For Online Publication

Appendix A: Supplementary tables

	D1 (n=367)	D1A (n=32)	D2L (n=102)	D2H (n=82)	D3 (n=163)
L0	2%	0%	2%	1%	20%
L1	27%	34%	57%	78%	44%
L2	1%	0%	5%	4%	0%
R	64%	50%	22%	14%	3%
N	6%	16%	15%	2%	33%

Table S1: Decision rules in the Blotto games. Messages from the two Blotto games are pooled together.

	D1 (n=145)	D1A (n=24)	D2L (n=42)	D2H (n=109)	D3 (n=144)	D4 (n=9)
L0	6%	8%	7%	3%	6%	0%
L1	48%	38%	17%	19%	66%	22%
L2	1%	0%	7%	4%	8%	0%
R	28%	17%	50%	62%	4%	33%
N	18%	38%	19%	13%	17%	44%

Table S2: Decision rules in the first-price auctions. Messages from the two auctions are pooled together.

	D1 (n=130)	D1A (n=3)	D2L (n=62)	D2H (n=37)	D3 (n=110)	D4 (n=59)
L0	13%	0%	2%	16%	22%	10%
L1	12%	33%	84%	51%	50%	2%
L2	0%	0%	3%	3%	10%	0%
R	58%	33%	5%	19%	3%	71%
N	17%	33%	6%	11%	15%	17%

Table S3: Decision rules in the all-pay auctions. Messages from the two auctions are pooled together.

Pairs of games	**Spearman correlation**
Blotto 6 & Blotto 7 (n=197)	0.579***
Auction 3 & Auction 4 (n=93)	0.483***
All-pay 3 & All-pay 4 (n=98)	0.397***
Blotto6 & Auction 3 (n=92)	0.494***
Blotto7 & Auction 3 (n=93)	0.442***
Blotto 6 & Auction 4 (n=91)	0.399***
Blotto 7 & Auction 4 (n=93)	0.431***
Blotto 6 & All-pay 3 (n=99)	0.192
Blotto7 & All-pay 3 (n=99)	0.336*
Blotto 6 & All-pay 4 (n=98)	0.248^{+}
Blotto 7 & All-pay 4 (n=98)	0.385***

Table S4: Correlation between the number of dimensions in messages in different games. Significance levels are Bonferroni-adjusted by the number of 11 game comparisons per dimension. $^{+}$ indicates p<0.1/11, * indicates p<0.05/11, ** indicates p<0.01/11, *** indicates p<0.001/11.

	D1	D1A	D2L	D2H	D3	Average
Blotto 6 & Auction 3	0.122	0.110	0.071	0.194	0.276^{+}	0.155
Blotto 6 & Auction 4	0.343**	-0.109	0.018	0.253	0.034	0.108
Blotto 7 & Auction 3	0.145	-0.004	0.109	0.199	0.192	0.128
Blotto 7 & Auction 4	0.233	0.017	0.140	0.238	0.071	0.140
Blotto 6 & All-pay 3	-0.162	-0.037	0.359**	-0.124	-0.052	-0.003
Blotto 6 & All-pay 4	-0.011	-0.024	0.346**	0.275**	0.006	0.118
Blotto 7 & All-pay 3	-0.067	-0.048	0.426***	-0.051	0.153	0.083
Blotto 7 & All-pay 4	0.043	-0.032	0.347**	0.253^{+}	0.184	0.159
Average	0.081	0.002	0.193	0.147	0.119	0.111
Average Blotto & Auction	0.211	0.004	0.085	0.221	0.143	0.132
Average Blotto & All-pay	-0.049	0.000	0.300	0.073	0.096	0.089

Table S5: Average correlation between games in the usage of all 5 dimensions.
Significance levels are Bonferroni-adjusted by the number of 8 game comparisons per dimension.
$^{+}$ indicates p<0.1/8, * indicates p<0.05/8, ** indicates p<0.01/8, *** indicates p<0.001/8.

