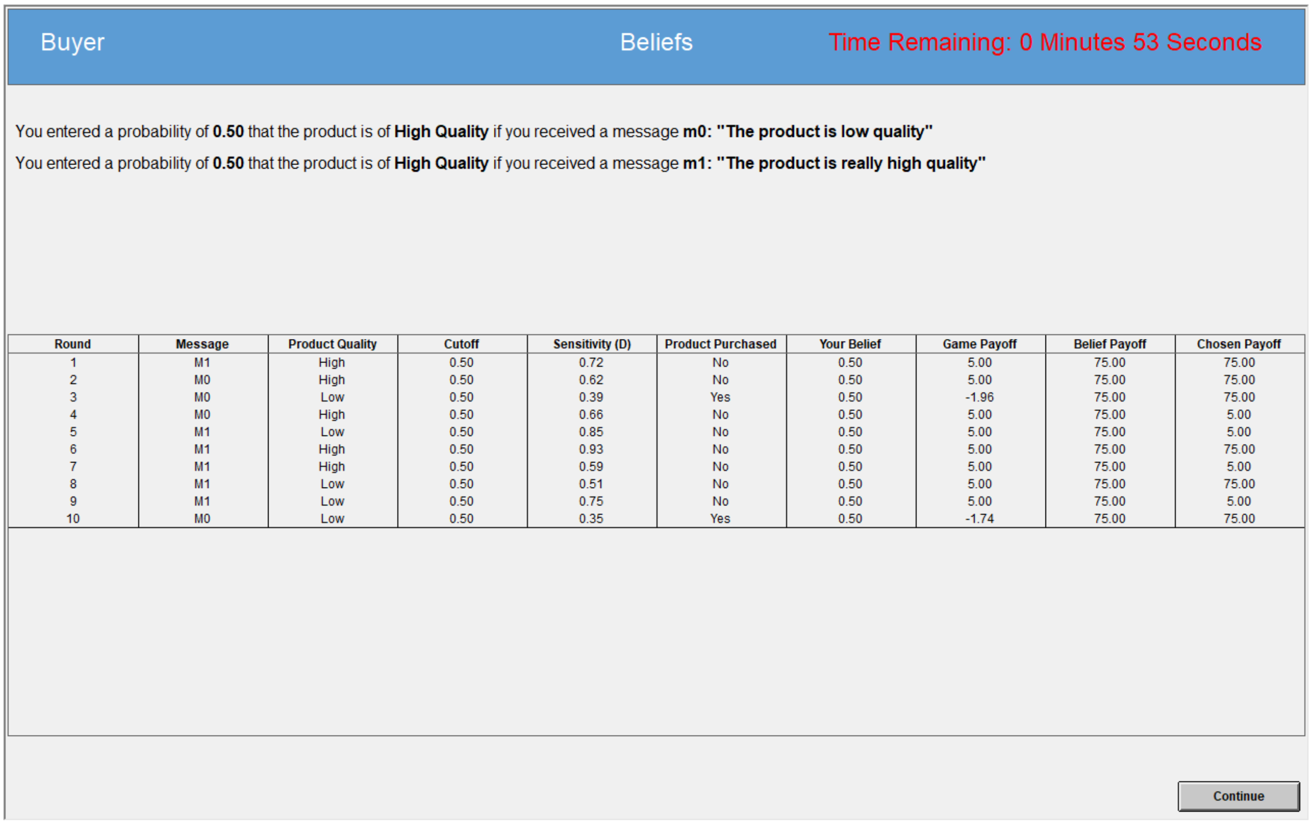
9. The task for the Buyer is to decide whether to buy the good given the message he receives knowing that he may be disappointed if he is tricked but not knowing how large that disappointment will be when he makes his decision. He has to determine a disappointment cutoff for each message received telling him to buy if his random disappointment value is below that cutoff.

10. These decisions will be made before each block of ten rounds and one block will be chosen for payment. In each round of this this block we will randomly (with equal probability) determine if you will be paid for your guesses or your game payoffs and then sum up your payoffs over the 10 rounds of the chosen block. We will then convert your ECU payoff into dollars at the rate of 1ECU = \$0.06 if you are a Buyer, and at the rate of 1 ECU = \$0.008 if you are a Seller.

