# Attention in Games: An Experimental Study*

Ala Avoyan† and Andrew Schotter ‡

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**Abstract**

One 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 have to decide how best to divide our limited attention across these settings. The question posed in this paper is how do people go about solving this attention-allocation problem, and how does this decision affect the way players behave in any given game when taken in isolation. We ask: What characteristics of the games people face attract their attention, and does the level of strategic sophistication exhibited by a player in a game depend on the other games he or she is engaged in? We find there is a great deal of between-game inter dependence which implies that if one wants to fully understand why a player in a game acts in a particular way, one would have to take a broader general-equilibrium view of the problem and include these inter-game effects.

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†Department of Economics, New York University. E-mail: *a.avoyan@nyu.edu*

‡Department of Economics, New York University. E-mail: *andrew.schotter@nyu.edu*

# 1 Introduction

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

The main question we pose in this paper is, how do people go about solving this attention-allocation problem? In particular, what characteristics of the games people face attract their attention and lead them to focus more on those problems rather than others; do people concentrate on the problems that have the greatest downside or the ones with the greatest upside payoffs; and do they pay more attention to games which are more complicated from a game-theoretical point of view, or maybe the payoff characteristics of the games trump these strategic considerations?

We view behavior in any given game as being determined by two factors. The first, as mentioned above, is how much attention a player decides to give to a game, given the other games he simultaneously faces. The second is how a player behaves given this self-imposed attentional constraint.

To discuss the first factor we use a modified version of Kőszegi and Szeidl (2013) (hereafter, KS) as a vehicle to structure our thinking. Other models could be used to equal advantage including an adaptation of the Alaoui and Penta (2015) model,[1] used to endogenously determine the level of strategic sophistication people use when playing a given game in isolation, or the models of Bordalo et al. (2012) which concerns the saliency of lottery attributes (prizes and probabilities) or Bordalo et al. (2016) where the salience of goods defined by their price and quality compete for the attention of consumers in a market (see also Cunningham (2011) and Bushong et al. (2015)).[2] In all of these models the objects vying for attention all have multiple attributes. We extend (to our knowledge, for the first time) the use of such models to study attention in games (objects which also have multiple attributes).

We have adopted the Kőszegi and Szeidl (2013) model because it presents an analysis

[1] We would like to 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 sutch 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), at http://www.econ.wisc.edu/apenta/EDRandRT.pdf.

[2] Gabaix (2011) redoes consumer theory using his sparse max analysis where the consumer needs to decide how much attention to pay to the prices of goods he faces. Such attention allocation in his model depends on how variable the price of a good is and its elasticity of demand.

that is closest to our intuition about the problem of attention allocation. However, the purpose of our paper is not to test the KS model (see Andersson et al. (2016) for a direct test). While it does help us structure our discussion and provides theoretical support for many of our conjectures, our paper deals with a number of issues that are outside of the KS framework. Nevertheless, as stated above, KS does provide a very nice structure that organizes our thinking.

In terms of our second factor, there is ample evidence that the level of sophistication one employs in a game depends on how much time or attention is devoted to it. For example, Agranov et al. (2015) allow players two minutes to think about engaging in a beauty-contest game. At each second the players can change their 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 is the most beneficial choice to make.

What these authors show is that, as time goes on, those players who are not acting randomly (level-zeros, perhaps) change their strategies in the direction of the equilibrium. Hence, Agranov et al. (2015) results suggest that the level-k chosen is a function of contemplation time or that, as Rubinstein (2016) proposes, as more time is allocated to the game people switch from an intuitive to a more contemplative strategy.

