AUA Working Paper Series No. 2010-2
February 2010

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The role of training in experimental auctions

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Abstract: In this paper we examine the role of providing extensive training to subjects in the context of experimental auctions. We conducted an experiment where we auctioned several lotteries with varying payoffs. One group of subjects was extensively trained while another group of subjects was only minimally trained. We find that subjects in the extensive training treatment, were submitting bids significantly higher than subjects in the minimal training treatment, suggesting that subjects without proper training may underreport their WTP.

1 Introduction

Experimental auctions have become a popular tool used by applied economists to elicit people's willingness to pay (WTP) for certain goods due to their demand revealing properties. They are considered demand revealing because of the theoretically incentive compatible nature of the auction mechanisms; that is subjects have the dominant-strategy in these mechanisms to reveal their true valuation of the goods. Participating in experimental auctions is, however, often a dubious task for unfamiliar subjects. While most subjects are probably familiar with the structure of an English auction, they most likely have never participated in a Vickrey auction or a Becker-DeGroot-Marshack mechanism typically used in experimental auctions. This is the reason why most experimenters employ a training phase that precedes the actual valuation task. The received wisdom is that subjects need to abandon market-like heuristics, like the well known strategy of "buying low", before they enter the auction. In addition, the incentive compatibility of the auction is not apparent and usually has to be demonstrated before the valuation task.

The training phase is an important component of experimental auction studies since there is considerable evidence from Vickrey auctions and induced value experiments that subjects need some time and practice to learn the dominant-strategy in these auctions (Harrison 2006). The purpose of any training procedure should then be to clear out any misconceptions about the mechanism that would prevent elicitation of true homegrown values and/or prevent strategic manipulation. There is however no unanimous acceptable training procedure applied. The training procedures used are normally applied almost mechanically and usually include some hypothetical auction rounds and/or real auction rounds with fictitious or test products, demonstration of the incentive compatibility of the auction, short quizzes on the mechanism, etc. Plott and Zeiler (2005) demonstrated that the WTP-WTA gap disappeared when they applied the union of the procedures that appeared in the literature, before proceeding to the elicitation of WTP and WTA. The complete set of controls included an incentive compatible elicitation device, training, paid practice, and anonymity.

The literature, however, is short of studies that report on the effect of subjects' training on bid behavior. In this paper, we examine this important issue by testing whether the amount of training actually makes a difference on subjects' bidding behavior. We report results from an experiment with two treatments: In one treatment subjects were provided with extensive training by demonstrating to them the incentive compatible property of the auction, were given quiz tests, participated in hypothetical as well as real auction rounds and questions were encouraged throughout the session. In the second treatment, the minimal training treatment, subjects only participated in hypothetical rounds with fictitious products. Subjects in both treatment then participated in 10 repeated auction rounds. The products were six different lotteries with varying payoffs. In addition, since posting of market clearing prices remains an open debate (see Corrigan et al., 2009, for an attempt to settle the issue), we extended the experimental design to accommodate two additional treatments: posting of market clearing prices vs. no-posting.

The following sections include the description of the experimental design, our econometric analysis, experimental results and concluding remarks.

2 The experiment

2.1 Description of the experiment

We conducted a conventional lab Vickrey auction experiment using the z-Tree software (Fischbacher 2007). Subjects consisted of undergraduate students at the Agricultural University of Athens in Greece. As mentioned earlier, a between-subject 2x2 design was adopted varying the extent of training (minimal vs. extensive training) and posting of market clearing prices (posting vs. no posting of the 2nd highest price). Each subject participated in only one treatment. The size of the groups varied from 17 to 18 subjects per treatment. Each treatment lasted no more than an hour. In total, 71 subjects participated in our experiments, which were conducted in March 2009.

Each session included four phases: the training phase, the choice phase, the lottery auction phase and the post-auction phase. Subjects were given prior instructions on the overall layout of the session and were also reminded about the procedures at the beginning of each phase.

