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Cognitive Ability and Bidding Behavior in Second Price Auctions: An Experimental Study

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Abstract

Behavioral biases are more pronounced for individuals with lower cognitive abilities. This paper examines what connection if any there is between cognitive ability and bidding strategy in second price auctions. Despite truthful revelation being a weakly dominant strategy, previous experiments have consistently observed overbidding, which makes use of such auctions for inferring homegrown value problematic. Examining the effect of cognitive ability is important as it may help identify when one can reliably recover values from bids. The results indicate that more cognitively able subjects behave in closer accordance with theory, and that cognitive ability partially explains heterogeneity in bidding behavior.

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1. Introduction

The private value second price sealed bid auction is a popular tool for applied economists to elicit people's willingness to pay (WTP) and/or willingness to accept (WTA) for new products, product attributes, etc. Findings from valuation research are used not only for marketing and business applications, but also for public policy and welfare analysis. The second price auction (SPA) is considered demand revealing since truthful bidding is the weakly dominant strategy. This theoretical prediction means that bidding behavior is not influenced by information about rival bidders, a bidder's risk attitude, etc. However, this auction mechanism may not always provide an accurate measure of value given behavioral anomalies observed in controlled laboratory experiments on bidding behavior. One consistent finding in repeated experimental auction studies is that subjects tend to deviate from rational behavior and exhibit a pattern of overbidding in SPAs (Kagel *et al*., 1987; Kagel and Levin, 1993; Harstad, 2000; Aseff, 2004; Andreoni *et al*., 2007; Cooper and Fang, 2008; Drichoutis *et al*., 2015; Georganas *et al*., 2017).

Several experimental studies have tried to explain this phenomenon in SPAs. Kagel *et al*. (1987) conjectured that subjects submit a higher bid due to the illusion that bidding higher improves the probability of winning with no real cost because the highest bidder pays the second highest bid. Alternatively, Morgan *et al*. (2003) explained bid deviations as being based on behavioral motives such as "spite". They suggested that subjects bid more aggressively in a SPA since the profit earned by a rival bidder could be reduced by a losing bidder's own bid. The overbidding behavior can be also explained by a "joy of winning". Subjects tend to bid higher than their own values as they derive extra utility from winning the auction. Cooper and Fang (2008) found that small and medium overbids are consistent with a (modified) joy of winning hypothesis but large overbids are more consistent with the "spite" hypothesis.

Understanding bid deviation and overbidding in the SPA is important not only for explaining individual's apparently irrational behavior but also for providing clarity as to when and how bids should be interpreted when trying to elicit homegrown WTA or WTP valuations. In this paper, we aim to help fill this void by investigating how individuals' cognitive ability influences bid deviations in SPAs. Our study is motivated by previous work by Kagel *et al*. (1987) and Ausubel (2004) who argued that the difficulty of understanding the SPA could lead to the prevalence and persistence of overbidding in the SPA as compared to the ascending price English auction even though both auction mechanisms are strategically equivalent. More recently, Li (2017) suggested that the overbidding observed in SPAs is due to the fact that it is not an obviously strategy-proof (OSP) mechanism, where an OSP mechanism is described as one a cognitively limited agent can recognize as a weakly dominant strategy. This suggests that more cognitively able bidders will understand the strategic properties of a SPA better than low cognitive ability bidders. Our study empirically tests this conjecture. While previous studies have examined the relationship between cognitive ability and economic behavior, no other study has examined how cognitive ability affects bidding in SPAs.

The behavior of people with higher cognitive ability can be different from those with lower cognitive ability in a variety of ways. For example, a number of studies have shown that high cognitive ability is positively correlated with patience (Parker and Fischhoff, 2005; Frederick, 2005; Slonim *et al*., 2007; Oechssler *et al*., 2009) while it is negatively associated with risk aversion (Frederick, 2005; Benjamin *et al*., 2006; Dohmen *et al*., 2010). People with higher cognitive ability are also more likely to join financial markets and receive more financial return than people with lower cognitive ability (Smith *et al*., 2010; Agarwal and Mazumder, 2013; Korniotis and Kumar, 2011). In addition, cognitive ability is highly correlated with saving behavior and therefore is a good predictor of saving performance (Ballinger *et al*., 2011). A number of studies have also investigated whether cognitive ability is related to individuals' behavioral biases and found that behavioral biases are more likely to be pronounced for individuals with lower cognitive abilities. For example, Oechssler *et al*. (2009) found that people with higher cognitive ability are likely to exhibit lower incidences of the conjunction fallacy and conservatism fallacy[1]. Hoppe and Kusterer (2011) replicated the finding of Oechssler *et al*. (2009) and found that people with higher cognitive ability are less susceptible to the base rate fallacy[2] and conservatism bias. Bergman *et al*. (2010) investigated the relationship between cognitive ability and the anchoring effect and found that greater cognitive ability moderates the anchoring effect. Andersson and Svensson (2008) also tested the hypothesis of a positive correlation between cognitive ability and scale bias in contingent valuation surveys. Their results indicated that respondents with higher cognitive skills give answers less influenced by scale bias[3].

Recent studies have also identified the connection between individuals' cognitive abilities and performance in behavioral tests for strategic behavior. For example, Gill and Prowse (2016)

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[1] The conjunction fallacy is a reasoning failure that occurs when people perceive the probability of a conjunction of events more likely than the probability of one of the constituent events (Tversky and Kahneman, 1983). The conservatism fallacy is a bias when people underweigh new evidence and overweigh the base rate (Edwards, 1968).
[2] The base rate fallacy is a tendency that occurs when people ignore the base rate and focus more on new evidence (Tversky and Kahneman, 1982).
[3] The scale bias was defined in the study as the insensitivity of participants' responses to the size of the risk reduction in a valuation survey.

investigated the effects of cognitive ability and character skills on how people learn to play equilibrium in the *p-beauty* contest. They found that subjects with higher cognitive ability more frequently play equilibrium strategies and also earn more money. Burnham *et al*. (2009), Brañas-Garza *et al*. (2012), Carpenter *et al*. (2013), and Civelli and Deck (2017) also found a similar relationship between cognitive ability and performance in the *p-beauty* contest. Jones (2008) and Jones (2014) examined the link between individuals' cognitive abilities and the likelihood of cooperation in the repeated prisoner's dilemma games. They both found that subjects with greater cognitive ability are more likely to be cooperative and use complex strategies.

To investigate the relationship between bidding behavior in the SPA and cognitive ability, we first measured subjects' cognitive abilities using a nonverbal Raven's Standard Progressive Matrices (RSPM) test (Gray and Thompson, 2004). We then classified subjects into two groups (i.e., a high cognitive ability group and low cognitive ability group) based on their RSPM test performance. Each group then participated in a series of second price induced value auctions.

2. Experimental Design

A total of 15 sessions were conducted, with each session comprising of 10 subjects. All sessions were conducted on weekdays between March 2017 and June 2017 in the behavioral lab at University of Arkansas, and each session lasted for approximately 90 minutes. The subjects, a majority of whom were undergraduate students, were recruited from the behavioral lab's database of volunteers. The show-up payment was $10 and subjects were also paid on their earnings in the auctions, which averaged $4.60 (SD=3.05, min=0, max=12.94) at the end of the experiment[4].

Upon arrival, participants signed a consent form and were then seated at a computer visually isolated from the other subjects. Both paper and computerized instructions were provided to each subject and read aloud. The experiment was comprised of three tasks in the following order: (1) the RSPM; (2) the induced value SPAs; and (3) a questionnaire. The experiment was conducted using the z-Tree software (Fischbacher, 2007).

We first measured the cognitive ability of all subjects using the RSPM which is used for measuring abstract reasoning and is considered a nonverbal estimate of fluid intelligence. The RSPM consists of 5 parts, labeled A to E, with 12 questions in each part. The subjects were given 3 minutes to complete each of the first two parts (i.e., part A and B) and 8 minutes to complete each of the last three parts (i.e., part C, D, and E). Subjects could move back and forth within each part and change their answers. We did not provide any monetary incentives for each correct answer during the Raven test to avoid a potential money effect influencing the auction part of the study that followed. We also provided two examples of the Raven test prior to the real task.

Since we look at the role of cognitive ability in subjects' individual and aggregate bidding behaviors, we classified a subject as either "high cognitive ability" if her test score was in the top half of all scores in the session or "low cognitive ability" if her test score was in the

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[4] This is the actual payment after the experiment. If a subject earned negative profit during the auction, he/she was only paid the show-up fee. The average profit (not actual payment) for subjects with greater cognitive ability was $4.36 while the average profit for subjects with lower cognitive ability was $3.57 in the auction. The difference is not statistically significant (t-statistic: -0.86; p-value: 0.38).

bottom half of all scores in the session. The ten subjects in each session were then split into two groups (i.e., a relatively high cognitive ability group and a relatively low cognitive ability group), with each group consisting of five subjects of similar ability. Subjects were unaware about which other subjects composed their group. The number of subjects in each group was kept constant to eliminate a potential confound (see discussion in Drichoutis *et al*., 2017). Each subject was informed whether she was classified as being in the "top half of all scores in the session" or in the "bottom half of all scores in the session" before participating in the auction, but was not informed of her exact RSPM score.

