ATTENTION IN GAMES:
AN EXPERIMENTAL STUDY*

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Abstract

A common assumption in game theory is that players concentrate on one game at a time. However, in everyday life, we play many games and make many decisions at the same time, and, thus, we have to decide how best to divide our limited attention across these settings. In this paper we ask how players solve this attention-allocation problem and how their decision affects the way players behave in any given game when that game is viewed in isolation. We find that the attention of players is attracted to particular features of the games they play: the maximum payoff in the game, the minimum payoff, the degree of inequality in the game's payoff, whether the game has zero payoffs, the complexity of the game, and the type of game being played. Moreover, how much attention a subject gives to a particular game depends on the other game that he or she is simultaneously attending to.

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1 Introduction

When studying or teaching game theory, it is commonly assumed that people play or concentrate on one game at a time. We typically analyze a player's behavior in the Prisoner's Dilemma, the Battle of the Sexes, or more sophisticated dynamic games in isolation. But in everyday life we play many games and make many decisions at the same time, and so we have to decide how to split our limited attention across all these settings.

This paper asks: How do people solve this attention-allocation problem? In particular, what characteristics of games attract people's attention and what leads people to focus more on those features rather than others? Do people concentrate on the problems that have the greatest downside or the ones that have the greatest upside payoffs? Do they pay more attention to games that from a game-theoretical point of view are more complicated, or do the payoff characteristics of games trump these strategic considerations?

To answer these questions, we conduct an experiment in which we present subjects with a sequence of pairs of matrix games that are shown to them on a screen for a limited amount of time (10 seconds), and ask them which of the two games displayed they would like to allocate more time to thinking about before they play them at the end of the experiment. Thus, the main task in the experiment is not to have the subjects play games; instead, we present them with pairs of games and ask them to allocate a fixed budget of contemplation time between them. These time allocations determine how much time the subjects will have to think about these games when they play them at the end of the experiment.

In addition to these questions, we investigate whether our subjects' attention-allocation behavior is consistent. For example, are these allocation times transitive in the sense that if a subject reveals that he would want to allocate more time to game G_i when it is paired with game G_j and game G_j when it is paired with game G_k, then he also would allocate more time to game G_i when it is paired with game G_k? Other consistency conditions are also examined.

Finally, we ask what it means for a player to decide that he would like to pay more attention to one game rather than another. Does it mean that he likes or would prefer to play that game more than the other, or does it mean the opposite: that he dreads playing that game and for that reason he needs to think more about it? To answer these questions we run a separate treatment during which subjects are presented with the same game pairs found in our original experiment, but rather than allocating contemplation time across these games, they are asked which one they would prefer to play at the end of the experiment. All of this attention time and game preference information is elicited in an incentive-compatible way with payoff-relevant choices.

We presume that two factors determine behavior in any given game. First, how much attention does a player decide to devote to a game, given the other games he simultaneously faces. Second, how does the player behave given this self-imposed attentional constraint. While a theory is required to analyze how subjects allocate attention across games, we can rely on some empirical findings to discuss how subjects behave given their time allocation. Next we examine these two factors one at a time.

1.1 Theoretical Considerations: Time Allocation

In terms of theory, given the time constraints that are placed on our subjects when they make their time-allocation decisions, any theory we impose on the data will have to respect these constraints. Hence, we feel that the time-allocation decision can only be based at most on superficial features of the two games presented to our subjects—attributes that are readily visible to players when they decide on an allocation of decision time. In this paper, we concentrate on features like the the maximum payoff in each game, payoff inequality, minimum payoffs, whether a matrix contains zero payoffs or not, and the complexity of the game, which we roughly define as the size of the matrix. Given time constraints we do not study any strategic aspects of the game except for the game-class into which each matrix falls (i.g., Prisoner's Dilemma, Battle of the Sexes, etc.). We do this because we assume that although the subjects may not be able to identify the exact game class, they will notice and respond to the fact that the games are different.[1] We do not expect our subjects to have enough time to make sophisticated calculations before they make time allocation decisions. Consequently, any theory that relies on subjects finding the equilibrium of each game, inferring the number of steps of iterated dominance needed to get to an equilibrium, or making other sophisticated calculations is rejected in favor of a theory that provides more primitive inputs, such as the focality or salience of payoffs. Theories of focality and salience in one-person choice problems have become increasingly popular (see Bordalo et al. (2013), Bushong et al. (2015) or Kőszegi and Szeidl (2013)). Below we relate what we do in this paper to this literature.

To outline the type of theory that would be appropriate, we define the fraction of time allocated to game G_i when compared to game G_j as $\alpha(i,j)$ and if we reverse the order $\alpha(j,i) = 1 - \alpha(i,j)$. We assume that this fraction is a function of the difference in the attributes of the games listed above. Hence, for games that have K attributes indexed $k = 1, 2, ..., K$, we can define games by the attributes they contain and write them as $G_i(a_i^1, a_i^2, ..., a_i^K)$ and $G_j(a_j^1, a_j^2, ..., a_j^K)$, where a_i^k and a_j^k are the values of attribute k in game G_i and game G_j, respectively. Define Δ_{ij}^k as the difference in attribute k across these two games. If a_i^k is a dichotomous attribute, such as whether the game matrix has any zero payoffs or not, then $a_i^k \in \{0,1\}$, and the difference Δ_{ij}^k will take on a value in $\{0,1\}$ as well.

We propose a function $\alpha(i,j) = f(\Delta_{ij}^1, ..., \Delta_{ij}^K)$ that defines the time allocated to game G_i when compared to game G_j as a function of the differences in these easily observable attributes. We are interested in the sign of $\frac{\partial f(\Delta_{ij}^1,.......,\Delta_{ij}^K)}{\partial \Delta_{ij}^k}, k = 1, 2, ..., K$, which indicates how we expect the time allocated to game G_i to change when, in a binary comparison with G_j, we increase the magnitude of attribute k in game G_i keeping all other attributes constant. We also are interested in the difference between $\alpha(i,l)$ - $\alpha(j,l)$ that is, when these two games, G_i and G_j, are independently compared to all games $G_l \in \mathcal{G}$ in some set $\mathcal{G}$.

Theories of choice under certainty and uncertainty that have the features we desire already

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[1] We are not claiming that subjects in the time given to them can classify each game presented to them. Instead, we think that subjects can notice that different games imply different theoretical considerations. As we will see, this assumption seems well founded.

exist in the literature. For example, a set of papers investigating what has been called focusing, salience, or relative thinking have been written by Bordalo et al. (2012), Kőszegi and Szeidl (2013), Bordalo et al. (2013), Bushong et al. (2015), Bordalo et al. (2016), and others. These papers investigate choice between multidimensional objects composed of a vector of characteristics (consumption vectors in $\mathbb{R}^k$, income streams with time-dated consumptions, lotteries). The importance given to each component of the vector or each characteristic is assigned a weight that is a function of the range of values that the characteristic takes on in the consumption set C when all objects are compared. For example, Kőszegi and Szeidl (2013) draw attention to a characteristic and give a decision increasing weight as a function of the difference between the maximal and minimal values of that characteristic in the consumption set. Characteristics whose values vary over a large domain are more heavily weighted under the assumption that they are more salient and, hence, are likely to attract consumer's attention. For Bushong et al. (2015), just the opposite is true. If two goods differ by a fixed amount in some characteristic then that difference will be given less weight in a consumption set where that characteristic varies greatly rather than in a consumption set where the variation is smaller. The idea here is that everything is relative, and relative to the large domain of variation, any fixed difference will look smaller as the domain increases in size. According to Bordalo et al. (2013), the salience of a particular attribute is increasing in the degree to which the options differ in that attribute. In their own words:

> "In our model, a good's salient attributes are those that stand out or are unusual in the sense of being furthest from those of the "reference good." In the basic version of the model, the reference good is defined as having the average level of each attribute, where the average is taken over the goods in the choice set. The consumer's attention is drawn to the salient attributes, which are then overweighted in his choice."

If one takes the view that games are nothing more than inter-personal decision problems that differ in their payoff or strategic attributes, then it is natural to apply the theories discussed here to model attention allocation. Although we do not do that explicitly, this approach to analysis is implicit in our methods and in the design of our experiment.

An alternative framework that we could have used is provided by Alaoui and Penta (2016), whose paper examines the data generated by our experiment and explains all of our results using an adaptation of the Alaoui and Penta (2015) model.[2] This model is impressive, but we do not adopt it because it does not sufficiently take into account the attentional constraint our subjects face when they decide how to allocate their time across games. For example, the time-allocation decision made in their model relies on calculations on how sophisticated to be when playing each game (i.e., what level-k to use), but this approach is too time-consuming for our subjects given the amount of time they have to make an allocation decision. We conclude that despite their

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[2] We thank Larbi Alaoui and Antonio Penta for making us aware of exactly how one could adapt their model, created to describe the endogenous determination of level-k within a given game to a multi-game setting such as ours. Even more appreciated is an analysis they did detailing how their model could be applied to our problem. For details see Alaoui and Penta (2016).

exhaustive explanation of our results, models of salience and focality are a more natural class to consider.

Our goal in this paper is empirical. We ask: When subjects are engaged in their time-allocation task which game characteristics do they regard as the most focal and salient? In our experiments, the subjects compare games in a controlled ceteris paribus manner in which the games they encounter differ in one of the characteristics mentioned above. However, since it is not always possible to change one game characteristic in isolation without affecting others, we also present a regression analysis that allows for simultaneous changes in game characteristics and investigates how individual and interacted changes in these characteristics affect time allocation.

1.2 Choice Under a Time Constraint

In addition to how our subjects allocate their attention across game pairs, we also are interested in how their behavior changes as the amount of attention or time they allocate to any one game varies. To do this we rely on a set of papers that present ample evidence that the level of sophistication that one employs in a game depends on how much time or attention one devotes to it. For example, Agranov et al. (2015) allow players two minutes to think about engaging in a beauty contest game. Each second the player can change his or her strategy, but at the end of the two minutes one of the times will be chosen at random, and the choice at that time will be payoff relevant. The design makes it incentive compatible at each point in time for the subject to enter his or her best guess as to what choice is likely to be the most beneficial.

These authors show that as time goes on, players who do not act randomly (level-zeros, perhaps) change their strategies in the direction of the equilibrium. Hence, the results of Agranov et al. (2015) suggest either that the level-k chosen is a function of contemplation time or that, as Rubinstein (2016) proposes, as more time is spent on the game people switch from an intuitive to a more contemplative strategy (See also Kessler et al. (2015) for an application of Agranov et al. (2015) technique to the Dictator and Prisoner's Dilemma games).

Similarly, Lindner and Sutter (2013), who use the 11-20 game of Arad and Rubinstein (2012), find that if you impose time limits on subjects who play this game, those subjects will change their choices in the direction of the equilibrium. As Lindner and Sutter (2013) suggest, this might be caused by the imposition of time constraints, which forces subjects to act intuitively (Rubinstein (2016)), and this fast reasoning leads them to choose lower numbers.[3] Rand et al. (2012) find that when people are given more time to think about their contribution in a public goods game, their contributions fall.[4] Finally, Rubinstein (2016) looks at the decision times used by subjects to make their decisions and infers the types of decision they are making (intuitive or contemplative) from their recorded decision time. For our purposes what is important is that as people pay more attention to a game their behavior changes.

One corollary to our analysis is that we describe how the behavior of an agent who is engaged

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[3] See also Schotter and Trevino (2014) for a discussion on use of response times as a predictor of behavior.

[4] See Recalde et al. (2014) for a discussion of the use of decision times and behavior in public goods games and the influence of mistakes.

in one specific game is affected by the type of other games in which he is simultaneously interacting. Our results indicate that the level of sophistication one employs in a game is determined endogenously and depends on the constellation of other games the person engages in and the resulting attention he allocates to the game under consideration. In other words, if one aims to explain the behavior of a person playing a game in the real world, one must consider the other games in which that person is involved in. Choi (2012) and Alaoui and Penta (2015) have provided models of the endogenous determination of sophistication within one game. Our model, which adopts a more expansive focus, includes more general-equilibrium type of interactions, such as inter-game factors.[5] This result follows naturally from our study of attention allocation in games.

1.3   A Summary of Our Results

In this paper, we present evidence that supports the idea that when two games vie for the attention of a decision maker, then, ceteris paribus, the game with the largest maximum payoff attracts more attention, as does the game with the greatest minimum payoff. Games that have equity concerns (i.e., games that feature an inequity in the payoff matrix as opposed to games without it) also attract more attention, whereas games that have zero payoffs attract less attention than identical games in which all payoffs are positive. In addition, the amount of time allocated to a game (compared to other game) varies according to the class to which the game belongs. On average, the most attention is paid to Prisoner's Dilemma games followed by Battle of the Sexes, Constant Sum, and Pure Coordination games. We also present evidence that clearly demonstrates that how a subject behaves when playing a given game varies greatly depending on the other game in which he or she is engaged in. This directly supports our conjecture that a key element in determining how a player behaves in a given game is the set of other games he or she is simultaneously considering.

Employing various consistency measures, we find that although our subjects acted in a generally consistent manner, they also exhibited considerable inconsistency. With regards to transitivity, however, our subjects appeared to be remarkably consistent: over 79% of subjects exhibited either zero or one intransitive allocation when presented with three pairs of connected binary choices. Other consistency metrics, however, provide evidence of substantial inconsistency.

Finally, it appears that the amount of time allocated to thinking about a game is positively related to a subject's preference for that game. One interesting exception is pure coordination games: subjects allocate relatively little time to them but state that they prefer playing them. This finding suggests that subjects recognize the simplicity of these games compared, for example, to constant sum games, and, hence, they decide to spend their time elsewhere.

We proceed as follows. In Section 2, we describe our experimental design. Section 3 outlines a set of intuitive hypotheses about the type of behavior we expect to see in our experiment. In Section 4 presents our results. Section 5 concludes.

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[5] Bear and Rand (2016) theoretically analyze agents' strategies when they are sequentially playing more than one type of game over time. For the effects of simultaneous play, cognitive load, and spillovers on strategies see Bednar et al. (2012) and Savikhin and Sheremeta (2013).

2 Experimental Design[6]

The experiment was conducted at the Center for Experimental Social Science (CESS) laboratory at New York University (NYU) using the software z-Tree (Fischbacher (2007)). All 194 subjects were NYU students recruited from the general population of NYU students. The experiment lasted about one hour and thirty minutes and subjects received an average of $21 for their participation. The experiment consisted of three different treatments run with different subjects. In two, subjects were asked to allocate time between two or sometimes three games. In the other, subjects were asked to choose the game they would prefer to play. We will call these the *time-allocation* treatment and the *preference* treatment. The experiment run for each treatment consisted of a set of tasks that we describe below.