2.2 The training phase

A 2nd price Vickrey auction was used to elicit subjects' values for lotteries. After arriving at the lab, subjects were randomly assigned to a computer. Subjects were given fifteen Euros (15€) as a participation fee at the end of the experiment. We emphasized that the 15€ was theirs to use as they please and that they should think that they have this money already. To control for possible monetary endowment effects, subjects were also told that a random amount of money between 0.5€ and 3€ was going to be assigned to each one of them. Everyone then received a random draw determining their individual-specific extra fee, which was added to their participation fee as soon as the computerized phase of the experiment began. We emphasized to the subjects that the endowment they received was private information and that they should not communicate this information to other subjects in the lab. All transactions were completed at the end of the experiment. No information about this additional endowment was given during recruitment.

Subjects in the extensive/full training treatment were given a short presentation to familiarize them with the auction and procedures. All instructions were in PowerPoint and were projected onto a screen in the front of the lab. The instructions emphasized that the participants should not communicate with each other. Subjects were given a short introduction on how the 2nd price Vickrey auction works, a short example on how bids are sorted in a descending order and on how the 2nd highest bid and the highest bidder are selected. In addition, a numerical example was given to demonstrate the incentive compatibility of the auction. Subjects then took a short computerized test which tested their comprehension of instructions. The correct answers were presented on their screen after everyone completed the test. The questions and the correct answers were read aloud and explained to subjects as well.

The first part of the training included five *hypothetical* multi-product[1] auction rounds. We emphasized to the subjects that these rounds were intended to familiarize them with the auction procedure and although they would not have to pay any money to buy any product, they should bid as if they were in a real auction and as if they really intended to buy the product. We also told them that one round and one product would be randomly chosen at the end of these rounds as binding. A screen with subjects' hypothetical payoffs was displayed after these rounds.

In the second part of the training, we included five *real* multi-product[2] auction rounds. We emphasized to the subjects that these rounds were real and that if they chose to buy a product, they would actually have to pay for it. Similar to the previous hypothetical rounds, one round and one product were randomly chosen as binding at the end of these rounds. A screen with subjects' payoffs was displayed after these rounds.

Subjects who participated in the minimal training treatment were not exposed to the full training described above. Subjects in the minimal training treatment were not provided with a numerical example on how a 2[nd] price auction works, were not given a computerized test and were not explicitly informed about the incentive compatible property of the auction. They also participated only in the *hypothetical* rounds, not in the *real* ones.

2.3 The choice phase

After the training phase, a phase where subjects chose between lotteries was performed. We asked subjects to indicate their preference for each of three pairs of lotteries with the understanding that each choice has an equal chance of being randomly selected as binding. Subjects were also informed that at the end of the choice phase and the lottery auction phase, a randomly generated number would determine which of the two phases would be selected as binding. During the training phase, subjects were shown numerical examples on exactly how their lottery payoffs would be determined.

The three pairs of lotteries with their corresponding chances and expected payoffs are exhibited in Table 1. To avoid an order effect, bet pairs and lotteries in

[1] The products were a packet of gums, a bag of cookies and a bag of potato chips.
[2] The products we used were a Tobleron chocolate, a pack of Soft Kings cookies and Kraft's Lacta chocolate.

each pair were randomly shown on each subject's screen and thus were presented to each subject in different order.

Table 1. Lotteries used in the experiment

Lottery	Bet type	Bet pair	Probability of win	Amount of win	Probability of loss	Amount of loss	Expected payoff
A	P-bet	1	90%	4	10%	1	3.50
B	$-bet		28%	16	72%	1.5	3.40
C	P-bet	2	80%	3	20%	1	2.20
D	$-bet		24%	12	76%	1	2.12
E	P-bet	3	75%	2	25%	1	1.25
F	$-bet		18%	9	82%	0.5	1.21

Bet pairs 1 and 3 were adopted from Cox and Grether (1996). Bet pair 2 was added as a medium expected payoff category to the high and low expected payoff lotteries of Cox and Grether. Notice that for bet pair 1, the bad outcome for the $-bet is worse than that for the P-bet[3]. The opposite is true for bet pair 3, while for bet pair 2, the bad outcomes are equal.

