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

Ronald Bosman† and Arno Riedl‡

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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.

JEL Classification Number: A12, C72, C91, C92

Keywords: auction, economic shock, emotion, experiment

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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 the market? 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'. As a consequence of these words, stock markets dropped considerably. Although one may simply view Greenspan's words as evidence for tighter monetary policy, Shiller (2000) claims that the reaction to these words "reflects the public's concern that the markets may indeed have been bid up to unusually high and unsustainable levels under the influence of market psychology (pp. 3-4)". He further 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 his claim that emotions are an important factor.

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 deal with either bargaining or social dilemma situations (see also section 2 where we shortly discuss this evidence).

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

[2] Some 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. See also Caplin and Leahy (2001) who incorporate anxiety into expected utility models. Finally, Thaler (2000, p. 139) predicts that in the future "Homo Economicus will become more emotional".

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

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 online 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

[3]Lucking-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 webpage transactions worth \$14.87 billion in annualized gross merchandise sales for 2002.

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 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 discussion.

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

[4]Because 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).

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.

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). The idea is that people who are in a positive emotional state want to maintain that state (mood maintenance hypothesis). Some 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 (i.e. negative feelings) 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 because individuals are willing 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. (2000) 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. In another earlier experiment, Pilltutla and Murnighan (1996) investigate rejections in an ultimatum game. They find that intentional low offers trigger feelings of anger and wounded pride and ultimately spiteful behavior. Finally, we mention a video experiment by Hennig-Schmidt (1999) suggesting that emotions play a crucial role in breaking up group bargaining.

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 other students came from various fields such as chemistry, psychology, and mathematics. Subjects received a show-up fee of 5 Dutch guilders (approximately 2 USD), independent of their earnings in the experiment. On average, subjects earned 27 Dutch guilders (approximately 11 USD) 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 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]

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

Table 1 — Sequence of events

0.	General information → experiment consists of two parts
	PART 1
1.	Instructions for part 1 ONLY → 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 computerized bidders are programmed to bid according to the risk-neutral Nash equilibrium strategy. It is important to note that 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. Subjects do not get any feedback during these 35 bidding rounds, except for 5 practice rounds where they receive information about whether they have won the auction or not, and their profit. Since our focus is on the effect of emotions - via an exogenous economic shock - on bidding behavior we have decided to give subjects no feedback in order to avoid learning and disturbances of the emotional state over the auction rounds.[7]

Before subjects start the 35 bidding rounds, we also give them information about the procedure determining their earnings of part 1 of the experiment. This procedure entails that with a 50 percent chance all their profits are multiplied with factor two

[6]Subjects 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.

[7]Emotional disturbances over the rounds may arise when subjects know whether or not they won in a particular auction round. 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).

and supplemented with an additional amount of 10 guilders (positive economic shock), and with a chance of 50 percent all their profits are divided by two (negative economic shock).[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. To assess the emotions subjects experience after part 1, 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 includes the following emotions:[9] 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. Before we measure individual emotions we 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.[10] 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.

[8]To determine to outcome of this procedure, we ask subjects individually to throw a die under supervision of the experimenter. Further, note that the positive shock, in contrast to the negative shock, includes a lump sum payment of 10 guilders. We have chosen this lump sum payment to assure that a positive shock has also economic consequences for those bidders that earn relatively little in the auction.

[9]The order of emotion names here is the same as in the questionnaire (see Appendix C).

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

Although assessing emotions with the help of self-reports may seem problematic, emotion theorists see it is 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".

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 question, which becomes particularly relevant if bidding behavior changes over the two parts of the experiment, is whether and, if so, how the emotional state affects bidding. Although the psychological evidence that we discussed in the previous section does not deal with auctions, it suggests the following. First, positive and negative emotions can affect behavior in asymmetric ways. Second, different negative or positive emotions can have different effects on behavior. Since our measurement comprises a variety of emotions, the experiment could be informative in this respect as well.

Besides emotions, other factors, in particular 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. Thereafter, we investigate the impact of the economic shock on emotions. Finally, we analyze how the emotional state affects bidding behavior.

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

$$b_{it} = \alpha_i + \beta_i v_{it} + \epsilon_{it},\ i = 1, ..., 126,\ t = 1, ..., 35 \tag{4.1}$$

where t is the auction round, and α_i and β_i are the parameters to be estimated.[11] 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). To estimate the bid functions we therefore use values in the interval $[50, 400]$.[12]

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).[13]

[11] In 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).

[12] A similar approach is used by Isaac and James (2000) and Ham et al. (forthcoming). For the sake of completeness we have also run regressions based on all values. Most results also hold when using these regressions. If we find a difference it is mentioned when presenting the result.

[13] 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 bids do not differ between subjects who face a positive and negative shock in part one. This is a rather surprising result for which we have no explanation.