11. It is never beneficial to not report your beliefs truthfully.

3 Screenshots: Feedback in both treatments

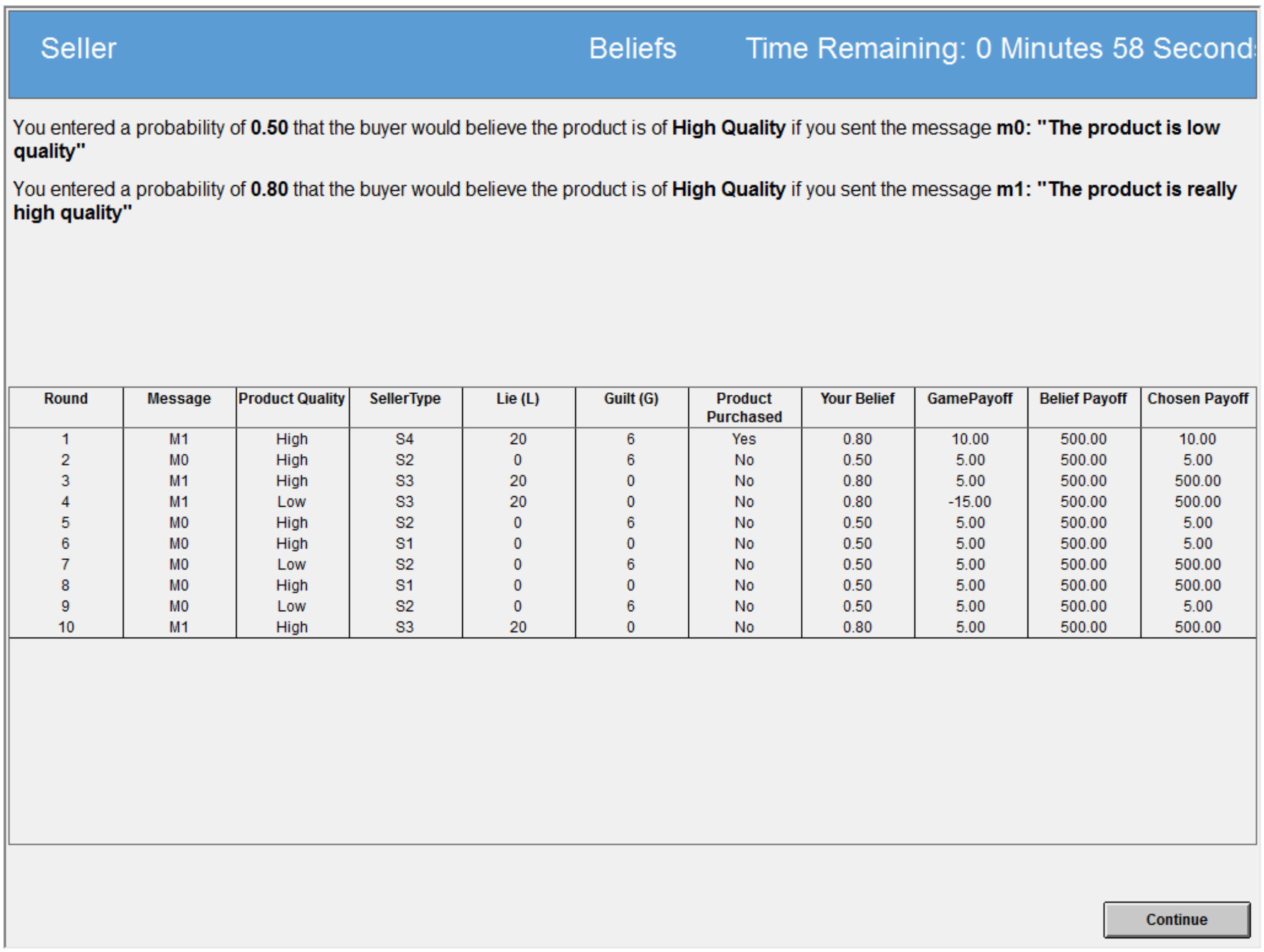
Figure 1: Feedback screen for the Buyers in No-Competition treatment



Round	Message	Product Quality	Cutoff	Sensitivity (D)	Product Purchased	Your Belief	Game Payoff	Belief Payoff	Chosen Payoff
1	M1	High	0.50	0.72	No	0.50	5.00	75.00	75.00
2	M0	High	0.50	0.62	No	0.50	5.00	75.00	75.00
3	M0	Low	0.50	0.39	Yes	0.50	-1.96	75.00	75.00
4	M0	High	0.50	0.66	No	0.50	5.00	75.00	5.00
5	M1	Low	0.50	0.85	No	0.50	5.00	75.00	5.00
6	M1	High	0.50	0.93	No	0.50	5.00	75.00	75.00
7	M1	High	0.50	0.59	No	0.50	5.00	75.00	5.00
8	M1	Low	0.50	0.51	No	0.50	5.00	75.00	75.00
9	M1	Low	0.50	0.75	No	0.50	5.00	75.00	5.00
10	M0	Low	0.50	0.35	Yes	0.50	-1.74	75.00	75.00

Notes: This is the screen that the Buyers observed at the end of each block of 10 periods in the No-Competition treatment.

