

EMOTIONS AND ECONOMIC SHOCKS IN A FIRST-PRICE AUCTION: AN EXPERIMENTAL STUDY*

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Abstract

We investigate experimentally whether emotions affect bidding behavior in a first price auction. To induce emotions, we confront subjects after a first auction series with a positive or negative random economic shock. We then explore the relation between emotions and bidding behavior in a second auction series. Our main results are: (i) the economic shock has a substantial impact on the experienced emotions of bidders; (ii) the emotional state systematically influences bidding behavior. In particular, negative emotions induce more competitive bidding. Our findings show that for a good understanding of bidder behavior the emotions have to be taken into account.

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*Any investor's biggest enemy is emotion.*¹

First Union Securities Senior Vice President R. William Bayliss III.

1 Introduction

Do emotions play a significant role in competitive environments like markets? Alan Greenspan, chairman of the Federal Reserve Board in Washington, suggests they do. At the end of 1996, Greenspan, referred to the behavior of stock market investors by using the term ‘irrational exuberance’. Robert Shiller (2000) argues that not “consensus judgment of experts” but rather “the combined effect of indifferent thinking by millions of people (...) who are motivated substantially by their *own emotions*, random attentions, and perceptions of conventional wisdom (p. 203; italics added)” determine stock market behavior. Shiller provides interesting evidence suggesting that markets do not operate as efficiently as economic theory predicts, but he does not offer any direct evidence for the claim that emotions are an important behavioral factor in competitive environments.

The aim of this paper is to provide such evidence. With the help of a laboratory experiment we show that emotions influence behavior, even in a competitive environment. This is an important issue because many economists seem to believe that emotions can be considered as noise, without any economically interesting effect on behavior. Psychological research, however, suggests that emotions can affect behavior in a systematic way. The contribution of this paper is that it supports the view that emotions are not mere noise but that they influence behavior in an economically relevant way.

Surprisingly, there has not been much economic work that deals with emotions explicitly.² To the best of our knowledge, all empirical studies investigating the role of emotions in economic decision making deal with either bargaining or social dilemma situations. (In Section 2 we shortly discuss this evidence). While economists may admit that emotions play a role in such environments, a key question from an economic point of view is whether emotions are also relevant when economic agents behave under core

¹Quote from *The Winchester Star* from April 19, 2000.

²Important exceptions are Frank (1988) who argues that emotions can be beneficial since they help to solve important commitment problems, Loewenstein (1996, 2000) who argues that emotions have effects on preferences not accounted for by economic theory (see also Loewenstein et al. (2001), and Elster (1996, 1998) for more general surveys). Caplin and Leahy (2001) incorporate anxiety into expected utility models. Finally, Thaler (2000, p. 139) predicts that in the future “Homo Economicus will become more emotional”.

institutions like competitive markets and auctions. In other words, can emotions endure competitive pressure?

In this paper we provide a first empirical step in establishing the role of emotions in a competitive environment. In particular, we focus on the impact of emotions on bidding behavior in a private value auction experiment. Auctions are considered to be of theoretical as well as practical importance: “In theoretical terms, auctions play a prominent role in the theory of exchange as they remain one of the simplest and most familiar means of price determination in the absence of intermediate market makers.” (Kagel, 1995, p.501). Kagel further argues that, “in practical terms, the value of goods exchanged each year by auctions is huge”. Also, with the introduction of Web-based auctions this transaction mechanism has become more and more important for ‘everyday’ business.³ The rapid growth of the number of business-to-business and business-to-consumer on-line auctions makes it obvious that understanding the driving forces of behavior in auctions is not only of interest for economists but also for business managers.

The set-up of our experimental auction is as follows. Each subject bids in two auction series. After the first auction, we confront each subject with a random economic shock, that is either positive or negative, in order to induce emotions. After this shock, which can be considered an economically relevant event, the experienced emotions of subjects are measured. Thereafter, they bid in a second auction series. With this design it is possible to test whether there is any *causal* relation between the emotional state and bidding behavior. To exclude strategic considerations and emotional ‘spillover’ effects between subjects (e.g. anger or envy towards other bidders) we use robot-bidders as competitors of our experimental subjects. Furthermore, subjects are not given any feedback during the auction in order to control for (possible) learning effects and changes in subjects’ emotional state other than caused by the random economic shock. We discuss the experimental design more thoroughly in section 3.

We deliberately choose this minimalist design because it provides a rather strong test for the influence of emotions on behavior. In addition, we confront subjects only with a modest economic shock. Therefore, any changes in subjects’ emotions due to the experience of such a shock are likely to be rather small. In spite of these

³Lucking-Reiley (2000) estimated the monthly revenue of the three large auction sites eBay, Yahoo!, and Amazon in summer 1999 on \$211,000,000. In spring 2003, eBay announces on its web-page transactions worth \$14.87 billion in annualized gross merchandise sales for 2002.

restrictions, the obtained results are surprisingly clear-cut and unambiguously show that emotions are not mere noise. (1) The economic shock has a substantial impact on the experienced emotions of bidders. Bidders facing a negative shock are in a very different emotional state than bidders facing a positive shock. (2) More importantly, *the emotional state systematically influences bidding behavior*: bidders in a negative emotional state increase their bids in the second auction series, whereas bidders in a positive emotional state do not change their bidding behavior.

The rest of the paper is organized as follows. In section 2 we first survey some relevant psychological literature on emotions and decision-making and shortly discuss the available experimental economic evidence on emotions. In section 3 we present our research questions and the experimental design. In section 4 the experimental results are reported. Section 5 closes the paper with a short summary and conclusion.

2 Emotions and decision making: psychological and economic experimental evidence

In this section we shortly discuss some relevant psychological and economic empirical studies investigating the role of emotions in decision making. Although these studies do not deal with auctions explicitly, they are of interest because they give an impression how emotions may influence behavior.

Psychological evidence.⁴ A large part of the psychological evidence is concerned with the behavioral effects of either positive or negative affect, rather than the effects of individual emotions. Isen (1999, 2000) surveys this line of research and concludes that it is now well established that positive affect promotes helpful, friendly, and socially responsible behavior. For example, in one study of Isen (1999) positive affect is induced by letting people unexpectedly find a dime in a public telephone booth. Subsequently, they are asked to help a stranger who accidentally drops a sheaf of papers when passing by. It is found that people in whom positive affect is induced (those who find a dime) are more willing to help than those who do not find a dime.