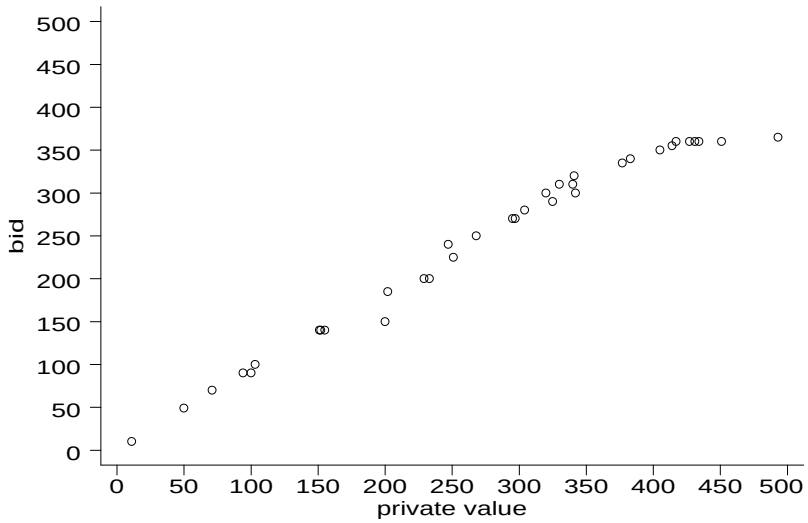


FIGURE 1 — AN EXAMPLE OF INDIVIDUAL BIDDING BEHAVIOR
(SUBJECT 1, SESSION 1, PART 1)

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	3.661	10.874	0.809	0.840	0.782
	(16.709)	(13.900)	(18.282)	(0.099)	(0.073)	(0.111)
part 2	7.069	4.701	9.147	0.832	0.858	0.809
	(19.964)	(12.573)	(24.629)	(0.107)	(0.076)	(0.124)
N	126	59	67	126	59	67

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

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 the robot-traders. (For the anchoring effect cf. Tversky and Kahnemann, 1974). We are mainly interested in the change of behavior between part 1 and part 2, and its possible relation with the economic shock and the emotions induced by the shock. Therefore, 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 ($p = 0.935$).[14] 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 ($p < 0.001$). In this respect, there is also 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 ($p = 0.0114$).[15] We summarize these findings in our first result.

Result 1 *Compared to part 1 of the auction all bidders place significantly higher bids in part 2 of the auction. This change in behavior is independent of the economic shock.*

The interesting question now is why bidders have changed their behavior. 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 shocks may influence the emotional state of bidders, and through this channel, 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 individual emotions. The first column of the table shows the emotion indicators. The second column gives the average scores

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

[15] When 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).

TABLE 3 — REPORTED INTENSITY SCORES OF EMOTIONS

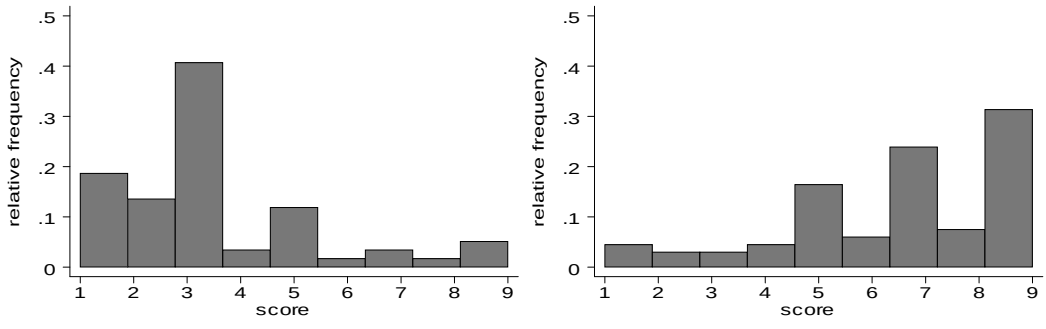
emotion	pos. shock mean score (st.dev.)	neg. shock mean score (st.dev.)	difference
emotional state	3.34	6.64	−3.30**
	(2.07)	(2.29)	
control	5.49	4.51	0.98**
	(1.49)	(2.15)	
arousal	5.75	5.54	0.21
	(2.27)	(2.32)	
sadness	2.32	3.69	−1.36**
	(1.56)	(1.93)	
happiness	4.44	2.45	1.99**
	(1.26)	(1.45)	
shame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

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 shows 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 negative 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 $1-4$) much 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. Note also 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 bad emotional state.



(a) Overall emotional state after positive shock

(b) Overall emotional state after negative shock

Figure 2 — Distribution of the scores of the emotional state

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. We conclude that economic shocks have important affective consequences.