2.4 The auction phase

In the auction phase, we presented subjects with the same six lotteries shown in table 1 and then asked subjects to indicate how much they would be willing to pay to buy each of the lotteries. The appearance of the lotteries was ordered randomly for each subject. Subjects repeated the bidding task for ten consecutive rounds and were informed that if the lottery auction phase was chosen as binding, only one lottery and one round would then be randomly chosen as binding. In the treatment with posted market clearing prices, subjects were able to observe the 2nd highest price and

[3] The P-bet lottery involves a bet with a high probability of winning a modest amount and a low probability of losing an even more modest amount and the $-bet involves a bet with a modest probability of winning a large amount and a high probability of winning a modest amount.

winner's ID in the previous round, while in the no-posted-market-clearing-prices treatment, subjects only observed the winner's ID.

2.5 The post-experimental phase

After the experiment, we collected standard socio-demographic information about subjects' age, household size and economic position of their household (evaluated using a 5-likert scale).

3 Econometric analysis and experimental results

Table 2 reports summary statistics for bids for a subset of lotteries (lotteries A, D and E). It is obvious that bids increase across rounds at a decreasing rate but mean bids tend to increase more rapidly than median bids. In addition, median bids are more stable across rounds especially for the lower expected payoff lotteries. Bids in the extensive-training treatment are higher than the minimal-training treatment but median bids tend to be equal in the extensive-training and the minimal-training treatments.

Table 2. Summary statistics for lottery auction bids

		Rounds									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	Training										
Lottery A	Mean	1.53	1.92	2.23	2.53	2.39	2.51	2.57	2.52	2.81	2.69
	Median	1.00	1.50	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
	Std. Dev.	1.10	1.26	1.35	1.50	1.57	1.62	1.67	1.83	1.81	1.93
Lottery D	Mean	1.23	1.76	1.85	2.55	2.70	2.90	3.18	3.17	3.36	3.46
	Median	1.00	1.10	1.25	2.00	2.00	2.50	3.00	2.50	3.25	3.00
	Std. Dev.	1.72	1.57	1.78	2.06	2.14	2.27	2.37	2.41	2.56	2.66
Lottery E	Mean	0.62	0.89	1.02	1.13	1.22	1.22	1.25	1.32	1.53	1.65
	Median	0.50	0.80	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Std. Dev.	0.49	0.65	0.79	0.77	1.10	0.98	1.05	1.28	1.54	1.69
	No training										
Lottery A	Mean	1.55	2.00	2.11	2.04	2.11	2.18	2.05	2.06	2.02	2.08

	Median	1.10	1.80	2.00	2.00	2.00	2.00	1.90	2.00	2.00	1.90
	Std. Dev.	1.19	1.28	1.30	1.46	1.37	1.49	1.57	1.55	1.60	1.72
Lottery D	Mean	1.20	1.68	1.91	2.31	2.53	2.73	2.51	2.95	2.97	2.50
	Median	1.00	1.50	1.30	1.10	1.20	1.50	1.00	1.50	2.00	1.00
	Std. Dev.	1.22	1.40	1.79	2.41	2.53	2.83	2.83	3.19	3.51	3.02
Lottery E	Mean	0.60	0.93	0.96	0.86	0.88	0.93	0.93	0.94	0.96	0.86
	Median	0.50	1.00	1.00	0.90	1.00	1.00	1.00	1.00	1.00	1.00
	Std. Dev.	0.55	0.62	0.70	0.75	0.68	0.77	0.67	0.69	0.75	0.70

Next we proceed with the conditional analysis. The dependent variable of interest is the bid of the individual *i* at round *t* for each lottey *j* where *j*=1 to 6. We use a tobit model with a panel structure to account for the censoring nature of the zero bids. To allow for individual heterogeneity in our models, we estimate a tobit model with random coefficients for the treatment variables (and the constant). The econometric specification we employ for the random coefficient tobit model is:

$$\begin{aligned} Bidj_{it} &= b_{1,i} + b_{2,i}Price_i + b_{3,i}Train_i + b_4 Round_{2,i} + \ldots + b_{12}Round_{10,i} + b_{13}Gender_i \\ &\quad + b_{14}Age_i + b_{15}Hsize_i + b_{16}TotFee_i + b_{17}EP_{2,i} + \ldots + b_{20}EP_{5,i} \end{aligned} \quad (1)$$

for *j*=1 to 6, where *Round* are round dummies, *Price* and *Train* are dummies for the treatments and *TotFee* is total fee endowed to each subject, a portion of which is randomly endowed as discussed earlier. We also included socioeconomic characteristics like self-assessment of the economic position of subject's household (*EP*), subject's age, gender and household size. Table 3 provides some basic descriptive statistics of the variables used in estimating equation (1).