Figure 2: Feedback screen for the Sellers in No-Competition treatment


Seller Beliefs Time Remaining: 0 Minutes 58 Second

You entered a probability of **0.50** that the buyer would believe the product is of **High Quality** if you sent the message **m0: "The product is low quality"**

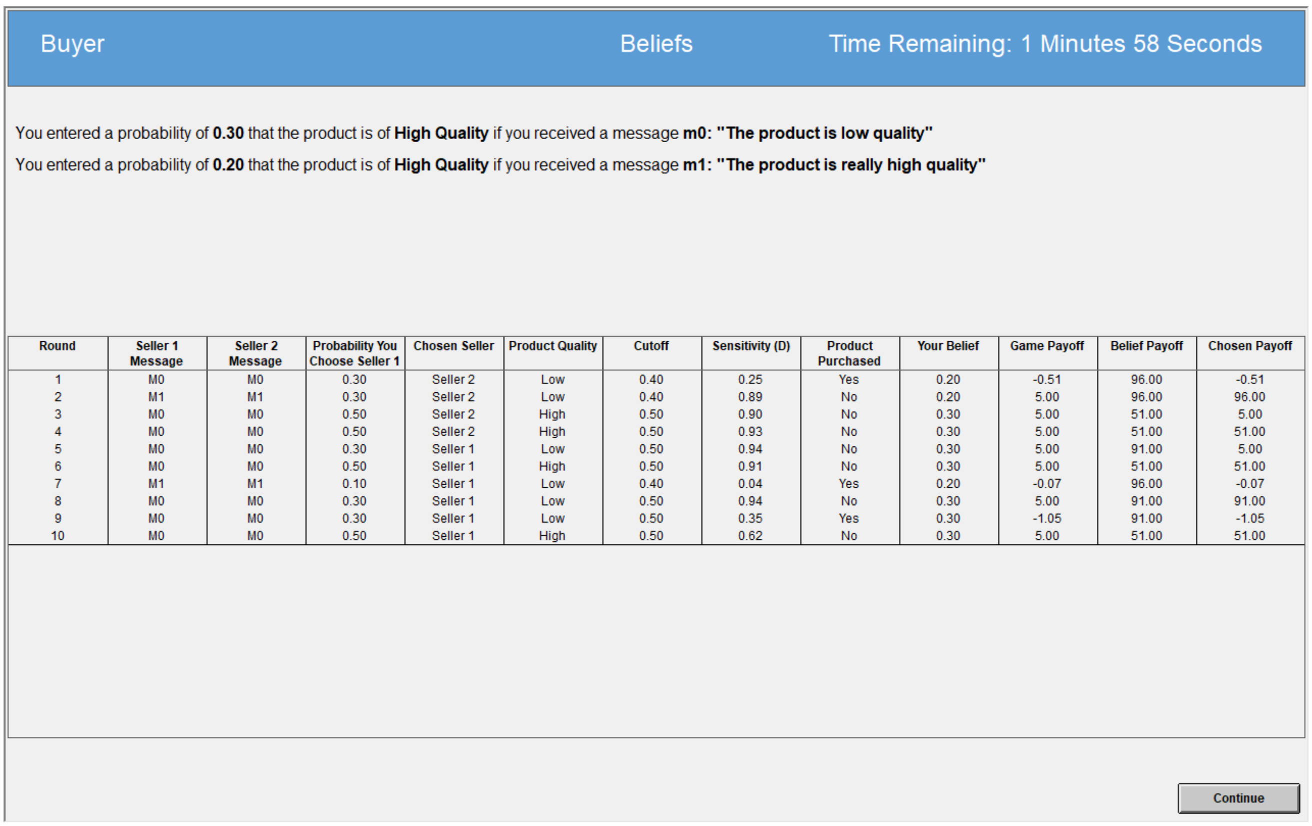
You entered a probability of **0.80** that the buyer would believe the product is of **High Quality** if you sent the message **m1: "The product is really high quality"**

Round	Message	Product Quality	SellerType	Lie (L)	Guilt (G)	Product Purchased	Your Belief	GamePayoff	Belief Payoff	Chosen Payoff
1	M1	High	S4	20	6	Yes	0.80	10.00	500.00	10.00
2	M0	High	S2	0	6	No	0.50	5.00	500.00	5.00
3	M1	High	S3	20	0	No	0.80	5.00	500.00	500.00
4	M1	Low	S3	20	0	No	0.80	-15.00	500.00	500.00
5	M0	High	S2	0	6	No	0.50	5.00	500.00	5.00
6	M0	High	S1	0	0	No	0.50	5.00	500.00	5.00
7	M0	Low	S2	0	6	No	0.50	5.00	500.00	500.00
8	M0	High	S1	0	0	No	0.50	5.00	500.00	500.00
9	M0	Low	S2	0	6	No	0.50	5.00	500.00	5.00
10	M1	High	S3	20	0	No	0.80	5.00	500.00	500.00

Continue

Notes: This is the screen that the Sellers observed at the end of each block of 10 periods in the No-Competition treatment.