⁴Because of space constraints we can only give a brief and highly selective overview of the relevant psychological literature. For detailed overviews we refer the interested reader to Isen (1999, 2000) and Loewenstein et al. (2001).

Other research has focused on how affect influences risk taking behavior (Isen 1999, 2000; Loewenstein et al., 2001). The available evidence suggests that people who feel good are inclined to take less risk than people who feel neutral, in particular when the stakes are high (Isen and Geva, 1987; Isen and Patrick 1983). A rationale for this observation is that people who are in a positive emotional state want to maintain that state (mood maintenance hypothesis). Other studies show that different negative emotions can affect risk behavior in different ways. For example, Raghunathan and Pham (1999) find that anxious individuals are biased towards low risk/low reward options whereas sad individuals tend to go for high risk/high reward options. Anxiety, they argue, primes an implicit goal of uncertainty reduction while sadness primes reward replacement. Leith and Baumeister (1996) report that angry or embarrassed subjects are more prone to risk taking than subjects in a sad or neutral state. They argue that a negative emotion in combination with high arousal leads to less careful rational thought and, through this way, to increased risk taking. Lerner and Keltner (2001) find that fear and anxiety tend to favor cautious, risk averse behavior whereas anger promotes risk seeking. Another group of researchers (Eisenberg, Baron and Seligman, 1996) also find that anxiety is positively correlated with risk aversion. Finally, there is evidence that affect not only influences behavior but also expectations. People in positive emotional states tend to make optimistic judgments and choices whereas people in negative emotional states tend to make pessimistic judgments and choices (see Loewenstein et al., 2001). Overall, the psychological evidence suggests that positive and negative emotional states have asymmetric effects on behavior.

Economic experimental evidence. Bosman and van Winden (2002) investigate the impact of emotions on retaliation in an appropriation game. They identify emotions as a new source of efficiency costs. Negative emotions seem to trigger individuals to give up scarce resources in order to punish an authority that puts a claim on their resources. Charness and Grosskopf (2001) investigate whether a person's level of (self-reported) happiness influences social comparisons in variants of the dictator game. They do not find a strong correlation between happiness and payoff inequity aversion. However, they report some correlation between unhappiness and the willingness to lower another person's payoff below one's own payoff. Kirchsteiger et al. (2001) investigate the effect of what they call 'mood' on decisions in two-person gift exchange games. They induce a particular emotional state by showing subjects either a funny or a

sad movie. They report that the second players' (i.e. those who may reciprocate) behavior is dependent on their emotional state. In particular, they find that 'bad mood' leads to stronger reciprocal behavior whereas 'good mood' induces more generosity. Pillutla and Murnighan (1996) investigate rejections in an ultimatum game and find that intentional low offers trigger feelings of anger and wounded pride and ultimately spiteful behavior. Hennig-Schmidt (1999) reports that emotions might play a crucial role in breaking up group bargaining. Fehr and Gächter (2002) suggest that negative emotions are the proximate source for non-selfish punishment in their public good with punishment experiments. Finally, de Quervain et al. (2004) employing fMRI scans during a punishment game find that people seem to derive satisfaction from punishing norm violations.

In summary, the available psychological and economic evidence suggest that emotions are important in decision making. The psychological studies are mostly concerned with hypothetical (individual) decisions, whereas the economic studies deal exclusively with either bargaining or social dilemma situations. Our experiment differs substantially from these studies because we focus on how emotions (generated by an economic relevant event) influence behavior in a competitive and risky environment, namely a private value auction.

3 Experimental design and research questions

Experimental design. In total 126 subjects, almost all undergraduate students from the university of Amsterdam, participated in seven experimental sessions. About 70 percent of the subjects were students of economics or econometrics while the rest came from various fields such as psychology, chemistry, and mathematics. Subjects received a show-up fee of € 2,30, independent of their earnings in the experiment. On average, subjects earned € 12,30 (approximately USD 15,-) in total. An experimental session took about one hour. All sessions were conducted at the CREED-laboratory of the University of Amsterdam.

The experimental procedure is as follows (see Table 1 for a summary of the sequence of events). At the beginning of a session subjects are told that the experiment consists of two parts that are independent of each other (a specimen of the instructions is provided in Appendix B). Furthermore, they are told to receive the instructions for

TABLE 1— SEQUENCE OF EVENTS

0.	General information → experiment consists of two parts
	PART 1
1.	Instructions for part 1 <u>only</u> → auction rounds, economic shock
2.	Conduct of 35 auction rounds; no feedback
3.	Information about earnings in auction rounds
4.	Random economic shock (positive or negative) → increase or decrease earnings
5.	Measurement of emotions
	PART 2
6.	Instructions for part 2 → same as part 1
7.	Conduct of 35 auction rounds; no feedback
8.	Information about earnings in auction rounds
9.	Random economic shock (positive or negative) → increase or decrease earnings
10.	Debriefing questionnaire

the second part after the end of the first part. In the first part, each subject has to bid against four computerized bidders in a series of 35 first-price sealed bid auctions.⁵

The computerized bidders are programmed to bid according to the risk-neutral Nash equilibrium strategy. Subjects are aware of the fact that they play against computerized bidders that bid according to a fixed rule.⁶ In each round all private values (including those of the computerized bidders) are independently drawn from a uniform distribution with support $[0, 500]$ Dutch cents. Except for five practice rounds, where subjects receive information about if they have won the auction and their profit, they do not get any feedback during the 35 bidding rounds. We have chosen this procedure, because our focus is on the effect of emotions, triggered by a controlled exogenous economic shock, on bidding behavior. The no-feedback mechanism helps in minimizing potential confound through learning and emotional disturbances over the auction rounds.⁷

⁵Walker et al. (1987) find that that the use of computerized competitors, instead of human rivals, generally does not change subjects' bidding behavior.

⁶Subjects are told that each computerized bidder always bids $4/5$ of its randomly drawn private value. We use this procedure because we want to control for emotional and strategic reactions to the behavior of human competitors.

⁷Emotional disturbances over the rounds may arise when subjects know whether they won the auction in a particular round or not. In order to investigate how emotions affect bidding in the second part, we want to have control over subjects emotional state in part 2 and therefore give them as little potentially disturbing information as possible. A similar procedure is used by Smith et al. (2002).

