Cross-game Learning and Cognitive Ability in Auctions – Supplementary Material

Appendix

Additional Tables and Figures

Table A1: Bids: Descriptive statistics

Treatment	Cogn. Group	FPA					SPA				
		Mean	Std. Dev.	Median	Min.	Max.	Mean	Std. Dev.	Median	Min.	Max.
FPA/SPA	LC	31.37	20.19	30	0	100	48.70	29.11	49	0	101
	HC	30.69	18.99	30	0	80	49.32	30.43	46.5	0	100
	all	31.1	19.71	30	0	100	48.95	29.64	48	0	101
SPA/FPA	LC	33.31	21.72	32	0	109	57.22	31.24	60	0	200
	HC	32.46	20.12	33	0	88	50.39	29.36	50	0	200
	all	32.86	20.87	32	0	109	53.57	30.42	54	0	200
Both	LC	32.20	20.87	31	0	109	52.35	30.32	52	0	101
	HC	31.69	19.65	32	0	88	49.92	29.82	49	0	200
	all	31.96	20.31	31	0	109	51.22	30.11	51	0	200

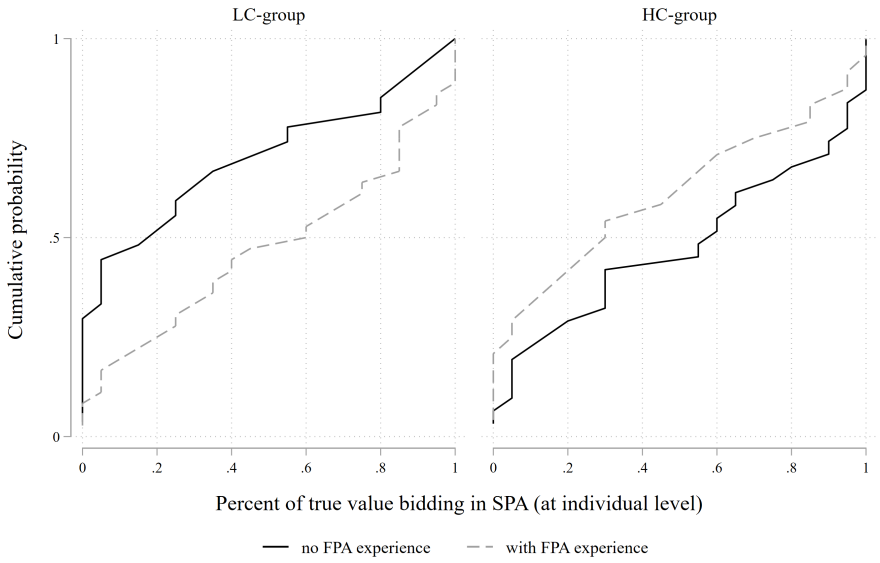


Figure A1: Percent of true-value bid decisions at the individual level in SPAs, across treatments and cognitive groups.

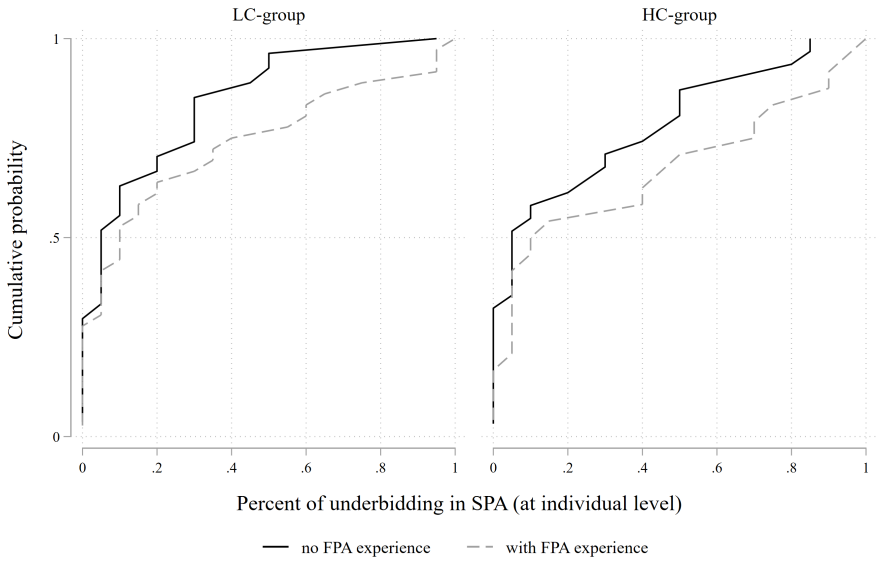


Figure A2: Percent of underbidding decisions at the individual level in SPAs, across treatments and cognitive groups.