	Blotto 6	Blotto 7	Auction 3	Auction 4	All-pay 3	All-pay 4
D1	-0.211	-0.344*	3.230	-6.026	4.142	5.739
	(0.175)	(0.169)	(2.149)	(4.203)	(2.803)	(4.669)
D1A	0.194	-0.269	1.852	-0.212	19.17*	7.614
	(0.165)	(0.145)	(3.133)	(4.975)	(8.475)	(21.82)
D2L	0.377***	0.378***	-7.457**	4.469	12.93***	22.20***
	(0.0901)	(0.0872)	(2.555)	(3.789)	(2.919)	(4.710)
D2H	0.195*	0.0635	-0.0202	-0.160	4.032	12.57*
	(0.0915)	(0.101)	(2.179)	(3.137)	(2.980)	(6.206)
D3	0.216**	-0.0194	1.344	3.891	5.642*	11.19*
	(0.0777)	(0.0791)	(2.131)	(6.057)	(2.473)	(4.995)
D4					-9.079**	-11.28*
					(2.722)	(5.274)
Constant	2.647***	3.456***	41.14***	63.80***	93.76***	107.3***
	(0.180)	(0.178)	(2.648)	(6.718)	(3.019)	(6.115)
N	193	198	97	98	97	99

Table S6: Coefficients (standard errors in parentheses) in a linear regression where the dependent variable is the score in the game and the explanatory variables are dummies for the various dimensions.
* indicates $p<0.05$, ** indicates $p<0.01$, *** indicates $p<0.001$.

Appendix B1: Free-form manual classification of the messages

A research assistant who is an undergraduate student in economics and psychology at Tel Aviv University and who was not familiar with the studied games was asked to identify the main **classes of decision rules / considerations** that subjects use in their messages in Blotto 6, Auction 3 and All-pay 3 (in this order). She was not instructed regarding the number of categories and was not shown any example of a class of decision rule. She read the experiment instructions and the subjects’ messages, and prepared a list which consists of 10, 11 and 12 categories for the three games, respectively. After preparing a list for a particular game, she classified the subjects’ messages using the categories that she came up with. A subject’s message often belonged to more than one category.

It turns out that her categories are analogous to the categories of dimensions (see list below). For example, in Blotto 6, her categories 1, 2 and 3 touch on the number of reinforced fronts (D1). Category 1 and 2 consist of focusing on part of the fronts and category 3 is the decision to split the resources equally (to not concentrate on a subset). Similarly, categories 5, 6, 7 and 8 touch on the order issue (D3), i.e., on which fronts to focus. Each of these categories reflects a different decision outcome concerning this aspect (e.g. focus on the middle fronts).

Below are the RA’s categories for each of the three games, followed by her classification results and its comparison to the classification based on guidance about the dimensional aspects (which was previously done by other research assistants, two for each game).

Overall, the free-form classification provides further support for the insights obtained by the guided classification: The RA did not detect any consideration which is not nested in the guided classification’s categories and vice versa. The most common consideration is in how many fronts to focus, followed by the order consideration and then the fine details of the assignments. Many subjects’ messages mention at least two of these considerations. Furthermore, the proportions of these considerations are similar in the two classifications.

<u>Classes of decision rules for Blotto 6</u>

1. **Focusing on part of the fronts -** focusing on a subset of the fronts only and assigning 0 soldiers to the other fronts.
2. **Focusing on part of the fronts without giving up the other fronts completely** - focusing on a subset of the fronts but also assigning a small number of soldiers to the other fronts in order to try and win them too.
3. **Equal distribution among all fronts** - not focusing on a strict subset of the fronts.
4. **Asymmetric distribution among fronts.**
5. **Focusing on the middle fronts** - assigning soldiers mainly to the middle fronts, expecting the other teams to assign their soldiers in the extreme fronts.
6. **Focusing on the extreme fronts** - assigning soldiers mainly to the extreme fronts, expecting the other teams to assign their soldiers to the middle fronts.
7. **Focusing on the last fronts** - assigning soldiers mainly to the last fronts, believing that other teams will assign their soldiers to the first fronts.
8. **Focusing on fronts that are not close to one another** - assigning soldiers to fronts that are not close to one another, believing that the other teams will assign their soldiers gradually.
9. **Assigning non-round numbers of soldiers** - expecting the other teams to assign round numbers of soldiers.
10. **Other.**

The analogy between the above categories and our dimensions in Blotto 6 is as follows:

Free-form Classification		**Guided Classification**	
Categories	*Proportion*	*Analogous Dimensions*	*Proportion*
1, 2, 3 (never go together)	88%	D1	86%
4	8%	D1A	7%
2 (i.e., 2 means D1+D2L)	20%	D2L	22%
9	17%	D2H	21%
5, 6, 7, 8 (never go together)	36%	D3	39%

Using the above analogy, we compared the guided classification to the free-form classification and found that, out of 211 participants' messages, 178 (84%) were classified identically by the two classification approaches. The table shows that the proportions of dimensions according to the two classifications are qualitatively similar.