Each group then participated in five rounds of a second price induced value auction where subjects submitted non-hypothetical bids for their private induced values. Prior to the auction, we carefully explained how the second price auction works. Subjects also participated in two practice rounds to help them understand the auction mechanism[5]. In every round of the actual auction, each subject was assigned an induced value for a fictitious good but no subject ever learned the induced value of another bidder. To reduce exogenous variation across sessions and subjects, a single set of induced values was predetermined and used for every session. For each auction, the induced values were $5.18, $11.26, $17.16, $23.82, and $29.12[6]. Each subject experienced each of these values in exactly one round of the auction (out of five) and each value was induced for every auction. Thus, the effective demand curve was constant across all auctions within and between groups.

[5] Feedback about his/her own profit was provided in the practice auction, but we did not provide feedback about the profit between rounds in the actual paid auction.
[6] These five induced values were randomly drawn from a distribution of $0 to $30 before the first session. Given the realized draws, the expected price was $23.82 and the expected profit to the winner was $5.30.

In the auction, subjects were asked how much they would be willing to pay for a fictitious good[7]. The subject placing the highest bid bought the good at the second highest bid and then resold it to the experimenter at his or her own induced value at the end of each round. Feedback about the highest bid in the auction and other subjects' earnings was not provided between rounds. The highest bidder's profit in each round is equal to the difference between his or her induced value and the second highest bid. Profits of subjects who do not purchase the good are zero. Subjects were paid their cumulative earnings from all five rounds at the end of the experiment.

After the auction, subjects were asked to complete a questionnaire containing demographics and character skills (i.e., personality traits: openness, conscientiousness, extraversion, agreeableness, and emotional stability, grit: perseverance and passion for long-term goals, and consideration of future of consequences) questions. We measured personality traits using the 10-item assessment of the Big Five personality traits (Gosling *et al*., 2003). We also measured grit using the 12-item Grit Scale (Duckworth *et al*., 2007) and consideration of future of consequences (CFC) using the 12-item CFC Scale (Strathman *et al*., 1994)[8].

3. Experimental Results

Table 1 compares the characteristics of subjects in the high and low cognitive ability groups. The mean RSPM test score for all subjects was 52.20 (correct out of 60 puzzles), with scores ranging from 37 to 60. The average test score for the higher cognitive group (the mean test score was

[7] A copy of the instructions used in the experiment is available from the authors.
[8] Following the questionnaire, data were also collected for another test of cognitive ability as part of a different research project (see Civelli and Deck, 2017).

55.37, with score ranging from 48 to 60) was about 6.3 higher than that of the lower cognitive group (the mean test score was 49.02, with score ranging from 37 to 56). The mean difference of the test scores between the two cognitive groups was statistically significant (t-statistic: -12.05; p<0.001). Overall, the two cognitive groups have similar characteristics. Specifically, the mean differences of demographics and character skills between the two groups are not statistically significant with the exception of GPA (t-statistic=-3.51; p<0.001 for testing equal GPA between groups). Previous studies have verified a high correlation between GPA and general cognitive ability (Jensen, 1998; Frey and Detterman, 2004) while other studies have used GPA as a measure of cognitive ability (Benjamin *et al*., 2006; Chen *et al*., 2013)[9]. That subjects in the two groups have similar characteristics suggests that any observed differences are due to their cognitive ability rather than other characteristics.

Table 1. Comparison of Subjects' Characteristics across Cognitive Groups

Variables	All	High cognitive group	Low cognitive group
RSPM***	52.20 (4.52)	55.37 (2.46)	49.02 (3.83)
Age (years)	24.01 (6.79)	23.27 (3.66)	24.75 (8.85)
Gender (1: male, 0: female)	0.48 (0.50)	0.49 (0.50)	0.47 (0.50)
Grade Point Averages (GPA)***	3.39 (0.51)	3.53 (0.46)	3.25 (0.52)
Employed (1: yes, 0: no)	0.59 (0.49)	0.60 (0.49)	0.59 (0.50)
Big5: Extraversion	8.48 (3.09)	8.75 (3.08)	8.21 (3.09)
Big5:Agreeableness	9.47 (2.47)	9.49 (2.55)	9.44 (2.40)
Big5:Conscientiousness	10.59 (2.69)	10.31 (2.92)	10.88 (2.42)
Big5:Emotional stability	9.54 (2.98)	9.87 (2.96)	9.21 (2.98)
Big5:Openness	10.65 (2.31)	10.77 (2.19)	10.53 (2.43)
Grit	41.23 (7.07)	40.93 (7.33)	41.53 (6.83)
CFC	42.59 (6.37)	42.92 (6.24)	42.25 (6.53)

Note: Each value represents the average of each variable. Standard Deviation for each value shown in parentheses. *** denotes the mean difference between the two groups are statistically significant at a 1% level. The Big five

[9] GPA and RPSM scores are positively correlated in our data (ρ=0.23). Based on regression analysis, a 1 percent change in the Raven test score was associated with a 0.42 percent change in GPA and it was highly significant (p-value=0.01).

personality traits use a seven-point Likert scale to measure responses to individual questions; the Grit scale and CFC use a five-point Likert scale to measure responses to each question.

3.1. *Overview of Bidding Behavior*

The bidding behavior from the experiment is summarized in Table 2 where we separate bids into three categories: *perfect demand*, *overbid*, and *underbid*. Results show that on average 29.4 percent (ranging from 26.7 to 30.7) of bids in the group of subjects with greater cognitive skills are perfectly demand revealing while only 13.4 percent (ranging from 10.7 to 14.7) of bids in the lower cognitive group are perfectly demand revealing. The two-sample proportion tests also reject the null hypothesis of equal proportions of perfectly demand revealing bids between two cognitive groups across rounds[10], indicating that subjects with greater cognitive ability are more likely to bid truthfully.

The number of subjects who bid higher than induced value is similar in both cognitive groups, and overbidding does not decrease with experience. However, among subjects who bid over induced value, subjects in the higher cognitive group are more likely to submit bids within 10 percent of their induced value (on average 66.3 percent of overbids by high types) as compared to those in the lower cognitive group (on average 48.5 percent of overbids by low types). More subjects in the lower cognitive group (on average 46.1 percent of bids) bid lower than induced value compared to those in the higher cognitive group (on average 29.1 percent of bids). Among subjects who bid lower than induced value, on average 83.9 percent of bids by low types are within 10 percent of induced value and 76.1 percent of bids by high types are within 10

[10] The test results across rounds are as follows: z-statistic: 3.02, p-value: 0.002 in round 1; z-statistic: 2.34, p-value: 0.019 in round 2; z-statistic: 2.34, p-value: 0.019 in round 3; z-statistic: 2.27, p-value: 0.022; z-statistic: 1.99, p-value: 0.046.

percent of induced value indicating that underbidding is typically only a small deviation regardless of cognitive ability.

Interestingly, the percentage of bids within 10 percent of induced value increased from round 1 (75 percent of bids) to round 5 (84 percent of bids) in the higher cognitive group while no clear pattern was found in the lower cognitive group (76 percent of bids in round 1 and 72 percent of bids in round 5 were within 10 percent of induced value), suggesting that subjects with greater cognitive skills may be better at learning to submit bids close to the optimum when they have more experience bidding in the second price auction. Interestingly, relatively high overbids (bids more than 10 percent above induced value) in the higher cognitive group significantly vanish with bidding experience[11]. This finding is consistent with other work on the role of cognitive ability in strategic games – for example, Gill and Prowse (2016) found that subjects with greater cognitive skills choose numbers close to equilibrium in the *p-beauty* contest.

Based on the induced values used in the auction, results suggest that truthful demand revealing bids occur less frequently as induced values increase in both cognitive ability groups. However, the percentages of relatively high overbids and underbids (bids above and below 10 percent of induced value, respectively) in both cognitive groups sharply decrease as their induced values increase, indicating that when subjects have relatively high values for the auctioned item, they tend to bid close to the optimum, which is consistent with the findings from Lusk et al. (2007) and Drichoutis et al. (2015). Since relatively high induced values could be associated with

[11] Extreme overbids, a bid high enough to cause bankruptcy when a subject is the highest bidder in a group, also decrease with more experience in the higher cognitive group. We found 4 extreme overbids in round 1 and only 1 extreme overbid in round 5 in the higher cognitive group. On the other hand, we found 6 extreme overbids in round 1 and 5 extreme overbids in round 5 in the lower cognitive group.

a high cost of "misbehavior" (Harrison 1989, 1992), subjects may put more efforts into the tasks. Interestingly, for the higher cognitive group, about 80 percent and 77 percent of overbids are within 10 percent of the induced values when values for the item are $23.82 and $29.12, respectively, suggesting that many overbids may be characterized by small mistakes when values for the item are relatively high[12]. Many subjects with lower cognitive skills tend to bid substantially above induced value (about 76 percent of overbids are above 10 percent of the induced value) when they have a low value for the item, and it sharply decreases as induced values increase.