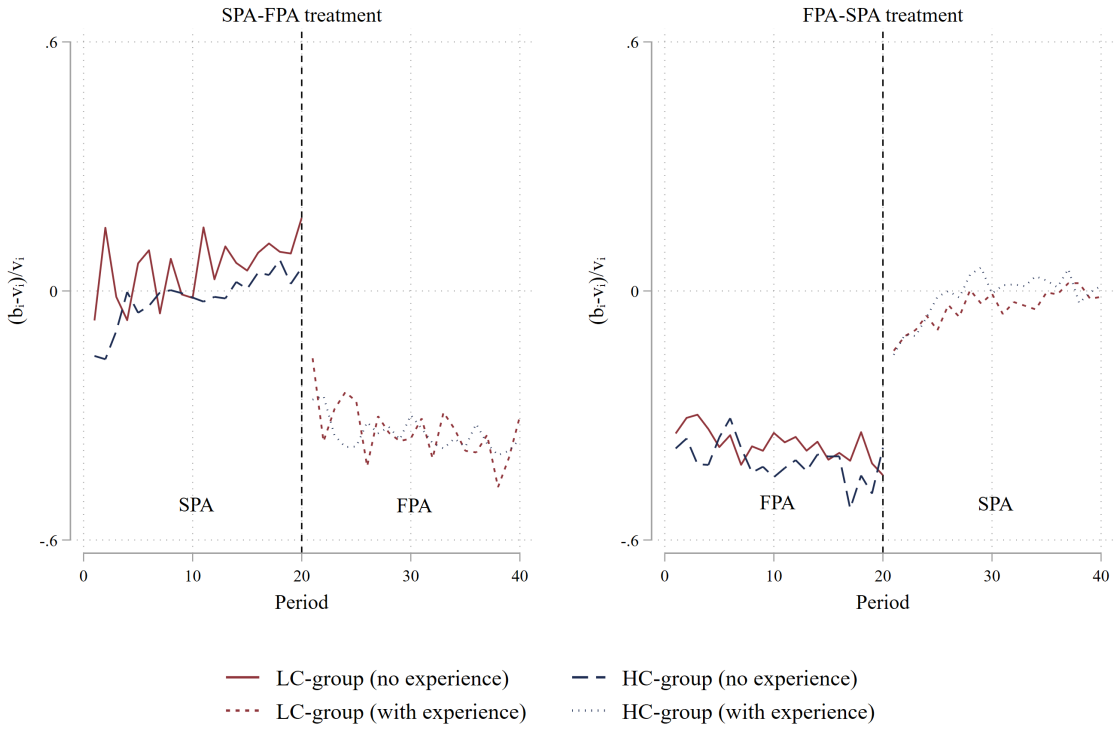


Figure A3: Average relative overbidding, $(b_i - v_i)/v_i$, over time by treatment and cognitive group for $v_i > 50$.

Table A2: SPA: Probit analysis (marginal effects).

	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)
Dependent Variable:	Overbid–Dummy = 1 if bid>value							
Reference category:	LC–group (without CGL, first 10 auctions)				LC–group (without CGL)		LC–group (without CGL, first 10 auctions)	
CognD (HC=1)	-0.294**	-0.275**	0.0958	0.142	-0.245***	-0.231**	-0.241**	-0.228*
	(0.131)	(0.134)	(0.104)	(0.118)	(0.0856)	(0.0901)	(0.116)	(0.120)
TimeD (auctions 11-20)	0.0726***	0.0749***	0.119***	0.120***			0.102***	0.102***
	(0.0168)	(0.0148)	(0.0269)	(0.0290)			(0.0142)	(0.0152)
CGL-D (FPA experience=1)					-0.301***	-0.314***	-0.304***	-0.316***
					(0.0725)	(0.0807)	(0.0716)	(0.0798)
CognD × TimeD	0.0296	0.0344	-0.0627	-0.0618			-0.0103	-0.00841
	(0.0701)	(0.0660)	(0.0461)	(0.0449)			(0.0719)	(0.0706)
CognD × CGL-D					0.349***	0.365***	0.370***	0.388***
					(0.0957)	(0.121)	(0.118)	(0.143)
CognD × TimeD × CGL-D							-0.0289	-0.0303
							(0.0545)	(0.0532)
Value		-0.000450		-0.00184		-0.00120		-0.00120
		(0.00261)		(0.00191)		(0.00151)		(0.00150)
Value^2		-1.53e-06		1.71e-05		8.02e-06		8.20e-06
		(2.71e-05)		(1.86e-05)		(1.68e-05)		(1.66e-05)
Female		0.134		0.108**		0.110		0.111
		(0.0868)		(0.0545)		(0.0687)		(0.0689)
Switch point (H&L)		-0.0384		0.0382***		0.00367		0.00339
		(0.0401)		(0.00588)		(0.0176)		(0.0177)
Incl. Obs.	SPA/FPA	SPA/FPA	FPA/SPA	FPA/SPA	All	All	All	All
Observations	1,160	1,160	1,200	1,200	2,360	2,360	2,360	2,360
Number of Subj.	58	58	60	60	118	118	118	118