Figure 3: Feedback screen for the Buyers in Competition treatment


Buyer Beliefs Time Remaining: 1 Minutes 58 Seconds

You entered a probability of **0.30** that the product is of **High Quality** if you received a message **m0: "The product is low quality"**

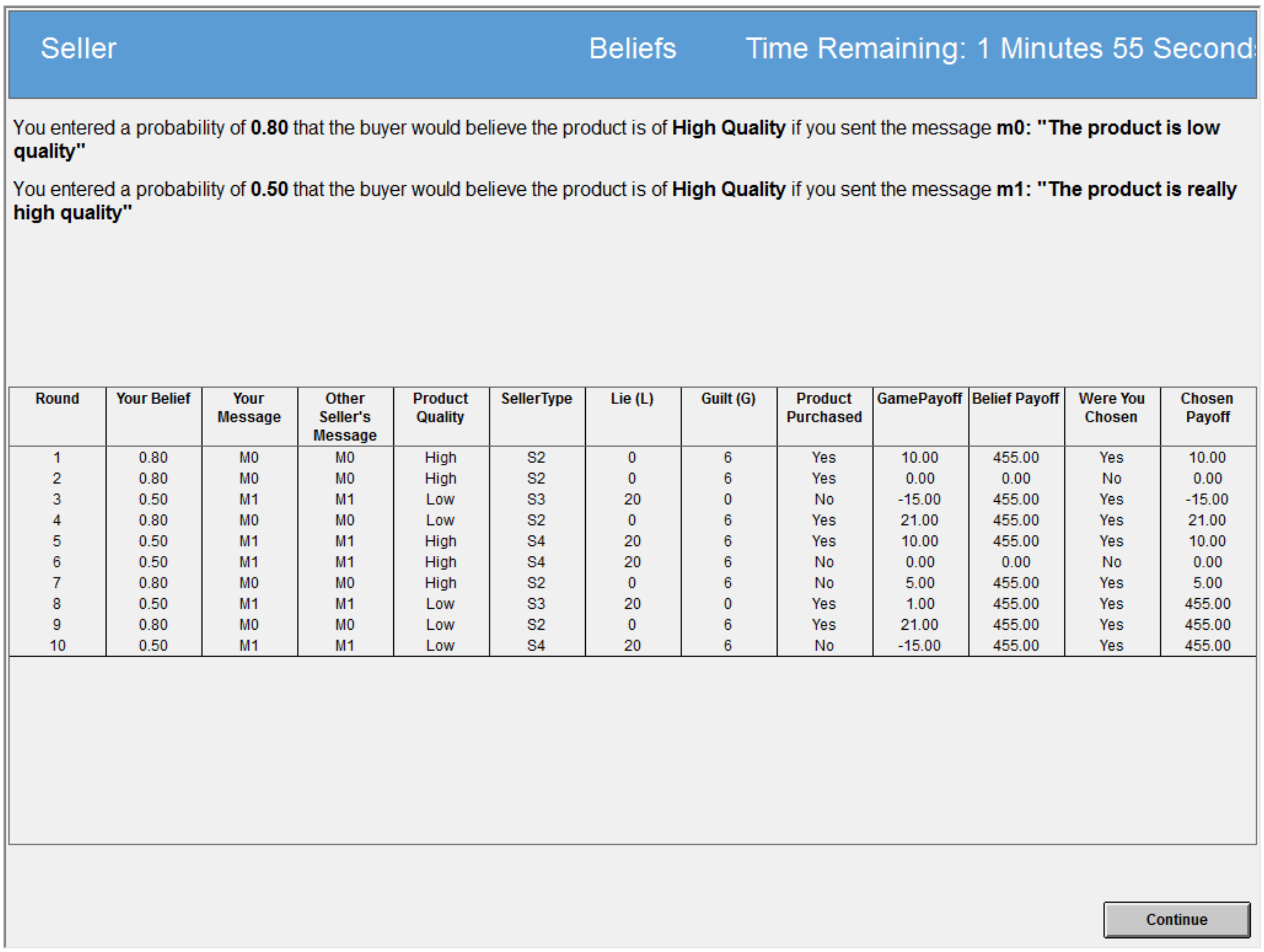
You entered a probability of **0.20** that the product is of **High Quality** if you received a message **m1: "The product is really high quality"**