Classes of decision rules for Auction 3

1. **Focusing on part of the auctions** - focusing only on a subset of the auctions while assigning no money to the other auctions.
2. **Focusing on part of the auctions without giving up the other auctions completely** - focusing mainly on a subset of the auctions while assigning a small amount of money to the remaining auctions in order to try and win them too.
3. **Equal distribution among all auctions** - not focusing on a strict subset of the auctions.
4. **Asymmetric distribution among auctions.**
5. **Focusing on the auctions in the middle** - assigning most of the money to the auctions in the middle while considering that the other teams will assign their money to the extreme auctions.
6. **Focusing on the extreme auctions** - assigning most of the money to the extreme auctions while considering that the other teams will assign their money to the auctions in the middle.
7. **Focusing on the last auctions** - assigning most of the money to the last auctions while considering that the other teams will assign their money to the first auctions.
8. **Focusing on the first auctions** - assigning most of the money to the first auctions while considering that the other teams will assign their money to the last auctions.
9. **Assigning a non-round sum of money** - believing that the other teams will assign a round sum of money.
10. **Assigning relatively low sums** - assigning relatively low sums (not close to 100) so that the potential winnings will be considerable.
11. **Other.**

The analogy between the above categories and our dimensions in Auction 3 is as follows:

Free-form Classification		**Guided Classification**	
Categories	*Proportion*	*Analogous Dimensions*	*Proportion*
1, 2, 3 (never go together)	67%	D1	62%
4	11%	D1A	13%
2 (i.e., 2 means D1+D2L)	20%	D2L	21%
9, 10	53%	D2H	63%
5, 6, 7, 8 (never go together)	50%	D3	51%
		D4	5%

Using the above analogy, we compared the guided classification to the free-form classification and found that, out of 101 participants' messages, 75 (75%) were classified identically by the two classification approaches. Overall, the proportions of dimensions and the patterns are quite similar.

Classes of decision rules for All-pay 3

1. **Focusing on part of the auctions** - focusing only on a subset of the auctions.
2. **Not giving up on auctions completely** - assigning a small amount of money to some of the auctions in order to try to win them too.
3. **Equal distribution among all auctions** - not focusing on a strict subset of the auctions.
4. **Asymmetric distribution among auctions.**
5. **Focusing on the auctions in the middle** - assigning most of the money to the auctions in the middle while considering that the other teams will assign their money to the extreme auctions.
6. **Focusing on the extreme auctions** - assigning most of the money to the extreme auctions while considering that the other teams will assign their money to the auctions in the middle.
7. **Focusing on the last auctions** - assigning most of the money to the last auctions while considering that the other teams will assign their money to the first auctions.
8. **Focusing on the first auctions** - assigning most of the money to the first auctions while considering that the other teams will assign their money to the last auctions.
9. **Assigning a non-round sum of money** - expecting that the other teams will assign a round sum of money.
10. **Assigning a small amount of money while keeping the rest for themselves**.
11. **Keeping all the money for themselves, not assigning any amount of money**.
12. **Other.**

The analogy between the above categories and our dimensions in All-pay 3 is as follows:

Free-form Classification		**Guided Classification**	
Categories	*Proportion*	*Analogous Dimensions*	*Proportion*
1, 3 (never go together)	67%	D1	64%
4	3%	D1A	2%
2	23%	D2L	23%
9	6%	D2H	19%
5, 6, 7, 8 (never go together)	38%	D3	38%
10, 11 (never go together)	26%	D4	28%

Using the above analogy, we compared the guided classification to the free-form classification and found that 83 out of 108 messages (77%) were classified identically. (8 disagreements were due to a missing category, which appeared in her Auction 3 classification as #10, that she would have added here as well after reconsideration.) Again, the proportions of dimensions are qualitatively similar.

Appendix B2: Computer classification of the messages

1. Method

We performed a complementary text analysis in which we used a machine-learning technique called *random forest* to create a model that classifies the written messages from the experiment (see Penczynski (2019) for an accessible introduction to the computational method). The technique uses our manual guided classification to both train and test an algorithm-generated bag-of-words model that relates word counts to dimensions. In a procedure called *crossvalidation*, the algorithm uses a large portion of the manually classified messages as a training set and classifies the rest of the messages with the trained model. Repeating this exercise using different portions of the classified messages as training sets, the computer eventually classifies all messages on the basis of a model that was trained on other messages.