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

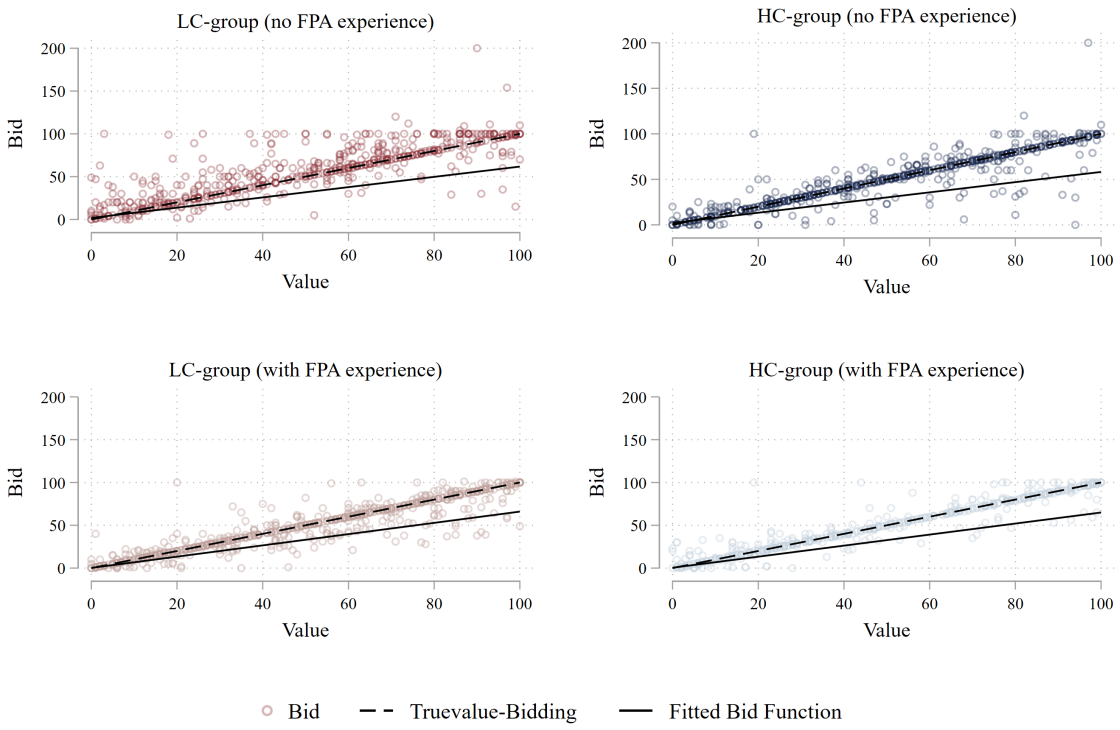


Figure A4: SPA: Scatter plots of individual bids by treatment and cognitive group.

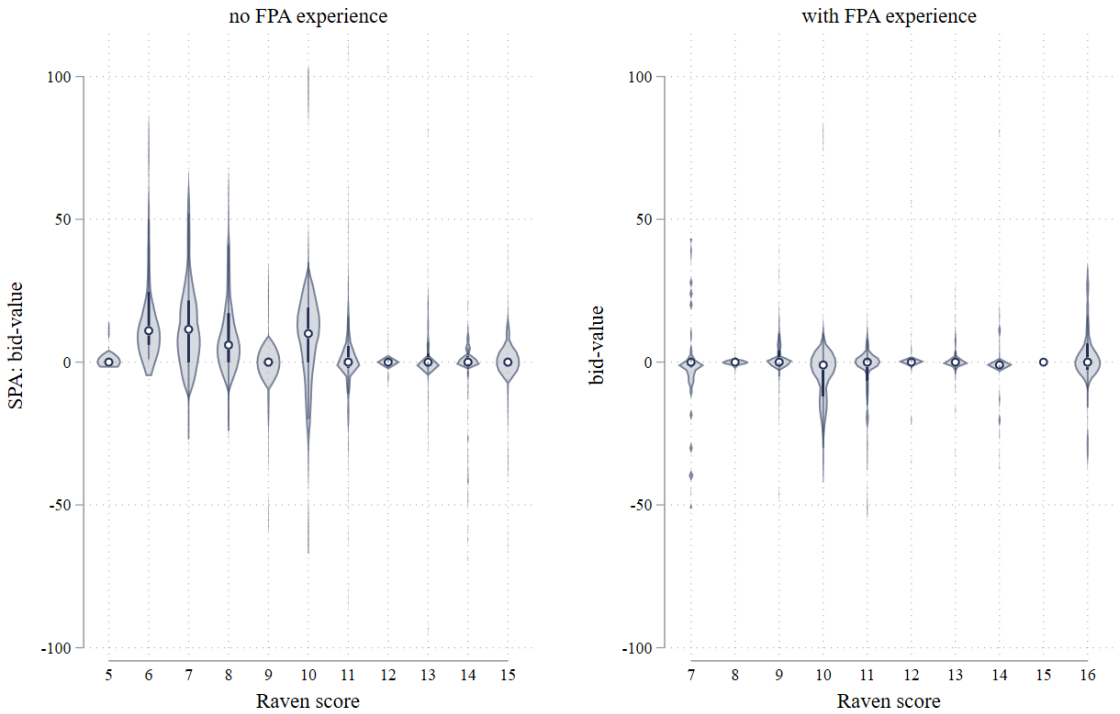


Figure A5: SPA: Violin plots for bid-value deviation, $b_i - v_i$, by Raven score.