In a similar vein, Lindner and Sutter (2013), using the 11-20 Game of Arad and Rubinstein (2012), find that, if you impose time limits on subjects who play this game, the choice made by subjects changes in the direction of the equilibrium. As Lindner and Sutter (2013) suggest, this might be the result of the fact that imposing time constraints forces subjects to act intuitively (Rubinstein (2016)) and such fast reasoning leads them to choose lower numbers.[3] Rand et al. (2012) find that as people are allowed more time to think about their contribution in a public goods game, their contributions falls.[4] Finally, Rubinstein (2016) reverses the causality and looks at the decision times used by subjects to make their decisions in situations and infers the type of decision they are making (intuitive or contemplative) from their recorded decision time. What is important for our purposes is that as people pay more attention to a game their behavior changes.

One corollary of our analysis is the fact that we describe how the behavior of an agent

[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 decision times and behavior in public goods games and the influence of mistakes. See Kessler et al. (2015) for behavior in Prisoners' Dilemma and Dictator Game made with more or less time and various incentives.

engaged in one specific game is affected by the type of other games he is inter-acting in. We provide results that indicate that the level of sophistication one employs in a game is determined endogenously and depends on the constellation of other games the person is engaged 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 that person is simultaneously engaged in. While others like Choi (2012) or Alaoui and Penta (2015) have provided models of the endogenous determination of sophistication within one game, we expand this focus and look to include more general-equilibrium like inter-game factors.[5] This result follows naturally from our study on attention allocation in games.

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

In addition to these questions, we also investigate whether 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 paired with game $G_j$ and game $G_j$ when paired with game $G_k$, then would he also allocate more time to game $G_i$ when paired with game $G_k$? Other consistency conditions are also examined.

Finally, we also 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, i.e., he dreads playing that game and for that reason feels he needs to think more about it? To answer these types of questions we run a separate treatment where subjects are presented the same game pairs as in our original experiment but, instead of 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 information, both for attention time and game preference is elicited in an incentive compatible way with payoff-relevant choices.

[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).

What we find is interesting. First, we present evidence that clearly demonstrates that how a subject behaves when playing a given game varies greatly depending on the other game 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 engaged in, and that the proper study of strategic behavior must include these interconnected elements. In this sense, conventional game theory presents a type of partial equilibrium analysis.

With respect to the allocation of time across games, we find that subjects respond to both the strategic elements of the games presented to them and their payoffs. For example, subjects on average allocate more time to Prisoners' Dilemma ($PD$) games than any other type or class of game shown to them, followed by Constant Sum games ($CS$) and then Battle of the Sexes games ($BoS$). They pay the least amount of attention to Pure Coordination games ($PC$), although the difference between the time allocated to Pure Coordination and Battle of the Sexes games is only marginally significant.

This does not, by any means, suggest that strategic factors alone determine allocation times, however. Payoffs are also relevant. For instance, subjects allocate less time to matrix games where some payoffs are zero in comparison to otherwise-identical games where all payoffs are positive. They also allocate more time to games as their payoffs increase holding the payoffs in the comparison game constant. In addition, the time allocated to different games in the same game class, such as different $PD$ games, when compared to an identical other game (such as a $BoS$ game), varies according to the payoff of the $PD$ games. This may be interesting in the sense that game theorists might think that once a subject identifies a game as being in a particular class, like the class of $PD$ games, then the amount of time allocated to that game might be invariant to payoff changes in those games, since despite their different payoffs, all games in the same game class are strategically equivalent, i.e., a $PD$ game is a $PD$ game is a $PD$ game. This might be the view of those who view allocation time to be a function of game complexity and, since all $PD$ games are of identical strategic complexity, they all would require the same attention allocated to them no matter what their payoffs are. Our data demonstrates that this is not the case. Different members of a game class when compared to identical other games elicit different allocation times.

In terms of consistency, we find that while our subjects acted in a generally consistent manner, on various consistency measures they also exhibited considerable inconsistency. In terms of transitivity, however, our subjects appeared to be remarkably consistent in that over 79% of subjects exhibited either 0 or 1 intransitive allocation times when three pairs of connected binary choices were presented to them. 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 since subjects allocate relatively little time to them but state that they prefer playing them. This is because subjects seem to recognize the simplicity of these games compared, let's say, to constant sum games, and hence decide to spend their time elsewhere.