Before subjects start the 35 bidding rounds, we also give them information about the procedure determining their final earnings in part 1 of the experiment. This procedure entails that with a 50 percent chance all their profits are multiplied with factor two and supplemented with an additional amount of € 4,50 (positive economic shock), and with a chance of 50 percent all their profits are divided by two (negative economic shock). To determine the outcome of this procedure, we ask subjects individually to throw a die under supervision of the experimenter.⁸

Directly after part 1 of the experiment, i.e. after the positive or negative economic shock but before they receive instructions for part 2, subjects are asked to fill out a questionnaire with questions concerning their experienced emotions. Subsequently, part 2 of the experiment starts. This part is exactly the same as part 1, except that in part 2 there are no practice rounds. After the end of the second part, subjects receive another questionnaire with questions about their motivations and background (age, gender, etc.).

A key feature of the experiment is the measurement of subjects' emotional state directly after the economic shock. We firstly assess subjects' overall emotional state in a visual way. To that purpose, subjects are given three series of figures (provided in Appendix C) and are asked for each series to select the figure that best describes how they currently feel.⁹ The first series of figures measures what psychologists call 'valence' and can be seen as an indicator of the overall emotional state. The second series measures feeling of control while the last series measures experienced arousal of the autonomic nervous system. Secondly, to assess the individual emotions subjects experience we give them a list of 14 emotion names and ask them to report the intensity of each emotion on a 7-point scale, ranging from "no emotion at all" to "high intensity of the emotion". The list contains the following emotions: sadness, happiness, shame, fear, envy, hope, anger, anxiety, joy, irritation, contempt, surprise, disappointment, nervousness. Note that the list not only includes the type of emotions that one may expect to be relevant in our setting, such as happiness/joy (in case of a positive economic shock) and sadness/disappointment (in case of negative shock). A variety of other both positive and negative emotions are included, in order to avoid that subjects are 'pushed' in a particular direction.

⁸The positive shock includes a lump sum payment of € 4,50 in order to assure that a positive shock has also economic consequences for bidders that earn relatively little in the auction.

⁹These figures, developed by Lang (1980) as a paper and pencil version of the so-called Self Assessment Manikin, are reprinted from Sonnemans (1991).

Assessing emotions with the help of self-reports may seem problematic. Emotion theorists, however, see it as a valuable method of measurement. According to Ortony, Clore, and Collins (1988, p.6) “There is as yet no known objective measure that can conclusively establish that a person is experiencing some particular emotion, just as there is no known way of establishing that a person is experiencing some particular color. In practice, however, this does not normally constitute a problem because we are willing to treat people’s reports of their emotions as valid. Because emotions are subjective experiences, like the sensation of color or pain, people have direct access to them, so that if a person is experiencing fear, for example, that person cannot be mistaken about the fact that he or she is experiencing fear”. Recently, Ben-Shakhar et al. (2004) find that self-report measures of emotions are actually highly correlated with physiological measures of emotions.

Research questions. Our first research question is whether subjects bidding behavior changes over the two auction series in the experiment. Since each subject bids in both parts, we can compare bidding behavior within a subject. Our second research question is whether random economic shocks affect the emotions experienced by subjects. The third and main question, is whether and, if so, how the emotional state affects bidding. Psychological evidence, discussed in the previous section, suggests the following. Firstly, positive and negative emotions can affect behavior in asymmetric ways. Secondly, different negative or positive emotions can have different effects on behavior. The literature is, however, silent about the effect of emotions on behavior in competitive environments. The results of our experiment will be informative in this respect.

Besides the emotional state, other factors, like experience, may also be relevant for understanding changes in subjects’ bidding behavior. There is experimental evidence, reviewed by Kagel (1995), that experienced bidders (those who have participated in several auction series) bid significantly higher than inexperienced bidders. Another potentially relevant factor that we investigate concerns a possible income or cash balance effect. Although no significant income effects are found in the studies Kagel (1995) reviews, some recent work suggest that income can have a negative effect on the level of bids (Ham et al., forthcoming). By taking these other factors into account as well we are able to disentangle the emotional component of bidding behavior.

4 Results

We first present a summary of bidding behavior, which establishes that bidders do change behavior from part 1 to part 2. Thereafter, we investigate the impact of the economic shocks on the emotional state. Finally, we analyze the determinants of the behavioral change and show that the emotional state indeed significantly affects bidding behavior.

Summary of bidding behavior. To investigate bidding behavior we have estimated the following linear bid function for each subject in *both* parts of the experiment:

$$b_{it} = \alpha_i + \beta_i v_{it} + \epsilon_{it}, \quad i = 1, \dots, 126, \quad t = 1, \dots, 35 \quad (4.1)$$

where t is the auction round, and α_i and β_i are the parameters to be estimated.¹⁰ The risk neutral Nash equilibrium bid function, $b_i = [(n-1)/n]v_i$, implies that $\alpha_i = 0$ and $\beta_i = 0.8$ in our experiment.

From other private value auction experiments it is well known that bidding behavior is approximately linear except for values close to the lower and the upper bound of the interval. At these values subjects usually show a tendency to decrease their bids (see e.g. Cox et al., 1988, Cox and Oaxaca, 1996). We also observe this pattern in our data (for an illustration see Figure 1). We, therefore, follow the approach of Isaac and James (2000) and Ham et al. (forthcoming) and use only values in the interval [50, 400] for the estimation of the bid function.

Table 2 shows the averages and standard deviations of the estimated intercepts and slopes of the bid functions for all subjects in both parts. For both parts the statistics are also shown separately for bidders having experienced a positive shock and bidders having experienced a negative shock. It appears that, on average, subjects' bid functions are relatively close to the risk neutral Nash equilibrium strategy, particularly in part 1 of the experiment. In this part, the average slope of the bid functions is equal to 0.809 and only marginally significantly different from the risk neutral equilibrium value of 0.800 ($p = 0.076$, Wilcoxon signed-rank test, 2-sided). Note that, although subjects are confronted with the economic shock *after* they place their bids in part 1 of the auction series, we have to reject the hypothesis that the slopes of bid functions

¹⁰In each auction round observations are censored between zero and the private value v_{it} . Since censoring values vary from observation to observation we used a generalization of Tobit estimates that allows each observation to be censored at a different point (see Amemiya, 1973).