2.1 Time-Allocation Treatment

2.1.1 Task 1: Comparison of Games

Comparisons of Pairs. In the first task of the time-allocation treatment, there were 45 rounds. In the first 40 rounds, subjects were shown a pair of matrix games (almost always 2×2 games) on their computer screen (we discuss the final five rounds in the next subsection). Each matrix game presented a situation in which two players had to choose actions that jointly determined their payoffs. At the beginning of each round a pair of matrix games appeared on their screen for 10 seconds. Subjects were asked not to play these games but to decide how much time they would like to allocate to thinking about the games if they were offered a chance to play them at the end of the experiment. To make this allocation subjects had to decide what fraction of X seconds they would allocate to Game 1 (the remaining fraction would be allocated to Game 2). The value of X was not revealed to them at this stage. They were told that X would not be a large amount of time and that in Task 1 they needed to identify the **relative amounts** of time they would like to spend contemplating these two games if they were to play them at the end of the experiment. We did not tell subjects how large X was since we wanted them to anticipate being somewhat time constrained when they played these games. In other word, we wanted the shadow price of contemplation time to be positive in the minds of each subject. We feared that if subjects perceived X to be so large that they could fully analyze each game before deciding, they might feel unconstrained and allocate 50% to each game. Avoiding this type of strategy was important since what we are interested in is the *relative amounts* of attention they would like to allocate to each game. We wanted to know which game they thought they needed to attend to more. Our procedure, we felt, was well suited to this purpose.

To indicate how much time each subject wanted to allocate to each game he or she had to write a number between 0 and 100 to indicate the percentage of time that he or she wanted to allocate to thinking about the game called "Game 1" on their screen. The remaining time was allocated to "Game 2." To this end we allowed subjects to view each pair of games for 10 seconds and then

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gave them 10 seconds to enter their percentage. We limited them to 10 seconds because we did not want to give them enough time to actually try to solve the games. Instead, we wanted them to identify the game that *appeared* most worthy of their attention. We expected them to view the games, evaluate their features, and identify the relative amounts of attention they would like to allocate to these games if they were to play them later on.

The constraints we imposed on our subjects are not artificial (although in the real world we typically have more than 10 seconds to think before allocating attention). In our daily lives, we are bombarded with chores and obligations and we seldom have time to complete all the tasks that require our attention. For example, as academics we need to prepare courses, get ready for our next seminar presentation, write grant proposals, serve on committees, and reserve time to be with our families. However, we know that during the chaotic course of our daily lives we need to set aside time to make important decisions. Thus we might know that, say next Tuesday we will have a free hour to think about and decide how to prioritize our attention.

For instance, say that we need to draw up a will, change our investment portfolio, choose a school for our child to attend, and decide whether to buy or repair a car. In our scenario these problems loom over us and we have to decide which of these tasks will take precedence next Tuesday during that precious free hour. To make that decision now we have to evaluate the attributes of each problem, for example, what is the worst thing that will happen to me if I fail to change my investment portfolio or get my car fixed, and what are the best things that can happen to me. If I am young and healthy I might place making a will at the bottom of the list of preferences and instead choose a school for my child. In making this decision I am saying that choosing a school will be more important goal next Tuesday when I will have time to think. On the basis of these characteristics, we decide to prioritize and determine which problem to attend to and, thus, the relative importance of each problem. What we do not have time to do now is actually think about these problems or spend the time needed to really understand them. We base our decision on their superficial attributes just as we think our subjects do.

On the screen that displayed the two games a counter appeared in the right-hand corner. The counter indicated how much time a subject had left before the screen went blank and they would be asked to enter their attention percentage in a subsequent screen, which also had a counter in the right-hand corner.

Comparisons of Triplets. When 40 rounds in sessions 1 and 2 were over, subjects were given five triplets of games to compare. In each of these last five rounds, they were presented with three matrix games on their screens and given 20 seconds to inspect them. As in the first 40-round task, subjects were asked not to play these games but rather to enter how much time out of 100% of total time available they would allocate to thinking about each of the games before making a decision. To do this, when the screen went blank after the the game description, subjects had 20 seconds to enter the percentage of total time they wanted to allocate to thinking about Game 1 and Game 2. (The remaining time was allocated to thinking about Game 3). After the choice for the round was made subjects were given time to rest before starting the next pair of problems, when the same

8

process was repeated.

All of the games used to make comparisons are presented in Tables 1, 3, 4, 16, 17, and 2. In total 34 games were used, and these includes Prisoner's Dilemma, Pure Coordination, Constant Sum, Games of Chicken, and variants on these games. Thirty of the 34 games were 2×2 games, two games 2×3 and two games 3×3. The 30 games used included a set of 10 games within which each game in the set was compared to every other. This set, called the *comparison set* $\mathcal{G}$ (Table 1), is a special interest for us, since it allows to compare how any two games attracted consideration time when compared to the same set of games. Games in the comparison set $\mathcal{G}$ let us hold compared games constant when evaluating whether one game attracted more attention than another.

Table 1: List of Games in comparison set $\mathcal{G}$

PC_{800}

800, 800	0, 0
0, 0	800, 800

PC_{500}

500, 500	0, 0
0, 0	500, 500

BoS_{800}

800, 500	0, 0
0, 0	500, 800

BoS_{500}

500, 300	0, 0
0, 0	300, 500

CS_{800}

800, 0	0, 800
0, 800	800, 0

CS_{500}

500, 0	0, 500
0, 500	500, 0

CS_{400}

400, 100	100, 400
100, 400	400, 100

PD_{800}

800, 800	100, 1000
1000, 100	500, 500

PD_{500}

500, 500	50, 800
800, 50	100, 100

PD_{300}

300, 300	100, 400
400, 100	200, 200

2.1.2 Task 2: Playing Games and Payoffs

With regards to payoffs, subjects were told that at the end of 45 rounds two of the 45 pairs of games they saw in Task 1 would be presented to them again, at which time they would have to play these games by choosing one of the strategies available to them (they always played as row players). For each pair of games, they were allowed an amount of time equal to the percentage of time they allocated to that game multiplied by X seconds, which at this stage they were told was 90 seconds. Hence, if they indicated that they wanted 60% of their available time for Game 1 and 40% for Game 2, they would have 54 seconds to think about their strategy when playing Game 1 and 36 seconds to think about Game 2. After choosing strategies for each game in the first pair, they were given 60 seconds to rest before playing the second pair.

Subjects were told that they would not play these games against other subjects in the experiment. Rather, they were told, in a previous experiment these games had been played by a different set of subjects, who played the games without any time constraints. Their payoff would be determined by both their strategy choice and the strategy choice of one of these other subjects, who had been chosen randomly.

We did this because when our subjects engaged in Task 1, we did not want them to decide

on an allocation time knowing that their opponent would be doing the same thing and possibly play against them at the end. We feared this might led them to play an "attention game" and choose to allocate more contemplation time to a particular game thinking that their opponent would allocate little to that game. Rather we wanted to know which game they thought was more worthy of attention and hence wanted to minimize (eliminate) their strategic thinking in Task 1 about their opponent's contemplation times.

To determine their payoffs, subjects were told that after playing their games against their outside opponents, they would be randomly split into two groups: Group 1 and Group 2. Subjects in Group 1 would be given the payoff they determined in the play of their game with their outside opponent, while the other half would passively be given the payoff of the outside opponent. In other words, if I were a subject and played a particular game against an outside opponent and was told afterwards that I was in Group 1, then I would receive my payoff in that game while my opponent's payoff would be randomly given to a subject in Group 2.

This procedure was used because although we wanted subjects to play against an outside opponent, we also wanted the payoffs they chose to have consequences for subjects in the experiment. Some of our hypotheses concern the equity in the payoffs of the games and we wanted these distributional consequences to be real for subjects in the lab. Hence, they played against outside opponents, and their actions had payoff consequences for subjects in the lab. Because when chose their strategies the did not know if they would be in Group 1 or Group 2, their strategies, their strategy choice was incentive-compatible in the respect that it was a dominant strategy to play in a manner that maximized their utility payoff.

After the subjects played their games in Task 2, one of the games played was selected to be the payoff-relevant game and subjects received their payoff for that game. Finally, after every subject made choices in Task 2, they were given a short survey. We gathered information on their major, GPA, gender, whether they had taken a Game Theory class and their thoughts about the experiment.

2.2 Preference Treatment

When a subject allocates more time to thinking about game G_i than game G_j it is not clear what exactly that implies about the preferences regarding these two games. For example, do people spend more time worrying about games that they would like to avoid or do they allocate more time to those that they expect to be pleasurable or perhaps profitable? In our preference treatment, subjects engage in an experiment that is identical to our time-allocation treatment with one except that in this treatment: when the subjects are presented with two games on their screen, their task is to decide which game they would prefer to play if they had to choose to play only one. In other words, when faced with 45 binary comparisons, subjects were given 10 seconds to decide which game they would prefer to play if at the end of the experiment this game pair was chosen for playing. Hence, this treatment elicits the preferences of subjects regarding pairs of games, and these preferences can be correlated with the time allocations of our subjects. At the end of the experiment, two pairs of games were chosen at random and subjects played the games they

said they preferred against an outside opponent who in a previous experiment had played these games as column chooser. In summary, our experimental design is as follows (we discuss Payoff-Rearrangement treatment later):

Figure 1: Experimental design

Treatment	Sessions	Task	No. of subjects
Time Allocation 1	1-2	45 comparisons	48
		(40 pairs and 5 triples)	
Time Allocation 2	3-4	40 comparisons	46
		(pairs, different than TA1)	
Preference	5-6	45 comparisons	46
		(All in comparison set $\mathcal{G}$)	
Payoff Rearrangement	7-8	45 comparisons	54

3   Hypotheses

As stated in the introduction, given the time constraints that our subjects face, we do not expect them to notice more than the basic features of the games they are comparing. The attributes we consider are the maximum payoff in each matrix, the minimum payoff in each matrix, the size of the maximum payoff inequality, whether or not the game has zero payoffs, and the size of the matrices. In this section we present a set of hypotheses regarding how changes in these game attributes affect the amount of time allocated to a game. We present the results of testing these hypotheses in the next section.

3.1   Zero and Minimum Payoffs

Psychologically a matrix with zero payoffs, perhaps like negative payoffs, can be perceived in many different ways. First, zeros may be scary numbers since they involve zero earnings. If this is the case, zero payoffs are things to be avoided, but avoiding them may require some consideration, and thus, more attention. On the other hand, having zero payoffs can simplify the matrix game by making it look less cluttered, and this can highlight strategic considerations. If this is true, then we would expect less time to be allocated to games that have zero entries.

Lowering a previously positive payoffs in a game with strictly positive payoffs to zero does two things, however. First it takes a game without zeros and introduces them into the matrix while also lowering the previous minimum payoff in the game from something positive to zero. These two effects are confounds since they may work independently but in the same direction to affect attention.

To separately identify the impact of zero and minimum payoffs we use the set of games in Table 2. Looking across the rows in this table we see a different set of three games taken from a specific game class, (i.e., PC games, BOS games, CS games and PD games). For example, looking across the first row we see three pure-coordination games which differ only in their off-diagonal payoffs. PC_0, for example, is identical to PC_{50} and PC_{100} and PC_{100} except for the fact that its

Table 2: Games for identifying min and zero effect

PC_0

800, 800	0, 0
0, 0	500, 500

PC_{50}

800, 800	50, 50
50, 50	500, 500

PC_{100}

800, 800	100, 100
100, 100	500, 500

BoS_0

800, 500	0, 0
0, 0	500, 800

BoS_{50}

800, 500	50, 50
50, 50	500, 800

BoS_{100}

800, 500	100, 100
100, 100	500, 800

CS_0

800, 0	0, 800
0, 800	800, 0

CS_{50}

800, 50	50, 800
50, 800	800, 50

CS_{100}

800, 100	100, 800
100, 800	800, 100

PD_0

800, 800	0, 1000
1000, 0	500, 500

PD_{50}

800, 800	50, 1000
1000, 50	500, 500

PD_{100}

800, 800	100,1000
1000,100	500, 500

off-diagonal elements are lowered to zero from their previous positive value of 50 and 100. We define a zero change as a change in the payoffs of a matrix which changes a previously positive minimum payoff in the matrix to zero leaving all other payoff characteristics (i.e., maximum, inequality etc.) identical. A minimum change is defined as a change in the payoffs of a matrix which lowers the minimum payoff from a previously positive value to a lower, but still positive, value. As we see in Table 2, when we compare PC_0 to PC_{50} and PC_{100} we have a pure zero change since all that has occurred is that we changed a previous minimum payoff from a positive number (50 or 100) to zero. Comparing PC_{50} and PC_{100}, however, is a pure minimum change since all we are doing is changing a previous positive minimum to a yet smaller, although still positive, value. The same is true for comparisons across the other rows of Table 2. Note, however, while our goal is to, whenever possible, to make ceteris paribus changes, that is not always possible. For example, across the last two rows of Table 2, while we make the same zero and minimum changes, because of the nature of the game class, we are simultaneously altering the inequality of the game's payoffs. Regression analysis done using the entire data set support the conclusions we report on using these controlled changes.

These considerations yield the following two Hypotheses:

Hypothesis 1 *Zeros: If game G_j is derived from game G_i by changing a positive minimum payoff in game G_i to zero while keeping other attributes the same, then a subject should allocate equal time to game G_i and G_j, when they are compared to each other.*

Hypothesis 2 *Minimums: If the minimum payoff in game G_i is strictly greater than in game G_j, and all other attributes across these games are identical, then a subject will allocate equal time to games G_i and G_j.*

3.2   Maximum Payoffs

Certain features of games are bound to attract one's attention. We examine the maximum payoff in a matrix. In the case of the maximum payoff, we take two games, G_1 and G_2, in which the maximum payoff in G_2 is greater than that of G_1 and all other attributes are equal. We expect

more time to be allocated to game G_2 when they are compared directly to each other and to any other game in comparison set $\mathcal{G}$.

For example, consider the following two games:

PC_{500}	A	B
A	$500, 500$	$0, 0$
B	$0, 0$	$500, 500$

PC_{800}	A	B
A	$800, 800$	$0, 0$
B	$0, 0$	$800, 800$

Note that in moving from PC_{500} to PC_{800} we increase the maximum payoff in PC_{800} but nothing else; i.e., the minimum is still zero in both matrices, the inequity of payoffs in any cell is still zero, the number of zeros in either matrix is the same, and both games are still pure coordination games. Since game PC_{800} in some sense is more desirable, we will conjecture that in a comparison with PC_{500} it will be allocated more time. In addition, it will be our conjecture that not only will $\alpha(2, 1) > \alpha(1, 2)$ hold, but $\alpha(2, 3) > \alpha(1, 3)$ also will be true for any game $G_3 \in \mathcal{G}$ ($G_1 = PC_{500}$ and $G_2 = PC_{800}$). These considerations yield our next hypothesis:

Hypothesis 3 *Maximums: If the maximum payoff in game G_i is strictly greater than the maximum in game G_j and all other attributes across these games are identical, then a subject will allocate more time to game G_i when these games are compared to each other or to any other game G_k in the comparison set $\mathcal{G}$.*

3.3 Equity

There is considerable evidence that subjects take longer to make decisions when equity concerns exist (see Rubinstein (2007)). In addition, there is a large literature that indicates that inequity aversion and other altruistic concerns weigh heavily on people's decisions (see Fehr and Schmidt (2000), Bolton and Ockenfels (2000)). However, our focus is not decision time but attention, i.e., do games with greater inequality attract more attention?