Table 2. Frequency of Bids Relative to Induced Value

			Number			Percentage		
			=	>	<	=	>	<
High cognitive	by Round	R1	23	28 (16)	24 (17)	30.7	37.3 (57.1)	32.0 (70.8)
		R2	23	29 (18)	23 (19)	30.7	38.7 (62.1)	30.7 (82.6)
		R3	23	32 (20)	20 (15)	30.7	42.7 (62.5)	26.7 (75.0)
		R4	20	36 (26)	19 (14)	26.7	48.0 (72.2)	25.3 (73.7)
		R5	21	31 (24)	23 (18)	28.0	41.3 (77.4)	30.7 (78.3)
	by Value	5.18	25	30 (17)	20 (14)	33.3	40.0 (56.7)	26.7 (70.0)
		11.26	25	25 (14)	25 (21)	33.3	33.3 (56.0)	33.3 (84.0)
		17.16	19	32 (19)	24 (20)	25.3	42.7 (59.4)	32.0 (83.3)
		23.82	22	35 (28)	18 (10)	29.3	46.7 (80.0)	24.0 (55.6)
		29.12	19	34 (26)	22 (18)	25.3	45.3 (76.5)	29.3 (81.8)
Low cognitive	by Round	R1	8	33 (18)	34 (31)	10.7	44.0 (54.5)	45.3 (91.2)
		R2	11	28 (12)	36 (27)	14.7	37.3 (42.9)	48.0 (75.0)
		R3	11	30 (13)	34 (26)	14.7	40.0 (43.3)	45.3 (76.5)
		R4	9	30 (17)	36 (32)	12.0	40.0 (56.6)	48.0 (88.9)
		R5	11	31 (14)	33 (29)	14.7	41.3 (45.2)	44.0 (87.9)
	by Value	5.18	12	29 (7)	34 (26)	16.0	38.7 (24.1)	45.3 (76.4)
		11.26	10	32 (16)	33 (28)	13.3	42.7 (50.0)	44.0 (84.4)
		17.16	9	31 (14)	35 (33)	12.0	41.3 (45.1)	46.7 (94.3)
		23.82	10	30 (18)	35 (27)	13.3	40.0 (60.0)	46.7 (77.1)

[12] We only find 1 and 2 extreme overbids, a bid high enough to cause bankruptcy when a subject is the highest bidder in a group, when the induced values are $23.82 and $29.12 respectively while we find 7 cases when the induced value is $5.18.

	29.12	9	30 (19)	36 (31)	12.0	40.0 (63.3)	48.0 (86.1)

Note: =, >, and < denote bid equal to induced value, bid larger than induced value, and bid smaller than induced value. Entries in parentheses are the number/percentage of individuals whose bids are within 10 percent of his/her induced value among subjects who overbid or underbid.

Another way to compare bidding behavior between the two cognitive groups is to look at their bid deviations from induced value. Table 3 reports the mean absolute deviation of revealed bid from induced value, with their standard deviations in parentheses. The results indicate that on average the deviations of bid from induced values in the higher cognitive group are generally smaller than those in the lower cognitive group. The Mann-Whitney non-parametric tests also reject the null hypothesis that bid deviations from induced value are equally distributed in both cognitive groups (χ^2-statistic: 12.30, $p<0.001$), suggesting that subjects in the higher cognitive group tend to submit bids closer to their induced value; i.e., they misbid less.

Table 3. Absolute Deviations of Bids from Induced Value

			Mean absolute deviation
High cognitive	by Round	R1	1.24 (2.84)
		R2	1.33 (2.80)
		R3	1.95 (7.78)
		R4	2.05 (8.10)
		R5	1.61 (6.09)
	by Value	5.18	0.70 (1.51)
		11.26	1.70 (8.06)
		17.16	1.48 (2.89)
		23.82	2.20 (7.83)
		29.12	2.09 (6.43)
Low cognitive	by Round	R1	2.10 (6.82)
		R2	1.79 (3.38)
		R3	3.72 (15.63)
		R4	3.49 (16.93)
		R5	2.11 (4.35)
	by	5.18	2.89 (16.70)

	Value	11.26	1.63 (3.19)
		17.16	3.84 (15.62)
		23.82	2.29 (4.56)
		29.12	2.57 (7.41)

3.2. *Cognitive Ability and Aggregate Bidding Behavior*

To identify the role of cognitive ability in bidding behavior in SPAs, we examine aggregate bidding behavior by round in each cognitive group, following the framework of analysis used in Drichoutis *et al*. (2015). We constructed the ratio of aggregate revealed demand over aggregate induced demand in each round. Because the induced values were held constant across auctions, the aggregate induced demand for each group in a given round of the auction is \$1298.10 = 15 sessions × (\$5.18+\$11.26+\$17.16+\$23.82+\$29.12). Figure 1 shows the ratio of the revealed demand to induced demand by round for both cognitive groups. The horizontal line at 100% denotes perfect demand revelation. Both cognitive ability groups have similar patterns over the rounds and neither is demand revealing. The ratio in the higher cognitive ability group is always below 110%, but this is not the case for the low cognitive ability group which also exhibits more variation.

The results generally indicate that regardless of cognitive ability, in aggregate, subjects tend to overbid in the second price auction, which is consistent with previous findings (Kagel *et al*., 1987; Kagel and Levin, 1993; Cooper and Fang, 2008; Drichoutis *et al*., 2015). However, the pattern of overbidding is somewhat moderated in the group of subjects with greater cognitive ability.

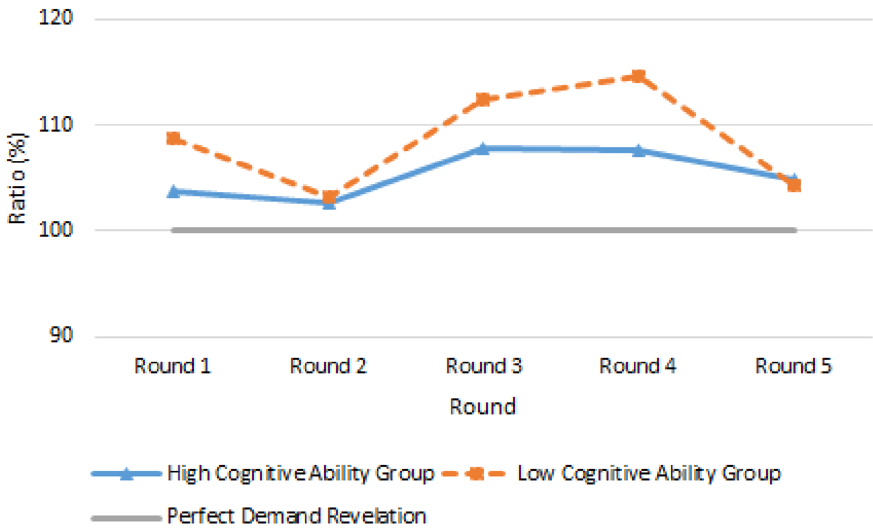

Figure 1. Aggregate Behavior by Rounds by Cognitive Ability Group

Figure 2 shows the ratio of revealed demand to induced demand conditioned on induced value. The average demand revelation ratio across induced values in the higher cognitive group is about 106.73%, while the average demand revelation ratio in the lower cognitive group is about 114.83%. Moreover, the variation of the demand revelation ratio across induced values in the lower cognitive group is much higher than that in the higher cognitive group, indicating that subjects with greater cognitive ability are less sensitive to changes in values for the auctioned item; thus aggregate behavioral bias is less pronounced for the group of subjects with greater cognitive ability.

From Figure 2, it is also clear that overbidding is particularly pronounced for low ability subjects with low induced values. For both groups, the ratio of revealed demand to induced demand tends to converge to the perfect demand revelation as induced values increase, which is consistent with previous results (e.g., Drichoutis *et al.*, 2015), indicating that individual bidders tend to perceive a greater incentive to bid optimally in a second price auction as their induced values increase. That is, bidders appear to take their bidding more seriously when they are more likely to actually win the auction. This could also be evidence of spite since low value bidders are unlikely to win the auction but may set the price someone else pays. The speed of convergence as induced values increase tends to be faster, however, in the high cognitive group.

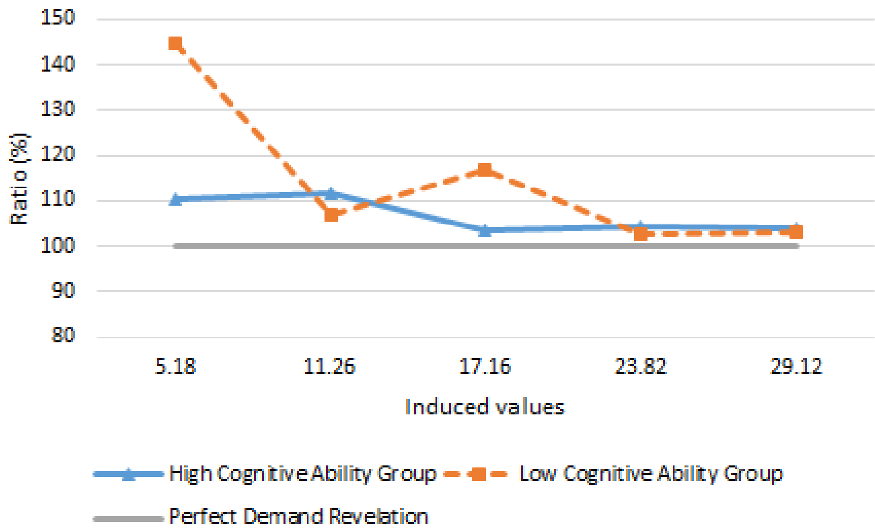

Figure 2. Aggregate Behavior by Induced Values by Cognitive Ability Group

3.3. *Cognitive Ability and Individual Bidding Behavior*

We now estimate a regression to examine whether cognitive ability influences bid deviation in a SPA[13]. We look at the effect of the treatment dummy (i.e., the dummy for subjects with greater cognitive ability) on absolute deviations of revealed bids from induced value (| Bid – Induced

[13] We also compare truthful bidding behavior between the two groups by estimating the bidding functions, which are reported in Appendix 1.