Table A3: SPA: Bid deviation from true-value bidding using the number of correctly solved matrices (Raven score), instead of cognitive dummy (CognD); GLS regressions.

	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)
Dependent Variable:	$b_i - v_i$	$b_i - v_i$	$b_i - v_i$	$b_i - v_i$	$b_i - v_i$	$b_i - v_i$	$b_i - v_i$	$b_i - v_i$
Constant	19.94***	24.76***	-5.010	-7.659***	21.40***	22.85***	18.97***	20.51***
	(4.457)	(2.618)	(4.734)	(1.649)	(4.955)	(4.726)	(4.450)	(3.841)
Ravenscore	-1.687***	-1.669***	0.241	0.305	-1.652***	-1.648***	-1.606***	-1.617***
	(0.374)	(0.445)	(0.368)	(0.299)	(0.403)	(0.447)	(0.364)	(0.417)
TimeD (auctions 11-20)	2.927	2.733	6.827**	6.548**			4.871*	4.624
	(4.213)	(3.953)	(3.027)	(2.943)			(2.825)	(2.820)
CGL-D (FPA experience=1)					-23.00***	-23.25***	-23.00***	-23.26***
					(6.734)	(6.499)	(6.738)	(6.502)
Ravenscore × TimeD	0.0692	0.0961	-0.356	-0.339			-0.0920	-0.0629
	(0.466)	(0.444)	(0.237)	(0.232)			(0.338)	(0.336)
Ravenscore × CGL-D					1.715***	1.731***	1.761***	1.786***
					(0.531)	(0.517)	(0.507)	(0.499)
Ravenscore × TimeD × CGL-D							-0.0930	-0.110
							(0.186)	(0.190)
Value		-0.00591		-0.0143		-0.0125		-0.0110
		(0.0517)		(0.0617)		(0.0401)		(0.0416)
Value^2		-0.000636		-0.000302		-0.000441		-0.000455
		(0.000707)		(0.000463)		(0.000462)		(0.000463)
Female		1.059		0.471		0.613		0.612
		(2.111)		(2.021)		(1.958)		(1.961)
Switch point (H&L)		-0.527		0.609**		0.0718		0.0719
		(0.762)		(0.282)		(0.402)		(0.402)
Incl. Obs.	SPA/FPA	SPA/FPA	FPA/SPA	FPA/SPA	All	All	All	All
Observations	1,160	1,160	1,200	1,200	2,360	2,360	2,360	2,360
Number of Subj.	58	58	60	60	118	118	118	118

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A4: SPA: Bid deviation from true-value bidding; excluding Raven score=11 (the mode/median); GLS regressions.

	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)
Dependent Variable:	$b_i - v_i$	$b_i - v_i$	$b_i - v_i$	$b_i - v_i$	$b_i - v_i$	$b_i - v_i$	$b_i - v_i$	$b_i - v_i$
Reference category:	LC–group (without CGL, first 10 auctions)				LC–group (without CGL)		LC–group (without CGL, first 10 auctions)	
Constant	7.094***	11.31**	-2.559	-6.917***	9.484***	9.870***	7.334***	7.735***
	(2.431)	(4.437)	(1.971)	(1.579)	(2.656)	(1.505)	(2.707)	(1.681)
CognD (HC=1)	-9.410***	-9.227***	1.855	3.211	-10.07***	-9.924***	-9.651***	-9.589***
	(2.738)	(3.136)	(2.101)	(2.290)	(2.534)	(2.718)	(2.972)	(3.199)
TimeD (auctions 11-20)	4.781***	4.946***	4.015**	3.896**			4.300***	4.236***
	(1.447)	(1.656)	(1.622)	(1.570)			(1.364)	(1.411)
CGL-D (FPA experience=1)					-10.04***	-10.56***	-10.04***	-10.55***
					(2.846)	(2.609)	(2.849)	(2.610)
CognD × TimeD	-1.314	-1.347	-2.319	-2.253			-0.832	-0.670
	(2.912)	(2.971)	(1.418)	(1.384)			(3.169)	(3.200)
CognD × CGL-D					10.76***	11.33***	11.65***	12.31***
					(2.655)	(2.604)	(2.911)	(2.926)
CognD × TimeD × CGL-D							-1.772	-1.948
							(3.149)	(3.197)
Value		-0.056		-0.009		-0.031		-0.031
		(0.068)		(0.071)		(0.043)		(0.046)
Value^2		-0.000		-0.000		-0.000		-0.000
		(0.001)		(0.000)		(0.000)		(0.0004)
Female		0.717		3.123*		1.804		1.804
		(3.454)		(1.783)		(2.167)		(2.170)
Switch point (H&L)		-0.135		0.660**		0.265		0.265
		(1.283)		(0.295)		(0.620)		(0.621)
Incl. Obs.	SPA/FPA	SPA/FPA	FPA/SPA	FPA/SPA	All	All	All	All
Observations	940	940	1,020	1,020	1,960	1,960	1,960	1,960
Number of Subj.	47	47	51	51	98	98	98	98

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A5: FPA: Relative bid shading using the number of correctly solved matrices (Raven score), instead of cognitive dummy (CognD); GLS regressions.