Translation. First, the participants' original messages were translated from Hebrew to English using Google translate and then improved by a research assistant. The research assistant fixed the erroneous sentences and replaced words that were translated wrongly or ambiguously (e.g., the Hebrew word for "women" is written the same way as the Hebrew term "we'll put", where only the latter was relevant in our experiment). In the English text, the RA looked for words with similar meanings and incorporated them into one (e.g., "deploy" and "assign" were replaced by "allocate"). Finally, in some cases, a particular word was used for two completely different purposes. As an example, "left" was used for "the left front" and for "the budget that is left". To disambiguate those, we replaced the word "left" as in "remaining" in the latter type of occurrences. We documented all the changes made to the sentences after the automatic translation.

Training. For the purpose of the machine-learning analysis, the messages from two games in the same class are pooled together to create a sufficiently large dataset. Training the computer was done on part of the classified messages, separately for each class of games. The training set is comprised of the words from the translated messages, after performing some common text analysis procedures (tokenization, stemming). The dataset was randomly divided into 5 segments. The predictions for each segment were obtained after training on the remaining 80% of the dataset. The training set includes the information on the dimensions that the RAs identified in the messages, that is, for each message and a possible dimension D, *positive* (P, classified as containing the dimension D) or *negative* (N, classified as not containing Dimension D).

Procedure and output. For each of the three classes of games, the following procedure was performed:

1. Establishing the training and testing datasets by performing the above preparations.
2. Building of a random-forest model using the training data to obtain the following output:
   A. **Dataset.** An updated dataset containing:
      i. **Probabilities:** For each message and a dimension D, the probability of the message being positive. These probabilities represent the number of decision trees having "voted" for that message as positive (negative) out of the 500 decision trees "grown" in the context of the random-forest model.
      ii. **Classification**: For each message and for each dimension, a binary decision whether to classify the message as containing the dimension or not. Messages whose probability to contain a given dimension was greater than 0.5 were classified as positive.

   B. **Importance Graphs.** For each dimension, a graph depicting the most important words in determining the classification outcome, ranked in decreasing order.

   C. **Accuracy outcome.** For each game and each dimension, we report the accuracy and the balanced accuracy of the computer classification. Denote *TP = "true positives"* and *TN = "true negatives",* where "true X" means that the RAs and the algorithm classified the message as X.

$$accuracy = \frac{\#TP + \#TN}{\#P + \#N}; \; balanced\ accuracy = \frac{\frac{\#TP}{\#P} + \frac{\#TN}{\#N}}{2}$$

2. Results

Tables S7, S8 and S9 below summarize the machine learning classification results for the prominent dimensions in the three classes of games. We report the average probability (that a message is classified as positive) for each dimension as well as the frequency of the dimension in the messages according to the guided and the computer classification, side by side. We also report the accuracy and balanced accuracy for each dimension.

The dimensions whose identification by the computer was more challenging are those in which the training set for the computer did not include enough examples of both positive and negative cases (according to the guided classification). Thus, the summary tables do not include dimension D1A that was identified by the RAs in less than 11% of the messages, as well as D4 in the auctions (identified by the RAs in 4% of the messages). Furthermore, we present the results for D2, a combination of D2L and D2H, because distinguishing between the two resulted in predictions of very low frequency and in low balanced accuracy, except for the case of the auctions in which the guided classification suggested that D2H is very frequent (and the computer classification was almost identical). We note that the average probabilities for both D2L and D2H were very similar to the frequencies of these dimensions in the guided classification.

	Guided frequency	Computer frequency	Average p (Computer)	Accuracy	Balanced Accuracy
D1	0.85	0.98	0.87	87%	57%
D2	0.38	0.20	0.34	70%	64%
D3	0.39	0.24	0.34	73%	68%

Table S7: Guided and computer classifications in the Blotto games.

	Guided frequency	Computer frequency	Average p (Computer)	Accuracy	Balanced Accuracy
D1	0.70	0.90	0.70	71%	57%
D2	0.62	0.69	0.57	69%	66%
D3	0.70	0.86	0.69	80%	69%
D4	0.04	0	0.04	96%	50%

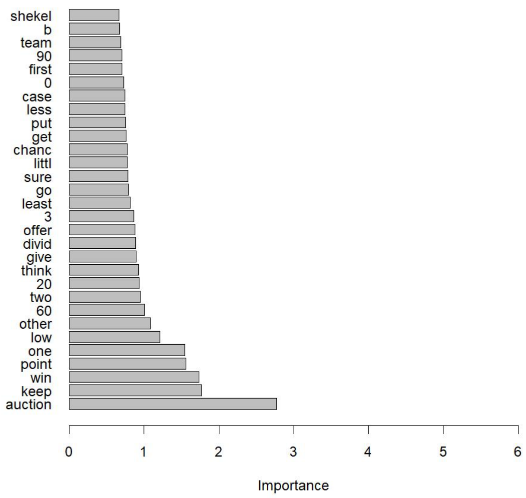
Table S8: Guided and computer classification in the auctions.