Round	Seller 1 Message	Seller 2 Message	Probability You Choose Seller 1	Chosen Seller	Product Quality	Cutoff	Sensitivity (D)	Product Purchased	Your Belief	Game Payoff	Belief Payoff	Chosen Payoff
1	M0	M0	0.30	Seller 2	Low	0.40	0.25	Yes	0.20	-0.51	96.00	-0.51
2	M1	M1	0.30	Seller 2	Low	0.40	0.89	No	0.20	5.00	96.00	96.00
3	M0	M0	0.50	Seller 2	High	0.50	0.90	No	0.30	5.00	51.00	5.00
4	M0	M0	0.50	Seller 2	High	0.50	0.93	No	0.30	5.00	51.00	51.00
5	M0	M0	0.30	Seller 1	Low	0.50	0.94	No	0.30	5.00	91.00	5.00
6	M0	M0	0.50	Seller 1	High	0.50	0.91	No	0.30	5.00	51.00	51.00
7	M1	M1	0.10	Seller 1	Low	0.40	0.04	Yes	0.20	-0.07	96.00	-0.07
8	M0	M0	0.30	Seller 1	Low	0.50	0.94	No	0.30	5.00	91.00	91.00
9	M0	M0	0.30	Seller 1	Low	0.50	0.35	Yes	0.30	-1.05	91.00	-1.05
10	M0	M0	0.50	Seller 1	High	0.50	0.62	No	0.30	5.00	51.00	51.00

Continue

<u>Notes:</u> This is the screen that the Buyers observed at the end of each block of 10 periods in the Competition treatment.

Figure 4: Feedback screen for the Sellers in Competition treatment



Seller Beliefs Time Remaining: 1 Minutes 55 Second

You entered a probability of **0.80** that the buyer would believe the product is of **High Quality** if you sent the message **m0: "The product is low quality"**

You entered a probability of **0.50** that the buyer would believe the product is of **High Quality** if you sent the message **m1: "The product is really high quality"**

Round	Your Belief	Your Message	Other Seller's Message	Product Quality	SellerType	Lie (L)	Guilt (G)	Product Purchased	GamePayoff	Belief Payoff	Were You Chosen	Chosen Payoff
1	0.80	M0	M0	High	S2	0	6	Yes	10.00	455.00	Yes	10.00
2	0.80	M0	M0	High	S2	0	6	Yes	0.00	0.00	No	0.00
3	0.50	M1	M1	Low	S3	20	0	No	-15.00	455.00	Yes	-15.00
4	0.80	M0	M0	Low	S2	0	6	Yes	21.00	455.00	Yes	21.00
5	0.50	M1	M1	High	S4	20	6	Yes	10.00	455.00	Yes	10.00
6	0.50	M1	M1	High	S4	20	6	No	0.00	0.00	No	0.00
7	0.80	M0	M0	High	S2	0	6	No	5.00	455.00	Yes	5.00
8	0.50	M1	M1	Low	S3	20	0	Yes	1.00	455.00	Yes	455.00
9	0.80	M0	M0	Low	S2	0	6	Yes	21.00	455.00	Yes	455.00
10	0.50	M1	M1	Low	S4	20	6	No	-15.00	455.00	Yes	455.00

Continue

Notes: This is the screen that the Sellers observed at the end of each block of 10 periods in the Competition treatment.

4 Belief elicitation procedure

In this section we discuss beliefs' elicitation procedures we used to elicit Buyers' first-order beliefs and Sellers' second-order beliefs regarding Buyers' first-order beliefs. We also discuss our payment scheme both for the beliefs task and the game. We show that while in general in psychological games standard tools for eliciting beliefs (such as quadratic scoring rules) are not generally incentive compatible due to the fact that reported beliefs affect not only payment subjects receive for belief elicitation task but also their payoffs in the game, we chose parameters of the payment scheme in such a way that misreporting one's true beliefs increases payoffs of our subjects by an insignificantly small amounts. On this basis we conclude that our payment scheme is 'essentially' incentive compatible.

4.1 Eliciting Buyers' beliefs

In our experiment, we elicit two beliefs from the Buyers:

- the probability that a Seller has a high quality product conditional on sending message m_0
- the probability that a Seller has a high quality product conditional on sending message m_1

We used the standard quadratic scoring rule to incentivize Buyers to report their beliefs. Specifically, there are two states of the world: s_1 (the state in which a Seller has a high quality product) and s_2 (a Seller has a low quality product). Denote by p_{m_i} the true belief of the Buyer about state s_1, and $1 - p_{m_i}$ is the true belief of the Buyer about state s_2. Say, that our Buyer reports to us r_{m_i} instead of her true belief. Then her expected payoff from beliefs task is

$$\begin{aligned}\mathbb{E}\Pi^{\text{beliefs}}(p_{m_i}, r_{m_i}) = & p_{m_i} \cdot \left[X - Y \cdot \left((1 - r_{m_i})^2 + (0 - (1 - r_{m_i}))^2\right)\right] + \\ & + (1 - p_{m_i}) \cdot \left[X - Y \cdot \left((0 - r_{m_i})^2 + (1 - (1 - r_{m_i}))^2\right)\right] = \\ & = p_{m_i} \cdot \left[X - 2Y(1 - r_{m_i})^2\right] + (1 - p_{m_i}) \cdot \left[X - 2Y(r_{m_i})^2\right]\end{aligned}$$

where (X, Y) are the parameters set by the experimenter. In our experiment, we chose $X = 100$ and $Y = 50$.