Value |) using a conditional regression. Since we have individual bids for multiple auction rounds, we consider the panel nature of the bidding data by estimating random effects regression models.

Columns (1) and (2) of Table 4 report the results from the random effects Tobit regressions with and without demographics and character skills. The results show that deviations of bids from induced value in the higher cognitive group are significantly lower than those in the lower cognitive group, suggesting that subjects with greater cognitive ability tend to submit less extreme bids compared to subjects with lower cognitive ability. We also compare bid deviation based on individual subjects' RSPM scores instead of using the treatment dummy to consider variations of individuals' cognitive skills (See Appendix 2). The coefficients of RSPM are negative as expected, suggesting that bids from subjects with higher RSPM scores are less deviated from induced value. The coefficients are not however statistically significant.

Table 4. The Effect of Cognitive Ability on Bid Deviation

	Without Controls	With Controls
Constant	0.05 (1.26)	3.57 (3.23)
Higher Cognitive	-2.76 (1.44)*	-2.97 (1.43)**
Induced Value	0.05 (0.03)	0.05 (0.03)
Gender	--	1.32 (1.45)
Age	--	-0.19 (0.12)*
Employed	--	1.20 (1.47)
Extraversion	--	-0.34 (0.78)
Agreeableness	--	0.40 (0.74)
Conscientiousness	--	-0.23 (0.78)
Emotional Stability	--	-0.91 (0.82)
Openness	--	0.67 (0.76)
Grit	--	-0.70 (0.88)
CFC	--	-0.39 (0.82)
Round dummies	Yes	Yes
σ_u	8.07 (0.59)***	7.74 (0.57)***
σ_e	6.78 (0.21)***	6.78 (0.21)***

N	750	750
Log-likelihood	-2161.71	-2156.14

Note: Standard error for each coefficient shown in parentheses. *, **, and *** denote statistical significance at 10%, 5%, and 1%.

We next examine if cognitive ability has an impact on bid deviations separately for each induced value and for each round with the same control variables. Tables 5 and 6 present additional regression results for each case. For brevity, we only post the coefficient of the treatment variable. Table 5 shows that the deviations of bids from induced value in the higher cognitive group are lower than those in the lower cognitive group in all induced values. In particular, the deviations of bids are more pronounced for subjects with lower cognitive ability with relatively smaller induced values, which is consistent with the previous results.

Table 6 also exhibits the smaller deviations of bids from induced value in the higher cognitive group in all bidding rounds. Particularly, the bid deviations in the higher cognitive group are significantly lower in the earlier bidding rounds, and the differences become insignificant with experience.

Table 5. The Effect of Cognitive Ability on Bid Deviation by Induced Value

	Induced value				
	5.18	11.26	17.16	23.82	29.12
Constant	0.30 (5.72)	1.31 (3.11)	3.66 (4.94)	3.02 (2.84)	6.62 (3.03)**
High Cognitive	-4.85 (2.32)**	-1.24 (1.19)	-4.25 (2.06)**	-1.28 (1.20)	-1.61 (1.29)
N	150	150	150	150	150
Log-likelihood	-472.88	-407.51	-492.49	-418.34	-436.64

Note: Standard error for each coefficient shown in parentheses. ** denotes statistical significance at 5%.

Table 6. The Effect of Cognitive Ability on Bid Deviation by Rounds

	Bidding Round				
	Round 1	Round 2	Round 3	Round 4	Round 5
Constant	1.68 (2.60)	2.71 (1.44)*	4.47 (5.57)	8.77 (6.05)	-1.32 (2.50)

High Cognitive	-1.91 (0.99)*	-1.06 (0.62)*	-4.36 (2.41)*	-3.71 (2.51)	-1.25 (1.00)
N	150	150	150	150	150
Log-likelihood	-395.68	-337.86	-490.87	-514.11	-396.25

Note: Standard error for each coefficient shown in parentheses. * denotes statistical significance at 10%.

3.4. *Cognitive Ability and Overbidding Behavior*

Now we examine whether cognitive ability can explain the pattern of overbidding behavior in SPAs. We classify overbids into two categories: small overbid (overbids ≤ 10% of induced value) and large overbid (10% of induced value < overbids)[14].

Figure 3 exhibits the percentage of each type of overbids among total overbids in both cognitive groups. From the figure, it is clear that overbidding has a different pattern between the two cognitive groups, indicating that the pattern of overbidding is not homogeneous across individuals, consistent with the finding from Cooper and Fang (2008). Subjects in the higher cognitive group submit more small overbids while subjects in the lower cognitive group submit more large overbids. The two-sample proportion tests also reject the null hypothesis of equal proportions between two cognitive groups in both small overbid (z-statistic: 3.19, p-value: 0.001) and large overbid (z-statistic: -3.19, p-value: 0.001).

[14] The categories are somewhat arbitrary. We define a small overbid as one when bids are within 10 percent of induced value since subjects with small overbids have a less chance to win the auction and thus would not experience a negative feedback.

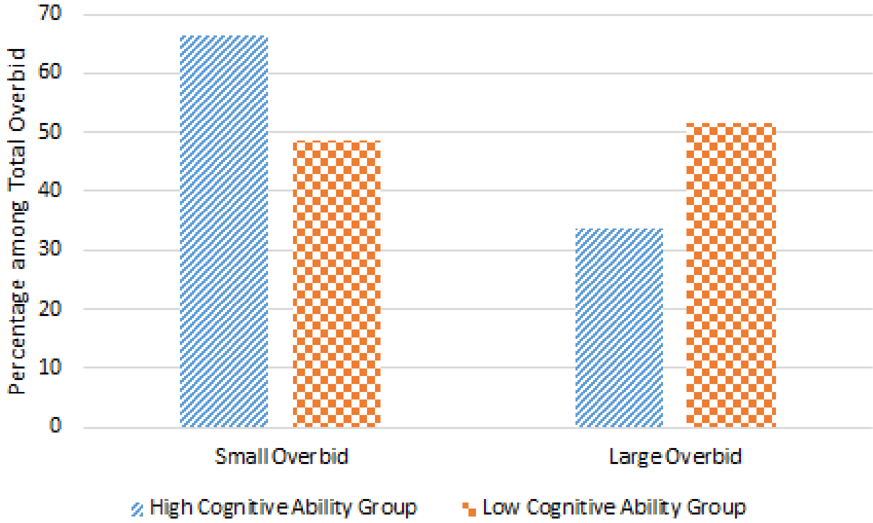

Figure 3. Pattern of Overbidding in Cognitive Groups

We confirm that cognitive ability impacts the pattern of overbidding using Probit models with the results reported in columns (1) and (2) of Table 7. The dependent variable in model (1) is a dummy for a small overbid; in model (2), the dependent variable is a dummy for large overbids. The results partially confirm our observation that subjects with greater cognitive ability are more likely to submit small overbids and less likely to submit large overbids as compared to subjects with lower cognitive ability as the coefficient of the treatment variable is only statistically significant in model (2). We also compare the magnitude of each type of overbid between the two cognitive groups with the results reported in columns (3) and (4) of Table 7. The dependent variable in model (3) is the magnitude of overbids when bids are small overbids; the dependent variable in model (4) is the magnitude of overbids when bids are large overbids. The results show that subjects with greater cognitive ability submit less extreme overbids as compared to subjects with lower cognitive ability in both models, but the coefficient is only statistically significant in model (3).

Table 7. The Effect of Cognitive Ability on the Pattern of Overbids

	Probability of Submitting Overbid		Magnitude of Overbid	
	Model (1) Small Overbids	Model (2) Large Overbids	Model (3) Small Overbids	Model (4) Large Overbids
Constant	-1.90 (0.63)***	-0.65 (1.07)	0.11 (0.32)	7.37 (11.74)
Higher Cognitive	0.35 (0.26)	-0.89 (0.44)**	-0.28 (0.12)**	-1.88 (4.12)
Induced Value	0.03 (0.007)***	-0.04 (0.01)***	0.02 (0.003)***	0.11 (0.17)
Gender	0.21 (0.26)	0.82 (0.45)*	0.08 (0.12)	4.99 (4.04)
Age	0.001 (0.02)	-0.04 (0.04)	0.004 (0.01)	-0.41 (0.43)
Employed	-0.45 (0.27)*	-0.16 (0.45)	-0.11 (0.12)	8.67 (4.18)**
Extraversion	0.08 (0.14)	-0.16 (0.24)	0.08 (0.06)	-1.65 (1.90)
Agreeableness	-0.21 (0.13)	0.06 (0.23)	-0.04 (0.06)	2.14 (2.16)
Conscientiousness	0.01 (0.14)	0.09 (0.24)	-0.02 (0.06)	-4.26 (2.41)*
Emotional stability	-0.01 (0.15)	-0.12 (0.25)	0.01 (0.07)	-1.51 (2.09)
Openness	0.17 (0.13)	0.27 (0.24)	0.07 (0.06)	-2.52 (2.77)
Grit	-0.07 (0.15)	-0.32 (0.27)	0.03 (0.07)	0.84 (3.03)
CFC	-0.16 (0.15)	0.15 (0.25)	0.03 (0.07)	-1.87 (2.06)
Round dummies	Yes	Yes	Yes	Yes
σ_u	1.23***	2.16***	0.42***	6.94***
σ_e	--	--	0.31***	15.45***
N	750	750	178	130
Log-likelihood	-329.54	-229.55	-100.39	-545.65

Note: Standard error for each coefficient shown in parentheses. *, **, and *** denote statistical significance at 10%, 5%, and 1%.