We will proceed as follows. In Section 2 we describe our experimental design. In Section 3 we present our adapted version of the KS model as applied to our time-allocation problem. In section 4 we outline a set of intuitive conjectures, some of which (concerning attention allocation) follow from the KS model, about the type of behavior we expect to see in our experiment. In Section 5 we reformulate these conjectures as statistical hypotheses and present our results. Section 6 concludes the paper.

# 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 subjects were NYU undergraduates recruited from the general population of NYU students. The experiment lasted about one hour and thirty minutes and, on average, subjects received \$21 for their participation. The experiment consisted of two different treatments run with different subjects. In one, subjects were asked to allocate time between two or sometimes three games. In the other, subjects were asked to choose which 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 which we will describe below.

## 2.1 Time-Allocation Treatment

### 2.1.1 Task 1

**Comparison of Game-Pairs** In the first task of the Time-Allocation Treatment there were 45 rounds. In each of the first 40 rounds subjects were shown a pair of matrix games (almost always 2×2 games) on their computer screen (we will discuss the final five round in the next subsection). Each matrix game presented a situation where two players had to choose actions which jointly determined their payoffs. In the beginning of any round a

[6] Instructions used in our experiment can be found in Appendix D and E.

pair of matrix games would appear on their screen for 10 seconds. Subjects were not asked to play these games but rather they were asked to decide how much time they would like to allocate to thinking about them if they were offered a chance to play these games at the end of the experiment. To make this allocation the 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, however. Rather they were told that $X$ would not be a large amount of time, hence, what they needed to decide upon in Task 1 was 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 had to play these games that is, we wanted the shadow price of contemplation time to be positive in their mind. We feared that if they 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 learn which game they thought they needed to attend to more. Our procedure, we felt, was suited to this purpose well.

To indicate how much time they wanted to allocate to each game the subjects had to write a number between 0 and 100 to indicate the fraction or percentage of time they wanted to allocate to thinking about the game designated as Game 1 on their screen. The remaining time was allocated to Game 2. To do this, we allowed subjects to view each pair of games for 10 seconds and then 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 but rather to indicate which game ***appeared*** more worthy of their attention later. We expected them to view the games, evaluate their features, and decide how much the relative amounts of attention they would like to allocate to these games if they were to play them later on.

On the screen displaying the two games was a counter in the right hand corner indicating how much time they had left before the screen would go 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.

<Figure 6> <Figure 7>

One of the games used for comparison was different from the others in that in involved chance and hence is called the Chance Game. When a subject had to choose between two games, one being a chance game, the subject's screen appeared as in Figure 7. What this says is that subjects will need to allocate time between Game 1 and Game 2 – the Chance Game. Game 2 says that with probability $\frac{1}{2}$ subjects will play the top game on the screen and with probability $\frac{1}{2}$ they will play the bottom game. However, in the Chance Game subjects must make a choice, A or B, before knowing exactly which of those two games they will be playing, that is determined by chance after their A/B choice is made. Note that strategically the chance game is identical to a pure coordination game (see game $PC_{500}$ in Table 1).

#### 2.1.2 The Last Five Rounds: Comparisons of Triplets

When 40 rounds were over, subjects were given 5 triplets of games to compare. In each of these last 5 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 not asked 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 description of the games, 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 seconds were allocated to thinking about Game 3). After the choice for the round was made subjects had some time to rest before the next pair of problems was presented for which they repeated the same process.

All of the games that were used to make comparisons are in Tables 1, 2, 3 and 4. In total, there were 25 games used, ranging from Prisoners' Dilemma, Pure Coordination, Constant Sum, Games of Chicken, and variants on these games. Of the 25 games 21 were $2\times2$ games with 2 games being $2\times3$ and 2 games being $3\times3$. Of the 25 games used, there were a set of 11 games where each game in the set was compared to every other. This set, called the *Comparison Set* $\mathcal{G}$ below, will be a central focus for us since it will allow us to compare how any two games attracted consideration time when compared to the same set of games. In other words, games in the *Comparison Set* $\mathcal{G}$ allow us to hold the games compared constant when evaluating whether one game attracted more attention than another.