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. We create a binary variable based on the overall emotional state score, which turns out to be a useful indicator because it captures almost all individual emotions (see Result 3). If the score on this indicator is lower than 5 the state dummy is set equal to one, 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.[16] The following result summarizes 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.*

[16]This 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).

The average estimated slope of the bid function for bidders in a negative (positive) emotional state is 0.7896 (0.8337) in the first part and 0.820 (0.847) in the second part of the auction.[17] 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 ($p = 0.172$). 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 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 ($p = 0.145$).

This result seems consistent with the observation of psychologists that positive and negative emotional states have asymmetric effects on behavior. In the following, we further explore this asymmetric effect. In particular, we investigate its robustness with respect to income (cash balance) and those emotions that are not captured by the overall emotional state indicator. To this end, we estimate a probit model with as dependent variable a dummy indicating the direction in which bidding behavior changes. It is set equal to one if a subject bids more aggressively in part 2 than in part 1 (that is, when the slope of the estimated bid function in the second part minus the estimated slope in the first part is larger than zero), and zero otherwise. As explanatory variables we consider again the overall emotional state, the emotions that are not captured by this indicator (hope, surprise, and nervousness), arousal, the cash balance after the economic shock in part 1, and gender. The following result is obtained.

Result 5 *In addition to the emotional state only the post-shock earnings in the first part of the auction significantly affect the likelihood that a bidder will place higher bids in the second part of the auction.*

This result is supported by the probit estimate shown in Table 4. Significant results are obtained for the emotional state indicator ($p = 0.001$) and post-shock earnings ($p = 0.004$) only. The coefficients for both variables are positive.[18] Result 5 shows that

[17] We 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).

[18] When using the slopes based on estimations taking the whole interval of possible private values into account the coefficient for the emotional state indicator stays significantly positive. Post-shock earnings, however, become insignificant. All other variables stay insignificant.

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	0.193	0.0570	3.387	0.001
arousal	0.052	0.0563	0.923	0.356
hope	0.111	0.0689	1.607	0.108
surprise	0.023	0.0725	0.322	0.747
nervousness	−0.092	0.0819	−1.123	0.262
post-shock earnings	0.001	0.0003	2.910	0.004
gender	0.089	0.2801	0.317	0.752
constant	−1.756	0.6467	−2.716	0.007
N = 126				
LR $\chi^2_{(7)} = 17.76$				
Prob $> \chi^2 = 0.013$				
Pseudo $R^2 = 0.11$				
Log L = -73.24				

the more negative a bidder's emotional state or the higher the total earnings in part 1 the larger the likelihood that he or she will bid more aggressively in part 2 of the auction.[19] Note, however, that the impact of the cash balance is relatively small.

The coefficient of the intercept is significantly negative indicating that ceteris paribus more experienced bidders have a tendency to lower their bids. This seems to be in con-

[19] We have also run probit estimations where we substitute the post-shock earnings by its constituents, the economic shock per se and the earnings from the auction series in part 1. With this specification we find that the emotional state indicator remains significantly positive ($p = 0.008$). The two new variables are significantly positive at the 10 percent level. All other variables stay insignificant. Additionally, we have also run an OLS-regression with the difference in slopes of the estimated bid functions between part 1 and part 2 as independent variable, and the same set of explanatory variables as in Result 5. 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 is marginally significantly positive. All other coefficients, with the exception of the intercept (which is marginally significantly negative), are not significantly different from zero. In our view, this indicates a non-linear relationship between the independent variable and the explanatory variables.

trast 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 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 the experience effect becomes negative. The cash balance has a significant positive effect, although it is very small (Result 5). A possible, admittedly speculative, explanation reconciling these 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 discussion

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 place significantly 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 changes in subjects' emotions

due to the shock. Of other potentially relevant factors such as gender, cash balance and experience, the latter two turn 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 causes. Furthermore, warnings from business professionals like "bidders may get so caught up in the emotion of the race or competition that they offer unreasonable low prices" and "(...) the competitive emotion overshadowed good business judgement" (Smeltzer and Carr, 2002) nicely illustrate the potential importance of emotions in bidding. Actually, such warnings seem justified as shown by the field study of Malhotra and Murnighan (2001) who attribute (too) late bidding to "competitive arousal".

An experiment has the advantage that one can isolate the emotion effect from other factors that potentially influence bidders' behavior. Naturally, this leads to a very stylized experimental design, which however 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. While emotions may affect behavior differently in different settings we have shown an important point with the help of a simple experimental design: emotions influence behavior of economic agents in a non-trivial way, even in competitive environments as first-price auctions.

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

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

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.

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

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.