Table 3. Variable description and descriptive statistics

Variable names	Variable description	Mean	Std. Dev.
Bid_1	Submitted bid for lottery A	2.198	1.541
Bid_2	Submitted bid for lottery B	2.724	2.682
Bid_3	Submitted bid for lottery C	1.532	1.210
Bid_4	Submitted bid for lottery D	2.475	2.444
Bid_5	Submitted bid for lottery E	1.036	0.943

Bid_6	Submitted bid for lottery F	2.119	2.065
$Round_1$ to $Round_{10}$	Round dummies	0.1	0.3
Price	Dummy, posted price treatment=1, else=0	0.493	0.500
Train	Dummy, extensive training treatment=1, else=0	0.507	0.500
Gender	Dummy, subjects is male=1, female=0	0.394	0.489
Age	Subjects' age	20.732	1.611
Hsize	Subjects' household size	4.380	1.093
TotFee	Total fee endowment	16.711	0.821
EP_1*	Dummy, household's economic position is very good=1, else=0	0.056	0.231
EP_2	Dummy, household's economic position is good=1, else=0	0.268	0.443
EP_3	Dummy, household's economic position is above average=1, else=0	0.268	0.443
EP_4	Dummy, household's economic position is average=1, else=0	0.324	0.468
EP_5	Dummy, household's economic position is worse than average=1, else=0	0.085	0.278

* Dropped for estimation purposes

In the case of the random coefficient tobit model, we allow the coefficients b_1, b_2, and b_3 to be formulated as $\mathbf{b}_i = \mathbf{b} + \mathbf{\Sigma w}_i$, where $\mathbf{b}$ is the fixed means of the distributions for the random parameters (we assumed normal distributions), $\mathbf{\Sigma}$ is a nonnegative definite diagonal matrix of standard deviations and $\mathbf{w}_i$ is unobservable random term. The random coefficient model is estimated with the Simulated Maximum likelihood (SML) estimation. The simulated log likelihood is maximized with respect to the elements of $\mathbf{b}_i$ and $\mathbf{\Sigma}$.

A likelihood ratio test can be employed to help choose between the random coefficient tobit model and the non-random counterpart using the statistic:

$$LR = -2\ln\frac{L_{non-random}}{L_{random}} \quad (2)$$

where $L_{non-random}$ is the value of the likelihood for the standard (non-random) tobit model and L_{random} is the value of the likelihood for the random parameters tobit model[4]. Under the null hypothesis this statistic follows a χ^2 distribution with degrees of freedom as many as the extra (random) parameters of the unconstrained model (random coefficient tobit). The *LR* test favors the random coefficient model for every lottery (LR_A=10.42, p-value=0.00 / LR_B=8.58, p-value=0.013 / LR_C=6.44, p-value=0.039 / LR_D=6.61, p-value=0.036 / LR_E=16.47, p-value=0.00 / LR_F=4.78, p-value=0.091)[5].

Table 4 shows the marginal effects from the random coefficient tobit models estimated according to equation 1. Regarding the variable of interest, one can see that extensive training has a positive and statistically significant effect on bidding behavior. This effect is consistent for all lotteries although the magnitude differs from as low as 0.28€ to as much as 1.15€. That is, subjects that received extensive training were bidding as much as 1.15€ more than subjects that received minimal training. Given that it is well known that many subjects carry heuristics of the “buy low” type, it is then possible that subjects given only minimal training before participating in experimental auctions may underreport their WTP. Our finding may also suggest that adequate training can bypass these heuristics.