To investigate this, we say that game G_i contains more inequality than game G_j if the maximum inequality in the cells of game G_i is greater than the maximum inequality in the cells of G_j. This implies that when subjects look across game matrices what pops out at them is the maximum of payoffs in the two games. A pure increase in inequality would be an increase in this maximum inequality that leaves all other attributes the same. However, for such changes it is often the case that when we increase inequality in one game we change the game class we are looking at. For example, consider the Pure Coordination game PC_{800} and the Constant Sum game CS_{800}:

PC_{800}	A	B
A	$800, 800$	$0, 0$
B	$0, 0$	$800, 800$

CS_{800}	A	B
A	$800, 0$	$0, 800$
B	$0, 800$	$800, 0$

According to our definition, the PC_{800} game has zero inequality in payoffs ($800 - 800 = 0 - 0 = 0$). Now we consider the second game, CS_{800}, which is a constant sum game. These two

games have identical maximums, the same number of zeros, identical minimums, and are of the same size. They differ in the respect that there is payoff inequality in CS_{800} and none in PC_{800}. Note, however, that by rearranging the payoffs in PC_{800} we have changed the game from a Pure Coordination game to a Constant Sum game.

Likewise, consider

BoS_{500}	A	B
A	$500, 300$	$0, 0$
B	$0, 0$	$300, 500$

PC_{500}	A	B
A	$500, 500$	$0, 0$
B	$0, 0$	$500, 500$

These games have identical maximums, identical minimums, and an equal number of zeros but they differ in the respect that there is payoff inequality in BoS_{500} and none in PC_{500}. They also are in different game classes, but this is unavoidable because by definition there is inequality in Battle of the Sexes games and none in symmetric Pure Coordination games.

Consistent with Rubinstein (2007) findings that subjects take longer to make decisions in games that have unequal payoffs, we expect to observe subjects allocating more attention to games that have greater inequity in payoffs. This is true for the following reason: in addition to the strategic variables that a player considers, inequality, when added to the mix, inserts a moral dimension that also must be considered. This yields the following hypothesis:

Hypothesis 4 *Equity: If two games, G_i and G_j, are identical with respect to all attributes (except perhaps for their game class) but game G_i contains a larger maximum inequality than game G_j, then a subject will allocate more time to game G_i when these games are compared to each other or to any other game $G_k \in \mathcal{G}$.*

3.4 Complexity

One might think that one of the major features of games that attract players' attention is their complexity. Unfortunately, there is very little consensus regarding what makes a game complex and no commonly agreed upon standard. Nonetheless, there are situations in which one might agree that game G_i is more complex than game G_j, and in our design, we think we have such a case. More precisely, in those few instances where we expanded our games beyond 2×2 games to 3×3 games we did so by adding dominated strategies to one of our existing 2×2 games. For example, consider the following three games.

Games CPD_1 and CPD_2 are derived from PD_{800} by the addition of two dominated strategies: one for the column chooser (column 3) and one for the row chooser (row 3). We consider CPD_1 and CPD_2 more complex than PD_{800} for two reasons. First, CPD_1 and CPD_2 involve more actions and, hence, are simply larger. Second, despite the fact that all three games have identical unique equilibria, the equilibria in CPD_1 and CPD_2 are reached by a more complicated strategic process that involves recognizing both dominance and iterative dominance. Given that the equilibria for all three games are identical and unique, we might want to consider CPD_1 and CPD_2 to involve more pure increases in complexity compared to PD_{800}. As such, we would intuitively

Table 3: Prisoners Dilemma and Its Transformations

PD_{800}

800, 800	100, 1000
1000, 100	500, 500

CPD_1

800, 800	100, 1000	1900, 600
1000, 100	500, 500	100, 100
600, 1900	100, 100	0, 0

CPD_2

800, 800	100, 1000	0, 0
1000, 100	500, 500	0, 100
0, 0	100, 0	0, 0

conclude that in a binary comparison between PD_{800} and either CPD_1 or CPD_2, we would expect more time to be allocated to the larger and more complex games. This yields the next hypothesis.

Hypothesis 5 *Complexity: If game G_i is derived from game G_j by adding a strictly dominated strategy to the row and column player's strategy set, then a subject will allocate more time to game G_i than game G_j.*

3.5 Strategic Attributes: Payoff-Rearrangement Treatment

When looking across types of games like Pure Coordination games, Battle of the Sexes games, Constant Sum games, or Prisoner's Dilemma games, subjects could believe that some of these games are easier to play than others, and these games will attract less attention. While we do not suggest that our subjects can quickly classify the games they are presented with and know their strategic properties, we do claim that subjects can notice and respond to differences in the way payoffs are arranged in the cells of the matrices. For example, it is easy to look at a Pure Coordination game of the type we present our subjects with and understand the strategic issues involved, but not a Prisoner's Dilemma. Likewise, given that in Pure Coordination games peoples' interests are aligned while in the Battle of the Sexes games they are not, we might expect subjects to allocate more time to the later than the former. These strategic hypotheses are not completely satisfactory since it is extremely difficult to provide a ceteris paribus change in the game class without also altering other important payoff attributes. In other words, finding a way to provide a change in payoffs that constitutes a pure strategic change is a challenge. Thus, we decided to run a treatment (called the payoff-rearrangement treatment) that offers a shot at solving this problem.

To explain our payoff-rearrangement treatment, consider the numbers 800, 500, 50, and 10. When these number are arranged as in Figure 4a, we have a Pure Coordination game (albeit with positive off-diagonal payoffs), whereas the arrangement in Figure 4b leads to a Battle of the Sexes game. Arranging numbers as in Figure 4c generates a Prisoner's Dilemma game.[7] The amount of time allocated to these games differs when they are compared either to each other or to all other games in the comparison set $\mathcal{G}$, and we conclude that this outcome supports the claim that game class affects the allocation of attention.

A trained game theorist who performed our experiment and used the standard algorithms to

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[7] We thank Guillaume Fréchette for suggesting this treatment.

Table 4: Rearranged Games

(a) PC_{RA}

	A	B
A	800, 800	50, 50
B	10, 10	500, 500

(b) BoS_{RA}

	A	B
A	800, 500	50, 50
B	10, 10	500, 800

(c) PD_{RA}

	A	B
A	500, 500	10, 800
B	800, 10	50, 50

solve games might conclude that once they placed a game presented to them into a game class, there should be no need to think more about that game since all games in that class, no matter their payoffs, are strategically equivalent. This would imply that the fraction of time allocated to such games and any other game in the set $\mathcal{G}$ should be identical. However, we expect that even among games that inhabit the same game class, the amount of time allocated to them will depend on their payoff attributes.

3.6 Interrelated Games

In our view, the attention allocated to a given game varies as we change the specific game to which it is compared—there is behavioral inter-game dependence. For example, suppose that an agent focuses a fraction $\alpha(i, j)$ of his total attention on game G_i when he compares it to game G_j. Now replace game G_j with a different game G_k. An agent is now comparing game G_i and game G_k and he must decide how much attention to focus on game G_i, (i.e., he must now determine $\alpha(i, k)$). However, since we have changed the opposing game, the attention that the agent focuses on G_i will change from $\alpha(i, j)$ to $\alpha(i, k)$, presumably with $\alpha(i, j) \neq \alpha(i, k)$. As a result, changing the second game under consideration from game G_j to game G_k will affect the attention that the agent focuses on game G_i and, hence, that agent's behavior in game G_i.

Hypothesis 6 *Interdependent Games: The way an agent behaves in a game is dependent on the specific other game an agent is simultaneously engaged in.*

4 Results

4.1 Preliminaries

Before we present our results, it is important to consider our data. We ran sessions $1, 2, 3$, and 4 to derive a set of 10 games, where all games in the set were paired with each other. For 10 games in the set

$$\mathcal{G} = \{PC_{800}, PC_{500}, BoS_{800}, BoS_{500}, CS_{800}, CS_{500}, CS_{400}, PD_{800}, PD_{500}, PD_{300}\}$$

we have a full set of comparisons such that each game in this set is compared to every other game.[8] This allows us to hold the comparison set constant and to compare how time is allocated between each game and every other game in the set $\mathcal{G}$; thus, we are able to make controlled comparisons.

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[8] All combination of two games out of ten without replacement and order is $C_2^{10} = \frac{10!}{2!8!} = 45$.

Many of our comparisons focus on these 10 games. Others involve binary comparisons of games in which either only one game is in $\mathcal{G}$ or both games are outside of $\mathcal{G}$.

Since any game $G_i \in \mathcal{G}$ has been compared to each of the other nine games in the set $\mathcal{G}$ we calculate the mean percentage of time allocated to the game G_i over all the comparisons in $\mathcal{G}$. We do this for each of the 10 games so that each will have a mean score that represents the mean fraction of time allocated to this game when compared to every other game in $\mathcal{G}$. Table 5 presents the results. For instance, referring to Table 5, we see that when subjects compared PC_{800} and PC_{500}, they devoted an average of 54.1% of their available time to the PC_{800} game and consequently, only 45.9% to the PC_{500} game. In other words, when subjects compared PC_{800} to PC_{500} they decided that they would like to spend more time contemplating PC_{800} before making a choice.

Table 5: Mean Allocation Times[a] (time allocated to the row game when compared to the column game)

	PC_{800}	PC_{500}	BoS_{800}	BoS_{500}	CS_{800}	CS_{500}	CS_{400}	PD_{800}	PD_{500}	PD_{300}
PC_{800}		**54.1**	49.6	55.1	48.3	51.9	**42.5**	**39.3**	**41.9**	**44**
		(1.62)	(2.79)	(3.09)	(1.38)	(2.92)	(2.16)	(2.24)	(2.46)	(1.81)
PC_{500}	**45.9**		**45.4**	49.2	**45.5**	47.5	**41.3**	**39.2**	**42.0**	**44.1**
	(1.62)		(1.48)	(1.55)	(1.96)	(1.7)	(1.99)	(2.06)	(2.06)	(2.24)
BoS_{800}	50.4	**54.6**		**58.3**	48.6	52.1	**43.9**	**40.2**	**45.3**	48.4
	(2.79)	(1.48)		(2.18)	(2.05)	(1.95)	(2.53)	(2.47)	(1.97)	(2.24)
BoS_{500}	44.9	50.8	**41.7**		**46.6**	**45.9**	**44.4**	**39.8**	**43.5**	**45.2**
	(3.09)	(1.55)	(2.18)		(1.81)	(1.58)	(1.84)	(2.4)	(2.02)	(1.91)
CS_{800}	51.7	**54.5**	51.4	**53.4**		**55.8**	**46.1**	**43.1**	**41.1**	**43.1**
	(1.38)	(2.04)	(2.05)	(1.81)		(1.73)	(1.92)	(2.00)	(2.41)	(2.21)
CS_{500}	48.1	**52.5**	47.9	**54.1**	44.2		**44.5**	**44.7**	**41.6**	**43.8**
	(2.92)	(1.7)	(1.95)	(1.58)	(1.73)		(1.75)	(2.49)	(2.05)	(2.08)
CS_{400}	**57.5**	**58.7**	**56.1**	**55.6**	**53.9**	**55.5**		**44.1**	47.0	50.0
	(2.16)	(1.99)	(2.53)	(1.84)	(1.92)	(1.75)		(2.25)	(2.59)	(1.43)
PD_{800}	**60.7**	**60.8**	**59.8**	**60.2**	**56.9**	55.3	**55.9**		**54.3**	**54.7**
	(2.24)	(2.14)	(2.47)	(2.4)	(2)	(2.49)	(2.25)		(1.75)	(1.83)
PD_{500}	**58.1**	**58.0**	**54.7**	**56.5**	**58.9**	**58.4**	53.0	**45.7**		52.8
	(2.46)	(2.06)	(1.97)	(2.02)	(2.41)	(2.05)	(2.59)	(1.75)		(2.14)
PD_{300}	**56.0**	**55.9**	51.6	**54.8**	**56.9**	**56.2**	50.0	**45.3**	47.2	
	(1.81)	(2.47)	(2.24)	(1.91)	(2.21)	(2.08)	(1.43)	(1.83)	(2.14)	

[a] Standard errors are in parentheses. Every element of this table is tested to be equal to 50% and the bold elements represent rejection of the null hypothesis at the 5% significance level.

This table is particularly interesting as we move across any given row since we see a large variation in the amount of time allocated to any particular game (we discuss this table and its implications in greater detail in Section 4.4). This indicates that the amount of attention that a player decides to allocate to a given game depends on the other game to which it is ibeing compared. This is particularly noticeable for a game like PD_{500}, to which subjects allocate 58.0% of their time when it is compared to PC_{500}, but the average declines to 45.7% when PD_{500} is compared to PD_{800}. If the behavior of a subject in a game depends on the attention that he or she pays to it, then understanding how a player behaves in a game requires that he or she knows the other

17

games that vie for his or her attention before the choice is made.

4.2 Hypotheses Testing

In this section we examine each of the hypotheses presented in Section 3. Our discussion of these hypotheses proceeds along two lines. First, in the case of hypotheses concerning game attributes like the minimum payoffs, maximum payoffs etc., we include in our design controlled ceteris paribus changes that allow us to directly determine how these attributes impact attention allocation. But in the case of some attributes there are only a small set of games that allow this type of comparison. Thus, moving along the second line, we conclude this section with a regression analysis that explains time allocation in an environment that utilizes all of our data and hence, is more powerful. With few exceptions, the results of our regressions are in agreement with our controlled comparisons. We start by restating and testing hypotheses.

Hypothesis 1 *Zeros: If game G_j is derived from game G_i by changing a positive minimum payoff in game G_i to zero while keeping other attributes the same, then a subject should allocate equal time to game G_i and G_j, when they are compared to each other.*

Using our design outlined in Table 2 we present results of the zero hypothesis in Table 6, which presents the results of our "zero change".[9]

Table 6: Zero Hypothesis

Comparisons	Mean	p-value	Comparisons	Mean	p-value
PC_0 vs PC_{50}	42.44	0.003	PC_0 vs PC_{100}	42.00	0.003
BoS_0 vs BoS_{50}	41.50	0.005	BoS_0 vs BoS_{100}	42.31	0.006
CS_0 vs CS_{50}	43.41	0.008	CS_0 vs CS_{100}	41.26	0.001
PD_0 vs PD_{50}	43.96	0.019	PD_0 vs PD_{100}	42.70	0.002

As indicated in Table 6, we can easily reject the Hypothesis 1 because it is clear that subjects allocate less time to games when their minimum payoffs are reduced to zero. This is true for all classes of games at significance levels consistently below 2%. This result is not a priori obvious. As mentioned above, when a payoff in a game is increased from zero to something positive, one might expect that the game will be "safer" in the respect that no matter what happens the player will at least avoid a zero payoff. One might also conclude that less time is needed to play these games, but this is not the case. Subjects believe that matrices that have zero payoffs are simpler to play and, hence, deserve less attention. As Table 18 in Appendix A indicates, this result is true for a wide variety of situations not presented in Table 6. Indeed, it is also corroborated by our regression results.

Hypothesis 2 *Minimums: If the minimum payoff in game G_i is strictly greater than in game G_j, and all other attributes across these games are identical, then a subject will allocate equal time to games G_i and G_j.*

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[9] Many games in our design could be used to test this hypothesis because in many cases we lower a previously positive payoff to zero keeping the game class the same, see Table 18 in Appendix F for additional comparisons.

Table 7 presents the same type of comparisons as Table 6 but it eliminates all games with a minimum of zero. As Table 7 indicates, we find broad support to reject this hypothesis. If we increase game's already positive minimum payoff and leave everything else the same, subjects will allocate more time to that game. By comparing games with positive minimum payoffs, we avoid a conflict with the zero effect.