4. Conclusions

Researchers know that there are considerable behavioral anomalies in bidding behavior in experimental auctions. One of the consistent findings in previous experimental studies is that people deviate from rational behavior and often submit bids above their own valuation in second price auctions. Deciphering the reasons for these behavioral anomalies helps to assess the appropriateness of using these mechanisms to infer people's homegrown values.

We investigate how subjects' bidding behaviors in second price auction vary with their cognitive ability. This topic is particularly relevant given Li's (2017) claim that second price auctions are not Obviously Strategy-Proof. Our study is also motivated by previous findings about the importance of understanding an auction mechanism (e.g., Kagel *et al*., 1987; Ausubel, 2004; Li, 2017) and the role of cognitive ability in decision making and strategy games (e.g., Frederick, 2005; Dohmen *et al*., 2010; Smith *et al*., 2010, Burnham *et al*., 2009; Carpenter *et al*., 2013; Gill and Prowse, 2016). To examine our objectives, we gave each subject a cognitive ability test and then classified and separated subjects based on the outcome of the test before having them participate in a series of second price auctions.

We found that at the aggregate level, the pattern of overbidding is somewhat moderated for subjects with greater cognitive ability. At the individual level, subjects in the higher cognitive group tended to submit bids closer to their induced values than subjects in the lower cognitive group. We also found that overbidding and bid deviation are more pronounced for subjects with lower cognitive ability when values for the item are relatively small. Subjects with greater cognitive ability are also less likely to submit bids far exceeding their value. The overbids from higher cognitive ability subjects are also smaller in magnitude than the overbids from lower cognitive ability subjects.

The results provide evidence that more cognitively able subjects behave in closer accordance with theory and that cognitive skills can partially explains heterogeneity in bidding behavior. Our results have important implications for future studies using second price auctions to infer homegrown values. Specifically, researchers should collect a measure of cognitive ability when performing such studies so as to better identify the true underlying demand conditions by being able to discount data collected from low ability subjects.

Acknowledgements

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Appendix. Additional Tables and Figures

1. Comparison of Truthful Bidding Behavior between Two Cognitive Groups

We estimate a bidding function to compare and test truthful bidding behavior between the two cognitive groups at the individual level. Given the prediction of induced value theory in the second price auction, the bidding function is specified as linear in induced value. Since we have individual bids for multiple auction rounds, we consider the panel nature of the bidding data by estimating random effects regression models.

$$Bid_{iR} = \alpha + \beta_1 IV_{iR} + \tau_R + u_i + \varepsilon_{iR} \quad (A1)$$

$$Bid_{iR} = \alpha + \beta_1 IV_{iR} + \beta_2 DHigh_i + \beta_3 IV_{iR} \times DHigh_i + \tau_R + u_i + \varepsilon_{iR} \quad (A2)$$

where Bid_{iR} is an individual i's bid in round R; IV_{iR} denotes individual i's induced values in round R; $DHigh_i$ is a dummy for individuals with greater cognitive skills; τ_R denotes round fixed effects; u_i is random effects which control for unobservable individual characteristics; ε_{iR} is the error term.

Table A1 shows the estimation results and Wald test statistics for the hypothesis that bidders are perfectly demand revealing. We first estimate the bidding function using equation (A1) separately for each cognitive group (column (1) of Table A1 for the higher cognitive group and column (2) for the lower cognitive group). Regression results of equation (A2) using the pooled data are reported in column (3) of Table A1. The Wald tests fails to reject the hypothesis of perfectly demand revealing bids in all three models[1]. We also test whether subjects in both

[1] As explained in Drichoutis et al. (2015), the test result in table A1 is a test of the hypothesis of perfectly demand revealing bids only in round 1. Following their approach, we test the hypothesis on a round by round basis in table A2.

cognitive groups have similar bidding behaviors. Bidding behavior between the two cognitive groups is similar if the coefficients of the dummy for subjects with greater cognitive ability and its interaction with induced value in the pooled model are both zero. The joint test fails to reject the hypothesis of similar bidding behavior between the two cognitive groups (χ^2 (2) = 1.86, p-value = 0.39). However, the intercept and the coefficient of the induced value variable are close to zero and one, respectively, in the regression results for the higher cognitive group while the intercept is relatively away from zero in the regression results for the lower cognitive group. Figure A1 plots the predicted bids in both cognitive groups against induced value. The predicted bids of subjects with greater cognitive skills are below the bids of subjects with lower cognitive skills, and they are more close to the perfect demand line. The divergence between bids and induced value in the lower cognitive group is relatively greater when the induced value is small, and it decreases with induced value.

Table A1. Test for Perfect Demand Revelation

	Higher cognitive	Lower cognitive	Pooled
Constant	0.38 (0.80)	2.38 (1.52)	2.24 (1.13)**
Induced Value	1.01 (0.02)***	0.95 (0.05)***	0.95 (0.04)***
Round 2	-0.19 (0.62)	-0.95 (1.26)	-0.57 (0.71)
Round 3	0.69 (0.62)	0.65 (1.26)	0.67 (0.71)
Round 4	0.67 (0.62)	1.04 (1.26)	0.85 (0.71)
Round 5	0.19 (0.62)	-0.75 (1.26)	-0.28 (0.71)
High Cognitive	--	--	-1.73 (1.47)
IV×High Cognitive	--	--	0.06 (0.05)
σ_u	4.76***	8.04***	6.60***
σ_e	3.82***	7.75***	6.12***
N	375	375	750
Log-likelihood	-1115.85	-1369.48	-2566.39
Perfect demand	χ^2 (6) = 6.20	χ^2 (6) = 7.08	χ^2 (6) = 7.41

Note: Standard error for each coefficient shown in parentheses. ** and *** denote statistical significance at 5% and 1%.

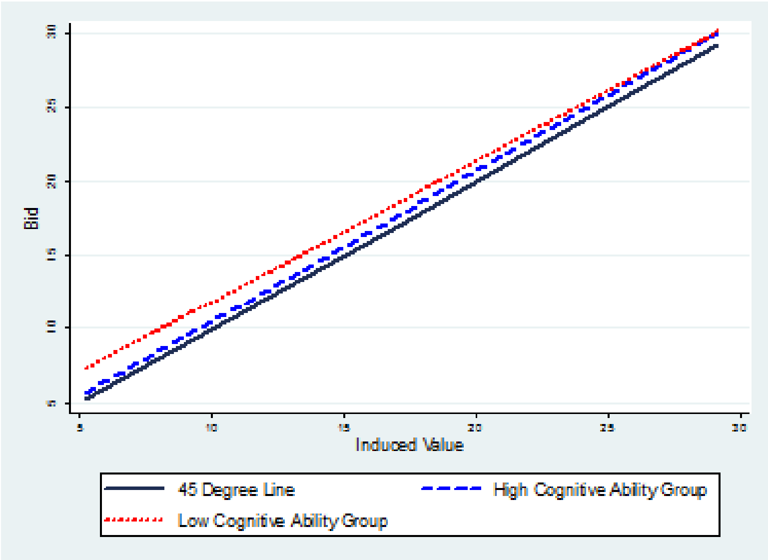


Figure A1. Bids vs Induced value

We next examine if bids exhibit perfect demand revelation by round. Table A2 presents the results from the Wald tests of the hypothesis of perfectly demand revealing bids for each round. The Wald tests fail to reject the hypothesis in all rounds in the higher cognitive group while the hypothesis of perfectly demand revelation is rejected in rounds 3 and 4 at the 5 percent significance level in the lower cognitive group.

Table A2. Test for Perfect Demand Revelation by Round

	Higher cognitive		Lower cognitive	
	χ^2-statistic	p-value	χ^2-statistic	p-value
Round 1	0.89	0.64	4.00	0.13
Round 2	0.24	0.88	2.60	0.27
Round 3	2.60	0.27	6.59	0.03
Round 4	3.24	0.19	7.47	0.02
Round 5	0.48	0.79	3.22	0.19

2. The Effect of Cognitive Ability on Bid Deviation (Based on RSPM Score)

Table A3. The Effect of Cognitive Ability on Bid Deviation (RSPM Score)

	Without Controls	With Controls
Constant	11.73 (8.48)	14.79 (9.02)*
RSPM	-0.25 (0.16)	-0.25 (0.16)
Induced Value	0.05 (0.03)	0.05 (0.03)
Gender	--	1.37 (1.46)
Age	--	-0.18 (0.12)
Employed	--	1.22 (1.49)
Extraversion	--	-0.54 (0.80)
Agreeableness	--	0.38 (0.75)
Conscientiousness	--	-0.21 (0.79)
Emotional Stability	--	-0.98 (0.83)
Openness	--	0.62 (0.77)
Grit	--	-0.59 (0.88)
CFC	--	-0.39 (0.83)
Round dummies	Yes	Yes
σ_u	8.11 (0.59)***	7.80 (0.58)***
σ_e	6.78 (0.21)***	6.78 (0.21)***
N	750	750
Log-likelihood	-2162.33	-2157.05

Note: Standard error for each coefficient shown in parentheses. * and *** denote statistical significance at 10% and 1%.