Table 4. Marginal effects for random parameters tobit model

		Lottery A Coef. (Std. error)	Lottery B Coef. (Std. error)	Lottery C Coef. (Std. error)	Lottery D Coef. (Std. error)	Lottery E Coef. (Std. error)	Lottery F Coef. (Std. error)
No	*Gender*	0.838** (0.082)	1.842** (0.129)	0.474** (0.061)	1.363** (0.115)	0.267** (0.048)	0.837** (0.103)

[4] Limdep ver 9. was used in all estimation steps. The likelihood of the standard random effects tobit model is computed using quadrature while the simulated maximum likelihood (SML) is used for the random coefficient model. To conduct the likelihood ratio test we estimated a tobit model with constant as the random coefficient (estimated with SML) which is equivalent to the random effects tobit model estimated with quadrature.

[5] Although, the null hypothesis is marginally rejected at the 10% level of significance for lottery F, results are qualitatively the same with those from the random effects tobit model.

	Age	0.015 (0.023)	0.560** (0.038)	0.007 (0.017)	0.578** (0.036)	0.017 (0.014)	0.469** (0.034)
	Hsize	0.155** (0.037)	0.191** (0.055)	0.144** (0.028)	0.126** (0.049)	0.147** (0.022)	0.029 (0.045)
	TotFee	0.171** (0.046)	0.067 (0.068)	0.120** (0.035)	0.178** (0.064)	0.043 (0.028)	0.294** (0.059)
	EP_2	-0.460** (0.193)	2.031** (0.294)	-0.257* (0.140)	1.828** (0.271)	0.114 (0.111)	1.395** (0.260)
	EP_3	0.172 (0.188)	2.365** (0.289)	-0.161 (0.138)	2.217** (0.268)	0.194* (0.108)	1.923** (0.258)
	EP_4	0.023 (0.180)	2.471** (0.285)	0.015 (0.130)	2.015** (0.258)	0.104 (0.102)	2.018** (0.250)
	EP_5	-0.722** (0.217)	1.022** (0.335)	-0.748** (0.157)	1.107** (0.303)	-0.185 (0.122)	0.722** (0.285)
	$Round_2$	0.386** (0.194)	0.677* (0.362)	0.250 (0.199)	0.492 (0.419)	0.300 (0.183)	0.384 (0.340)
	$Round_3$	0.592** (0.204)	0.990** (0.324)	0.409* (0.211)	0.615 (0.378)	0.370** (0.144)	0.747** (0.294)
	$Round_4$	0.701** (0.178)	1.297** (0.308)	0.457** (0.158)	1.169** (0.377)	0.362** (0.135)	0.919** (0.310)
	$Round_5$	0.665** (0.248)	1.595** (0.448)	0.485** (0.143)	1.357** (0.300)	0.419** (0.148)	1.165** (0.302)
	$Round_6$	0.761** (0.221)	1.712** (0.402)	0.586** (0.174)	1.580** (0.330)	0.439** (0.149)	1.458** (0.327)
	$Round_7$	0.723** (0.267)	2.081** (0.465)	0.623** (0.177)	1.610** (0.397)	0.462** (0.167)	1.494** (0.242)
	$Round_8$	0.708** (0.210)	1.964** (0.356)	0.603** (0.174)	1.833** (0.356)	0.504** (0.157)	1.559** (0.415)
	$Round_9$	0.831** (0.262)	2.361** (0.320)	0.636** (0.196)	1.934** (0.315)	0.614** (0.157)	1.726** (0.237)
	$Round_{10}$	0.798** (0.235)	2.136** (0.246)	0.718** (0.182)	1.742** (0.225)	0.632** (0.128)	1.531** (0.234)
Random	*Price*	-0.390** (0.081)	0.375** (0.119)	-0.044 (0.059)	0.325** (0.109)	-0.174** (0.048)	-0.056 (0.102)
	Train	0.539** (0.081)	1.148** (0.122)	0.283** (0.059)	0.491** (0.107)	0.114** (0.046)	0.518** (0.100)

** (*) Statistically significant at the 5% (10%) level.

Regarding the other treatment variable i.e. posting of market clearing prices, results are mixed. For two out of our six lotteries, posting of market clearing prices has a negative effect i.e. subjects exposed to posted market clearing prices are bidding on average lower than subjects that were not exposed to posted market clearing prices. For the other two lotteries, we find the exact opposite and for the rest of the lotteries we find no statistically significant effect.