#### 2.1.3 Task 2: Playing Games and Payoffs

In terms of payoffs, what the subjects were told is that at the end of the 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 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 in the first pair, they were given 60 seconds to rest before playing the second pair.

To determine their payoffs subjects were told that they would not play these games against other subjects in the experiment. Rather, they were told that in a previous experiment these games were played by a different set of subjects who played these games without any time constraint. Their payoff would be determined by their strategy choice and the strategy choice of one of these other subjects 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 (or less) contemplation time to a particular game thinking that their opponent would allocate little (much) 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 followed because even though we wanted subjects to play against an outside opponent, we did want the payoff they determined to have consequences for subjects in the experiment. This was so because some of our hypotheses concern the equity in the payoffs of the games presented to our subjects and we wanted these distributional consequence to be real for subjects in the lab. Hence, while they played against outside opponents, their actions had payoff consequences for subjects in the lab. Because subjects did not know if they would be in Group 1 or Group 2 when they chose their strategies, their strategy choice was incentive compatible in 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 as being the payoff relevant game and subjects received their payoff for that game.

**Table 1** – List of Games in Comparison Set $\mathcal{G}$

$PC_{500}$

| | |
|---|---|
| 500, 500 | 0, 0 |
| 0, 0 | 500, 500 |

$PC_{800}$

| | |
|---|---|
| 800, 800 | 0, 0 |
| 0, 0 | 800, 800 |

$BoS_{800}$

| | |
|---|---|
| 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 |

$Chance$

| | |
|---|---|
| 500, 500 | 0, 0 |
| 0, 0 | 500, 500 |

**Table 2** – 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 |

$PC^{800_1}_{500}$

| | |
|---|---|
| 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 |

**Table 3** – List of 2×3 Games outside Comparison Set $\mathcal{G}$

$LPD1$

| | | |
|---|---|---|
| 90, 90 | 0, 0 | 0, 40 |
| 0, 100 | 180, 180 | 0, 40 |

$LPD2$

| | | |
|---|---|---|
| 90, 90 | 0, 0 | 400, 40 |
| 0, 100 | 180, 180 | 400, 40 |

**Table 4** – List of 3×3 Games outside Comparison Set $\mathcal{G}$

$LLPD_1$

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

$LLPD_2$

| | | |
|---|---|---|
| 800, 800 | 100, 1000 | 0, 0 |
| 1000, 100 | 500, 500 | 0, 100 |
| 0, 0 | 100, 0 | 0,0 |

#### 2.1.4 Task 3

Finally, after every subject made their choices in Task 2 subjects were given a short survey. We gathered information on their major, GPA, gender and whether they had taken a Game Theory class.

### 2.2 Preference Treatment

When a subject allocates more time to thinking about game $G_i$ rather than game $G_j$, it is not clear what exactly that implies about his preferences over 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 except that in this treatment, when the subjects are presented with two games on their screen, their task is to decide which of the two games 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 over pairs of games and these preferences may be correlated with the time allocations of our subjects. At the end of the experiment pairs of games were chosen at random and subjects played those games they said they preferred again against an outside opponent who had played these games as column choosers in a previous experiment. In summary our experimental design is as follows:

Experimental Design

| **Treatment** | **Sessions** | **Task** | **No. of subjects** |
|---|---|---|---|
| Time Allocation 1 | 1-2 | 45 comparisons | 48 |
| Time Allocation 2 | 3-4 | 40 comparisons (Different than Treatment 1) | 46 |
| Preference | 5-6 | 45 comparisons (All in Comparison Set $\mathcal{G}$) | 46 |

# 3 Attention in Games

In our presentation here we will divide our discussion into two parts. First, we concentrate on the attention-allocation decision of subjects. Here we are interested in how subjects go about deciding what fraction of their available time they wish to allocate to each of the games they face. To do this, we adapt the model of Kőszegi and Szeidl (2013),[7] to provide structure for our analysis.