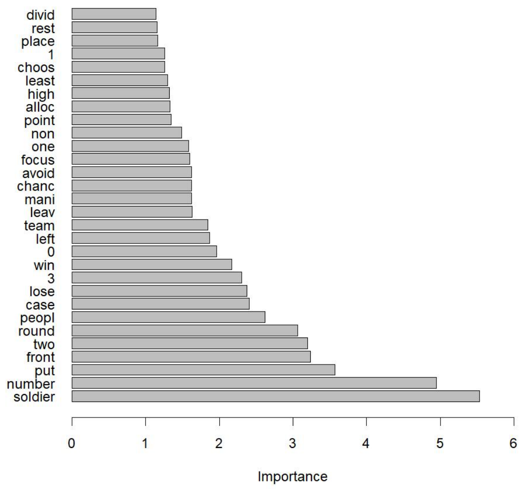
	Guided frequency	Computer frequency	Average p (Computer)	Accuracy	Balanced Accuracy
D1	0.60	0.88	0.71	60%	53%
D2	0.38	0.22	0.27	71%	65%
D3	0.50	0.51	0.34	74%	74%
D4	0.27	0.06	0.22	77%	58%

Table S9: Guided and computer classifications in the all-pay auctions.

Overall, the computer's final binary classification (positive or negative, for each dimension) is qualitatively similar to the guided classification in terms of the dimensions' frequencies; The accuracy and balanced accuracy are generally reasonably high. Furthermore, for all dimensions, the average probability that a message is identified as positive in the random forest was very close to the frequency by which the dimension was identified in the messages in the guided classification. In the graphs shown below, the nature of the dimensional reasoning is reflected in the variable importance, which tracks the improvement in the model error thanks to each word variable ("auction" and "win" in D1 and "number", "soldier" and "round" in D2).

All-pay D1: **Blotto D2:**





Using the computer classification, we examined whether subjects' reasoning in terms of dimensions is correlated between two games of the same class and found correlations in the use of numerous dimensions, similar to the analysis performed using the guided classification. In addition, according to the computer classification, most of the messages mentioned more than one dimension (similar to the original analysis). Overall, the results reinforce our findings that thinking in terms of a number of dimensions is common in the three classes of games explored in this paper.

Appendix C: Instructions for the experiment

The following instructions were provided to subjects in the experiment and were read out loud:

Welcome to the experiment

You are about to participate in an experiment on making decisions in a group. Please pay close attention to the instructions.

During the course of the experiment, you will be able to earn a considerable sum of money. Your decisions and those of the other participants in this room are the factors that will determine the size of the sum (a detailed explanation is provided below). In each game, you will be able to earn points that can be converted to shekels at the end of the experiment at the conversion rate of 5 points = 1 shekel. **In addition to your winnings in the various games, each participant who completes the experiment will receive a sum of 35 shekels**. You will receive the total sum of money you earn immediately upon conclusion of the experiment, personally and in cash.

You are not allowed to talk to other participants or look at their computer screen during the experiment.

If you have any questions, please raise your hand and one of the staff members will be glad to respond.

You will play four games in the experiment. The experimenter will read the instructions for each game out loud, and then all of the participants will play the game on the computer.

At the beginning of each game, each participant will be randomly teamed with another participant from this room – each such pair will play together as one group. The team's earnings will be divided equally between the two participants.

In each game, the computer will randomly pair the participants into teams.

How is the "team decision" determined in the game?

In each of the games, each member of the team will be asked to enter a "final decision." After the computer receives the final decision of both team members, it will randomly select one of the two possibilities. That is, there is a 50% probability that the computer will select your final decision as the one to represent the team, and a 50% probability that it will choose the final decision of the other team member. However, you can influence the final decision of your teammate in the following way: Before entering your final decision, you can send (only) **one** written message to the other member of the team. **The message should include your proposed course of action, together with a detailed explanation of why you chose this option**. This message is your only way to influence your teammate's decision – use it wisely and explain your decision in a clear and persuasive way.

This message will appear on your teammate's computer screen before he or she makes a final decision. In the same way, before you make your final decision, a message will appear on your computer that includes your partner's proposal, together with an explanation of why he or she believes it is the correct course of action. As noted above, the computer will randomly select one of the two final decisions your team submits. (If one of the participants succeeds in persuading his or her teammate, then the two final decisions will be identical and the fact that the computer selects only one of them is insignificant.) With the final decision that the computer selects to represent your team, you will compete against the other teams participating in the game.