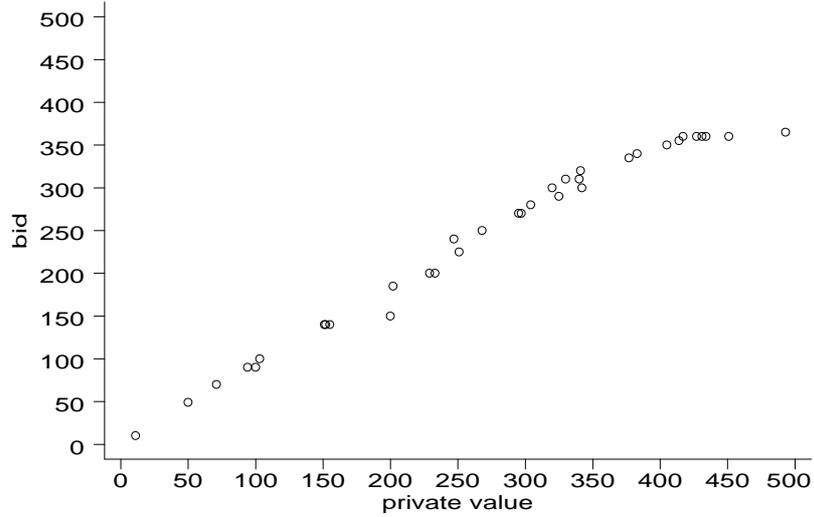


FIGURE 1– AN EXAMPLE OF INDIVIDUAL BIDDING BEHAVIOR
(SUBJECT 1, SESSION 1, PART 1)

do not differ between subjects who face a positive and negative shock in part 1. Given our sample size and the random assignment we have to attribute this result to ‘bad luck’. Fortunately, our experimental design still allows to investigate our main research questions, which focus on behavioral changes between part 1 and part 2 and their relation to economic shocks and emotional states of the bidders.

The closeness of the average bid function to the risk neutral Nash equilibrium could be due to an anchoring effect because subjects are informed about the strategies of

TABLE 2– SUMMARY OF ESTIMATED BID FUNCTIONS

	intercept α_i			slope β_i		
	overall	pos. shock	neg. shock	overall	pos. shock	neg. shock
part 1	7.497 (16.709)	3.661 (13.900)	10.874 (18.282)	0.809 (0.099)	0.840 (0.073)	0.782 (0.111)
part 2	7.069 (19.964)	4.701 (12.573)	9.147 (24.629)	0.832 (0.107)	0.858 (0.076)	0.809 (0.124)
N	126	59	67	126	59	67

Note: Reported numbers are averages; standard deviations in parentheses.

the robot-traders. (For the anchoring effect cf. Tversky and Kahnemann, 1974). In our view, this is not problematic since any anchoring effect putting inertia on behavior would strengthen results showing behavioral changes between the two parts.

The average value of the intercept is significantly greater than zero in both parts but with values of 7.497 and 7.069, respectively, relatively low. These two values are not significantly different from each other ($p = 0.935$).¹¹ This also holds true when looking at bidders experiencing a positive or a negative shock after part 1 ($p > 0.5$ in both cases). This picture changes, however, when looking at the estimated slope of the bid functions. When taking all bidders into account, it turns out that on average bids are significantly more aggressive in part 2 than in part 1. Overall, the average slope increases from 0.809 to 0.832 ($p < 0.001$). Interestingly, in this respect, there is no difference between bidders experiencing a positive or a negative economic shock. For those who face a positive shock, the hypothesis of equal slopes in both parts has to be rejected ($p = 0.024$). The same holds for bidders who face a negative economic shock ($p = 0.011$).¹² We summarize these findings in our first result.

Result 1 *Compared to part 1 of the auction on average bidders place significantly higher bids in part 2 of the auction. This change in behavior is independent of the type (positive or negative) of the economic shock.*

The interesting question now is why bidders have changed their behavior, given that it cannot be attributed to the positive or negative economic shock per se. In Section 3, we identified three possible factors that could be relevant for bidding behavior: experience, income effects, and changes of the emotional state due to the economic shock. It is generally observed in experimental auctions that more experienced bidders tend to place higher bids. Hence, our Result 1 is consistent with such an experience effect. The sign of the economic shock does not appear to influence this effect considerably. We come back to this in more detail below.

Apart from an experience effect and an effect of the economic shock per se, we hypothesize that the emotional state of bidders, which is likely to be affected by the

¹¹In this section all reported p -values are based on 2-sided Wilcoxon signed-rank tests unless noted otherwise.

¹²When using the slopes from estimations based on the whole interval of private values as units of observation bidders experiencing a positive shock change their behavior only marginally ($p = 0.066$, one-sided Wilcoxon signed rank test).

economic shocks, influences the change in bidding behavior. We first assess whether bidders' experienced emotions are indeed related to the type of economic shock.

Economic shocks and emotions. Table 3 shows the intensity scores on the overall emotional state, feeling of control, arousal, and the individual emotions. The first column of the table shows the emotion indicators. The second column gives the average scores of bidders confronted with a positive economic shock, while the third column shows the average scores of bidders confronted with a negative shock. The fourth column shows the difference in scores between these two subgroups of bidders and whether the difference is significant. As can be clearly seen from this table, the intensity of emotions triggered by the two types of economic shocks appear to be significantly different in a number of cases. The following result explicates the cases where significant differences are found (2-sided Mann-Whitney test, with as null hypothesis that the score of emotion indicators do not differ between subjects confronted with a positive and negative economic shock).

Result 2 *Bidders faced with a negative economic shock report a significant worse overall emotional state and less feeling of control than those faced with a positive shock. Furthermore, compared to bidders experiencing a negative economic shock, those experiencing a positive economic shock report significantly more happiness and joy, and significantly less sadness, envy, anger, anxiety, irritation and disappointment.*

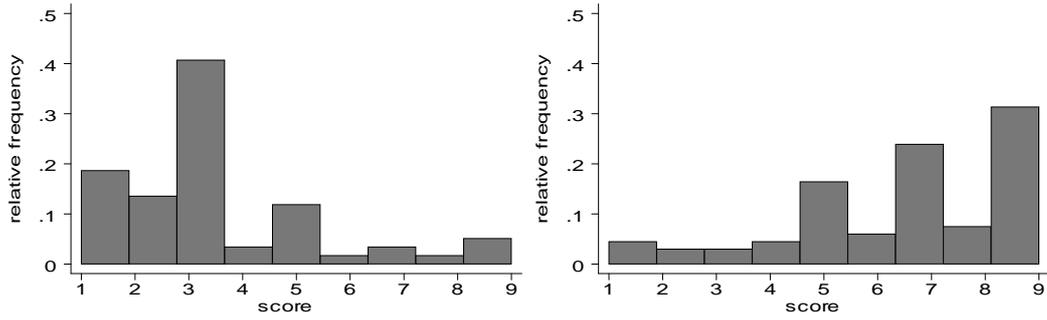
Figure 2 depicts the distribution of scores for the overall emotional state. It nicely shows that bidders who experience a positive economic shock (left panel) report a positive emotional state (scores 1 – 4) more often than bidders who face a negative shock (right panel). For the scores representing a bad emotional state (scores 6 – 9) it is precisely the other way round. For later reference, it is important to note that not all bidders who face a positive shock report a positive emotional state. Similarly, not all bidders who experience a negative economic shock report a negative emotional state. This variation will help us to separate the emotion effect from the economic shock effect and the income effect (see Results 4 and 5 below).