Once we have described how the attributes of games attract subject attention, we will turn our focus to how the amount of attention subjects allocate to a particular game affects their play in that game. To do this we will rely on the empirical findings of our paper and those of Rand et al. (2012), Rubinstein (2016) and Agranov et al. (2015), where it is shown that the type of strategy chosen depends on the time spent on thinking about that game.

As we stated in our introduction, one of the key points of our paper is the demonstration that the way a person plays a given game is intimately related to the other games or decision problems that a person is engaged in. Hence, it becomes hard to judge the rationality of a person in a given game without knowing how he or she has split her attention between the various games or decision problems he or she faces. In this paper, we show that one consequence of our analysis on attention allocation is that how a player behaves in a given game (his level of strategic sophistication) depends on the other games that vie for his attention.

## 3.1 A Model of Attention

In this section we outline a model that describes the way subjects allocate their attention across a set of games that “compete” for their attention. As stated above, our model is an adaptation of the model of KS who provide a theory of focus and choice for economic agents who have to choose between multi-attribute goods. In their model, goods are

[7] See also Woodford (2012).

described as bundles of attributes. More precisely, in their theory agents choose from a finite set $C \subset R^K$ of $K-$dimensional consumption vectors, where each dimension represents an "attribute." The consumption utility and welfare from a choice $c = (c_1, ......, c_K)$ is $U(c) = \sum_{k=1}^{K} u(c_k)$. The key to their analysis, however, is a description of the fact that while welfare is described by consumption utility, the good chosen is a function of what they call its *focus-weighted utility* where focus or attention on a good is drawn to those attributes that present the largest difference across goods. More precisely, subjects maximize $U(c) = \sum_{k=1}^{K} g_k u_k(c_k)$, where $g_k = g(\Delta_k C)$, $\Delta_k C = (\max_{c \in C} u_k(c_k) - \min_{c \in C} u_k(c_k))$, and $g(\cdot)$ is an increasing function. What this function says is that when looking across bundles in $C$ a consumer's attention is drawn disproportionately to those attributes which display the largest difference across the available goods. Large differences are given larger weights via the $g_k(\cdot)$ function. This focus on big differences leads people, as suggested by KS to, for example, declare California preferable to Ohio as a place to live because of a large difference in climate, while ignoring other attributes where the differences aren't as sizable. In KS the set of attributes is given exogenously.

In this paper, our subjects face a choice between matrix games each of which have different attributes defined by their payoffs and their strategic attributes, i.e., the type of game they are. For example, games differ in their maximum and minimum payoffs, by how unequal their payoffs are, as well as the class of game they fall into, such as Prisoners' Dilemma, Constant Sum, Battle of the Sexes or Pure coordination games.When our subjects look across these games and have to decide on what fraction of their limited attention they want to pay to either game, they consider these attributes and the differences in them across these games.

More precisely, games differ in their strategic and payoff attributes. To represent this let a game $\Gamma$ be described by its attribute vector $a = (a_1, ....a_K, \theta(\Gamma))$, where the first $K$ attributes concern the payoffs in the game (i.e., maximum payoff, minimum payoff, how inequitable are payoffs, etc.) and the second set of attributes relate to the type of game the matrix represents denoted by a *game-class variable* $\theta(\Gamma)$. All strategic differences between games will be represented by the class of game they fall into, i.e., whether they are $PC$, $BoS$, $CS$, or $PD$ games. In contemplating how much time or attention to allocate to a particular game, the game-class variable $\theta(\Gamma)$ will function as an additive constant that is added to the amount of time a subject will spend contemplating that game as determined by its relative payoffs. For example, when comparing two games, if game $G_1$ is a Pure Coordination while game $G_2$ is a Prisoners' Dilemma game, then if that distinction is recognized by the subjects and if they believe that $PD$ games are more difficult to contemplate than Pure Coordination games, then the time constant $t(PD)$ added to the attention allocated to the $PD$ game will be greater than the time constant added to the Pure Coordination game $t(PC)$. Note that this game-class variable only refers to the types of games we are comparing and not their payoffs.