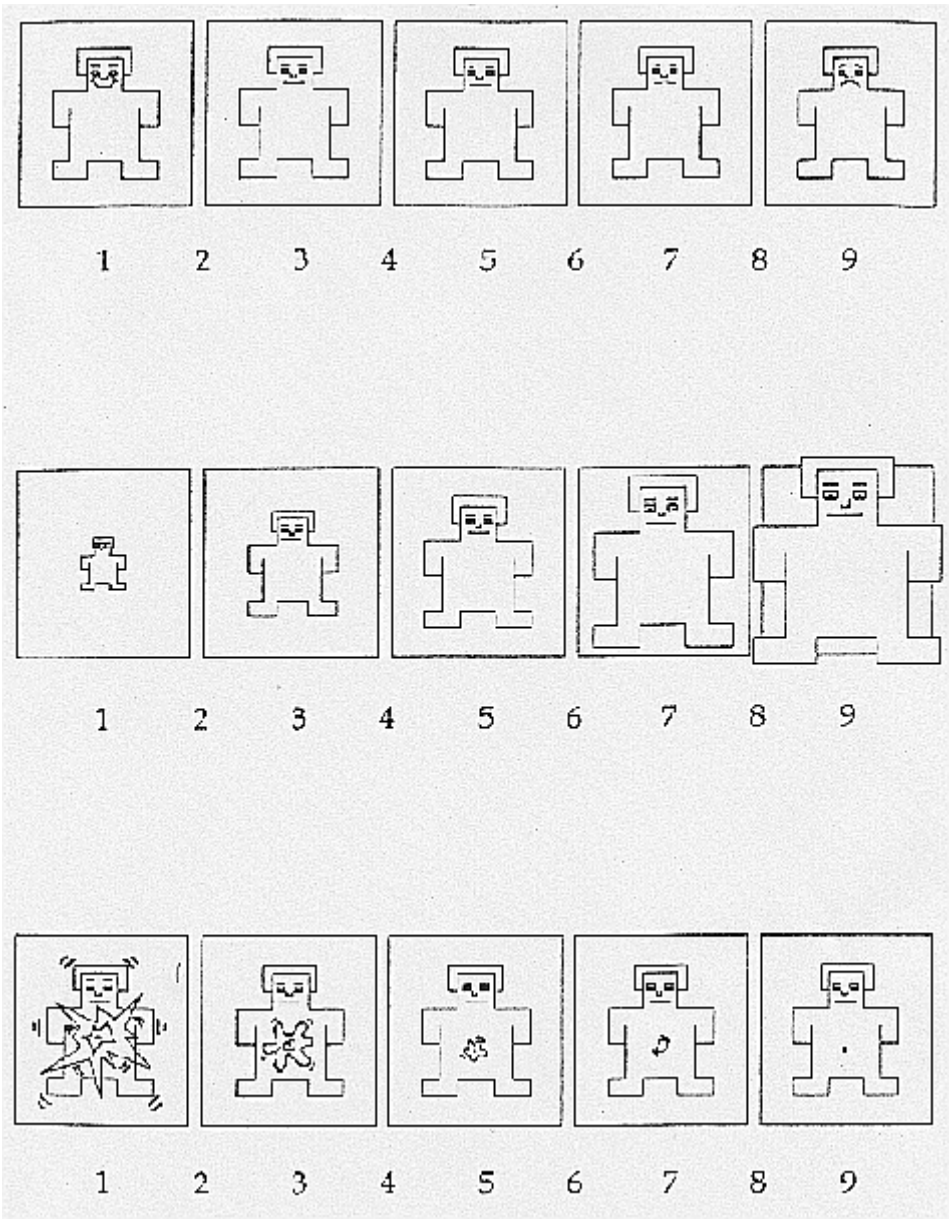
[subjects do part 1]

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).



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	⌊|||||||⌋	Very intense
Happiness:	Not at all	⌊|||||||⌋	Very intense
Shame:	Not at all	⌊|||||||⌋	Very intense
Fear:	Not at all	⌊|||||||⌋	Very intense
Envy:	Not at all	⌊|||||||⌋	Very intense
Hope:	Not at all	⌊|||||||⌋	Very intense
Anger:	Not at all	⌊|||||||⌋	Very intense
Anxiety:	Not at all	⌊|||||||⌋	Very intense
Joy:	Not at all	⌊|||||||⌋	Very intense
Irritation:	Not at all	⌊|||||||⌋	Very intense
Contempt:	Not at all	⌊|||||||⌋	Very intense
Surprise:	Not at all	⌊|||||||⌋	Very intense
Disappointment:	Not at all	⌊|||||||⌋	Very intense
Nervousness:	Not at all	⌊|||||||⌋	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	⌊|||||||⌋	Very intense
.....:	Not at all	⌊|||||||⌋	Very intense
.....:	Not at all	⌊|||||||⌋	Very intense