The differences in experienced emotions are also in the predicted direction. Bidders confronted with a positive shock experience positive emotions more intensely and negative emotions less intensely than bidders confronted with a negative shock.

TABLE 3— REPORTED INTENSITY SCORES OF EMOTIONS

emotion	pos. shock	neg. shock	difference
	mean score (st.dev.)	mean score (st.dev.)	
emotional state	3.34 (2.07)	6.64 (2.29)	-3.30**
control	5.49 (1.49)	4.51 (2.15)	0.98**
arousal	5.75 (2.27)	5.54 (2.32)	0.21
sadness	2.32 (1.56)	3.69 (1.93)	-1.36**
happiness	4.44 (1.26)	2.45 (1.45)	1.99**
shame	1.69 (1.22)	2.27 (1.75)	-0.57
fear	1.66 (1.31)	1.85 (1.34)	-0.19
envy	2.12 (1.82)	3.13 (2.01)	-1.02**
hope	4.22 (1.76)	3.70 (1.98)	0.52
anger	2.39 (1.67)	3.60 (1.99)	-1.21**
anxiety	2.22 (1.70)	2.73 (1.67)	-0.51*
joy	4.39 (1.50)	2.42 (1.37)	1.97**
irritation	2.85 (1.94)	4.09 (2.06)	-1.24**
contempt	2.19 (1.69)	2.75 (1.85)	-0.56
surprise	4.00 (1.63)	3.48 (2.00)	0.52
disappointment	2.80 (1.93)	5.00 (1.75)	-2.20**
nervousness	2.29 (1.55)	2.46 (1.63)	-0.17
N	59	67	

Note: ** significance at the 1 percent, and * at the 5 percent; two-sided Mann-Whitney test. The intensity scale for emotional state, feeling of control, and arousal ranges from 1 to 9. The intensity scale for emotions ranges from 1 (no emotion) to 7 (high intensity).



(a) OVERALL EMOTIONAL STATE AFTER POSITIVE SHOCK

(b) OVERALL EMOTIONAL STATE AFTER NEGATIVE SHOCK

FIGURE 2— DISTRIBUTION OF THE SCORES OF THE EMOTIONAL STATE

One might speculate that differences in the emotional states also reflect different experiences during the first 35 auction rounds. We do not deny this possibility but do not find strong indications that this is the case. When looking at the correlation between pre-shock earnings from the first auction series and our emotion measures we only find a marginally significant correlation for the emotion shame (Spearman rank order correlations). We are therefore confident that the economic shocks rather than auction earnings are responsible for the change of the emotional state of bidders.

Before we investigate the relation between emotions and bidding behavior, we take a look at the pairwise correlations between the different emotions (see Table 5 in Appendix A). This table shows that the score of the emotional state is strongly correlated with almost all individual emotion scores in the expected direction (recall, that the higher the score on the emotional state indicator the more negative the emotional state). In particular, the indicator shows a significant negative correlation with feeling of control, happiness and joy, and a significant positive one with sadness, shame, fear, envy, anger, anxiety, irritation, contempt and disappointment ($p < 0.01$ for all correlation statistics, see Appendix A). This leads to the following result.

Result 3 *The score on the overall emotional state is a good indicator because it captures almost all individual emotions.*

Emotions and bidding behavior. Psychological research suggests that positive and negative emotional states are not symmetric with respect to their influence on behavior (see Section 3). For our analysis it seems, therefore, natural to distinguish

between these two emotional states. To this end we create a binary variable based on the overall emotional state score, which is a useful indicator because it captures almost all individual emotions (see Result 3). If the score on this indicator is lower than 5 the emotional state dummy is set equal to 1, representing a positive emotional state. If the score is equal to or higher than 5 the dummy is set equal to 0, representing a negative emotional state.¹³ When categorizing bidders with respect to this indicator we find that 55 are in a positive emotional state, of which 45 experienced a positive economic shock and 10 a negative economic shock. Of the 71 bidders reporting a negative emotional state, 57 experienced a negative economic shock and 14 a positive economic shock. With the help of this emotional state indicator we can get a first indication concerning the effect of the emotional state on bidding behavior.

Result 4 *Compared to part 1 of the auction, bidders who are in a negative emotional state increase their bids significantly in part 2 of the auction, whereas bidders in a positive emotional state do not change their bidding behavior.*

The average estimated slope of the bid function for bidders in a negative (positive) emotional state is 0.790 (0.834) in the first part and 0.820 (0.847) in the second part of the auction.¹⁴ Using a Wilcoxon signed-ranks test, the hypothesis that the estimated slopes are the same in both parts of the auction has to be rejected for bidders in a negative state ($p < 0.001$) but not for bidders who are in a positive state ($p = 0.172$).

Since the differences in slopes of the bid functions between the two auction series is correlated with the slopes in part 1 and to account for the difference in bidding behavior in part 1 with respect to the emotional state, we also look at the percentage change of the estimated slopes. It turns out that the result is robust with respect to this variation. On average, for bidders in a negative emotional state the slope of the bid function increases by four percent and for bidders in a positive state by only two percent. In the former case this change is significant ($p < 0.001$), whereas in the latter case this change is not significantly different from zero ($p = 0.145$).

¹³This distinction between positive and negative emotional state emerges quite naturally from the expressions on the faces in the emotional state item (see appendix C). The results we obtain with this binary variable are robust to some variation in the cut-off point (i.e. an increase or decrease by one unit of the interval where the dummy is set equal to zero).

¹⁴We have to reject the hypothesis that the estimated slopes of bidders in a positive emotional state and those in a negative state do not differ for the first but not for the second series of auctions ($p = 0.016$ and $p = 0.351$, respectively; Mann-Whitney tests, two-tailed).