The experiment will be conducted as follows:

<u>Proposals and messages stage</u>:

1. Game 1: You will be asked to submit a proposed action + a message to your teammate
2. Game 2: You will be asked to submit a proposed action + a message to your new teammate
3. Game 3: You will be asked to submit a proposed action + a message to your new teammate
4. Game 4: You will be asked to submit a proposed action + a message to your new teammate

<u>Final decision stage</u>:

1. Game 1: You will be asked to make a final decision
2. Game 2: You will be asked to make a final decision
3. Game 3: You will be asked to make a final decision
4. Game 4: You will be asked to make a final decision

The results of the games will be reported only at the end of the experiment.

If you have questions at this stage, please raise your hand.

We'll start with the proposals stage and will read the instructions for the first game

* Numbers of games in practice corresponded to the order of games played in the session.

Instructions for Game 1 (Blotto 6)

The computer assigns a teammate to each participant in the experiment.

In this game, your team will compete in a tournament against **all of the other teams** in the experiment.

You will play the role of a general commanding an army in time of war; the other teams in the experiment are commanders of enemy armies. Each team has **120 soldiers** it must deploy on **6 separate fronts**.

In each game against another team, you win on the fronts where you deploy more soldiers than the other team. If both teams deploy the same number of soldiers to a particular front, both lose on that front. You must decide how to deploy your soldiers without knowing the deployments selected by the other teams.

You play automatically with your selected deployment vis-à-vis each of the teams in the experiment (you cannot select different deployments against different teams).

Your team's final score in the game will be the total number of victories you win against all of the teams.

The winner in the tournament will be the team that receives the highest score among the teams.

In the case of a tie, the computer will randomly select the winner.

The prize for the winning team is 150 points.

- **Now send your teammate your proposed course of action and your message**
- **Remember that this is not your final decision**
- **Remember that in this game you were paired with a new teammate**

<u>Instructions for Game 2 (Blotto 7)</u>

The computer now reassigns a teammate to each participant in the experiment.

In this game too, your team will compete in a tournament against **all of the other teams** in the experiment.

The game is similar to the previous game, but now each team has **210 soldiers** to deploy to **7 separate fronts**.

You play automatically with your selected deployment vis-à-vis each of the teams in the experiment (you cannot select different deployments against different teams).

Your team's final score in the game will be the total number of victories you win against all of the teams.

The winner in the tournament will be the team that receives the highest score among the teams.

The prize for the winning team is 150 points.

- **Now send your teammate your proposed course of action and your message**
- **Remember that this is not your final decision**
- **Remember that in this game you were paired with a new teammate**

Instructions for Game 3 (Auction 3)

The computer assigns teams in the experiment.

In this game, your team will compete against **two other teams** only. Those teams will be randomly selected by the computer.

The game entails three different "auctions" (A, B, and C) in which your team can choose to participate. The team is entitled to submit a bid in each auction. The bid is the number of points it is willing to pay in the event that it wins the auctions. The winning team in each auction is the one that submits the highest bid from among the competing teams.

Each team must simultaneously decide which bid to submit in each of the auctions – of course, without knowing what the other teams are planning.

- If your team wins Auction A, it will receive a prize of **100 points**
- If your team wins Auction B, it will receive a prize of **100 points**
- If your team wins Auction C, it will receive a prize of **100 points**

As noted, each auction is separate. The way to win is to submit the highest bid among the three competing teams. If there is a tie in a particular auction (if two teams submit the same highest bid), the computer will randomly select one of them as the winner.

You are entitled to participate in each of the three auctions, as long as the total of your bids does not exceed **120 points**.

Please note! You will be required to pay the bid you submitted only if you win the auctions.

Illustration of the game**:**

Let's assume a particular team proposes x points in Auctions A, y points in Auctions B and z points in Auctions C. The team is happy to learn that it won in Auctions A and in Auctions B. In this case, it receives 200 points in prizes and pays x+y points (the sum of points it bid in Auctions A and B).

If the team wins only in Auctions B, it receives a prize of 100 points and pays y points.

- **Now send your teammate your proposed course of action and your message**
- **Remember that this is not your final decision**
- **Remember that in this game you were paired with a new teammate**

Instructions for Game 4 (Auction 4)

The computer now reassigns a teammate to each participant in the experiment.

In this game too, your team will compete against **two other teams** only. Those teams will be randomly selected by the computer.