Following KS, and restricting ourselves to comparisons of two matrix games at a time (as is typically the case in our experiment), we define the *focus-weighted attention score* of game $G_i$ when it is compared to game $G_j$ as $T^{ij}$. More precisely, in our context we will define $T^{ij} = \sum_{k=1}^{K} g_k t_k(a_k^i) + t(\theta(G_i))$ as the attention score of game $i$ when compared to game $j$ and likewise $T^{ji} = \sum_{k=1}^{K} g_k t_k(a_k^j) + t(\theta(G_j))$ for $G_j$'s attention score when $G_j$ is compared to game $G_i$. Here $g_k$ is the weight associated with attribute $k$ given its difference across the two games under investigation, while $t_k(a_k)$ is the amount of time that a game, containing attribute $k$ of magnitude $a_k$, adds to a subject's contemplation time. For example, as the largest payoff in a game matrix increases the game becomes more attractive and attracts more of a player's attention. The same is true as the worst payoff in a game gets smaller since such a decrease lowers the value of the game and the worse it gets the less one has to think about that game.[8] Furthermore, as Rubinstein (2007) and others have shown, games with large inequalities in payoffs also attract attention or at least lead subjects to take longer before making a decision. The interesting aspect of the KS model when applied to our analysis here is that the weight $g_k$ attached to each payoff element, $t_k(a_k^i)$, depends on how big is the difference in this attribute across the two games. For simplicity, we define the fraction of time allocated to game $G_i$ when compared to game $G_j$ as: $\alpha(i,j) = \frac{T^{ij}}{T^{ij}+T^{ji}}$. Obviously, $\alpha(j,i) = 1 - \alpha(i,j)$. Note that this simply says that the fraction of time allocated to game $G_i$ is in proportion to its focus weighted attraction score.

To give an example of how this model determines attention times across two games, consider an agent playing the following two games:

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

| $PD_{300}$ | $A$ | $B$ |
|---|---|---|
| $A$ | $300, 300$ | $100, 400$ |
| $B$ | $400, 100$ | $200, 200$ |

Let us assume that there are three payoff attributes that attract the subject's attention: the maximum and the minimum payoff in each matrix as well as the largest unequal payoff. For these two games we see that the largest payoff in $BoS_{500}$ is 500 while the

[8] See, for example, Devetag et al. (2015) and Stewart et al. (2015) on eye-tracking studies on attention focus in matrix games.

largest payoff in $PD_{300}$ is 400. Hence the difference is 100. The minimum payoff in the $BoS_{500}$ game is 0 while it is 100 in the $PD_{300}$ game. Finally, while the largest inequality in payoffs for the $BoS_{500}$ is $200 = 500 - 300$, it is $300 = 400 - 100$ in the $PD_{300}$ game. As $BoS_{500}$ is in the Battle of the Sexes game class and $PD_{300}$ is in Prisoners' Dilemma game class the *game-class variable* $\theta(\Gamma)$ returns $\theta(BoS_{500}) = BoS$ and $\theta(PD_{300}) = PD$. Using the focus weighted attention function specified above this yields,

$$\begin{aligned} T^{BoS,PD} &= g_{Max}(500-400)t_{Max}(500) + g_{Min}(100-0)t_{Min}(0) \\ &+ g_{Equity}(300-200)t_{Equity}(200) + t(BoS) \end{aligned}$$

while

$$\begin{aligned} T^{PD,BoS} &= g_{Max}(500-400)t_{Max}(400) + g_{Min}(100-0)t_{Min}(100) \\ &+ g_{Equity}(300-200)t_{Equity}(300) + t(PD) \end{aligned}$$

Hence, $\alpha(BoS_{500}, PD_{300}) = \frac{T^{BoS,PD}}{T^{BoS,PD}+T^{PD,BoS}}$, with $\alpha(PD_{300}, BoS_{500}) = 1-\alpha(BoS_{500}, PD_{300})$.