The above result strongly suggests that the emotional state indeed influences bidding behavior in the second auction series, and that positive and negative emotional states have asymmetric effects on behavior. In the following we further explore the robustness of this result, in particular with respect to earned income in part 1 (cash balance effect). We estimate a probit model with as dependent variable a dummy indicating the direction of change of bidding behavior. It is set equal to one if a subject bids more aggressively in part 2 than in part 1 (that is, when the estimated slope of the bid function in the second part minus the estimated slope in the first part is larger than zero), and zero otherwise. As explanatory variables capturing the affective effects we consider the overall emotional state variable, the individual emotions that are not captured by this variable (these are hope, surprise, and nervousness, which turned out not to be correlated with the overall emotional state variable), arousal, the cash balance after the economic shock in part 1, and gender. To control for the differences in behavior during the first auction series we also include the estimated slope of the bid function in part 1 as an explanatory variable. The following result is obtained.

Result 5 *A bad emotional state significantly increases the likelihood to bid more aggressively in the second auction series. Of other potentially relevant factors only the cash balance (post-shock earnings in the first part of the auction) turns out to have a significant effect.*

Statistical support for this result is provided by the probit estimate shown in Table 4. Significant coefficients are obtained for the emotional state variable ($p = 0.001$) and post-shock earnings ($p = 0.004$) only. The coefficients for both variables are positive. This result shows that, when controlling for other potential factors influencing bidding behavior, the emotional state of a bidder remains a behaviorally important factor. In particular, it shows that the more negative a bidder's emotional state the larger is the likelihood that he or she bids more aggressively in part 2 of the auction. Interestingly, the individual emotion hope has a similar but only marginally significant effect. Total earnings in part 1 also seem to shift bidding behavior towards more competitiveness. Yet, quantitatively the impact is very small. Importantly, the coefficient of the variable capturing bidding behavior in part 1, slope in part 1, has the expected negative sign. The effect is statistically not significant, however.¹⁵

¹⁵We have also run probit estimations where we substitute the post-shock earnings by its constituents, the economic shock per se, the pre-shock earnings from the auction series in part 1, and both variables

TABLE 4— PROBIT ESTIMATE: DETERMINANTS OF LIKELIHOOD TO PLACE HIGHER BIDS IN THE SECOND PART OF THE AUCTION

DEPENDENT VARIABLE: prob. of higher bid				
Independent variables	Coefficient	Std.err.	z-value	p-value
emotional state	0.186	0.0580	3.21	0.001
arousal	0.042	0.0575	0.72	0.471
hope	0.131	0.0710	1.84	0.065
surprise	0.016	0.0741	0.21	0.832
nervousness	-0.095	0.0828	-1.15	0.252
post-shock earnings	0.001	0.0003	2.94	0.003
gender	0.164	0.2865	0.57	0.566
slope in part 1	-2.079	1.2781	-1.63	0.104
constant	-0.061	1.2182	-0.05	0.960
N = 126				
LR $\chi^2_{(8)} = 20.44$				
Prob > $\chi^2 = 0.009$				
Pseudo $R^2 = 0.12$				
Log L = -71.90				

The coefficient of the intercept is negative but not significant. This seems to be in contrast to the finding that more experienced bidders have a tendency to place higher bids (Kagel, 1995). Our finding that the cash balance effect is positive seems to be at odds with the result found by Ham et al. (forthcoming). These authors introduce small earning shocks in each auction round in order to separate a cash balance effect from an experience effect. They find that the cash balance is negatively related to the bid and that the level of bids increases over time. They conjecture that bidders enter the auction with some target earnings in mind. During the auction bidders realize that they must win the auction in order to meet their targets, which makes them place higher simultaneously, respectively. In all these specifications the emotional state variable indicator remains significantly positive at least at the 5 percent level.

Additionally, we have also run an OLS-regression with the difference in slopes of the estimated bid functions between part 2 and part 1 as independent variable, and the same set of explanatory variables as in the reported probit estimates. It turns out that the signs of the explanatory variables are the same as those reported in Table 4. The coefficient of the emotional state indicator loses its significance, however. The only significant variable is the slope of the bidding function in part 1. Together the probit and OLS regressions indicate that the emotional state can explain the direction of change in bidding behavior but not the magnitude of this change.

bids (learning/adjustment effect). However, when during the auction cash balances increase, bidders come closer to their targets and allow themselves to take a chance of a higher profit by lowering their bids.

When we do not control for the influence of emotions, we also observe a positive experience effect (Result 4). However, when we do take the emotions into account this experience effect vanishes. The cash balance has a significantly positive effect, although it is very small (Result 5). A possible, admittedly speculative, explanation reconciling these seemingly contradictory findings is that in the experiment of Ham et al. it is actually not the cash balance and experience per se which influence bidding behavior but rather the emotional state of bidders. To see this, suppose that bidders indeed have an earnings target in mind when they enter the auction. From a psychological point of view it then seems likely that if this target cannot be reached this will have a negative impact on the emotional state of a bidder. If, on the other hand, the target is met or even improved upon this will have a positive emotional impact.

5 Summary and conclusion

The main research question of this paper is whether emotions are important for economic decision-making in a competitive environment, namely a first price auction. The answer is affirmative. Firstly, we find that random economic shocks influence the emotional state of bidders. Secondly, and more importantly, we find that the emotional state of bidders is related to their bidding behavior. In particular, we find that bidders who are in a negative emotional state have a significantly higher likelihood to place higher bids, while bidders in a positive emotional state do not change their bidding behavior. In other words, negative feelings evidently induce more aggressive bidding behavior. It is thus not the economic shock per se that changes bidding behavior but the emotional state of bidders, which is influenced by this shock. Of other potentially relevant factors only the cash balance turns out to be important as well.

Our findings show that for a good understanding of bidder behavior the emotional component has to be taken into account. For optimal auction design, this means that not only parameters controlling for strategic behavior, like opening bid and hidden reserve price (see Bapna et al., 2003), but also non-strategic or ‘emotional’ responses have to be considered. This seems to be of particular importance for business-to-consumer auctions with a relatively large number of non-professional and inexperienced bidders.

A field study by Roth and Ockenfels (2002) suggests that non-strategic forces seem to be at work also in real world auctions. They investigate the phenomenon of late bidding ('sniping') in Internet auctions and argue that part of this behavior can be attributed to non-rational factors. Similarly, in a field study Malhotra and Murnighan (2001) attribute (too) late bidding to "competitive arousal". Warnings from business professionals like "bidders may get (...) caught up in the emotion of the race of competition" and "(...) competitive emotion overshadowed good business judgement" (Smeltzer and Carr, 2002) also illustrate the potential importance of emotions in bidding.