Supplemental Material (Not for Publication)

1. Outline of the Design of the Experiment

10 subjects in a session	A total of 15 sessions (150 subjects)

↓

Participants sign a consent form and are then seated as a computer

↓

Introduction and Raven instruction with two examples

↓

Raven Test (60 puzzle problems)
Classifying a subject as either “High Cognitive Ability” or “Low Cognitive Ability” based on the test score

↓

Auction instruction with examples and review questions

↓

Two rounds of induced value practice auction with feedback about the profit

↓

Five rounds of actual paid induced value auction without feedback about the profit

↓

Summary for the Raven test score and Five rounds of actual auction

↓

Questionnaire

2. Information on the Selection and Eligibility of Participants

The research was reviewed and approved by the Institutional Review Board at a large state university in the U.S. (IRB #16-11-268). The subjects in the experiment were recruited from the behavioral lab's database of volunteers at a large state university in the U.S. A majority of the subjects were undergraduate students. To recruit the subjects, the researchers posted timeslot of the study with brief description about the study (i.e., a brief objective of the study, time length, payment). The subjects voluntarily participated in the study and they were free to withdraw from the study at any point with no negative repercussions. The subjects were also informed that all information in the experiment will remain confidential to the extent allowed by law and University policy.

3. Experimental Instructions

Instructions were provided in both paper form and computerized form within the z-Tree environment.

Introduction

Thank you for participating in this experimental session on economic decision-making. You are about to participate in the experiment. You will be asked to complete some survey questions and participate in the auction. Please follow all instructions carefully.

You will receive $10 for completing the study plus whatever you earn in the study. During the experiment you will have the opportunity to purchase fictitious goods. If you make money in an auction this amount will be added to your $10. If you lose money in an auction then this amount will be subtracted from your $10. You will be paid privately in cash at the end of the experiment.

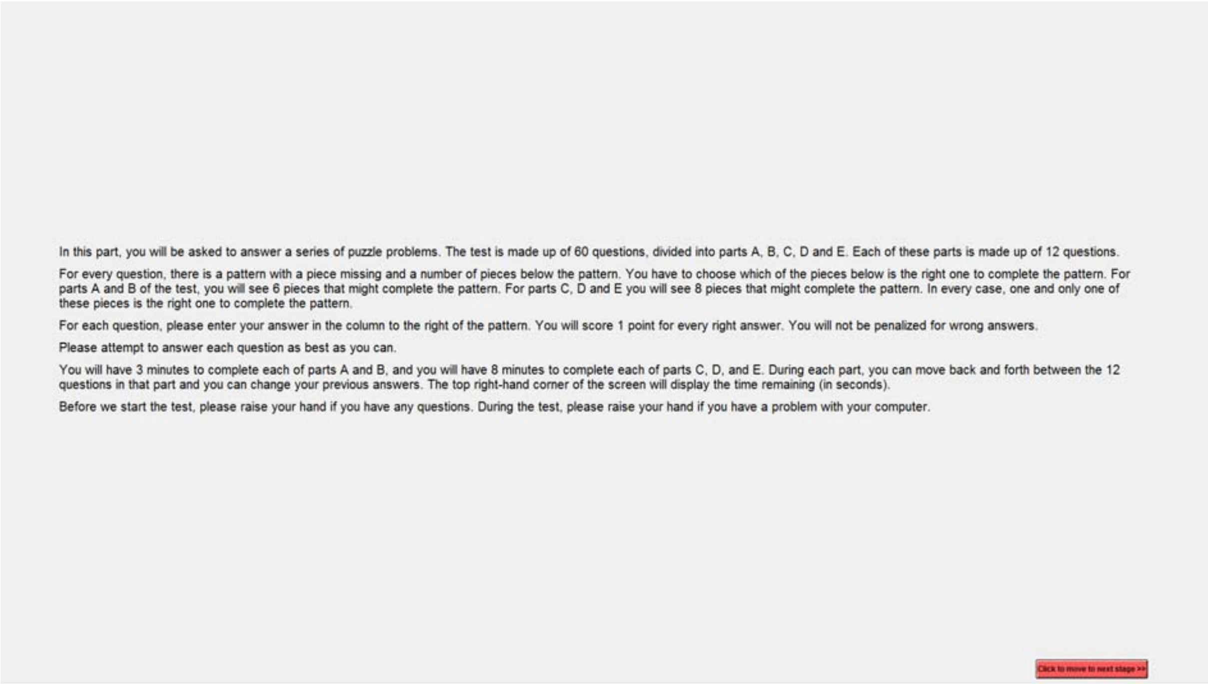
Throughout the experiment, you should not talk or communicate in any way with any other participant. Doing so will result in your dismissal from the study. If you have a question at any point, quietly raise your hand and someone will approach you.

In the study you will be provided with an ID number. This ID number is used to associate your actions with your responses and payoff, but is designed to ensure your anonymity. Please use this ID number (and not your student ID number) where requested throughout the remainder of the study.

You should read all instructions carefully and answer any questions accurately. It is very important to understand instructions because you may earn or lose money depending on your decisions.

Please now turn off cell phones and any other electronic devices.

Screen 1 (Raven Instruction)


In this part, you will be asked to answer a series of puzzle problems. The test is made up of 60 questions, divided into parts A, B, C, D and E. Each of these parts is made up of 12 questions.

For every question, there is a pattern with a piece missing and a number of pieces below the pattern. You have to choose which of the pieces below is the right one to complete the pattern. For parts A and B of the test, you will see 6 pieces that might complete the pattern. For parts C, D and E you will see 8 pieces that might complete the pattern. In every case, one and only one of these pieces is the right one to complete the pattern.

For each question, please enter your answer in the column to the right of the pattern. You will score 1 point for every right answer. You will not be penalized for wrong answers.

Please attempt to answer each question as best as you can.

You will have 3 minutes to complete each of parts A and B, and you will have 8 minutes to complete each of parts C, D, and E. During each part, you can move back and forth between the 12 questions in that part and you can change your previous answers. The top right-hand corner of the screen will display the time remaining (in seconds).

Before we start the test, please raise your hand if you have any questions. During the test, please raise your hand if you have a problem with your computer.