Table 7: Minimum Hypothesis

Comparisons	Mean	p-value
BoS_{50} vs BoS_{100}	41.24	0.003
PC_{50} vs PC_{100}	46.91	0.110
PD_{50} vs PD_{100}	45.93	0.038
CS_{50} vs CS_{100}	42.48	0.000

Hypothesis 3 *Maximums: If the maximum payoff in game G_i is strictly greater than the maximum in game G_j, and all other attributes across these games are identical, then a subject will allocate same time to both games when these games are compared to each other or to any other game G_k in the comparison set $\mathcal{G}$.*

Making the type of ceteris paribus changes we desire is difficult when we change the maximum payoff in a matrix because many times this increases inequality. It is not a concern, however, in Pure Coordination games because in these games such issues can be avoided. To test this hypothesis we compare PC_{500} and PC_{800}, where the maximum is increased without affecting equity concerns. As expected, we find that significantly higher fraction of time is allocated to PC_{800} (the game that has a higher maximum) when a binary comparison of these games is made (see Table 8). We also calculate the average fraction of time that subjects allocated to PC_{500} and PC_{800} when these games were compared to each of the games in comparison set $\mathcal{G}$, which we designate as $\overline{PC}_{500}$ and $\overline{PC}_{800}$. Using a Wilcoxon test, as shown in Table 8, the game that has the higher maximum is allocated a greater fraction of time when compared to all other games in $\mathcal{G}$, and the difference is significant at 5% significance level.

Further support for this hypothesis is presented in Section 4.3, which demonstrates that when we run a pooled regression using all our data, change in the maximum payoff in a game leads to an increase in the amount of time allocated to that game.

Table 8: Maximum Hypothesis

Game(s)	Allocation	p-value
PC_{500} vs PC_{800}	45.40	0.006
$\overline{PC}_{500}$ vs $\mathcal{G}$	43.73	$\Big\}$ 0.042
$\overline{PC}_{800}$ vs $\mathcal{G}$	46.10	

Hypothesis 4 *Equity: If two games, G_i and G_j are identical with respect to all attributes but game G_i contains a larger maximum inequality than does game G_j, then a subject will allocate same time to both games when these games are compared to each other or to any other game G_k in the comparison set $\mathcal{G}$.*

Probably the easiest way to introduce inequality in the payoffs of one of our matrix games without affecting any other of its features is to compare a Pure Coordination and a Battle of the Sexes game, such as PC_{500} and BoS_{500} or PC_{800} and BoS_{800}. As we know, BoS games differ from PC games in the respect that they have unequal equilibrium payoffs. The results of this comparison are presented in Table 9, which presents binary comparisons of both PC_{500} and BoS_{500} and PC_{800} and BoS_{800}. The table also compares the average fraction of time allocated to each of two the games, when they are compared to all other games in the comparison set $\mathcal{G}$.

Table 9: Equity Hypothesis

Game(s)			Allocation	p-value
PC_{500}	vs	BoS_{500}	49.19	0.215
$\overline{PC}_{500}$	vs	$\mathcal{G}$	43.73	} 0.076
$\overline{BoS}_{500}$	vs	$\mathcal{G}$	44.73	
PC_{800}	vs	BoS_{800}	49.60	0.336
$\overline{PC}_{800}$	vs	$\mathcal{G}$	46.10	} 0.036
$\overline{BoS}_{800}$	vs	$\mathcal{G}$	47.82	

Despite the greater inequality in the payoffs of the BoS's games, there is no significant difference in the amount of time allocated to BoS_{500} or BoS_{800} when they are compared directly to PC_{500} and PC_{800}. The only statistically significant result is that when PC_{800} and BoS_{800} are compared to all games in $\mathcal{G}$, BoS_{800} is allocated greater amount of time at the significance level of 5%.

Reaction times is the time it takes a subject to make a decision when faced with a particular game or decision. As reported by Rubinstein (2007), subjects tend to take a longer to make decisions when the games they face involve payoff inequality. That we find no such result here leads us to ask: What, in general, is the relationship between reaction times and attention times? In other words, if a subject thinks that game G_i requires more attention than game G_j, does he or she actually take more time to decide what to do in game G_i than in game G_j when he or she is playing these games and has no time constraint? This is a question we will explore in future work.

It might be worth noting, however, that our results on the equity hypothesis change when we examine our time-allocation regression: we find that more time is allocated to games with unequal payoffs.

Hypothesis 5 *Complexity: If game G_i is derived from game G_j by adding a strictly dominated strategy to the row or column player's strategy set, then a subject will allocate equal time to games G_i and G_j.*

Our complexity hypothesis states that we will call game G_i more complex than game G_j if G_i is identical to G_j except for the addition of a pair of strictly dominated strategies (one each for the row and column players). In other words, G_i not only has more actions than G_j it also requires more cognitive steps (elimination of dominated strategies) before its equilibrium is reached. In the experiment, we take the PD_{800} game and modify it two ways using dominated strategies to yield CPD_1 and CPD_2, both of which are 3×3 games. Table 10 presents the results of this complexity hypothesis.

Table 10: Complexity Hypothesis

Comparisons	Mean	p-value
PD_{800} vs CPD_1	35.5	0.000
PD_{800} vs CPD_2	40.6	0.001

Table 10 suggests that as games get more complex in the manner just described, subjects allocate more and more time to them. In the case of the comparisons made here, this effect is extremely strong in the respect that subjects on average allocate only 35.5% and 40.6% of their time to PD_{800}. These percentages are lower than in any other of the many comparisons we make. Adding a dominated strategy to the PD_{800} game dramatically lowers the amount of attention subjects pay to it when that game is compared to its new and larger cohort.

4.2.1 Strategic Attributes

Up until this point we have discussed only the impact of payoff characteristics on attention. Yet it is also possible that the type of game presented to subjects, independently of its payoffs, affects the way they allocate their time across games. Although we do not expect our subjects to have enough time to do a strategic analysis of the games presented to them, we do think it is possible that subjects sense, due to the arrangements of the payoffs, that some games look more salient than others and hence attract more attention.

To investigate this in a controlled manner, we performed the payoff-rearrangement treatment. Thus, we held fixed the payoffs that the subjects faced, and to create different types of games we simply rearranged them in different matrices. If such rearrangements change the time allocated to these games, then such a result must be imputed to the strategic aspects of the games because all payoffs are being held constant. This treatment comes as close as possible to what could be considered a ceteris paribus change in the strategic aspects of the game being played.

Recall that in this treatment we take the payoffs 800, 500, 50, and 10 and rearrange them to form three classes of games: Pure Coordination, Battle of the Sexes, and Prisoner's Dilemma, denoted as PC_{RA}, BoS_{RA} and PD_{RA}. (Note that there is no way to rearrange the payoffs and generate a constant-sum game without dropping some payoffs, thus that game class is omitted.) Although we expect that these rearrangements will have an impact on the time allocations we observe, we tested the following null hypothesis:

Hypothesis 6 *Strategic Aspect: When the same payoffs are rearranged in game matrices to generate games in different game classes, the time allocated to these games will be equal, when compared to each other in a binary fashion and to all the games in the comparison set $\mathcal{G}$.*

The results of our hypothesis are presented in Tables 11 and 12. In Table 11, we see the results of a set of binary comparisons that compare the amounts of time allocated to each of our three games when they are matched pairwise. As we can see, except for the comparison between PC_{RA}

Table 11: Direct Comparisons of Rearranged Payoffs

Comparison	Allocation	p-value
BoS_{RA} vs PC_{RA}	50.33	0.972
PD_{RA} vs BoS_{RA}	48.42	0.269
PC_{RA} vs PD_{RA}	45.81	0.026

and PD_{RA} there are no significant differences in the time allocated to our three games.[10]

Table 12: Rearranged Payoffs

Game	Allocation	Comparison	p-value
$\overline{BoS}_{RA}$ vs $\mathcal{G}$	55.29	$\overline{BoS}_{RA}$ vs $\overline{PC}_{RA}$	0.030
$\overline{PD}_{RA}$ vs $\mathcal{G}$	53.65	$\overline{PD}_{RA}$ vs $\overline{BoS}_{RA}$	0.064
$\overline{PC}_{RA}$ vs $\mathcal{G}$	52.64	$\overline{PC}_{RA}$ vs $\overline{PD}_{RA}$	0.364

This result does not imply that strategic elements are unimportant. Indeed, other comparisons that can be made that do indicate that our rearrangement is not innocuous. For example, instead of comparing the amounts of time allocated to our games when they are compared directly to each other in a pairwise manner, we can compare the average amount of time allocated to them when they are compared to all games in the comparison set $\mathcal{G}$. In Table 11, we see that compared to all games in $\mathcal{G}$, the BoS_{RA} game receives on average a time allocation of 55.29% while the rearranged PD_{RA} and PC_{RA} games receive average allocations of 53.65% and 52.64%, respectively. These percentages are significantly different (at the 5% and 10% level of significance, respectively) when we compare the BoS_{RA} and PC_{RA} games as well as BoS_{RA} and PD_{RA} games, but they are insignificantly different for the PC_{RA} and PD_{RA} games. This suggests that the BoS_{RA} game attracts more attention because it stands out strategically. Note that the comparisons in Table 12 are averaged over all games in comparison set $\mathcal{G}$. In Appendix F Table 19, we look at individual comparisons of rearranged games with each game in comparisons set $\mathcal{G}$.

Finally, a third, albeit less controlled, comparison investigates how strategic considerations affect attention. To do this, let $\overline{PC}$, $\overline{BoS}$, $\overline{CS}$, and $\overline{PD}$ represent the mean time allocated to all the Prisoner's Dilemma games, Constant Sum games, Battle of the Sexes games, and Pure Coordination games, respectively, when these are compared to all other games in $\mathcal{G}$. Unlike the games in our payoff-rearrangement treatment, the payoffs in these games vary within and across games and game classes. Hence, they are not held constant. Nonetheless, the comparisons suggested above can be informative.

Table 13, which presents the mean time allocated to games in our four game classes, clearly indicates that strategic elements are important. For example, subjects clearly allocated the most time to PD games (56.60%), then to CS games (48.75%), then BoS games (46.27%), and PC games

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[10] This comparison reveals a significant difference only when we eliminate those few subjects who always allocate either 0 or 100 percent of their time to one game.

(44.93%). A set of binary Wilcoxon signed-rank tests corrected for multiple hypotheses testing indicate that these differences are statistically significant for all comparisons ($p < 0.01$) except PC and BoS games where $p > 0.05$. A Friedman test rejects our null hypothesis with $p < 0.01$ that the mean attention time paid to games is equal across all game types: i.e. $\overline{PC} = \overline{BoS} = \overline{CS} = \overline{PD}$.[11]

Game Class	Mean Time	p-value
$\overline{PD}$	56.60	
$\overline{CS}$	48.75	< 0.000
$\overline{BoS}$	46.27	
$\overline{PC}$	44.93	

Table 13: Game Class Ordering in $\mathcal{G}$

In the hypothesis below we ask a different but associated question about the impact of strategic factors on time allocation. In this hypothesis, we are motivated by the idea that if strategic aspects are the only important factor for attention allocation, then there should not be any difference in the amount of time allocated to different games within a game class whose payoffs differ when those games are compared to all other games in the comparison set $\mathcal{G}$. In other words, as a game theorist might suggest, once a player can identify the type of game he is playing, then the amount of attention he allocates to it should not be affected by the game's payoffs because strategically speaking, all games in the same game class are equivalent. These considerations yield the following null hypothesis:

Hypothesis 7 *Game Class Irrelevance: For any two games G_i and G_j in the same game class (i.e., both PD games, both CS games, etc.), the mean amount of time allocated to each game should be identical when they are compared to any game G_k in the comparison set $\mathcal{G}$.*

Table 14: Game Class Hypothesis (p-values are adjusted for multiple hypothesis testing)

Game	Mean	Comparison	p-value	Game	Mean	Comparison	p-value
$\overline{BoS}_{800}$	47.82	$\overline{BoS}_{800}$ vs $\overline{BS}_{500}$	0.050	$\overline{PC}_{800}$	46.10	$\overline{PC}_{500}$ vs $\overline{PC}_{800}$	0.143
$\overline{BoS}_{500}$	44.73			$\overline{PC}_{500}$	43.82		
$\overline{PD}_{800}$	58.53	$\overline{PD}_{800}$ vs $\overline{PD}_{500}$	0.410	$\overline{CS}_{800}$	47.07	$\overline{CS}_{500}$ vs $\overline{CS}_{800}$	0.951
$\overline{PD}_{500}$	56.89	$\overline{PD}_{500}$ vs $\overline{PD}_{300}$	0.021	$\overline{CS}_{500}$	46.48	$\overline{CS}_{500}$ vs $\overline{CS}_{400}$	0.000
$\overline{PD}_{300}$	54.36	$\overline{PD}_{800}$ vs $\overline{PD}_{300}$	0.022	$\overline{CS}_{400}$	52.70	$\overline{CS}_{800}$ vs $\overline{CS}_{400}$	0.000

As indicated in Table 14, the hypothesis is rejected. For example, for PD games that depend on which PD game is examined, the mean fraction of time allocated to that game for all out-of-class comparisons differs. The average mean percentage of time allocated to PD_{800} when the subject faces non-PD games in the set $\mathcal{G}$ was 58.52%, but in the case of PD_{300} it was 54.36%. This indicates

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[11] The Friedman test is a non-parametric alternative to the one-way ANOVA with repeated measures. We use Friedman test throughout this paper to test hypotheses that involve more than two groups. For one- or two-group analysis, we use Wilcoxon signed-rank tests. In cases of multiple hypotheses testing, such as in Table 14, we use the Bonferroni correction to adjust significance thresholds.

that although both games are PD games, subjects regarded them different. Table 14 supports this result. For no class of games can we accept the null hypothesis of equality of mean time allocations across games within the same class. Thus, payoff features are important to subjects when they decide how to allocate attention across games.

4.3 Regression Analysis

In the discussion of our results above, we explored the effects of important game features on time allocation decisions in a controlled manner. In this section, we perform a similar analysis but use all the data gathered in our time allocation treatments.

Our data consist of time allocation decisions for different game pairs. We model the time allocation decision as a function of relevant game attributes and individual characteristics. For game attributes, we use the maximum and minimum payoff in a game, whether there are equity concerns in the comparison, number of zeros, and interactions between these variables. We express the observed time allocation choice as

$$\alpha_{i,jk} = f(G_j, G_k, \mathbf{Z}_i),$$

where $\alpha_{i,jk}$ is the time allocated by subject i to game G_j when it is compared to game G_k, and $\mathbf{Z}_i$ is a vector of subject-specific characteristics.

For the purposes of estimation, we separate f into two additively separable parts: a smooth component, h, and a set of categorical variables, $\mathbf{D}_{jk}$. We do not impose a parametric form on h, only a weak requirement that it be sufficiently smooth (for example, differentiable), and we use this smoothness property to approximate h using a power basis (also known as a complete polynomial basis)—a commonly employed strategy in sieve-based estimations (see, e.g., Chen (2007)).

The smooth component is a function of the difference between the maximum payoffs in two games, which we will denote by $x_{1,jk}$, and the difference in the minimum payoffs between the two games, denoted by $x_{2,jk}$. For example, the maximum payoff in game G_j is \$20, while in game G_k it is \$15, then $x_{1,jk} = 5$; similarly, if the minimum payoff in game G_j is \$10, while in game G_k it is \$0, then $x_{2,jk} = 10$. As emphasized in our hypothesis section, changes in maximum attribute frequently affect inequality while changes in the minimum are confounded with zero changes. Hence, we decided to keep maximum and minimum as continuous variables, but made equity and zeros variables to get the full effect in one coefficient for each variable.