Now let's calculate payoff of this subject from playing the game. This payoff depends on disappointment parameter ω, true belief p_{m_i}, and reported belief r_{m_i}:

$$\mathbb{E}\Pi^{\text{game}}(p_{m_i}, r_{m_i}, \omega) = \begin{cases} 10p_{m_i} + (1 - p_{m_i}) \cdot (-10\omega \cdot r_{m_i}) & \text{if this payoff is greater than 5} \\ 5 & \text{otherwise} \end{cases}$$

Therefore, the overall expected payoff of the Buyer is

$$\mathbb{E}\Pi^{\text{Buyer}}\left(p_{m_i}, r_{m_i}, \omega\right) = \frac{1}{2} \cdot \mathbb{E}\Pi^{\text{belief}}\left(p_{m_i}, r_{m_i}\right) + \frac{1}{2} \cdot \mathbb{E}\Pi^{\text{game}}\left(p_{m_i}, r_{m_i}, \omega\right)$$

Risk-neutral Buyer should report belief r_{m_i} which maximizes his overall expected payoff $\mathbb{E}\Pi^{\text{Buyer}}\left(p_{m_i}, r_{m_i}, \omega\right)$. The optimal report $r^*_{m_i}$ is

$$r^*_{m_i} = \begin{cases} p_{m_i} & \text{if } p_{m_i} \leq \bar{p}_{m_i} \\ p_{m_i} \cdot \left(1 + \frac{5}{2Y}\right) - \frac{5}{2Y} & \text{otherwise} \end{cases}$$

where $\bar{p}_{m_i} = \frac{1}{\sqrt{2}} = 0.7071$. The cutoff $\bar{p}_{m_i}$ does not depend on (X, Y) as long as $Y \geq 10$. Note, that $\max|p_{m_i} - r^*_{m_i}| = \frac{5}{2Y} \cdot (1 - \bar{p}_{m_i})$, which is really small for $Y > 10$.

Finally, the distortions computed above are the highest possible, since they are computed for player A with highest disappointment aversion parameter of $\omega = 1$. For example, when $X = 100$ and $Y = 50$, the highest distortion in beliefs reported by A is

$$\max|p_{m_i} - r^*_{m_i}| = 0.01$$

which means that our payment scheme is "practically" incentive compatible.

Eliciting Sellers' beliefs

We also elicit two beliefs from the Sellers (these are second-order beliefs):

- Seller's belief about Buyer's belief that Seller has high quality product conditional on sending message m_0
- Seller's belief about Buyer's belief that Seller has high quality product conditional on sending message m_1

We used relatively simple scheme that elicits the mean Seller's belief (rather than eliciting the whole distribution). Specifically, denote by $b^1_B(m_i)$ first-order belief of a Buyer that a Seller has a high quality product if he sent message m_i. We are interested in eliciting the second-order beliefs of Sellers about $b^1_B(m_i)$. Say that a Seller has a distribution in mind regarding $b^1_B(m_i)$. For instance, a Seller believes that $b^1_B(m_i) = v_1$ with probability p_1, $b^1_B(m_i) = v_2$ with probability p_2 and $b^1_B(m_i) = v_3$ with probability p_3, where $p_1+p_2+p_3 = 1$. However, we do not allow Sellers to specify the distribution. Instead, we are asking them for one number, call it q_{m_i}. We will be paying Sellers for how close their belief is to the belief $b_B^1(m_i)$ that Buyers report using quadratic scoring rule. Therefore, expected payoff of a Seller from belief task is

$$\mathbb{E}\Pi^{\text{beliefs}}(q_{m_i}) = V - W \cdot \left[p_1(v_1 - q_{m_i})^2 + p_2(v_2 - q_{m_i})^2 + p_3(v_3 - q_{m_i})^2\right]$$

where parameters take values $V = W = 500$. That means, that risk-neutral Seller would choose to report the average belief $q_{m_i} = p_1 v_1 + p_2 v_2 + p_3 v_3$ since this report maximizes his expected payoff.