	(1a)	(1b)	(1c)	(1d)	(2a)	(2b)	(2c)	(2d)
Dependent Variable:	$\frac{v_i-b_i}{v_i}$	$\frac{v_i-b_i}{v_i}$	$\frac{v_i-b_i}{v_i}$	$\frac{v_i-b_i}{v_i}$	$\frac{v_i-b_i}{v_i}$	$\frac{v_i-b_i}{v_i}$	$\frac{v_i-b_i}{v_i}$	$\frac{v_i-b_i}{v_i}$
Constant	0.277***	0.287***	0.258***	0.249***	0.199**	0.212***	0.206***	0.200***
	(0.0797)	(0.0574)	(0.0673)	(0.0509)	(0.0963)	(0.0672)	(0.0677)	(0.0513)
Ravenscore	0.00758	0.00620	0.0114**	0.00956**	0.0126**	0.0108*	0.0146***	0.0127**
	(0.00641)	(0.00596)	(0.00489)	(0.00463)	(0.00641)	(0.00571)	(0.00560)	(0.00515)
TimeD (auctions 11-20)					0.158***	0.147***	0.102***	0.100***
					(0.0481)	(0.0471)	(0.0315)	(0.0242)
CGL-D (SPA experience =1)	-0.0423	-0.0573	0.00349	-0.0130	0.153	0.134	0.0232	0.00627
	(0.133)	(0.134)	(0.126)	(0.119)	(0.104)	(0.107)	(0.108)	(0.100)
Ravenscore × TimeD					-0.0102***	-0.00927***	-0.00615**	-0.00602***
					(0.00374)	(0.00360)	(0.00258)	(0.00189)
Ravenscore × CGL-D	0.00124	0.00252	-0.00439	-0.00287	-0.0164**	-0.0148	-0.00670	-0.00509
	(0.00921)	(0.00941)	(0.00756)	(0.00683)	(0.00825)	(0.00907)	(0.00633)	(0.00594)
TimeD × CGL-D					-0.392**	-0.383**	-0.0355	-0.0340
					(0.154)	(0.152)	(0.0713)	(0.0734)
Ravenscore × TimeD × CGL-D					0.0353**	0.0346**	0.00437	0.00413
					(0.0137)	(0.0137)	(0.00558)	(0.00570)
Value		0.00115		0.00107***		0.00128		0.00102***
		(0.00102)		(0.000287)		(0.00111)		(0.000295)
Value^2		-3.55e-06				-5.02e-06		
		(8.63e-06)				(9.60e-06)		
Female		-0.0102		-0.0213		-0.0105		-0.0208
		(0.0288)		(0.0234)		(0.0288)		(0.0236)
Switch point (H&L)		-0.00623		-0.00731**		-0.00621		-0.00715**
		(0.00602)		(0.00358)		(0.00607)		(0.00357)
Value	all	all	value> 50	value> 50	all	all	value> 50	value> 50
Observations	2.339	2.339	1,172	1,172	2.339	2.339	1,172	1,172
Number of Subj.	118	118	118	118	118	118	118	118

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

(Note: relative bid shading not defined for $v_i = 0$)

Table A6: FPA: Relative bid shading (treatment FPA/SPA); GLS regressions.

	LC–group (without CGL)			HC–group (without CGL)			LC–group (without CGL)		HC–group (without CGL)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent variable:	$(v_i - b_i)/v_i$	$(v_i - b_i)/v_i$	$(v_i - b_i)/v_i$	$(v_i - b_i)/v_i$	$(v_i - b_i)/v_i$	$(v_i - b_i)/v_i$	$(v_i - b_i)/v_i$	$(v_i - b_i)/v_i$	$(v_i - b_i)/v_i$	$(v_i - b_i)/v_i$
Period	0.00766**	0.00812**	0.00373***	0.00424**	0.00279	0.00288	0.00778***	0.00718***	0.00295	0.00303
	(0.00348)	(0.00402)	(0.000862)	(0.00177)	(0.00248)	(0.00275)	(0.00199)	(0.00234)	(0.00223)	(0.00223)
other's bid $(t-1)$		-0.00249**	-0.000997***		-0.000461	-0.000327				
		(0.00123)	(0.000228)		(0.000378)	(0.000494)				
other's bid $(t-2)$			-0.000626***			5.66e-05				
			(0.000175)			(0.000783)				
other's bid $(t-3)$			-0.000256			-0.000471				
			(0.000443)			(0.000424)				
won in $t-1$ (with forgone profit)							0.158***		0.0305	
(instrumented by other's bid)							(0.0402)		(0.0434)	
lost in $t-1$ (with forgone profit)								-0.447***		-0.0565
(instrumented by other's bid)								(0.130)		(0.0960)
Constant	0.272***	0.341***	0.387***	0.327***	0.361***	0.369***	0.188**	0.353***	0.331***	0.356*
	(0.0687)	(0.0465)	(0.0337)	(0.0364)	(0.0361)	(0.0536)	(0.0735)	(0.0677)	(0.0443)	(0.202)
Observations	714	678	607	477	453	407	678	678	453	453
Number of bidders	36	36	36	24	24	24	36	36	24	24