Our model to be estimated is then

$$\alpha_{i,jk} = h(\mathbf{X}_{jk}) + \Gamma \cdot (\mathbf{X}_{jk} \cdot \mathbf{Z}_i) + \Lambda \cdot \mathbf{D}_{jk} + \varepsilon_{i,jk},$$

where Γ and Λ are coefficient vectors, $\varepsilon_{i,jk}$ is an idiosyncratic error, $\mathbf{X} = (x_{1,jk}, x_{2,jk})$, and $\mathbf{Z}_i$ is a vector of subject-specific characteristics;[12] $\mathbf{D} = (y_{1,jk}, y_{2,jk}, y_{3,jk})$ is an integer-valued vector,

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[12] The subject specific characteristics we considered where gender, GPA, and familiarity with game theory and their

24

where $y_{1,jk}$ and $y_{2,jk}$ are zero and equity variables that take values 1, 2, or 3 and $y_{3,jk}$ is a complexity dummy variable. If there are more zeroes in game G_k than in G_j, $y_{1,jk} = 1$; if there are more zeroes in game G_j, then $y_{1,jk} = 3$; otherwise we have $y_{1,jk} = 2$. If there is an 'equity concern'—that is, if payoffs differ only in game G_k but not in G_j—then $y_{2,jk} = 1$; if there is an equity concern only in G_j, then $y_{2,jk} = 3$; otherwise we have $y_{2,jk} = 2$. Finally, $y_{3,jk}$ is a complexity variable that equals 1 when the second game, G_k, is larger than a 2×2 game, that is, it is 2×3 or 3×3. (We discuss these variables in more detail when we discuss our regression results below.) Finally, for estimation, we set the order of the polynomial approximation to two.

Table 15 presents results for the regression

$$\alpha_{i,jk} = \beta_{11}x_{1,jk} + \beta_{12}x_{1,jk}^2 + \beta_{21}x_{2,jk} + \beta_{22}x_{2,jk}^2 + \delta x_{1,jk}x_{2,jk} + \lambda_1 y_{1,jk} + \lambda_2 y_{2,jk} + \lambda_3 y_{3,jk} + \varepsilon_{i,jk},$$

with standard errors clustered at the subject level.

The estimation results reveal some interesting interactions. If we focus on the linear effect of $x_{1,jk}$ on $\alpha_{i,jk}$, given by β_{11}, we see that if the difference between the maximum payoffs increases, then time allocated to the first game increases as well. For instance, if the maximum payoff in the first game stays the same but the maximum payoff in the second game decreases, then the first game becomes relatively more attractive and is allocated more time. This result is not surprising given our result for the maximum hypothesis. However, the new insight that the estimation provides is that the difference in maximum payoffs seems to have a diminishing effect—that is, the coefficient in front of the squared term is negative in specifications (I) - (IV). Moreover, the interaction term of maximum and minimum, δ, has a systematic negative and statistically significant effect on time allocation.

The full effect of increasing the maximum payoff difference on time allocation is given by:

$$\frac{\partial \alpha_{i,jk}}{\partial x_{1,jk}} = \beta_{11} + 2\beta_{12}x_{1,jk} + \delta x_{2,jk}$$

As the partial derivative above is a function of $x_{1,jk}$ and $x_{2,jk}$, we can calculate the effect locally—for example, at the average of these variables. A five dollar increase in the maximum difference from the average of $x_{1,jk}$ and $x_{2,jk}$ leads to 1% increase in time allocated to the game with greater maximum. Recalling the maximum hypotheses and the example pair of games considered, if we increase the maximum from 500 to 800, everything else equal, the increase in time allocation will be 3%.

A similar result holds for changes in the minimum where an increase in the minimum in Game 1 or a decrease in the minimum of Game 2 leads to an increase in the amount of time allocated to Game 1. We find that the impact of zero payoffs is consistent with our previous results on the zero hypothesis in the respect that if a game has more number of zeros than the game it is paired with

interactions with attributes. We dropped them from our discussion since the did not lead to any systematic significant effects on the time allocation.

Table 15: Estimation with Clustered SEs[a]

Time allocated to Game 1	(I)	(II)	(III)	(IV)	(V)
ΔMax	0.204***	0.149***	0.205***	0.150***	0.186***
	(0.033)	(0.030)	(0.034)	(0.030)	(0.030)
ΔMax^2	-0.002***	-0.002***	-0.002***	-0.002***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
ΔMin	0.887***	0.242**	0.827***	0.147	0.359**
	(0.131)	(0.099)	(0.134)	(0.100)	(0.097)
ΔMin^2	0.022***	0.001	0.021***	0.000	0.015***
	(0.005)	(0.004)	(0.005)	(0.004)	(0.005)
ΔMax $\times$ ΔMin	-0.032***	-0.011***	-0.032***	-0.009**	-0.009**
	(0.005)	(0.004)	(0.006)	(0.004)	(0.004)
Zeros		4.269***		4.380***	4.279***
		(0.671)		(0.661)	(0.653)
Equity			2.250***	2.486***	1.969**
			(0.699)	(0.692)	(0.704)
Complexity					-16.225***
					(2.256)
Constant	48.924***	41.159***	44.083***	35.361***	36.358***
	(0.625)	(1.446)	(1.605)	(1.833)	(1.841)
# of obs.	6190	6190	6190	6190	6190

[a] **Note:** Standard errors are clustered at the subject level;
Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

then the latter game will get less time allocated to it.

Although the equity hypothesis left us with a negative result, the regression results tell a different story. If we move from having equity concerns in the second game to no equity concerns, or from no equity concerns to equity concerns in the first game, then time allocated to the first game increases. Recall that 'equity' here is a variable that takes values in $\{1, 2, 3\}$ depending on whether there are equity concerns and in which game they occur (the order of the games matters). Estimation results suggest that games that feature equity concern get more time allocated to them than games without equity issues.

As we established in the complexity hypothesis, when the second game matrix is larger than 2×2—(e.g., 2×3 or 3×3), then time allocated to the first game decreases. We find a similar result with our estimation. The dummy variable $y_{3,jk}$ equals 1 when the second game is not 2×2 and the coefficient in front of this variable, λ_3, is negative and is statistically significant. Finally, we dropped the subject specific characteristics such as gender, GPA, and familiarity with game theory as these variables and their interactions with attributes did not lead to any systematic significant effects on the time allocation.

In summary, our regression estimation neatly summarizes the results established by our hypotheses. The attention of subjects to a game depends on the relative magnitude of its maximum

and minimum payoffs, whether there is equity concern in the game, the number of zero payoffs in the game, and how complex it is.

4.4 Interrelated Games

It is our claim in this paper that the time you allocate to thinking about any given game depends on the specific other games in which you are simultaneously pursuing. However, because the way you behave in a game depends on the amount of time you leave yourself to think about it, the strategic and attention problems are intimately linked. In this section of the paper we investigate these two issues. We start by testing the following hypotheses.

Hypothesis 8 *Interdependent Games: 1. The time allocated to a given game is independent of the other game a subject is facing; 2. The level of strategic sophistication or the type of strategy chosen in a given game is independent of the time the subject devoted to that game.*

Given our data, Hypothesis 8 is easily rejected. A simple illustration of how the amount of time allocated to a game is affected by the other games a subject faces is provided in Figure 2, which presents the mean amount of time allocated to the PC_{800}, BoS_{800}, CS_{800}, and PD_{800} games, respectively, as a function of the other games the subject was pursuing.

Looking first at Figure 2a, we see that there is a large variance in the amount of time allocated to PC_{800} as we vary the other game that subjects who are engaged in this game face. For example, subjects on average allocate less than 40% of their time to PC_{800} when they also play PD_{800}, whereas they allocate nearly 55% of their time to this game when also face PC_{800}. In Figure 2b we see a similar pattern wherein subjects allocating close to 52% of their time to that game when they also face the PC_{800} game but they allocate only about 40% to it when they simultaneously face PD_{800}. The same results hold in Figures 2c and 2d. To illustrate the robustness of these results, in Appendix C we present similar graphs for all games in the comparison set $\mathcal{G}$.

Table 5 presents the mean time allocated to each game in our comparison set $\mathcal{G}$ as a function of the other game that the first game was paired with. Looking across each row, we test the following hypothesis that there is no difference in the fraction of time allocated to any given game as a function of the "other game" the subject is playing. Although for some individual comparisons the difference is insignificant, by and large there is a distinct pattern in the time allocated to a given game, and that pattern is a function of the other game a subject is simultaneously considering. This is supported by a Friedman test, so that for any game in $\mathcal{G}$ we can reject part one of the Hypothesis 8.

The second step in our analysis of interrelated games is to connect the type of strategy chosen to response times. In other words, do subjects change the behavior as the time spent game changes. If so, and if the time allocated to a game depends on the other games that a subject faces, then we have demonstrated that we must consider the full set of games that a person is playing before we can predict behavior in one isolated game.
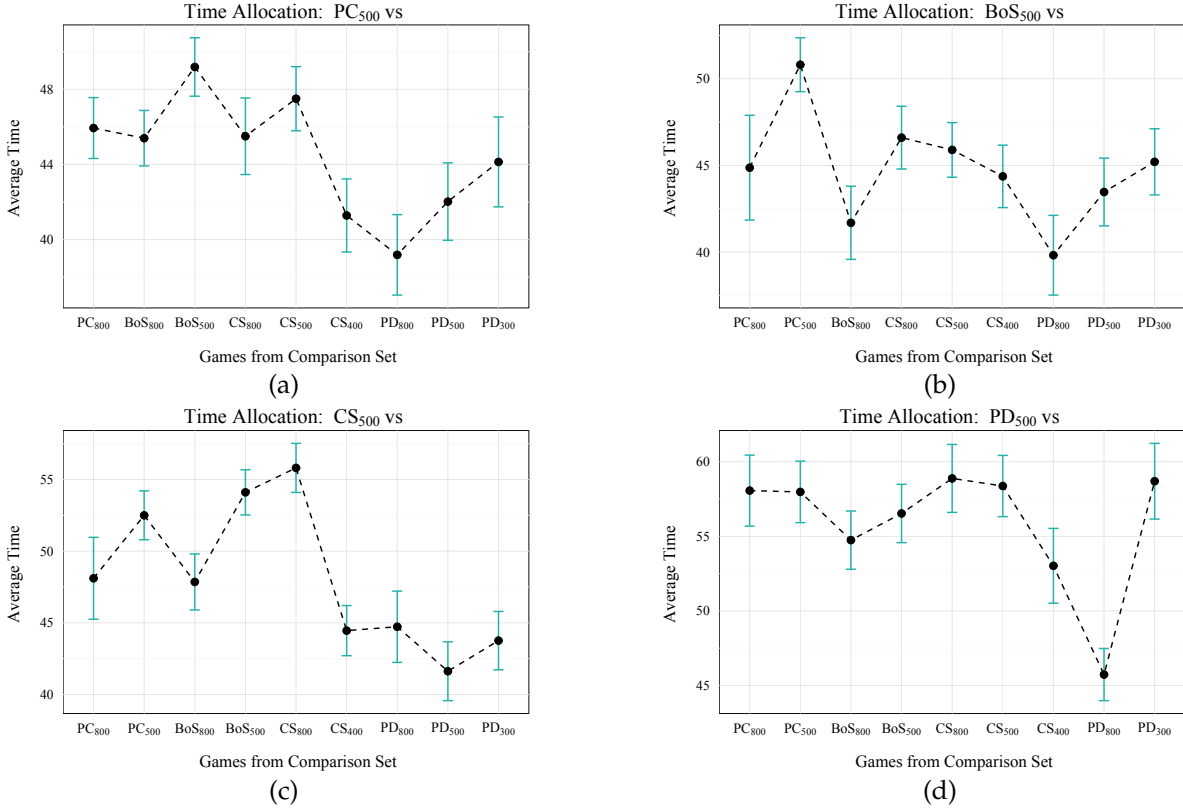
Figure 2: Time Allocation

We look for evidence of a function that describes the relationship between contemplation time and strategic choice, but given our design, we have to content ourselves with aggregate rather than individual level data. Figure 3 presents the results.

In these figures, we present decision time on the horizontal axis divided into two segments for those subjects who spend less or more than the mean time of all subjects playing this game. We put the fraction of subjects choosing Action A in a given game on the vertical axis. In other words, for any given game we compare the choices made by those subjects who thought relatively little about the game (spent less than the mean time thinking about it) to the choices of those who thought longer (more than the mean time). The results are similar when we use the median instead of the mean.

In Figure 3d, which looks at the PD_{500} game, the fraction of subjects choosing Action A who think relatively little about this game is dramatically different from those who think for a longer time. For example, more than 64% of subjects who decide quickly in that game choose Action A while, for those who think longer, this fraction drops to 25%. This indicates that quick choosers cooperate while slow choosers defect. A similar, but more dramatic pattern is found in Figure 3c for the CS_{500} game. Here the fraction of subjects who choose Action A drops from 93% to 33%. Finally, we see in Figure 3a that for some games choice is invariant with respect to decision time. In the case of the game $PC_{800} \atop {}^{500}$ all subjects choose Action A no matter how long they think about
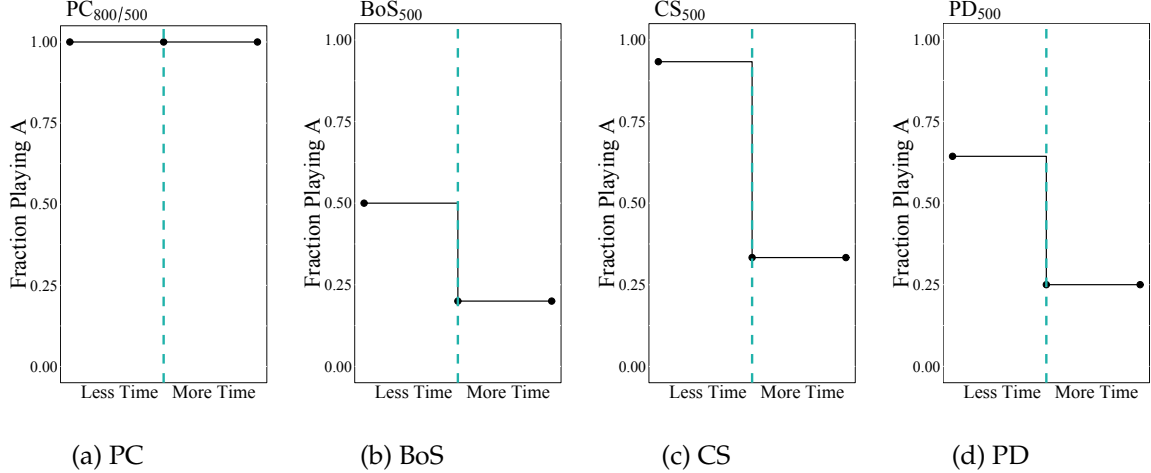
Figure 3: Time and Actions

the game. Note that this is a coordination game that has two Pareto-ranked equilibria: in one each subject receives a payoff of 800; in the other the payoff is 500 (off-diagonal payoffs are 0). Choice in this game appears to be straightforward: all subjects see that they should coordinate on Action A. Similar graphs for all games played by our subjects are in Appendix D.