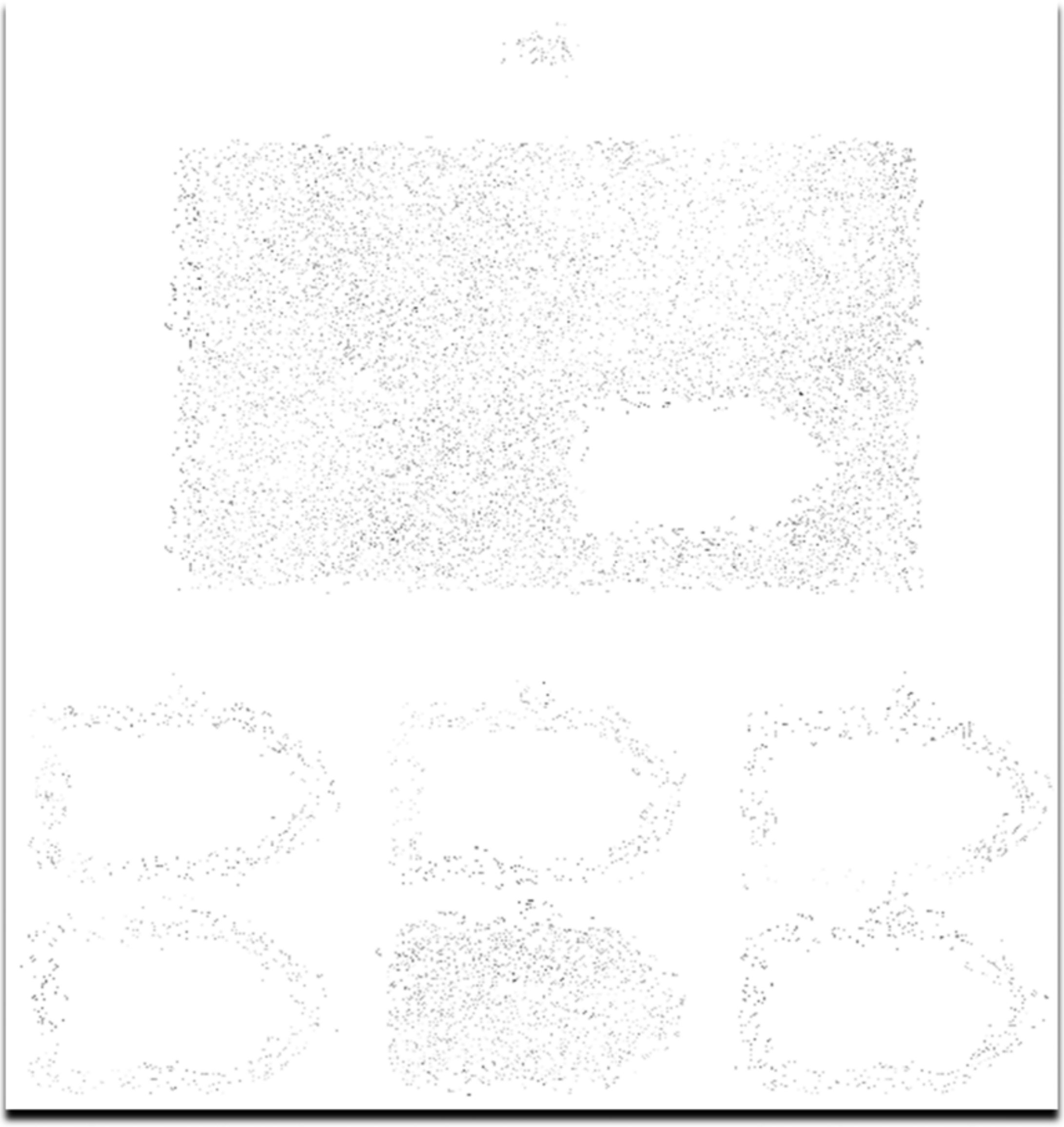
Click to move to next stage >>

Here are some examples of the kinds of problems that you will answer.

Example 1. The top part of Problem A1 is a pattern with a bit cut out of it. Look at the pattern, think what the piece needed to complete the pattern correctly both along and down must be like. Then find the right piece out of the six bits shown below. Only one of these pieces is perfectly correct. (RSPM images are blurred here due to copyright issues)

Answer: Number 4

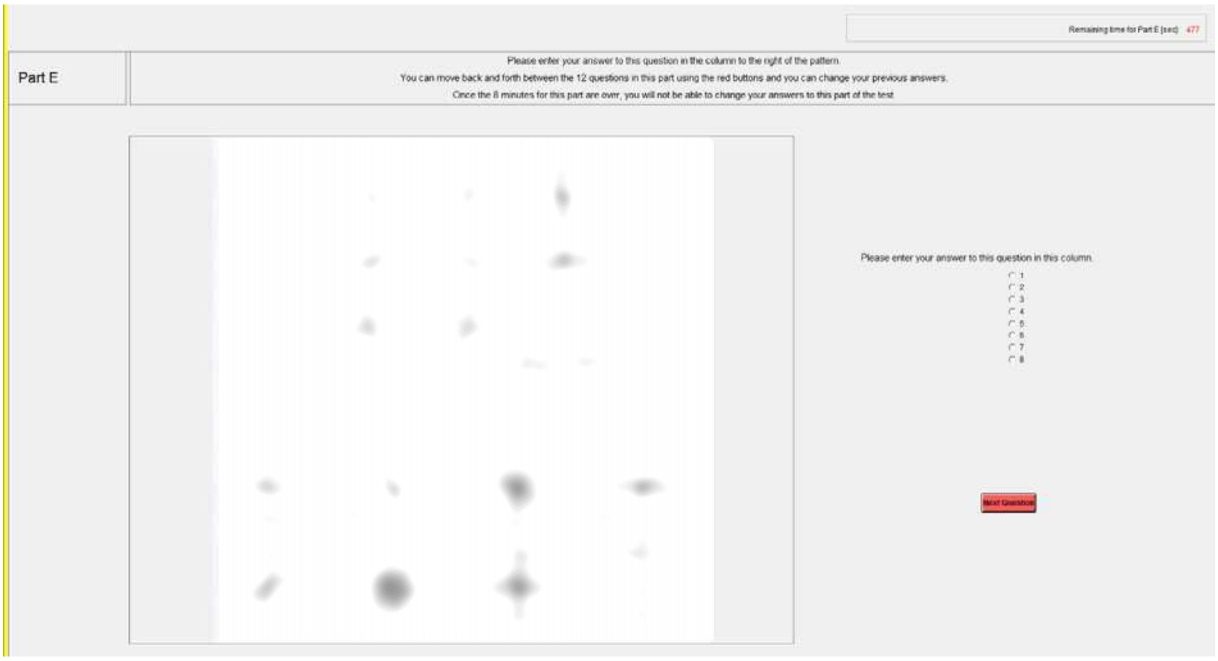
Example 2. The top part of Problem A2 is a pattern with a bit cut out of it. Look at the pattern, think what the piece needed to complete the pattern correctly both along and down must be like. Then find the right piece out of the six bits shown below. Only one of these pieces is perfectly correct. (RSPM images are blurred here due to copyright issues)



Answer: Number 5

- Please look at your computer now –

Screen 2 (One Sample Screen Shot of the Raven Test) (RSPM images are blurred here due to copyright issues)



Screen 3 (The Raven Test Result)

Auction Instructions

In this study you will be participating in a series of **second price sealed bid auctions**.

In these auctions you will be asked how much you would be willing to pay for a fictitious good. Although the good is fictitious, it will have some "**real value**" to you - you can think of this as being the amount of money that the experimenter will pay you for the item if you obtained it in the auction ("**resale value**").

Prior to the start of an auction, you will be provided with your **resale value.** You will complete multiple auctions and your resale value for the good will change for each auction. Each of the four other bidders will also receive a resale value. The resale value for the four other bidders is different from yours and also changes for each auction.

Resale values are drawn from $0.00 to $30.00. The resale values that you receive are independent, which means that knowing your resale value for any one round gives you no additional information about your resale values for the other rounds. You will never learn the resale values of others and they will never learn your resale value.

In an auction, the bidder placing **the highest bid will buy the good at the second highest bid** and then **resale it to the experimenter at his or her own resale value**.

Thus, the highest bidder's profit in each round will be determined as follows:
Profit = Assigned Resale Value – Second Highest Bid in the round

The profit for every bidder that is not the highest bidder is $0.

Procedure

Each second price auction has 5 basic steps:

Step 1: Each of the five bidders look at his/her *resale value* displayed at the computer screen.
Step 2: Each of the five bidders submits a bid to buy the good through the computer
Step 3: The computer ranks all five bids from highest to lowest
Step 4: The person that submit the highest bid buys the good but pays the second highest bid. If you do not bid the highest bid then you do not purchase the good.
Step 5: The person who purchases the good, sells the good back to the experimenter at his/her resale value. Thus, his/her profit is determined by the difference between a resale value and the second highest bid he/she paid (the profit = the resale value – the second highest bid). If you do not purchase the good, your profit is zero.

The profit could be either a positive or negative value:

Positive: If you are the highest bidder and your resale value is bigger than the second highest bid (Resale value - Second highest bid > 0), your profit will be positive.

Negative: If you are the highest bidder and your resale value is smaller than the second highest bid (Resale value - Second highest bid < 0), your profit will be negative.

Examples

Here are 5 examples of what could happen.

Example 1. Suppose the resale value assigned to you was $2.75.

Your bid - $2.50: Let's say your bid was $2.50 and other participants bid $1.80, $1.95, $2.05, and $2.35. You are the top 1 bidder and thus your profit in this round is $0.40 (= your resale value ($2.75) – the second highest bid ($2.35)).

Example 2. Suppose the resale value assigned to you was $2.50.

Your bid - $1.90: Let's say your bid was $1.90 and other participants bid $1.71, $1.91, $2.15, and $2.35. You are not the top 1 bidder and thus you earn $0 as your profit in this round.

Example 3. Suppose the resale values assigned to you was $1.70.

Your bid - $2.05: Let's say your bid was $2.05 and other participants bid $1.60, $1.80, $1.85, and $2.00. You are the top 1 bidder and thus your profit in this round is -$0.30 (= your resale value ($1.70) – the second highest bid ($2.00)).

Example 4. Suppose the resale values assigned to you was $2.00.

Your bid - $2.50: Let's say your bid was $2.50 and other participants bid $1.65, $1.85, $1.90, and $2.00. You are the top 1 bidder and thus your profit in this round is $0 (= your resale value ($2.00) – the second highest bid ($2.00)).

Example 5. Suppose the resale values assigned to you was $2.20.

Your bid - $2.20: Let's say your bid was $2.20 and other participants bid $1.77, $1.89, $1.95, and $2.15. You are the top 1 bidder and thus your profit in this round is $0.05 (= your resale value ($2.20) – the second highest bid ($2.15)).

Review Questions

Before we begin the study, we would like you to answer some questions that are meant to review the rules of the auctions.

<u>Your earnings will not be affected by your answers to these questions</u>. It is only intended to ensure that you understand the experiment rules. Please raise your hand once you are done. The experimenter will explain the answers once everyone has finished.

1. How many people can obtain the profit in an auction (round)?

2. Suppose the resale value assigned to you is $2.50. You bid $2.30 which is the highest bid among bidding participants and the second highest bid is $2.20. What is your profit in this auction?