An experiment has the advantage that one can isolate the emotion effect from other factors that potentially influence bidders' behavior. Although, this leads to a very stylized experimental design it offers the possibility for extensions into various directions. Future research might include human competitors instead of robot-traders, experienced versus inexperienced bidders, and deal with other auction formats (e.g., second-price auctions) or market forms.

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A Correlations between emotion indicators

TABLE 5— PAIR WISE CORRELATIONS BETWEEN EMOTION INDICATORS

Emotion	emotional state	control	arousal	sadness	happiness	shame	fear	envy
emotional state	1.00							
control	-0.52 (0.00)	1.00						
arousal	-0.11 (0.23)	-0.06 (0.51)	1.00					
sadness	0.60 (0.00)	-0.47 (0.00)	-0.09 (0.30)	1.00				
happiness	-0.74 (0.00)	0.47 (0.00)	0.10 (0.28)	-0.56 (0.00)	1.00			
shame	0.39 (0.00)	-0.33 (0.00)	0.10 (0.29)	0.34 (0.00)	-0.30 (0.00)	1.00		
fear	0.29 (0.00)	-0.31 (0.00)	-0.08 (0.40)	0.33 (0.00)	-0.19 (0.03)	0.39 (0.00)	1.00	
envy	0.48 (0.00)	-0.38 (0.00)	-0.02 (0.80)	0.54 (0.00)	-0.47 (0.00)	0.29 (0.00)	0.36 (0.00)	1.00
hope	-0.09 (0.31)	0.05 (0.58)	0.16 (0.08)	0.05 (0.58)	0.24 (0.01)	-0.01 (0.95)	0.11 (0.22)	0.07 (0.47)
anger	0.52 (0.00)	-0.41 (0.00)	-0.08 (0.38)	0.57 (0.00)	-0.51 (0.00)	0.40 (0.00)	0.23 (0.01)	0.70 (0.00)
anxiety	0.30 (0.00)	-0.28 (0.00)	0.06 (0.53)	0.48 (0.00)	-0.25 (0.01)	0.43 (0.00)	0.64 (0.00)	0.39 (0.00)
joy	-0.71 (0.00)	0.42 (0.00)	0.09 (0.30)	-0.54 (0.00)	0.81 (0.00)	-0.25 (0.01)	-0.18 (0.05)	0.42 (0.00)
irrit	0.56 (0.00)	-0.25 (0.00)	-0.18 (0.04)	0.54 (0.00)	-0.46 (0.00)	0.29 (0.00)	0.22 (0.02)	0.57 (0.00)
contem	0.40 (0.00)	-0.16 (0.08)	-0.12 (0.19)	0.51 (0.00)	-0.34 (0.00)	0.42 (0.00)	0.34 (0.00)	0.66 (0.00)
surprise	0.02 (0.87)	-0.04 (0.67)	-0.07 (0.43)	0.04 (0.67)	0.06 (0.52)	0.26 (0.00)	0.25 (0.01)	0.17 (0.06)
disap	0.72 (0.00)	-0.41 (0.00)	-0.11 (0.21)	0.59 (0.00)	-0.56 (0.00)	0.24 (0.01)	0.16 (0.08)	0.53 (0.00)
nervous	0.14 (0.11)	-0.22 (0.01)	0.01 (0.91)	0.26 (0.00)	-0.05 (0.59)	0.30 (0.00)	0.36 (0.00)	0.22 (0.02)

Emotion	hope	anger	anxiety	joy	irrit	contem	surprise	disap	nervous
hope	1.00								
anger	-0.04 (0.67)	1.00							
anxiety	0.21 (0.02)	0.39 (0.00)	1.00						
joy	0.25 (0.00)	-0.41 (0.00)	-0.24 (0.01)	1.00					
irrit	-0.06 (0.54)	0.72 (0.00)	0.34 (0.00)	0.45 (0.00)	1.00				
contem	0.06 (0.54)	0.66 (0.00)	0.40 (0.00)	0.29 (0.00)	0.64 (0.00)	1.00			
surprise	0.28 (0.00)	0.20 (0.03)	0.27 (0.00)	0.05 (0.57)	0.16 (0.08)	0.23 (0.01)	1.00		
disap	0.04 (0.63)	0.60 (0.00)	0.29 (0.00)	0.58 (0.00)	0.60 (0.00)	0.42 (0.00)	0.17 (0.06)	1.00	
nervous	0.07 (0.43)	0.30 (0.00)	0.46 (0.00)	0.05 (0.60)	0.26 (0.00)	0.28 (0.00)	0.28 (0.00)	0.18 (0.04)	1.00

Note: p-values in parentheses.

B Instructions

The experiment of today consists of two parts. You can earn money in both parts. The amount you earn depends, among other things, on your own decisions. Both parts are independent of each other. This means that your earnings in part 1 do not influence your earnings in part 2, and vice versa. Your total earnings in the experiment will be paid out to you privately at the end. This means that other participants will not know how much money you earn in the experiment. You will see the instructions of the experiment presently. If part 1 has been finished, part 2 will start. You will receive the instructions of part 2 when part 1 has been finished. If you have a question during the experiment, please raise your hand. One of us will come to you to answer your question. You ought to be quiet during the experiment and refrain from communicating with others.

Part 1

The first part of the experiment consists of 35 rounds. You are a buyer in a market with four other buyers during all 35 rounds. The other buyers are not participants but computerized buyers. In each round you can bid on a fictitious good. The value that this fictitious good has for you will be determined randomly in each round. The computer system randomly selects a number from 0 up to and including 500. This number represents the value of the fictitious good in cents. Each number from 0 up to and including 500 has an equal chance of being selected. For each buyer in the market, thus also for the computerized buyers, a value is drawn independently. This means that your value and all of the values of the computerized buyers are nearly always different. These values are private and will not be known by other buyers. The value of the fictitious good can be seen as the price at which you can sell the good. You thus receive a new value in each round and can bid on the good a single time. You can only bid in whole cents. If your bid is the highest bid, you buy the good at the price that you bid. Your profit is equal to the difference between your value and the price that you paid.

$$\text{Profit} = \text{Value} - \text{Price}$$

If your bid is not the highest, you earn nothing. If two or more buyers have placed the same highest bid, one buyer will be randomly selected to buy the fictitious good.