The objective of the Figures 2 and 3 for this paper's thesis should be obvious. The time allocated to a given game depends on the particular other game a subject is facing and choice in a game typically depends on the time spent on it.

4.5 Consistency

In this section we focus on whether the time-allocation decisions of our subjects were consistent. Consistency of behavior has been studied with respect to choice, but it has rarely been examined at with respect to attention. For example, in a two-good commodity space, Choi et al. (2007) present subjects with a series of budget lines using a clever interface that allows them to test the GARP and WARP axioms. We want to study whether the subject choices, made both within and across classes of games, are consistent. To do this we specify a set of consistency conditions that we think are reasonable and we investigate whether our data support them.

Our attention allocation function $\alpha(i, j)$ can be used to define a binary relation on the set of games $\mathcal{G}$ called the "*more worthy of attention*" relationship such that if $\alpha(i, j) \geq \alpha(j, i)$ we would say that game G_i is more worthy of attention in a binary comparison with game G_j. With this notation we specify four consistency conditions.

Condition 1 *Transitivity: If $\alpha(i, j) \geq \alpha(j, i)$ and $\alpha(j, k) \geq \alpha(k, j)$, then $\alpha(i, k) \geq \alpha(k, i)$ for all G_i, G_j, and $G_k \in \mathcal{G}$.*

Clearly, transitivity is the workhorse of rational choice and, hence, it is a natural starting point here. This condition simply says that if a subject allocates more time to G_i in the G_i vs G_j comparison, and more time to G_j in the G_j vs G_k comparison, then he should allocate more time to G_i in the G_i vs G_k comparison.

Condition 2 *Baseline Independence (BI): If $\alpha(i,k) \geq \alpha(j,k)$, then $\alpha(i,l) \geq \alpha(j,l)$, for any game G_k and $G_l \in \mathcal{G}$.*

This condition basically says that if game G_i is revealed to be more worthy of attention than game G_j when each is compared to the same baseline game G_k, then it should be revealed more worthy of attention when both games are compared to any other game $G_l \in \mathcal{G}$. Reversal of this condition for any G_k and G_l will be considered an inconsistency.

A variant of our Baseline Independence condition is what we call Baseline Consistency, which can be stated as follows:[13]

Condition 3 *Baseline Consistency (BC): If $\alpha(i,k) \geq \alpha(j,k)$, then $\alpha(i,j) \geq \alpha(j,i)$, for any game $G_k \in \mathcal{G}$.*

This condition states that if game G_i is indirectly revealed to be more worthy of time than game G_j when each is compared to the same baseline game G_k, then it should be revealed to be more worthy of time when they are compared directly to each other. Since *BI* assumes that the condition holds for all $G_k \in \mathcal{G}$, it also holds when $G_l = G_j$; thus, condition *BC* is already nested in condition *BI*. However, because it is a more direct and transparent condition, we specify it separately.

Finally, in some comparisons that have yet to be described, subjects are asked to allocate time between three games rather than two. Such three way comparisons allow us to specify our final consistency condition. For this condition we need an additional notation that indicates that when three games G_i, G_j, and G_k are compared, $\alpha(i,j,k) \geq \alpha(j,i,k)$ means that the decision maker allocates more time to game G_i than game G_j when all three games are compared at the same time.

Condition 4 *IIA: If $\alpha(i,j) \geq \alpha(j,i)$ then $\alpha(i,j,k) \geq \alpha(j,i,k)$, for any game $G_k \in \mathcal{G}$.*

The final condition states that if game G_i is revealed to be more worthy of time than game G_j when they are compared directly in a two-game comparison, then in a three-game comparison, when we add an additional game G_k and ask our subject to allocate time across these three games, game G_i should still be revealed to be more worthy of time than game G_j.

Next we examine each of these consistency conditions and test them using our data.

4.5.1 Transitivity

In Figure 4, the dark gray histograms present calculations for our experiment data while the lighter gray are similar calculations for randomly generated data. That is, we simulated random responses for the same number of subjects as in our data and then calculated the corresponding inconsistencies for these fictional subjects. These comparisons give us a baseline and a sense of how different the observed data is from a randomly generated one.

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[13] In Condition 2, take $G_k = G_j$, then $\alpha(i,j) \geq \alpha(j,j) = .5$. As $\alpha(j,i)$ by definition is $1 - \alpha(i,j)$, we get $\alpha(i,j) \geq \alpha(j,i)$ - Condition 3.

Our subjects prove themselves to be quite consistent in terms of transitivity. More precisely, transitivity is defined for every connected triple of games for which we have data. In other words, we can check our transitivity condition for three games, G_i, G_j, and G_k, if in our experiment we have G_i compared to G_j, G_j compared to G_k, and G_k compared to G_i by the same subject. We call this cyclical comparison a triangle, and in our analysis below we calculate the fraction of such triangles aggregated over all subjects for which transitivity holds. There were 28 triangles in the comparisons used by subjects in Sessions 1 and 2 and 20 triangles in Sessions 3 and 4.

Our transitivity calculation is presented in Figure 4a, which looks at all our subjects and portrays the fraction of subjects who make intransitive choices. As we can see, in all sessions 79% of subjects exhibited either zero or one intransitivity while 96% exhibited strictly less than four. A similar pattern exists when we look at the individual sessions. For example, in Sessions 1 and 2, 90% of subjects exhibited strictly less than three intransitivities and no subject exhibited more than four. For Sessions 3 and 4 the corresponding percentage is 91%. In short, our *more-worthy-than* relationship has proved itself to be largely transitive.
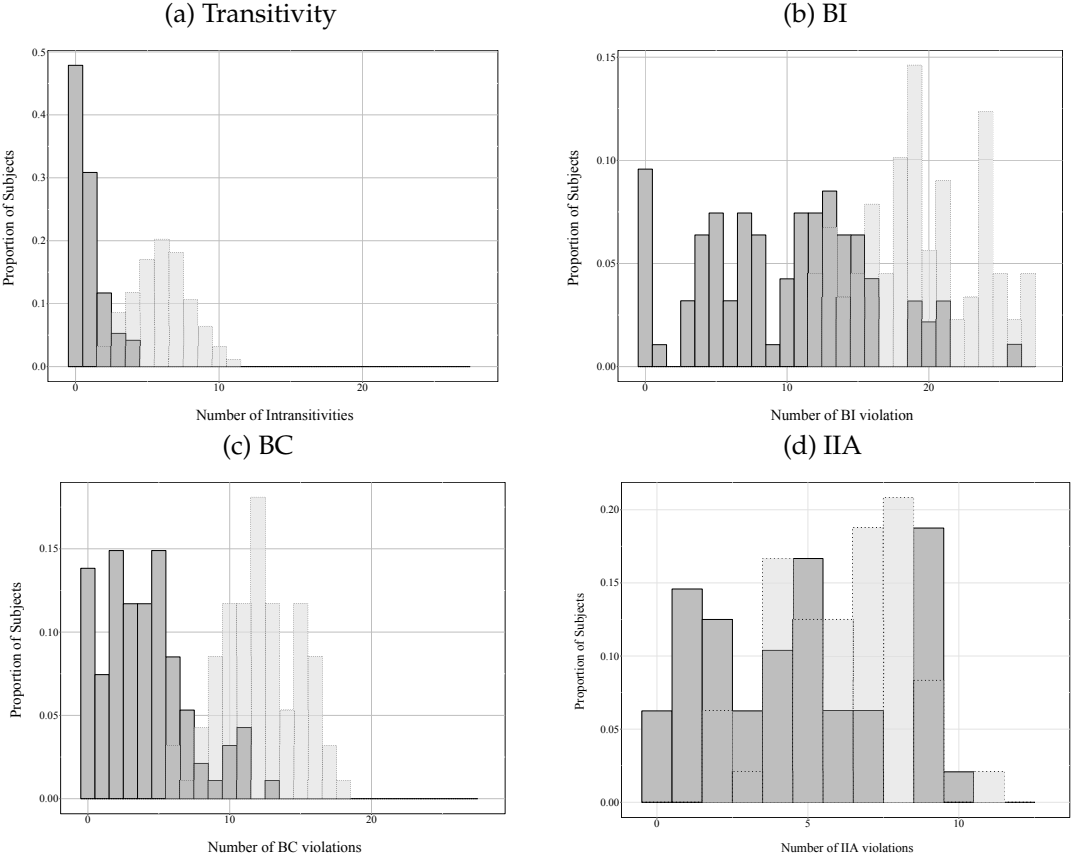
Figure 4: Consistency histograms

4.5.2 Baseline Independence (*BI*)

Transitivity is the easiest of our conditions to satisfy because all comparisons are direct comparisons where the subject chooses, for example, between say games G_i and G_j directly, then G_j and

G_k directly, and then G_i and G_k. For our other conditions some of the comparisons are indirect and, hence, they are more likely to exhibit inconsistencies. For example, consider our *BI* condition. Here we are saying that if G_i is shown to be more time worthy than G_j when they are both compared to game G_k, then it should be more time-worthy when it is compared to any other game G_l in the set of all games. This condition is more likely to meet with inconsistencies since in the comparisons above game G_l can be in a different game class than game G_k. Thus, what is more time worthy when G_i and G_j are compared to game G_k might not be considered as relevant when they are compared to game G_l.

This conjecture turns out to be true. In Figure 4b we present a histogram that indicates the frequency of violations of our Baseline Independence condition. The choices made implied 46 comparisons where violations could be detected in Sessions 1 and 2 and 33 in Sessions 3 and 4; hence, when we detect a violation the maximum numbers of such violations are 46 and 33, respectively. As we can see, an extremely large number of violations of our *BI* condition occurred. For example, the mean and median number of violations per subjects were 9.8 and 10.5, respectively. Only ten out of 94 subjects (11%) had one or fewer violations of *BI* whereas the same number is 79% for Transitivity condition.

4.5.3   Baseline Consistency (*BC*)

We might expect that Baseline Consistency would be easier to satisfy than Baseline Independence given that, under our consistency condition, if game G_i is revealed to be more worthy of time than G_j when both are compared to game G_k, then G_i should be revealed to be more worthy of time when G_i and G_j are compared directly. *BI* requires that G_i must be revealed to be more worthy of time in all possible other comparisons that could be made. This is a far more stringent condition given that when we make these other comparisons we will be comparing game G_i to a variety of games inside and outside of its own game class. In contrast, under *BC* we only compare it directly to game G_j. Note that Baseline Consistency is more difficult to satisfy than Transitivity as *BC* implies Transitivity but the converse is not true.[14]

As indicated in Figure 4c, our results are consistent with this intuition. For example, only 20 subjects (21%) exhibited one or fewer violations of our Baseline Consistency condition; this compared to 79% for Transitivity and 11% for Independence. Thirty-eight subjects (40%) exhibited five or more violations of *BC*, whereas no subject violated Transitivity that many times and 75 (80%) had that many violations of *BI*.

4.5.4   Independence of Irrelevant Alternatives (*IIA*)

Our final consistency measurement concerns the *IIA* condition. In Sessions 1 and 2, 48 subjects were presented with the type of three-game comparisons that allows us to test the *IIA* condition. For each subject, there were 13 relevant comparisons or situations where we could detect an *IIA*

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[14] Consider three games: G_i, G_j, and G_k. Suppose pair G_i, G_k gets $40 - 60\%$, G_j, G_k gets $30 - 70\%$, and G_i, G_j gets $25 - 75\%$. We have a set $\{(k, i), (k, j), (j, i)\}$ that satisfies transitivity, but it violates consistency because game G_i appears to be more time valuable than G_j when it is compared to G_k. Nevertheless, when it is compared directly to game G_k, G_i is allocated less time than game G_j.

violation. As Figure 4d indicates, violations were the rule rather than the exception. For example, out of 13 possible situations the mean and median number of violations per subject were 4.5 and 4.5, respectively. Only three subjects out of 48 had no *IIA* violations.

In summary, while our subjects appeared to have made consistent choices when viewed through the lens of transitivity, they appeared to fail to do so when the consistency requirements were strengthened or at least became more indirect. It is difficult for our subjects to maintain consistency when the comparisons they face span different types of games that, in turn, have varying payoffs. While transitivity is likely to be violated when goods are multidimensional we find that transitivity was the consistency condition that fared best.

4.6   Attention and Preferences

When a subject decides to pay more attention to some game rather than another, what does that imply about his or her preferences for these games? Are preferences and attention correlated, and if so, in what direction? Are subjects more consistent in their preferences than in their time allocation behavior?

We use the data generated by our preference treatment to answer the questions posed above. To compare behavior in our time-allocation and preference treatments we merely need to compare the fraction of subjects who allocate more time to a game and the fraction of subjects who state that they prefer that game. In other words, if in our time-allocation treatment we define a binary variable to take the value of 1 when a subject allocates more time to game G_i than game G_j and 0 otherwise, then in our preference treatment we can compare this variable to one that takes a value of 1 when a subject states that he or she prefers game G_i over game G_j and 0 otherwise. We exploit this feature repeatedly.

In this section, we try to infer what it means when a subject decides to spend more time thinking about game G_i rather than game G_j. An inference that suggests that the subject prefers game G_i to game G_j may be faulty. For example, the revealed preference statement "Since Johnny spends all day thinking about his little league game at the expense of his school work he must enjoy it more than school work" might ignore the fact that little Johnny could actually hate baseball and obsesses about it because it is a source of great anxiety as he may fear humiliation in front of his friends.

To examine this relationship we took each of the 10 games in the comparison set $\mathcal{G}$ and looked at both the time allocated to this game when compared to the other nine games and also how often this game was preferred to the game with which it was paired. For each game, we then split the game comparisons into four subsets on the bases of the time allocated and the preference stated in each comparison.

To explain this more fully, take one of the 10 games in $\mathcal{G}$, say PD_{800}. This game was compared to each of the other nine games in $\mathcal{G}$. Take all subjects who made these comparisons and for any given comparison look at the fraction of subjects who allocated more time to PD_{800} than to the other game in the comparison. Also calculate the fraction of times subjects stated that they preferred PD_{800} in this comparison. Now divide the outcomes of all such comparisons into

four subsets: those outcomes where PD_{800} was simultaneously allocated more time by at least 50% of subjects and also was preferred by more than 50% of them; those where the opposite was true—that is, cases in which more than 50% of the subjects allocated less time to this game and in which the game was preferred by less than 50% of subjects; and the two mixed cases in which subjects either allocated more time to a game but liked it less or allocated less time on a game and liked it more. (Note that because we did not run a within-subjects design, we cannot make these calculations subject by subject but must aggregate across all subjects.)