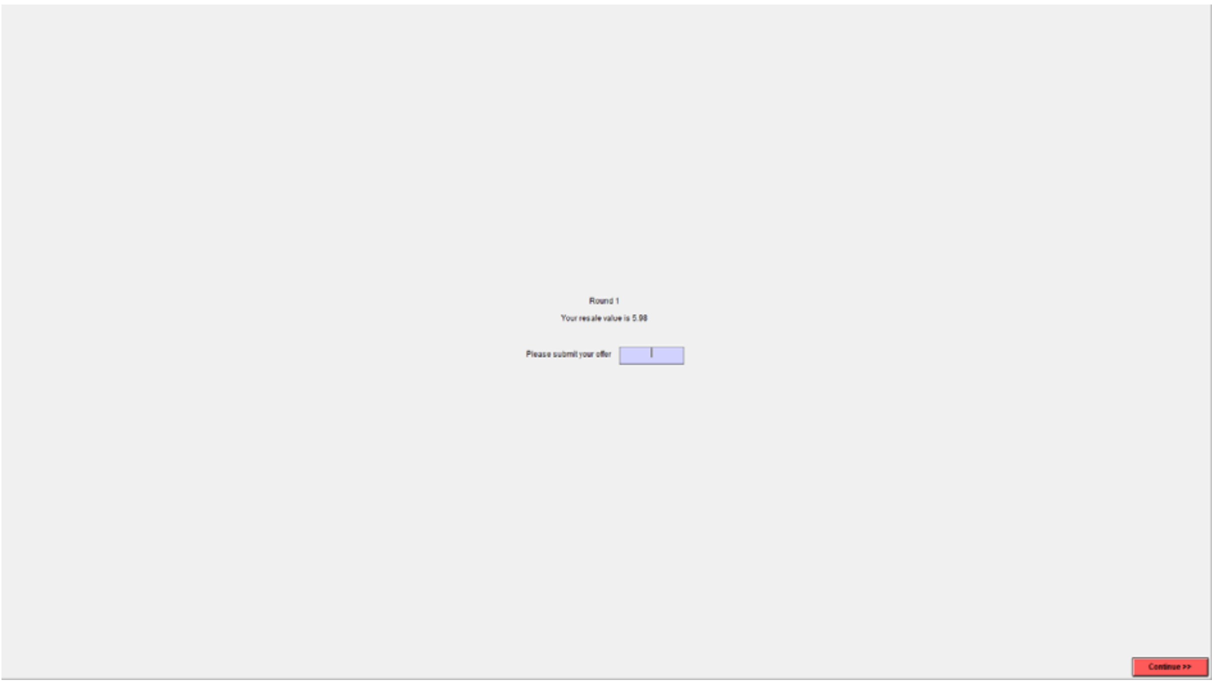
3. Suppose the resale value assigned to you is $2.30. You bid $2.50 which is the highest bid among bidding participants and the second highest bid is $2.40. What is your profit in this auction?

Before we proceed – are there any questions about the procedures of auctions? If so, please raise your hand and someone will approach you.

- Please look at your computer now –

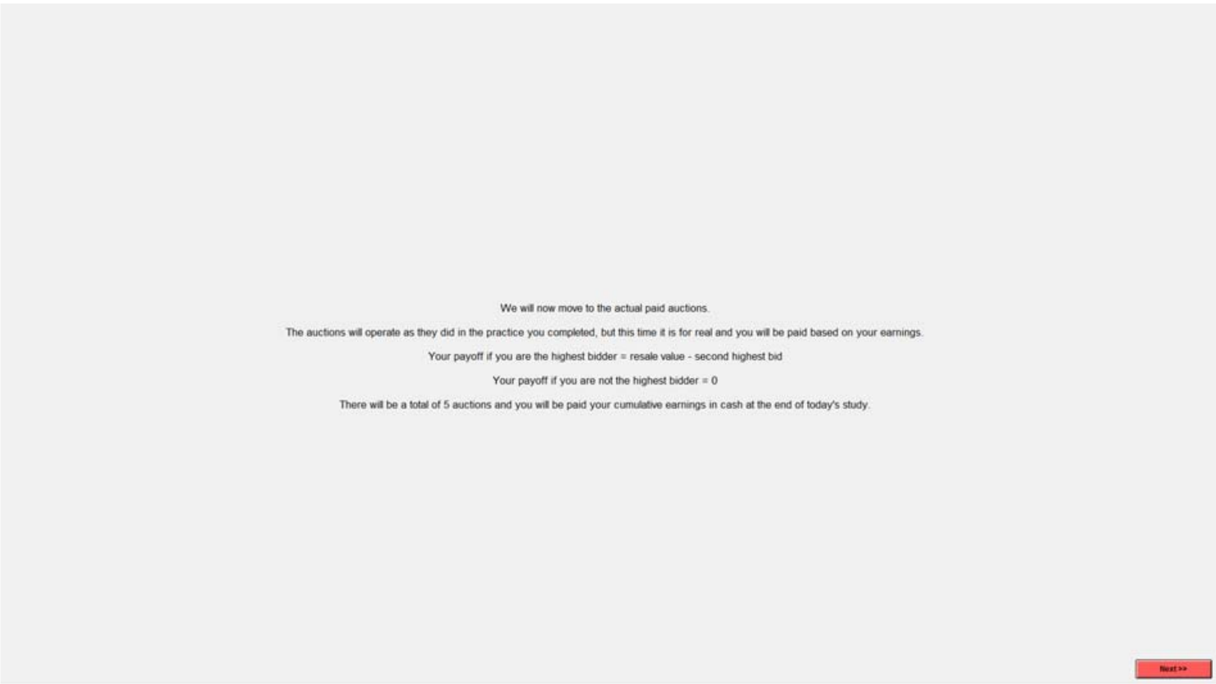
Screen 4 (Practice Auction Instruction)

Screen 5 (One Sample Screen Shot of the Practice Auction)

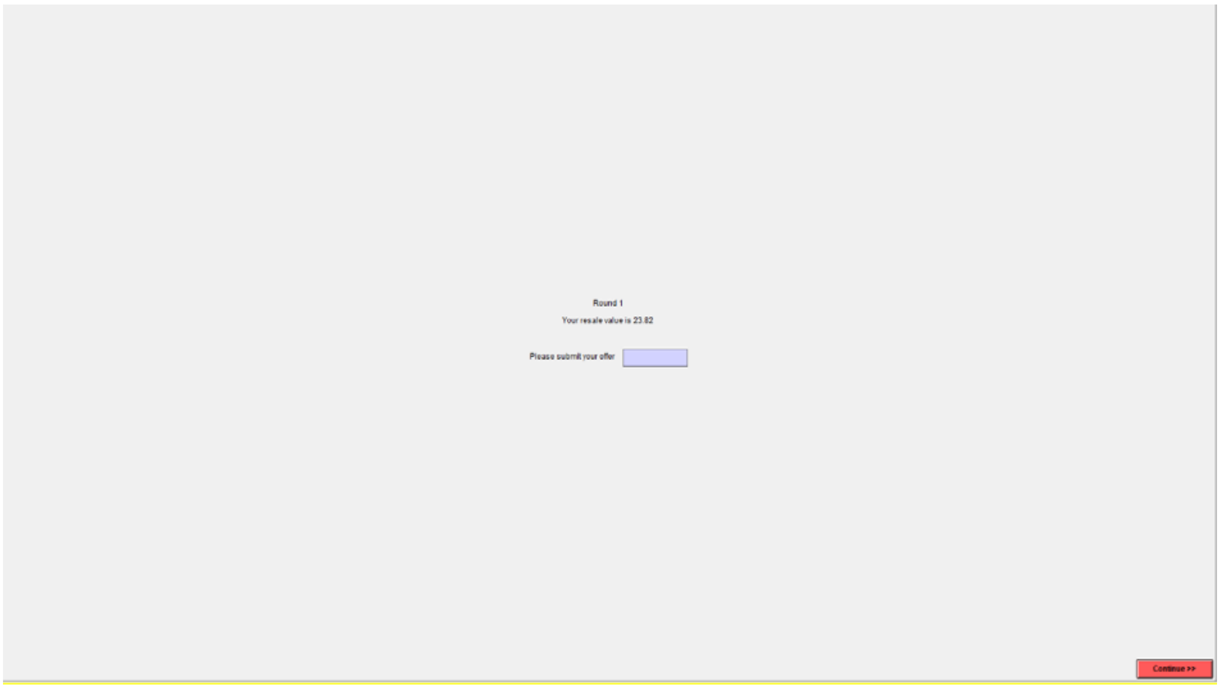


Screen 6 (One Sample Screen Shot of the Practice Auction)

Screen 7 (Actual Auction Instruction)



Screen 8 (One Sample Screen Shot of the Actual Auction)



Screen 9 (Summary)

	Round 1	Round 2	Round 3	Round 4	Round 5
Your resale values was:	23.82	5.18	11.26	29.12	17.16
Your bid was:	23.82	5.18	11.26	29.12	17.16
The 2nd highest price was:	23.82	23.82	23.82	23.82	23.82
You ... :	...were NOT the highest bidder.	...were NOT the highest bidder.	...were NOT the highest bidder.	...were the highest bidder.	...were NOT the highest bidder.
Your payoff (Resale value - 2nd Highest price) is:	0.00	0.00	0.00	5.30	0.00

Your cumulative payoff over all Rounds is: 5.30

At the start of this session you took a test. Your test score was 1 out of 60.

Continue >>