The rest of the variables have the expected effects. We find for example that males are bidding higher than females and that older subjects are bidding higher than younger subjects. Total endowed fee also plays a role in explaining bidding behavior i.e. subjects that were endowed with more money are bidding higher than subjects with lower money endowments. Finally, using repeated rounds to auction products has a positive and statistically significant effect on bidding behavior. Specifically, subjects tend to bid higher with subsequent rounds up to the last round, which in some cases can be as much as 2.1€ more than round 1 of the auction (e.g. Lottery B).

To check the robustness of our findings, we also estimated a pooled OLS regression where we controlled for lottery characteristics by using lottery dummies (Table 5). The general finding is similar in that extensive training positively affects bid values.

Table 5. Pooled OLS regression

	Coef.	(Std. error)
Constant	-7.165**	(0.737)
Gender	0.866**	(0.061)
Age	0.161**	(0.018)
Hsize	0.097**	(0.027)
TotFee	0.183**	(0.035)
EP_2	0.910**	(0.140)
EP_3	1.052**	(0.138)
EP_4	0.980**	(0.131)
EP_5	0.462**	(0.159)
$Round_2$	0.438**	(0.123)
$Round_3$	0.644**	(0.123)
$Round_4$	0.845**	(0.123)
$Round_5$	0.973**	(0.123)
$Round_6$	1.110**	(0.123)
$Round_7$	1.183**	(0.123)
$Round_8$	1.216**	(0.123)
$Round_9$	1.370**	(0.123)
$Round_{10}$	1.285**	(0.123)

Price	0.210**	(0.060)
Train	0.431**	(0.058)
Lottery A	0.079	(0.095)
Lottery B	0.606**	(0.095)
Lottery C	-0.587**	(0.095)
Lottery D	0.356**	(0.095)
Lottery E	-1.083**	(0.095)

** Statistically significant at the 5% level.

4 Conclusion

In this paper, we tried to assess the effect of training on bidding behavior of subjects that participate in experimental auctions. We used a 2nd price Vickrey auction, a commonly used elicitation mechanism, to assess valuation for a number of lotteries with varying expected payoffs. We generally find that bid values of subjects given extensive training are higher than those of subjects given only minimal training prior to the actual auctions. This finding implies that extensive training tends to increase WTP values. This also then implies that subjects who are not well trained are likely to underreport their WTP.

In the experimental economics literature, the WTP-WTA (willingness to accept) gap has been attributed to the endowment effect, loss aversion and status quo bias (Kahneman, Knetsch and Thaler 1991; Kahneman and Tversky 1979; Thaler 1980). However, Plott and Zeiler (2005) showed that the WTP-WTA gap disappeared when they eliminated subjects' misconceptions about the elicitation mechanism by applying the union of procedures that were used in previous experiments. Specifically, they conducted auctions where they made sure: to use an incentive compatible auction, to train their subjects, to provide practice rounds (including paid practice) and to ensure anonymity. This is exactly what we did in our extensive training treatment. In studies that examined the WTP-WTA divergence issue, WTA is generally found to be higher than WTP. Hence, we speculate based on our finding that the result obtained by Plott and Zeiler (i.e. equality of WTP and WTA) is due to the fact that subjects who are trained well and adequately tend to increase their WTP, which would then reduce or eliminate the empirically known WTP-WTA gap.

Assuming that our minimal training indeed did not provide adequate training to subjects or did not provide enough information about the dominant strategy properties of the auction institution, our finding further implies that extensive training could elicit more accurate homegrown WTP values from subjects. We then would urge researchers to devote considerable time in training subjects in homegrown experiments. An alternative approach, according to Harrison (2006), is to use a series of training experiments in induced value settings to give subjects a chance to learn about the incentive compatible properties of the auction mechanism.

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