<table>
<tr><td rowspan="2"></td><td colspan="2" align="center">*Preference Treatment*</td></tr>
<tr><td align="center">**More than** 50</td><td align="center">**Less than** 50</td></tr>
<tr>
<td align="center">**More than** 50</td>
<td align="center">$PC_{800}, PC_{800}, PC_{800}$;
$BoS_{800}, BoS_{800}, BoS_{800}$;
$CS_{800}, CS_{800}, CS_{800}$;
$CS_{400}, CS_{400}, CS_{400}, CS_{400}$;
$PD_{800}, PD_{800}, PD_{800}, PD_{800}, PD_{800}, PD_{800}, PD_{800}, PD_{800}, PD_{800}$;
$PD_{500}, PD_{500}, PD_{500}, PD_{500}, PD_{500}, PD_{500}, PD_{500}, PD_{500}$;
$PD_{300}, PD_{300}, PD_{300}, PD_{300}, PD_{300}, PD_{300}$;</td>
<td align="center">BoS_{800};
BoS_{500};
CS_{500}, CS_{500};
CS_{800}, CS_{800};
CS_{400};</td>
</tr>
<tr>
<td align="center">**Less than** 50</td>
<td align="center">PC_{500}, PC_{500};
$PC_{800}, PC_{800}, PC_{800}$;
BoS_{800};
BoS_{500};
CS_{800};
PD_{300};</td>
<td align="center">$PC_{500}, PC_{500}, PC_{500}, PC_{500}, PC_{500}, PC_{500}, PC_{500}$;
$PC_{800}, PC_{800}, PC_{800}$;
$BoS_{800}, BoS_{800}, BoS_{800}, BoS_{800}$;
$BoS_{500}, BoS_{500}, BoS_{500}, BoS_{500}, BoS_{500}, BoS_{500}, BoS_{500}$;
$CS_{500}, CS_{500}, CS_{500}, CS_{500}, CS_{500}, CS_{500}, CS_{500}$;
$CS_{800}, CS_{800}, CS_{800}$;
$CS_{400}, CS_{400}, CS_{400}$;
PD_{500};
PD_{300}, PD_{300};</td>
</tr>
</table>

Allocation Treatment (left margin label)

Figure 5: Time allocation and preferences combined

Figure 5 presents the results of this calculation for each game in the comparison set $\mathcal{G}$. As we can see, preferences and time allocation appear to be highly correlated in the sense that most of the observations are arrayed along the diagonal, which indicates a positive association between time allocation and preference. Looking at the games in each cell is interesting. For example, PD games heavily occupy the upper left hand cell in Figure 5, which indicats that PD games attract a lot of attention and also are preferred to their comparison games. More precisely, in the case of the PD_{500} game, in 9 out of 9 comparisons more than 50% of subjects allocated more time to it and they stated they preferred it to the game to which it was being compared. This was also the case in eight of the nine comparisons made for the PD_{500} game and 6 of the 9 comparisons made for the PD_{300} game. The opposite seems to be true of PC games. For example, there are no PC_{500} entries in the upper left hand cell of Figure 5 yet in the bottom right-hand cell, where more than 50% of subjects both allocated less time to PC_{500} and listed it as their least preferred alternative, there are 7 PC_{500} entries. With regards to the PC_{800} game, in 6 of 9 comparisons more than 50% of subjects preferred it as their top alternative, yet in three of those comparisons more than 50% of subjects allocated less than 50% of their time to it.

Games in the bottom right-hand cell appear to be unpopular; that is, subjects choose to allocate less time to them. For example, BoS_{500} and CS_{500} seem to be the least popular games in the respect

that in 6 of 9 companions they were each the least preferred choice of more than 50% of subjects and more than 50% of subjects allocated less time to them. As stated above, one might think that unpleasant games might attract more attention (remember little Johnny), but this seems not to be the case. Some of this can be explained by looking at payoffs. For example, PC_{500} is a pure coordination game with payoffs of 500 each for subjects in the upper left and lower right-hand cells and zeros in the off diagonals. PC_{800} is the same game except that it has payoffs of 800. Perhaps because of its lower payoffs, PC_{500} was an unpopular game and also one that people decided to allocate less time to while PC_{800} was popular (preferred in 6 of 9 comparisons) but did not receive much attention (in only three of nine comparisons did more than 50% of subjects allocate more time to it). There are relatively few mixed cases—entries in the off-diagonal cells in Figure 5, in which subjects either preferred a game but allocated less time to it or did not prefer the game but spent a lot of time thinking about it.

The take-away line of Figure 5, therefore, appears to be that the time allocated to a problem (or at least whether more (or less) than 50% of subjects allocate more time to it in any comparison) is a sign that subjects prefer (or do not prefer) playing that game rather than its comparison game.
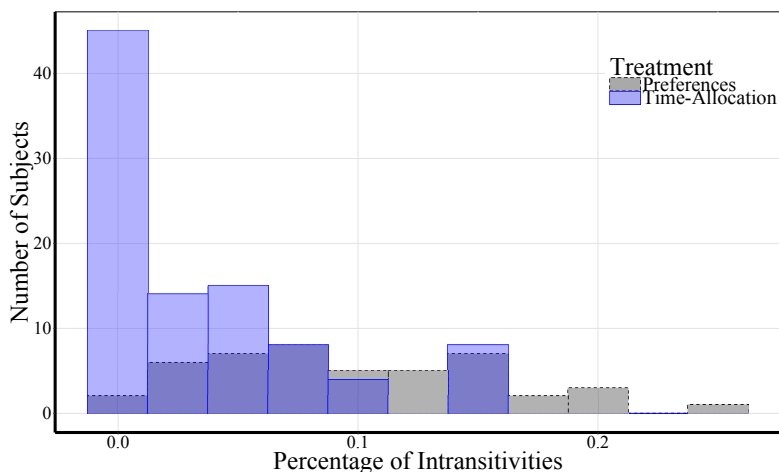
Figure 6: Transitivity: Time allocation and preference treatment

Finally we ask how consistent our subjects' preferences were across games in the respect that if they stated a preference for game G_i over game G_j and for game G_j over game G_k, they also stated a preference for game G_i over game G_k. This is exactly the same transitivity question asked of our subjects with respect to their time allocation. As Figure 6 suggests, our subjects were far more consistent in their time allocations than they were in their preferences.

For example, the fraction of subjects who violated transitivity less than 2% of the time is far greater in the attention treatment than in the preference treatment. More precisely, while 47.9% of subjects in the attention treatment violated transitivity less than 2% of the time, 6.5% violated transitivity that often in the preference treatment. Furthermore, the distribution of intransitivities in the preference treatment first-order stochastically dominates that of the attention treatment.

5 Conclusions

In this paper, we examine the question of why people behave the way they do in games. In answering this question we have extended the set of concerns that players have when they play a game to include attentional issues that derive from the fact that people do not play games in isolation. Instead, they have to share their attention across a set of games. The choices that people make in one game viewed in isolation can only be understood by including the other problems that these people face.

We have posited a two-step decision process for games. First, an attentional stage prescribes how much time players should allocate to any given game when they are faced with several games to play simultaneously. After solving this problem our subjects then need to decide how to behave given the time they have allocated.

With respect to the first, the attentional problem, by presenting subjects with pairs of games and asking them to allocate a fraction of decision time to them, we have tried to examine what features of games attract the most attention and, hence, are played in a more sophisticated way. As might be expected, the amount of time a subject allocates to a game is a function of the game's payoffs and its strategic properties in comparison to the other game they are playing simultaneously. As payoffs in a given game increase, ceteris paribus, subjects allocate more time to the game. As the number of zeros in a game increase, subjects tend to want to think less about the game. Equity affects attention, but that effect only arises when we use all the data available to us and not simply the controlled comparisons that are available in our design. Finally, the strategic aspects of the games being played are important, but their influence is complicated.

With regards to behavior, our results strongly support the idea that how people play in any given game depends on the other game that simultaneously competes for their attention. This can help to explain why some people can look very sophisticated in their behavior in some parts of their lives but rather naive in others; given the demands on their time, they rationally choose to attend more to some situations and not to others. Hence, when we observe a person behaving in what appears to be a very unsophisticated manner in a strategic situation, it may not be the case that he or she is unknowing. Instead, he or she might be optimally responding to the constraints in their life.

Our results cast some light on the relationship between the time allocated to a game and a subject's preference for that game. Interestingly, we have found that subjects devote more time to games they prefer to play. For example, subjects seem to allocate more time to Prisoner's Dilemma games. One might conclude, therefore, that they do so because these games present them with the most intricate strategic situation and that the time they allocate is spent thinking of what to do. If this were the case, however, we might expect them to avoid these games when they have the choice of playing another (less complicated or more profitable) game, but this is not what they do. Subjects indicate a preference for playing Prisoner's Dilemma games even as their payoffs vary and their equilibrium (and out-of-equilibrium) payoffs decrease.

While subjects behave in a remarkably transitive manner with respect to the time they allocate

to games, their behavior is less consistent when we examine other more stringent consistency conditions. Much of this behavior can be ascribed to the fact that when subjects play games of different types their behavior changes. It is interesting to note, however, that the time-allocation behavior of subjects across games is far more consistent than their stated preferences.

Finally, this paper constitutes a first step to introduce attention issues into game theory. To our knowledge, our paper is the first to look at how behavior in games is interrelated given an attention constraint.[15] Clearly there is more to be done in this regard.

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[15] Kloosterman and Schotter (2015) also look at a problem where games are interrelated but their set-up is dynamic in that games are played sequentially rather than simultaneously.

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Appendix

A   Additional Figures and Tables
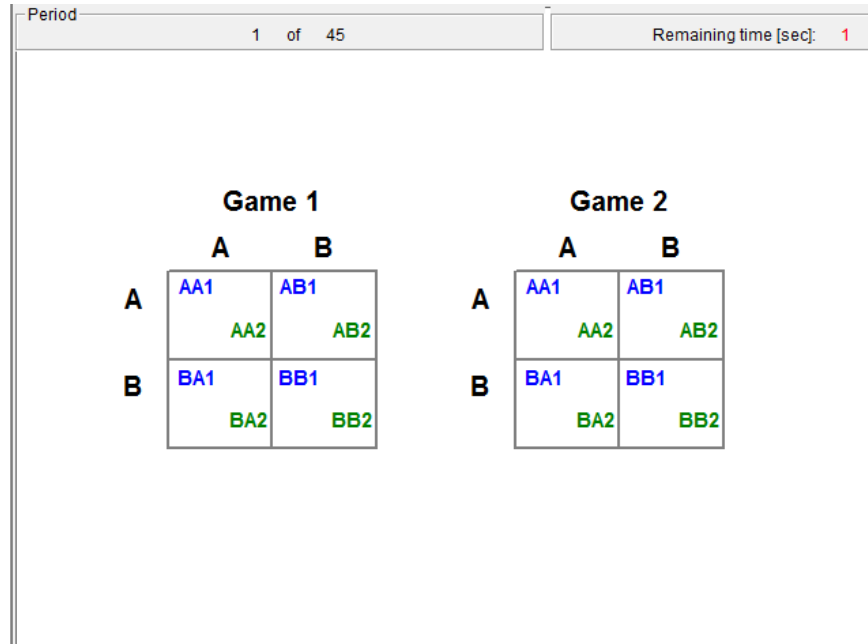
Figure 7: Sample screen
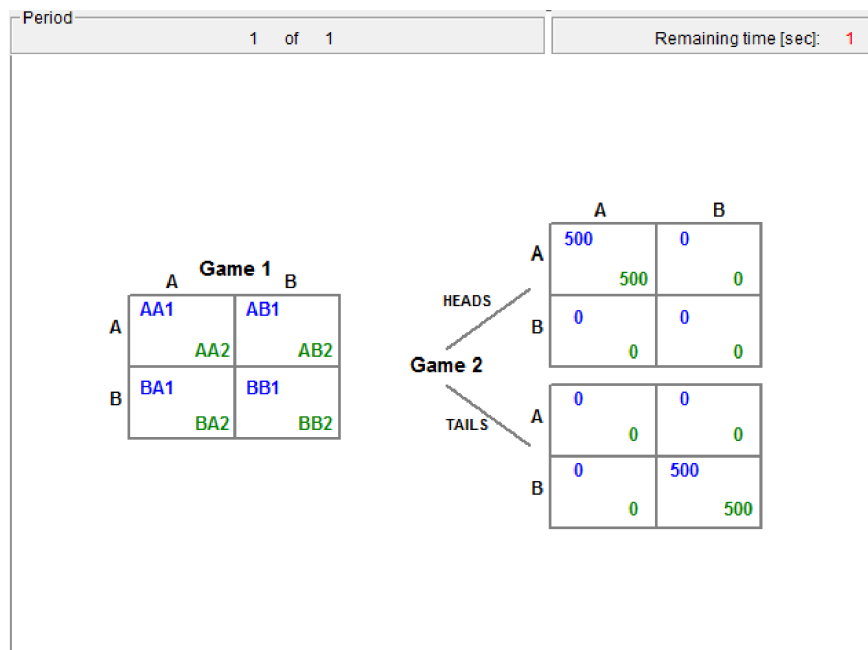
Figure 8: Sample chance screen

B Games outside of the comparison set $\mathcal{G}$

Table 16: List of 2×2 Games outside comparison set $\mathcal{G}$

PC^{500}_{100}

500, 500	100, 100
100, 100	500, 500

PC^{800}_{500}

800, 800	0, 0
0, 0	500, 500

$PC^{800}_{500}1$

800, 800	100, 100
100, 100	500, 500

PC^{800}_{100}

800, 800	100, 100
100, 100	800, 800

BoS^{800}_{0}

800, 0	0, 0
0, 0	0, 800

BoS^{800}_{100}

800, 100	0, 0
0, 0	100, 800

CS^{900}_{100}

900, 100	100, 400
100, 400	400, 100

PD^{800}_{0}

800, 800	0, 1000
1000, 0	500, 500

Ch_1

800, 800	500, 1000
1000, 500	400, 400

Ch_2

800, 800	500, 1000
1000, 500	0, 0

$Chance$

500, 500	0, 0
0, 0	0, 0

0, 0	0, 0
0, 0	500, 500

A game called the Chance game, which involved move of nature, was included for purposes of comparison. When faced with a choice between two games, the subject was told to allocate time between Game 1 and Game 2, the Chance game. Chance game says that with probability $1/2$ subjects will play the top game on the screen and with $1/2$ probability they will play the bottom game. However, in the Chance game subjects must make a choice, A or B, before they know which of those two games they will be playing—a decision that is determined by chance after their A/B choice is made.