This game is similar to the previous game, but there are four different auctions here:

- If your team wins Auction A, it will receive a prize of **90 points**
- If your team wins Auction B, it will receive a prize of **90 points**
- If your team wins Auction C, it will receive a prize of **90 points**
- If your team wins Auction D, it will receive a prize of **110 points**

You are entitled to participate in each of the four auctions, as long as the total of your bids does not exceed **120 points**.

- **Now send your teammate your proposed course of action and your message**
- **Remember that this is not your final decision**
- **Remember that in this game you were paired with a new teammate**

Instructions for Game 5 (All-pay 3)

The computer now reassigns a teammate to each participant in the experiment.

In this game, your team will compete against **two other teams** only. Those teams will be randomly selected by the computer.

The game entails three different "auctions" (A, B, and C) in which your team can choose to participate. The team is entitled to submit a bid in each auction. The winning team in each auction is the one that submits the highest bid from among the competing teams.

Each team receives **60 points** it can use for bidding in the auctions. **In this game, each bid in each auction must be paid, even if the team does not win the auctions**. Unused points will remain in the possession of the team at the end of the game, and will be added to the team's winnings.

Each team must simultaneously decide which bid to submit in each of the auctions – of course, without knowing what the other teams are planning.

- If your team wins Auctions A, it will receive a prize of **90 points**
- If your team wins Auctions B, it will receive a prize of **90 points**
- If your team wins Auctions C, it will receive a prize of **90 points**

As noted, each auction is separate. The way to win is to submit the highest bid among the three competing teams. If there is a tie in a particular auction (if two teams submit the same highest bid), the computer will randomly select one of them as the winner.

Please note! You will be required to pay the total number of points you bid in a particular auction, even if you lose the auctions.

Illustration of the game**:**

Let's assume a particular team proposes x points in Auctions A, y points in Auctions B, and z points in Auctions C. The team is happy to learn that it won in Auctions A and in Auctions B. In this case, it receives 180 points in prizes and pays x+y+z points (the sum of points it bid in all of the auctions). That is, in this case, the team receives 60 plus 180 minus (x+y+z).

If the team only wins in Auctions B, it receives a prize of 90 points and pays x+y+z points. That is, the sum the team receives at the end of the game is 60 plus 90 minus (x+y+z).

- **Now send your teammate your proposed course of action and your message**
- **Remember that this is not your final decision**
- **Remember that in this game you were paired with a new teammate**

<u>Instructions for Game 6 (All-pay 4)</u>

The computer now reassigns a teammate to each participant in the experiment.

In this game, your team will compete against **two other teams** only. Those teams will be randomly selected by the computer.

This game is similar to the previous game, but there are <u>four</u> different auctions here:

- If your team wins Auctions A, it will receive a prize of **90 points**
- If your team wins Auctions B, it will receive a prize of **90 points**
- If your team wins Auctions C, it will receive a prize of **90 points**
- If your team wins Auctions D, it will receive a prize of **80 points**

Again, each team receives **60 points** it can use for bidding in the auctions. **In this game, each bid in each auction must be paid, even if the team does not win the auctions**. Unused points will remain in the possession of the team at the end of the game, and will be added to the team's winnings.

- **Now send your teammate your proposed course of action and your message**
- **Remember that this is not your final decision**
- **Remember that in this game you were paired with a new teammate**

Last page:

Now we'll move on to the stage of final decisions in the four games

- You can proceed to Game 2 only after you make a final decision in Game 1, and so on.
- Before you make the decision, please read the reminder about the rules of game and the proposal + message you received from your teammate in this game

Appendix D: Classification instructions

For each class of game, two research assistants were assigned. Each research assistant received specific instructions for either the two Blotto games or the two multi-object first-price auctions or the two all-pay multi-object auctions.

1. General classification instructions

Each of you is asked to classify the message of every subject from the Blotto 6 (or Auction 3 or All-pay 3) game and then classify the message of every subject from the Blotto 7 (or Auction 4 or All-pay 4) game. It is important that you do not link between subject's choices in these two games and hence each game has its own classification sheet in the attached Excel file.

After completing the classification, please send me the file.

Then, I will ask you two to meet and examine incompatibilities in your classifications. In your meeting, you will try to convince each other of the accuracy of your classification and may agree on one of the classifications or keep both if you still disagree. Incompatibilities are legitimate and may be common due to the vagueness of the messages.

The main part of the classification is to understand whether the subject deliberated in terms of dimensions of strategies. If the subject did, you are asked to mention only the dimensions that were explicitly specified in the subject's message. You may use the subject's suggested strategy (the vector of assignments) to better understand the subject's message, but classify it based only on considerations that were explicitly mentioned in the message.