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A7: Tests of relationships between subjects' relative overbidding in SPA and experience in FPA (treatment FPA/SPA)

	Correlation Coefficients			Regression Coefficients		
SPA rel. overbidding $(b_i - v_i)/v_i$	Overall	LC	HC	Overall	LC	HC
FPA bid shading $(v_i - b_i)/v_i$	-0.320**	-0.441***	-0.151	-2.177**	-3.790***	-0.312
Avg FPA Price	0.311**	0.271	0.331	0.022	-0.027	0.065
% FPA wins	0.126	0.288*	-0.001	-0.931	-1.237*	-0.554
Avg FPA Profit	-0.102	-0.195	0.017	0.058**	0.059**	0.058
Avg FPA other's bid	0.167	0.092	0.283	-0.008	0.005	-0.027
Constant				-0.002	2.332**	-2.062
				$R^2 = 0.219$	$R^2 = 0.565$	$R^2 = 0.158$
Nr. of obs.	60	36	24	60	36	24

*** p<0.01, ** p<0.05, * p<0.1

Table A8: Average hypothetical profit, std. dev. in parentheses.

Treatment	Cogn. Ability	Hyp. Profit FPA	Actual Profit FPA	Actual Profit SPA	Actual Profit Both
FPA/SPA	LC	10.78	11.09	16.97	14.03
		(15.620)	(15.407)	(25.245)	(21.111)
	HC	13.72	12.24	17.35	14.79
		(14.111)	(16.330)	(24.604)	(21.201)
SPA/FPA	LC	10.31	10.24	14.42	12.33
		(14.711)	(15.251)	(24.822)	(20.696)
	HC	11.62	10.48	15.98	13.23
		(13.726)	(13.513)	(24.003)	(19.663)
Both	LC	10.58	10.72	15.87	13.30
		(15.233)	(15.340)	(25.09)	(20.947)
	HC	12.54	11.25	16.58	13.91
		(15.323)	(16.577)	(24.398)	(20.359)

Instructions (SPA/FPA treatment, translated from German)

Welcome to the experiment! From now on, please do not talk to other participants in the experiment.

Please read these instructions carefully. They are identical for all participants. If there is anything you do not understand, please indicate this by raising your hand. We will then come to you and answer your questions privately. You will make your decisions on the computer. All decisions remain anonymous. This means that you do not learn the identity of other participants and no participant learns your identity.

This experiment consists of four parts. The four parts are independent of each other; this means: your decisions in one part have no effect on other (later) parts. At the beginning of each part, you will receive detailed information about that part.

In each part of the experiment, you earn money. How exactly you earn money is described in the instructions.

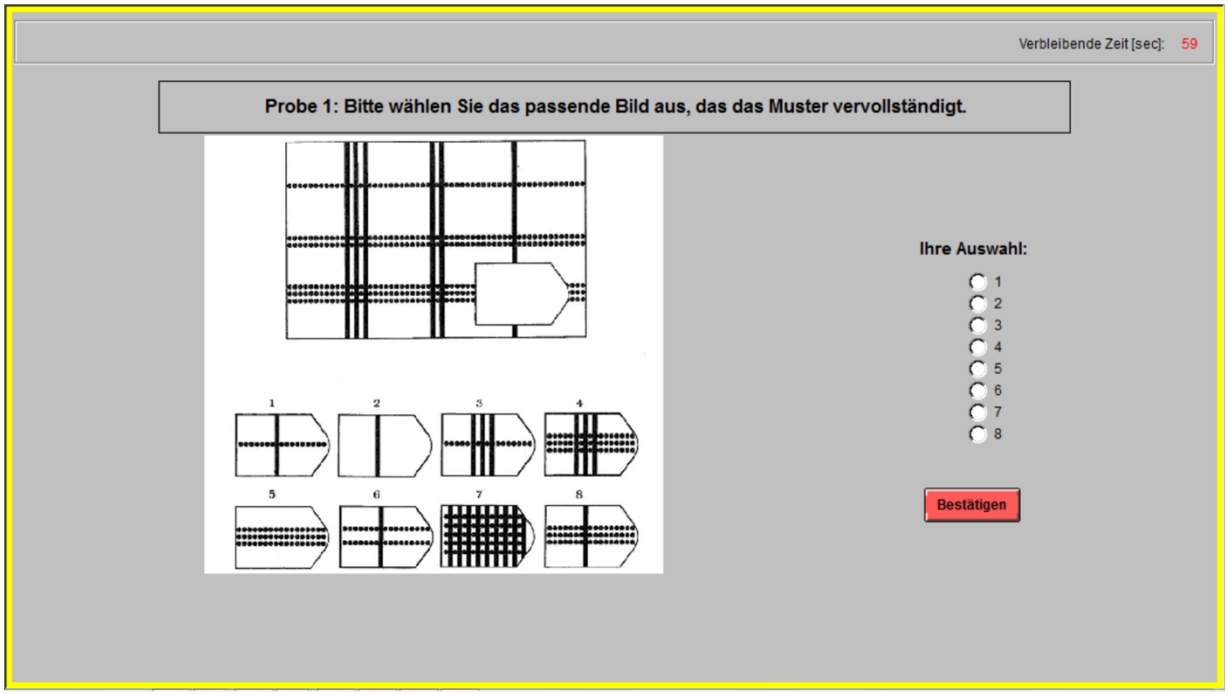
Your earnings in this experiment (sum of your earnings from all four parts) will be paid to you privately and in cash at the end of the experiment.