Table 17: List of 2×3 Games

LC_1

90, 90	0, 0	0, 40
0, 100	180, 180	0, 40

LC_2

90, 90	0, 0	400, 40
0, 100	180, 180	400, 40

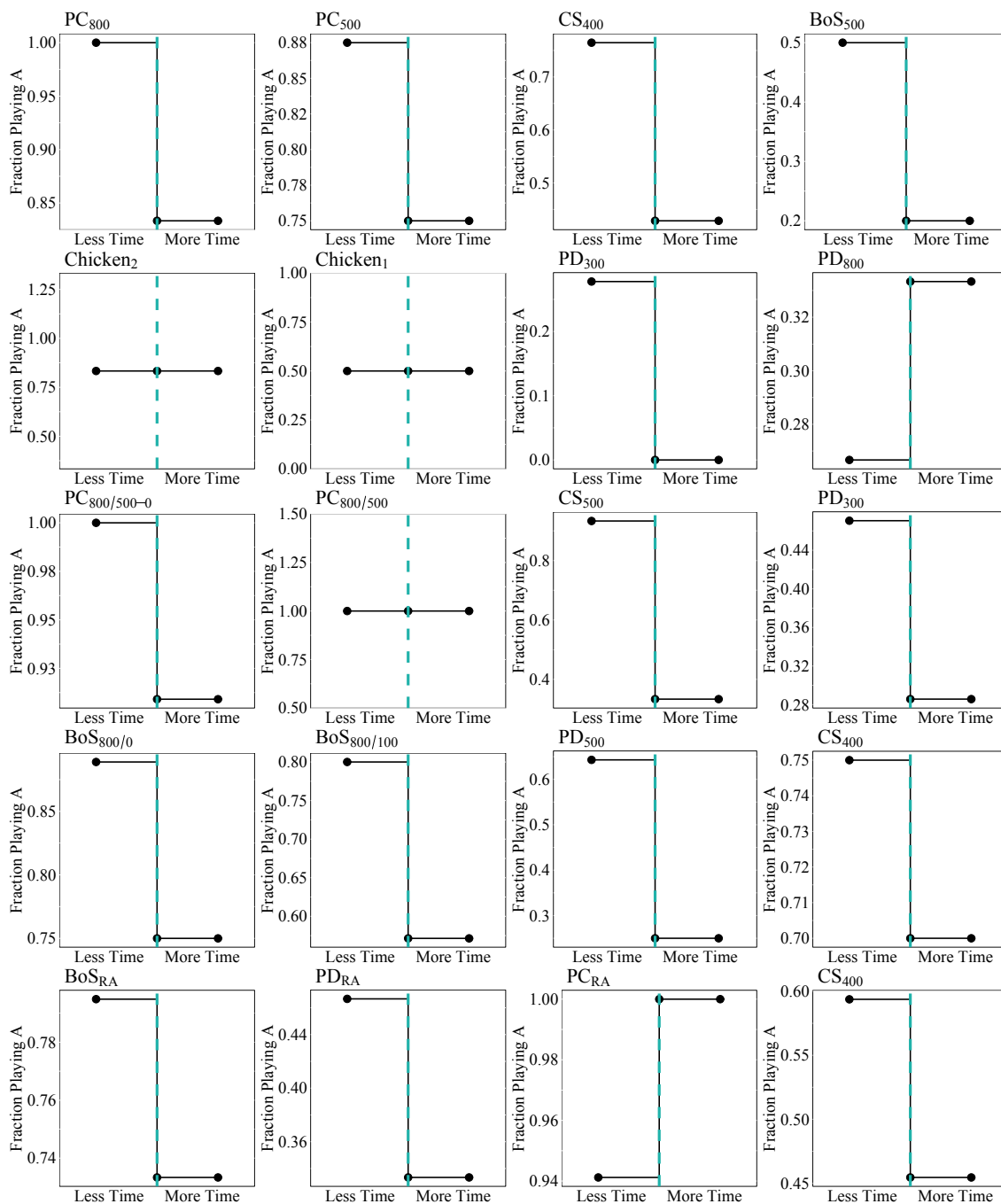# C Time Allocation: Games in comparison set $\mathcal{G}$

Figure 9: Time Allocation
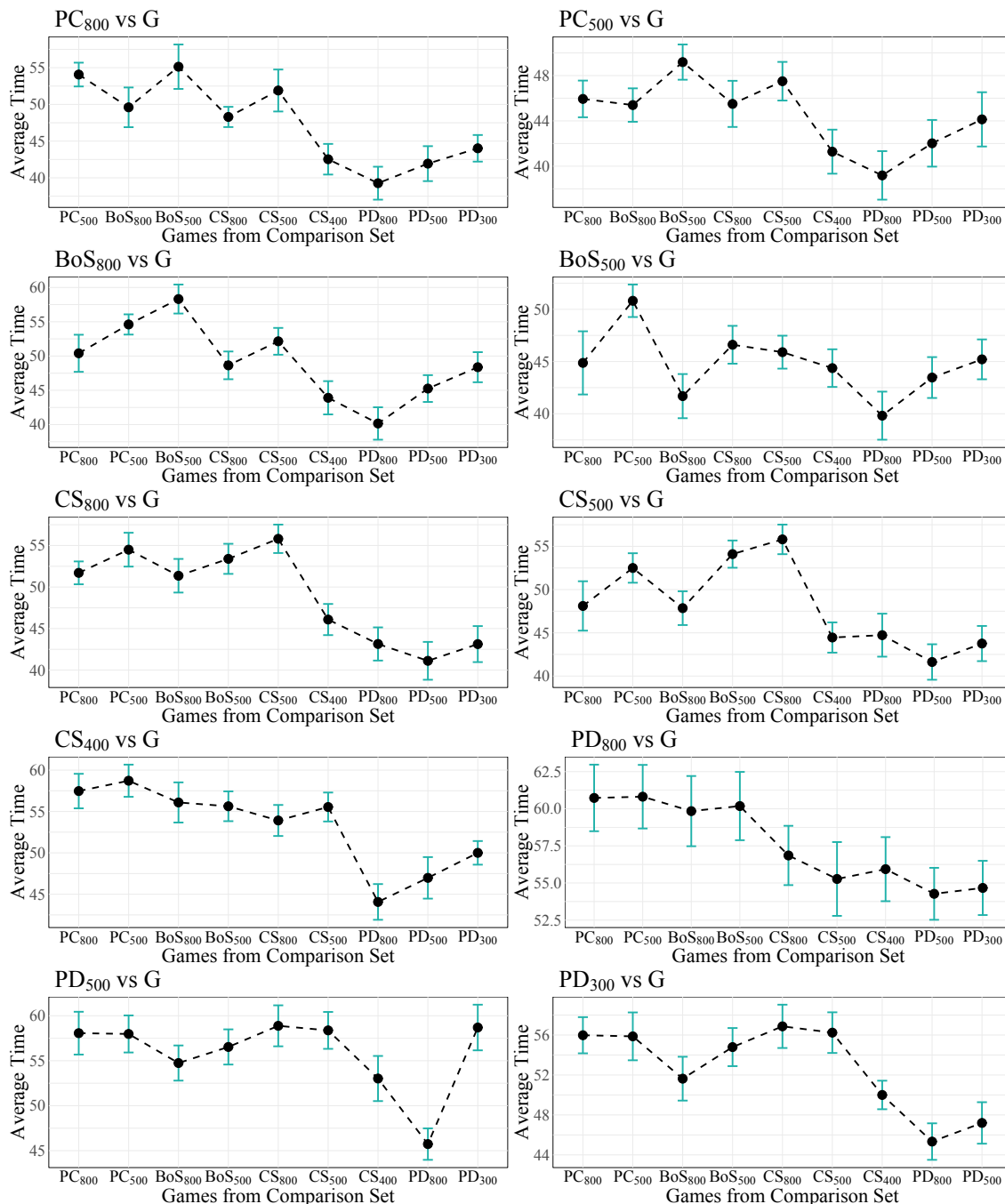
Notes: For each game in comparison set $\mathcal{G}$ we calculate average time allocated to that game when it was compared to the rest of the comparison set. We plot the results as shown above.

D   Response Times and Actions

Figure 10: Response Times and Actions

Notes: In each time-allocation treatment subjects played four games. For all these games, we have calculated the fraction of subjects playing Action A when they think relatively little or relatively more about that game. We present the results in this figure. The games are arranged in the order our subjects executed them. We present each session results separately, without pooling the data.

E   List of Comparisons in Each Session

Sessions 1 and 2 (Time Allocation)

1. BoS_{800}, PC_{500}
2. PC_{500}, PC_{800}
3. PC_{500}, BoS_{500}
4. PD_{800}, PC_{500}
5. PC_{500}, PD_{500}
6. PC_{500}, CS_{500}
7. CS_{800}, PC_{500}
8. BoS_{800}, PD_{500}
9. BoS_{800}, CS_{500}
10. CS_{800}, BoS_{800}
11. PD_{800}, PC_{800}
12. PD_{300}, PC_{800}
13. CS_{800}, PC_{800}
14. PD_{300}, BoS_{500}
15. CS_{500}, BoS_{500}
16. CS_{800}, BoS_{500}
17. BoS_{500}, CS_{400}
18. PD_{300}, CS_{400}
19. PD_{300}, PD_{800}
20. PD_{800}, PD_{500}
21. CS_{500}, PD_{800}
22. CS_{500}, PD_{500}
23. CS_{800}, PD_{800}
24. CS_{800}, CS_{500}
25. CS_{400}, CS_{500}
26. $PC_{500},$ Chance
27. $BoS_{800},$ Chance
28. $PD_{800},$ Chance
29. $CS_{500},$ Chance
30. $CS_{400},$ Chance
31. $CS_{\frac{900}{100}}, PD_{500}$
32. $CS_{800}, PC_{\frac{500}{100}}$
33. CS_{500}, CPD_1
34. $PD_{800},$ Ch1
35. Ch2, LC_1
36. Ch2, LC_2
37. Ch1, LC_2
38. PD_{800}, CPD_1
39. PD_{800}, CPD_2
40. Ch2, Ch1
41. $PD_{800}, PD_{500}, PD_{300}$
42. $PD_{800}, PD_{500}, CS_{500}$
43. $BoS_{500}, CS_{400}, PD_{300}$
44. $CS_{800}, CS_{500}, CS_{400}$
45. $CS_{800}, PD_{800}, PC_{800}$

Sessions 3 and 4 (Time Allocation)

1. BoS_{800}, PC_{800}
2. BoS_{500}, PC_{800}
3. BoS_{500}, BoS_{800}
4. PD_{800}, BoS_{800}
5. PD_{800}, BoS_{500}
6. PD_{500}, PC_{800}
7. PD_{500}, BoS_{500}
8. PD_{300}, PC_{500}
9. PD_{300}, BoS_{800}
10. CS_{500}, PC_{800}
11. CS_{500}, PD_{300}
12. CS_{800}, PD_{500}
13. CS_{800}, PD_{300}
14. CS_{400}, PC_{500}
15. CS_{400}, PC_{800}
16. CS_{400}, BoS_{800}
17. CS_{400}, PD_{800}
18. PD_{500}, CS_{400}
19. CS_{800}, CS_{400}
20. $PC_{800},$ Chance
21. $BoS_{500},$ Chance
22. $PD_{500},$ Chance
23. $PD_{300},$ Chance
24. $CS_{800},$ Chance
25. PD_{500}, PD_{300}
26. $BoS_{\frac{800}{0}}, BoS_{800}$
27. $BoS_{\frac{800}{100}}, BoS_{800}$
28. $BoS_{\frac{800}{0}}, BoS_{500}$
29. $BoS_{500}, BoS_{\frac{800}{100}}$
30. $BoS_{\frac{800}{0}}, BoS_{\frac{800}{100}}$
31. $PC_{\frac{800}{500}}, PC_{800}$
32. $PC_{\frac{800}{500}}, PC_{500}$
33. $PC_{500}, PC_{\frac{800}{500}1}$
34. $PC_{800}, PC_{\frac{800}{500}1}$
35. $PC_{\frac{800}{500}1}, PC_{\frac{800}{500}}$
36. $PD_{800}, PD_{\frac{800}{0}}$
37. $PD_{\frac{800}{0}}, PD_{500}$
38. $PD_{300}, PD_{\frac{800}{0}}$
39. $PC_{\frac{800}{100}}, PC_{800}$
40. $PC_{\frac{800}{100}}, PC_{\frac{800}{500}1}$

Sessions 5 and 6 (Preference Treatment)

1. BoS_{800}, PC_{500}
2. PC_{500}, PC_{800}
3. PC_{500}, BoS_{500}
4. PD_{800}, PC_{500}
5. PC_{500}, PD_{500}
6. PC_{500}, CS_{500}
7. CS_{800}, PC_{500}
8. BoS_{800}, PD_{500}
9. BoS_{800}, CS_{500}
10. CS_{800}, BoS_{800}
11. PD_{800}, PC_{800}
12. PD_{300}, PC_{800}
13. CS_{800}, PC_{800}
14. PD_{300}, BoS_{500}
15. CS_{500}, BoS_{500}
16. CS_{800}, BoS_{500}
17. BoS_{500}, CS_{400}
18. PD_{300}, CS_{400}
19. PD_{300}, PD_{800}
20. PD_{800}, PD_{500}
21. CS_{500}, PD_{800}
22. CS_{500}, PD_{500}
23. CS_{800}, PD_{800}
24. CS_{800}, CS_{500}
25. CS_{400}, CS_{500}
26. BoS_{800}, PC_{800}
27. BoS_{500}, PC_{800}
28. BoS_{500}, BoS_{800}
29. PD_{800}, BoS_{800}
30. PD_{800}, BoS_{500}
31. PD_{500}, PC_{800}
32. PD_{500}, BoS_{500}
33. PD_{300}, PC_{500}
34. PD_{300}, BoS_{800}
35. CS_{500}, PC_{800}
36. CS_{500}, PD_{300}
37. CS_{800}, PD_{500}
38. CS_{800}, PD_{300}
39. CS_{400}, PC_{500}
40. CS_{400}, PC_{800}
41. CS_{400}, BoS_{800}
42. CS_{400}, PD_{800}
43. PD_{500}, CS_{400}
44. CS_{800}, CS_{400}
45. PD_{500}, PD_{300}

Sessions 7 and 8 (Rearranged Treatment)

1. BoS_{800} vs PC_{RA}
2. PC_{RA} vs PC_{800}
3. PC_{500} vs PC_{RA}
4. PD_{800} vs PC_{RA}
5. PC_{RA} vs PD_{500}
6. PC_{RA} vs CS_{500}
7. CS_{800} vs PC_{RA}
8. PC_{RA} vs PD_{300}
9. BoS_{500} vs PC_{RA}
10. PC_{RA} vs CS_{400}
11. BoS_{800} vs PD_{RA}
12. PD_{RA} vs PC_{800}
13. PC_{500} vs PD_{RA}
14. PD_{800} vs PD_{RA}
15. PD_{RA} vs PD_{500}
16. PD_{RA} vs CS_{500}
17. CS_{800} vs PD_{RA}
18. PD_{RA} vs PD_{300}
19. BoS_{500} vs PD_{RA}
20. PD_{RA} vs CS_{400}
21. BoS_{800} vs BoS_{RA}
22. BoS_{RA} vs PC_{800}

F   Additional Tables

Table 18: Additional comparisons for zero hypothesis

Original vs Zero Game	Mean	p-value
$PC_{800_{500}}1$ vs $PC_{800_{500}}$	58.11	0.000
$PC_{800_{100}}$ vs PC_{800}	57.22	0.009
BoS_{800} vs BoS_{800_0}	60.74	0.000
$BoS_{800_{100}}$ vs BoS_{800_0}	57.22	0.006
PD_{800} vs PD_{800_0}	54.50	0.018

Table 19: Rearranged Games vs Comparison Set $\mathcal{G}$[a]

	PC_{800}	PC_{500}	BoS_{800}	BoS_{500}	CS_{800}	CS_{500}	CS_{400}	PD_{800}	PD_{500}	PD_{300}
PC_{RA}	54.3	**59.1**	**56.8**	**58.3**	52.2	**56.6**	52.1	**40.1**	**43.6**	53.3
	(2.35)	(2.91)	(2.89)	(3.15)	(3.00)	(3.13)	(2.89)	(2.83)	(2.90)	(2.98)
BoS_{RA}	54.0	**63.5**	**59.7**	**61.0**	**56.8**	**59.9**	52.2	**45.9**	49.4	50.5
	(2.83)	(2.52)	(2.59)	(2.52)	(2.57)	(2.70)	(2.46)	(2.96)	(1.90)	(2.50)
PD_{RA}	**57.8**	**61.9**	54.2	**58.5**	54.0	**58.4**	50.8	**41.9**	47.1	51.8
	(2.48)	(2.31)	(2.66)	(2.45)	(2.69)	(2.75)	(2.36)	(2.51)	(2.00)	(2.14)

[a] Standard errors are in parentheses. Every element of this table is tested to be equal to 50% and the bold elements represent rejection of the null hypothesis at the 5% significance level.