There may be subjects who did not think in terms of dimensions. For example, a subject may have chosen a strategy in response to a concrete belief (vector of assignments) on competitors' strategies or a distribution of such. Another type of non-dimensional reasoning might be a "random allocation." In such cases, you should note in the classification sheet "not multi-dimensional reasoning." If you are not sure, please state it on the sheet.

2.1 Specific classification instructions for the Blotto games

<u>The following are potential dimensions of a strategy (a vector of 6 or 7 components)</u>:

D1 How many fronts should be "neglected" (or how many should be reinforced).

D1A Asymmetry in reinforced fronts (e.g., "one should be stronger than the other").

D2L What to allocate to "neglected" fronts: the unit digit in neglected fronts.

D2H The specific assignment in reinforced fronts: the unit digit in such fronts.

D3 Which fronts should be neglected / reinforced or the "order" of assignments.

<u>Decision rules within the above dimensions could be, for example</u>:

L0 Intuitive explanation.

L1 A response to the belief that the competitor chooses intuitively.

L2 A response to the belief that the competitor is sophisticated and uses decision rule L1.

R A reasonable explanation that is not a response to a certain belief on the opponent's behavior (e.g., aiming at winning the majority of fronts).

S Safety (win for certain a minimal number of fronts).

* After classification was completed, S (which is a sub-category of R) was merged with R.

2.2 Specific classification instructions for the first-price and all-pay multi-object auctions

<u>The following are potential dimensions of a strategy (a vector of 3 or 4 components)</u>:

D1 How many auctions should be "neglected" (or how many auctions are reinforced).

D1A Asymmetry in "reinforced" auctions (e.g., "one bid should be larger than the other").

D2L What to allocate to "neglected" auctions.

D2H Values in "reinforced" (high-bid) auctions (considerations of the specific bid or an approximate value of the bid, e.g., the value may stem from the auction prize value, or from beliefs on the competitor's bid).

D3 Which auctions should be neglected / reinforced ("identity" of auctions or "order" of bids).

D4 Budget usage (how much of the budget to use for bids and how much to save).

<u>Decision rules within the above dimensions could be, for example</u>:

L0 Intuitive explanation.

L1 A response to the belief that the competitor chooses intuitively.

L2 A response to the belief that the competitor is sophisticated and uses decision rule L1.

R A reasonable explanation that is not a response to a certain belief on the opponent's behavior (e.g., aiming at winning the majority of auctions).

S Safety (win for certain a minimal number of auctions).

M Bid value that ensures a minimal reasonable gain in case of winning.

P Bid value that is proportional to the auction's prize value.

* After classification was completed, S, M, and P (which are sub-categories of R) were merged with R.

3. Additional classification instructions given to all research assistants

- If there is no message or a short message without any strategic content, please note **N** (no explanation).
- If there is clear dimensional thinking (e.g., "We need to think of how many auctions/fronts we should reinforce") but there is no explicit decision rule, classify the decision rule in the certain dimension as **N**.
- If there are two decision rules in one dimension, please indicate both of them.
- If you are not sure whether a dimension or a decision rule was mentioned in the text, you can note that with a question mark.

Additional comments:

1. An argument about the status of the player and not his strategy ("I am an engineer" or "I studied game theory") should be noted and quoted briefly.
2. An argument that reveals hesitation should be noted and quoted.
3. An argument that reveals confidence should be noted and quoted.
4. Inconsistency between the suggested strategy and the accompanying message should be noted.
5. A misunderstanding of the game by the subject should be noted.
6. Unusual arguments should be noted.
7. If the message includes rows with "0," it means that the last sentence prior to the 0 was erased. Please refer to the whole text but mention in your file that the subject erased text.

If there are dimensions/arguments that are not specified in the instructions, you may add them. Before adding any new dimension/argument, you should inform me. Adding a rule will be approved if it appears multiple times in the messages of different subjects.

Attached please find an Excel file to fill in your classification. Please e-mail me if there is any question.

4. Oral Clarifications and Amendments

At the beginning and throughout the classification process, the following clarifications and amendments were made to the instructions:

- Excel classification sheet was introduced and explained to the research assistants.
- The difference between dimension 1' and dimension 3 was clarified (D1A refers only to asymmetry between fronts/auctions without mention of order).
- Goals were added to the auction games classification (subjects used ”Goals” as a major part of their strategy in the auction games. An example of such a goal: winning a minimal number of auctions).
- A decision rule called “Le” (Leftovers) was added: allocation of the budget residues to an auction/front. After classification was completed, it was merged with R.