Suppose your value is 450 cents. It is not possible to place a bid that is higher than your value. You bid 300 and have the highest bid. In this case your profit is equal to $450 - 300 = 150$ cents (1.5 guilders). Suppose your bid is not the highest. In that case you earn nothing.

The four computerized buyers with whom you are in the market always bid according to a fixed rule. They are programmed to bid always $4/5$ of their value. Note, that in each round a value from 0 up to and including 500 is randomly drawn for each computerized buyer separately. During the 35 rounds you do not get any information about the bids of the computerized buyers. You also do not get any information about which bid is the highest or how much profit you have made. When the 35 rounds are over, you will receive information about your profit per round and total profit over all rounds.

Before the 35 rounds start, you can first bid in a number of practice rounds. You cannot earn money in these practice rounds. Their purpose is make you conversant with the bidding procedures. In contrast to the real 35 rounds, you do receive information in each round about your profit during the practice rounds. When the practice rounds have been finished, you again have the opportunity to ask questions. Subsequently, the 35 rounds will start where you can earn money.

Earnings part 1

Your earnings of part 1 are determined by a procedure with the total profit you have made in all 35 round as a starting point. This procedure will be explained after the practice rounds.

If you have a question at this moment, please raise your hand. If there are not any question, the practice rounds will start instantly.

[subjects do practice rounds]

Before the 35 rounds start where you can earn money, information about the procedure used to determine your earnings of part 1 will be given. This procedure takes as a starting point your total profit over the 35 rounds. After these 35 rounds, each participant will be asked to throw a die individually a single time under supervision. If the die shows an even (2, 4, or 6) number, your total profit will be multiplied with factor two and you will receive an extra of 10 guilders. If the die shows an uneven (1, 3, or 5) number, your total profit will be divided by two.

Finally, it is noted that during the 35 rounds you do not receive any information about your profit per round. When the 35 rounds are over, you will receive information about your profit per round and total profit over all rounds.

[subjects do part 1]

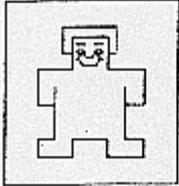
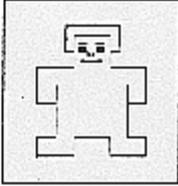
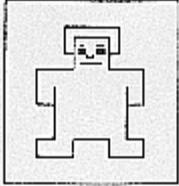
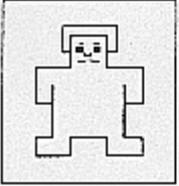
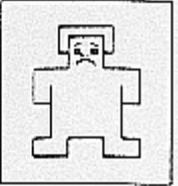
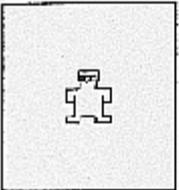
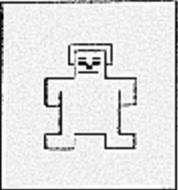
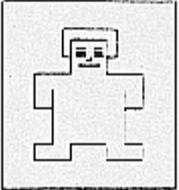
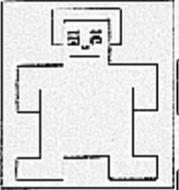
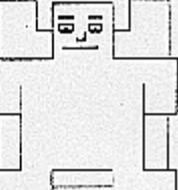
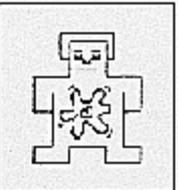
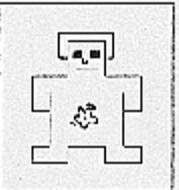
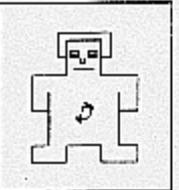
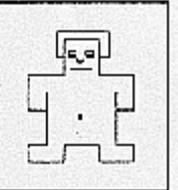
Part 2

Part 2 of the experiment will start instantly. Part 2 is exactly the same as part 1 of the experiment. You are again a buyer in a market with four other, computerized, buyers. Again, there are 35 rounds where you can bid on the fictitious good. The value of the fictitious good for each buyer is randomly drawn from 0 up to and including 500. Your earnings of part 2 of the experiment will be determined by the same procedure as in part 1. This means that after 35 rounds, you again ought to throw a die. If the die shows an even (2, 4, or 6) number, your total profit of part 2 will be multiplied with factor two and you will receive an extra of 10 guilders. If the die shows an uneven (1, 3, or 5) number, your total profit of part 2 will be divided by two. When part 2 has been finished, you will again be asked to fill out a short questionnaire. Subsequently, subjects are paid and the experiment ends. In part 2 there not any practice rounds. When the 35 round start, you can immediately earn money. Note that you will receive information about profit per round and total profit over all rounds when the 35 rounds are over.

C Emotions and mood questionnaires

Mood questionnaire (translated from Dutch)

How do you feel at this moment? Choose in each row below with the help of the figures the number that best describes how you currently feel (choose one number in each row).

								
1	2	3	4	5	6	7	8	9
								
1	2	3	4	5	6	7	8	9
								
1	2	3	4	5	6	7	8	9

Emotion questionnaire (translated from Dutch)

We would like to have some information about how you feel at this moment. We ask you to go through the following list of emotion names. Subsequently, we ask you to report the intensity of each emotion you experience at this moment.

Sadness:	Not at all	<input type="checkbox"/>	Very intense
Happiness:	Not at all	<input type="checkbox"/>	Very intense
Shame:	Not at all	<input type="checkbox"/>	Very intense
Fear:	Not at all	<input type="checkbox"/>	Very intense
Envy:	Not at all	<input type="checkbox"/>	Very intense
Hope:	Not at all	<input type="checkbox"/>	Very intense
Anger:	Not at all	<input type="checkbox"/>	Very intense
Anxiety:	Not at all	<input type="checkbox"/>	Very intense
Joy:	Not at all	<input type="checkbox"/>	Very intense
Irritation:	Not at all	<input type="checkbox"/>	Very intense
Contempt:	Not at all	<input type="checkbox"/>	Very intense
Surprise:	Not at all	<input type="checkbox"/>	Very intense
Disappointment:	Not at all	<input type="checkbox"/>	Very intense
Nervousness:	Not at all	<input type="checkbox"/>	Very intense

If you believe that one or several other emotion words describe your experience better, please report these words and intensities below:

.....:	Not at all	<input type="checkbox"/>	Very intense
.....:	Not at all	<input type="checkbox"/>	Very intense
.....:	Not at all	<input type="checkbox"/>	Very intense