Part 1

In this part, you have to complete graphic patterns. There are 22 patterns of increasing difficulty in total. You have a total of **5 minutes (300 seconds)** to complete as many patterns as you can. There will always be eight possible answers per pattern. You will receive €0.30 for each correct answer. At the end of the experiment, i.e., after Part 4, you will be shown the result of Part 1.

There are two example patterns at the beginning. These are intended to help you familiarize with the task. We will display the correct answers (only) for the two example tasks after you solved them. You do not have a time limit for solving the test patterns and the results do not influence your payout. Afterward, you continue directly with the part of the task that is relevant for your payment.

A screen always shows only one pattern and looks like this:



[Trial task 1: Please choose the picture that completes the pattern, your choice:, Confirm].

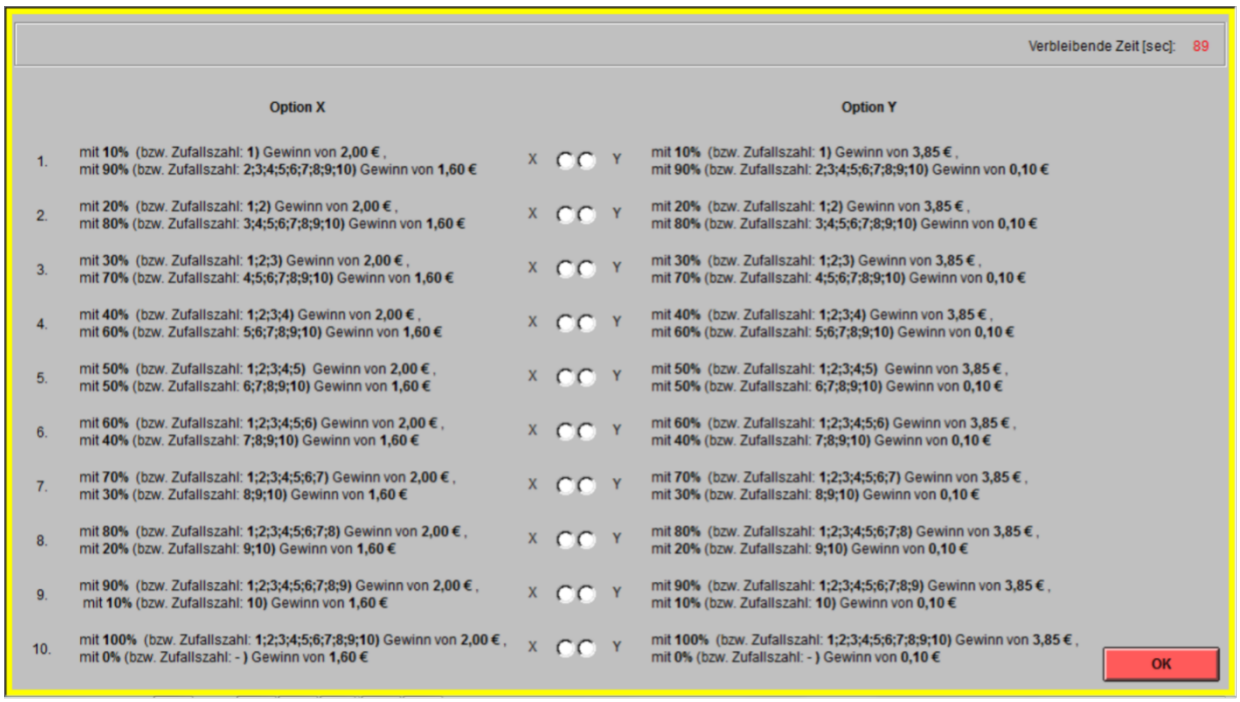
In the left part of the screen, you will see the pattern shown and the eight pos-

sible answers. Only one out of the eight answers is correct. At the top right of the screen, you will see the remaining time you have for Part 1. To complete a pattern, select one of the numbers 1-8 in the right-hand side of the screen and click the "Confirm" button. Only then will you move on to the next pattern. It is not possible to jump back and forth between patterns.