From now on, denote by $\bar{b}_S^2(m_i)$ the true average second-order belief of a Seller regarding first-order belief of a Buyer upon receiving message m_i, while q_{m_i} is the belief reported by a Seller in our beliefs elicitation task.

If, game is chosen for payment, then a Seller will get payoff

$$\mathbb{E}\Pi^{\text{game}}(\bar{b}_S^2(m_i), q_{m_i}, q_H, g, l, \omega) = a(\bar{b}_S^2(m_i)) \cdot 10 + (1 - a(\bar{b}_S^2(m_i))) \cdot 5 \quad \forall m_i$$

$$\mathbb{E}\Pi^{\text{game}}(\bar{b}_S^2(m_1), q_{m_1}, q_L, g, l, \omega) = a(\bar{b}_S^2(m_1)) \cdot (21 - 10 g q_{m_1} \omega - l) + (1 - a(\bar{b}_S^2(m_1))) \cdot (5 - l)$$
$$\mathbb{E}\Pi^{\text{game}}(\bar{b}_S^2(m_0), q_{m_0}, q_L, g, l, \omega) = a(\bar{b}_S^2(m_0)) \cdot 21 + (1 - a(\bar{b}_S^2(m_0))) \cdot 5$$

where $a(\bar{b}_S^2(m_i))$ is probability that Buyer purchases the product upon receiving m_i.

The overall expected payoff of a Seller is

$$\mathbb{E}\Pi^{\text{Seller}}\left((\bar{b}_S^2(m_i), q_{m_i}, q_H, g, l, \omega\right) = \frac{1}{2} \cdot \mathbb{E}\Pi^{\text{belief}}\left(\bar{b}_S^2(m_i), q_{m_i}\right) + \frac{1}{2} \cdot \mathbb{E}\Pi^{\text{game}}\left(\bar{b}_S^2(m_i), q_{m_i}, g, l, \omega\right)$$

or

$$\mathbb{E}\Pi^{\text{Seller}}\left(\bar{b}_S^2(m_i), q_{m_i}, q_L, g, l, \omega\right) = \frac{1}{2} \cdot \mathbb{E}\Pi^{\text{belief}}\left(\bar{b}_S^2(m_i), q_{m_i}\right) + \frac{1}{2} \cdot \mathbb{E}\Pi^{\text{game}}\left(\bar{b}_S^2(m_i), q_{m_i}, g, l, \omega\right)$$

depending on his type and message that he chose to send where

$$\mathbb{E}\Pi^{\text{belief}}\left(\bar{b}_S^2(m_i), q_{m_i}\right) = V - W \cdot (\bar{b}_S^2(m_i) - q_{m_i})^2$$

Notice that the only place where reported belief of Seller affects Seller's payoff in the game is the case in which Seller owns a low quality product, has positive guilt parameter g and sends message m_1. In all other cases, Seller's payoff in the game is independent of the reported belief, which means that Seller would maximize his payoff by reporting his true average second-order belief, i.e., $q_{m_i}^* = \bar{b}_S^2(m_i)$.

So the only type we need to worry about is a Seller who owns low quality product, have $g > 0$ and sends message m_1. For this type, the highest distortion occurs when

$\bar{b}^2_S(m_1)$	q_{m_1}	$\bar{b}^2_S(m_1)$	q_{m_1}
0	0	0.60	0.58
0.20	0.20	0.62	0.59
0.30	0.30	0.63	0.60
0.40	0.40	0.64	0.61
0.50	0.50	0.65	0.62
0.52	0.52	0.67	0.63
0.55	0.54	0.70	0.65
0.57	0.56	0.80	0.75
0.58	0.56	0.90	0.85
0.59	0.57	1.00	0.95

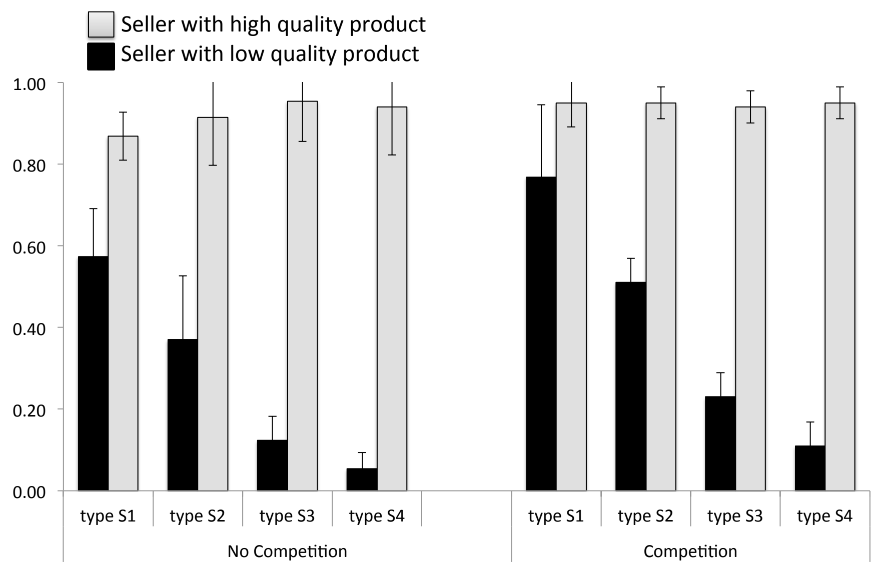
$\omega = 1$. Table below reports the true average Seller's second-order beliefs of Seller who owns low quality product, has $g > 0$, sends message m_1 and expects $\omega = 1$ as well as optimal report for parameters that we implemented in our experiment, i.e., $V = W = 500$. The highest distortion in this case is $\max |\bar{b}^2_S(m_1) - q^*_{m_1}| = 0.05$.

Given these calculations, we therefore expect that subjects would report their beliefs truthfully, since this is the best they can do to maximize their payoff in our experiment.

5 Additional analysis of experimental data

Figure 5 presents communication strategy of Sellers in the first 5 blocks of our experimental sessions. This figure shows results similar to those presented in the main manuscript, i.e., our Sellers were using very similar communication strategies both in the first 5 and the last 5 blocks of the experiment.

Figure 5: Communication Strategy of Sellers (first 5 blocks)



Notes: Average frequency of sending message m_1 is presented for each type of the Seller in each treatment in the first half of the experiment. 95% confidence intervals are computed using robust standard errors obtained by clustering observations by session.

In the next table (Table 1), we replicate Table 9 presented in the main manuscript for the first 5 blocks of the experiment. Specifically, we are interested in understanding which types of Buyers and Sellers suffer the most from the competition? The results concerning Sellers' payoffs broken down by psychological types and qualities of the product look very similar between the first and the last 5 blocks of the experiment. On the contrary, results are quite different for Buyers: while we don't observe any significant differences between Buyers' payoffs in the game with and without competition in the first 5 blocks, this is not the case in the last 5 blocks of the experiment, in which Buyers with high sensitivity for disappointment suffer from the presence of competition.

Table 1: Which Types of Buyers and Sellers Suffer the Most from Competition (first 5 blocks)?

		No-Comp	Comp	Difference
SELLERS low quality product	type S1 ($G = 0, L = 0$)	12.07 (0.63)	14.03 (0.88)	YES* ($p = 0.09$)
	type S2 ($G = 6, L = 0$)	8.32(0.55)	7.83 (0.68)	NO ($p = 0.57$)
	type S3 ($G = 0, L = 20$)	8.44 (1.27)	1.75 (0.84)	YES*** ($p < 0.01$)
	type S4 ($G = 6, L = 20$)	8.73 (0.62)	1.33 (1.74)	YES*** ($p < 0.01$)
SELLERS high quality product	type S1 ($G = 0, L = 0$)	7.96 (0.27)	7.54 (0.22)	NO ($p = 0.22$)
	type S2 ($G = 6, L = 0$)	7.75 (0.38)	8.01 (0.32)	NO ($p = 0.60$)
	type S3 ($G = 0, L = 20$)	7.70 (0.23)	7.68 (0.36)	NO ($p = 0.92$)
	type S4 ($G = 6, L = 20$)	7.85 (0.23)	7.57 (0.23)	NO ($p = 0.39$)
BUYERS	$\omega \leq 0.2$	4.02 (0.28)	4.27 (0.32)	NO ($p = 0.96$)
	$0.2 < \omega \leq 0.4$	4.49 (0.34)	3.59 (0.49)	NO ($p = 0.16$)
	$0.4 < \omega \leq 0.6$	4.37 (0.25)	4.28 (0.30)	NO ($p = 0.81$)
	$0.6 < \omega \leq 0.8$	4.29 (0.25)	4.63 (0.25)	NO ($p = 0.34$)
	$\omega > 0.8$	4.92 (0.15)	4.62 (0.25)	NO ($p = 0.34$)

Notes: We report average payoffs of Buyers and Sellers for each type in the first 5 blocks of the experiment and the robust standard error in the parenthesis, where standard errors are clustered at the session level. The last column reports the result of a statistical test comparing payoffs for a fixed type of Buyers or Sellers in the two treatments. The test is performed using Random Effects GLS regressions, in which we regress the payoffs of interest on a constant and a dummy variable indicating one of the treatments, while clustering observations by session. Statistical difference between treatments is assessed by looking at the significance of the estimated dummy coefficient. We use standard convention of * indicating significance at 10% level, ** indicating significance at 5% level, and *** indicating significance at 1% level and report p-value associated with estimated dummy variable in the parenthesis.