If you still have questions, please raise your hand and an experimenter will come to you to clarify your question. This also applies if something is unclear to you during this part.

Part 2

In Part 2 you make 10 decisions. The screen with all 10 decision problems looks like this:



In each of these decision problems you can choose between **two alternative options**. Your decision is not valid until you have made a choice for all problems (i.e., for each row) and confirmed your choice by clicking the OK button. Take your time to make your decisions because your choice - as described below - will determine your payoff from Part 2. All monetary amounts in Part 2 are Euro amounts.

Your payoff is determined as follows: The computer randomly draws two numbers between 1 and 10. The first random number determines the row in the table shown above. The option you choose in this row is then executed with the second randomly drawn number. The profit from this option is then paid to you at the end of the experiment.

For example: Assume that the computer randomly chooses the number 2 first, i.e., the decision problem in the 2nd row of the table, and you have chosen option

X there. In this case, you will receive either €2 (with probability 20% or if the second randomly selected number is 1 or 2) or €1.60 (with probability 80%, that is, if the second randomly selected number is either 3, 4, 5, 6, 7, 8, 9 or 10). Assuming the computer randomly chooses 9 as the second number, your payoff for Part 2 of the experiment would be €1.60.

You make your choices only **once**. The random numbers are drawn after the end of Part 4. Then you will be shown the result from Part 2.

If you still have questions, please raise your hand and an experiment leader will come to you. This also applies if something is unclear to you during the part.

Part 3

In Part 3 you participate in 20 auctions. All entries in Part 3 are denoted in ECU (Experimental Currency Unit). Each auction consists of two bidders, i.e., you and one other bidder. This other bidder is another participant in the room who is randomly selected before each auction.

In each auction, a fictitious good is auctioned off. At the beginning of each auction, the bidders' personal product values are determined. These values are integers from the interval 0 to 100 ECU and are determined randomly. Every integer between 0 and 100 is equally likely. The personal product values of the different bidders are independent of each other, i.e., they will usually be different. Each bidder learns only the own product value, but not that of the other bidder. Then, knowing their product values, the bidders each place a single integer bid for the good.

The following auction rule applies:

Second-price auction: The bidder with the highest bid receives the good. The bidder then pays the second-highest bid as the price. His profit is the difference between his product value and the price. The bidder with the second highest bid

receives nothing and pays nothing, i.e., his profit is zero. If the bids are identical, the buyer is chosen randomly. In this case, the second-highest bid is equal to the highest bid.

After each auction you will find out whether you have won the auction. Furthermore, you will find out the price paid for the good, the bid of your fellow bidder and your own profit in this auction. However, you will not know the product value of the other bidder. For your information, your own product value and your own bid for this auction are displayed again.

Please note that losses are possible. Should the price in an auction be higher than your product value and should you win the auction, then you will make a loss. This will be offset against your winnings or the initial endowment. You will receive an initial endowment of 30 ECU for this part.

The exchange rate ECU to € is: 1 ECU = 0.03 €. At the end of the experiment, i.e., after Part 4, you will be paid your earnings from all auctions in Part 3.

If you still have questions, please raise your hand and an experiment leader will come to you. This also applies if something is unclear to you during the part.

Part 4

In Part 4 you participate in 20 auctions. All entries in Part 4 are denoted in ECU (Experimental Currency Unit). Each auction consists of two bidders, i.e., you and one other bidder. This other bidder is another participant in the room who is randomly selected before each auction.

In each auction, a fictitious good is auctioned off. At the beginning of each auction, the bidders' personal product values are determined. These values are integers from the interval 0 to 100 ECU and are determined randomly. Every integer between 0 and 100 is equally likely. The personal product values of the different bidders are independent of each other, i.e., they will usually be different. Each bidder learns only the own product value, but not that of the other bidder. Then, knowing their product values, the bidders each place a single integer bid for the good.

The following auction rule applies:

First price auction: The bidder with the highest bid acquires the good. The bidder pays his bid as the price. His profit is the difference between his product value and the price. The bidder with the second-highest bid receives nothing and pays nothing, i.e., his profit is zero. If the bids are identical, the buyer is chosen randomly.

After each auction you will find out whether you have won the auction. Furthermore, you will find out the price paid for the good, the bid of your fellow bidder and your own profit in this auction. However, you will not know the product value of the other bidder. For your information, your own product value and your own bid for this auction are displayed again.

Please note that losses are possible. Should the price in an auction be higher than your product value and should you win the auction, then you will make a

loss. This will be offset against your winnings or the initial endowment. You will receive an initial endowment of 30 ECU for this part.

The exchange rate ECU to € is: 1 ECU = 0.03 €. At the end of the experiment, i.e., after this part, you will be paid your earnings from all auctions in this part.

We then ask you to answer a few more questions about yourself honestly and completely. Once all participants have completed answering these questions, you will be told your earnings from Parts 1 to 4. We will then call you individually using your participant number. Your total earnings will then be paid to you privately and in cash.

If you still have questions, please raise your hand and an experiment leader will come to you. This also applies if something is unclear to you during the part.