Higher fraction of attention will be focused on game $BoS_{500}$ than to $PD_{300}$, if $T^{BoS,PD} > T^{PD,BoS}$ or

$$\begin{aligned} t(BoS) - t(PD) > & \; g_{Max}(100)t_{Max}(400) + g_{Min}(100)t_{Min}(0) \\ &+ g_{Equity}(100)t_{Equity}(200) - g_{Max}(100)t_{Max}(400) \\ &- g_{Min}(100)t_{Min}(100) - g_{Equity}(100)t_{Equity}(300) \end{aligned}$$

Our experimental results show that on average $PD_{300}$ gets significantly higher fraction of attention than $BoS_{500}$, despite the higher maximum payoff in $BoS_{500}$. The result suggests that $t(PD)$ is high enough to compensate for lower max and equality in $PD_{300}$. We further analyze the average ranking of game classes in Conjecture 2 and Hypothesis 2a, 2b.

Given the attention allocation set up, a number of comparative static predictions follow. For example, a simple *monotonicity property* should be satisfied; for any two games in the same game class, if the payoffs in game $G_i$ are at least as large as those of game $G_j$ then, when those two games are compared to each other, a higher fraction of time should be allocated to game $G_i$. In the same direction, we would think that if we take two games, $G_i$ and $G_j$ which are identical except for the fact that $G_j$ was generated from $G_i$ by taking some of the (non-maximum) positive payoffs in i and lowering them to *zero* (keeping the game class the same), then more time should be allocated to game $G_j$

since its minimum payoff has just been lowered making the difference in that minimum even higher. Further, if we take two identical games, $G_i$ and $G_j$ that only differ in that the payoffs in one cell of game $G_i$ is unequal while those in game $G_j$ are identical, then we would expect a large fraction of time or attention to be allocated to game $G_i$. In our analysis here we look at maximum inequality as the maximum difference between payoffs in any cel of the matrix. In our later analysis we will restrict these inequalities to equilibrium payoffs.

The predictions of our model stated above might contradict those of models who consider that attention is drawn to more complex games where more computation is needed to analyze them. That is, suppose one writes an algorithm to find an optimal strategy in $2 \times 2$ matrix game. Then, if two games are in the same game class, it will take the algorithm exactly the same time to find the solution. The time needed to return an answer will depend on the class of the game, but will not depend on the magnitude of payoffs. However, following our discussion on attributes, if the games are in the same game class (the $\theta(\Gamma)$'s are the same) then the attention focused on one game will be strictly determined by the payoffs since they will affect each games' attention score. In the following section we state a set of conjectures that follow from our analysis. In our Results Section we will reformulate these conjectures as hypotheses and use our data to test them.

# 4 Conjectures

Most of our conjectures concern a comparison between the time allocated to either of two games, games $G_i$ and $G_j$ when those games are compared to each other or to the same set of alternative games, the Comparison Set $\mathcal{G}$. To be more precise, let the set $\mathcal{G}$ contain $M$ games denoted $\mathcal{G} = \{G_1, G_2, ..., G_M\}$. In our experiment, as described above, a subject is asked in a pair-wise fashion to allocate a fraction of time, $X$ seconds, between game $G_i \in \mathcal{G}$ and each of the other games in $\mathcal{G}$. The conjectures below concern this allocation.

## 4.1 Interrelated Games

One consequence of the KS model when applied to our experiment is that the attention allocated to a given game varies as we change the game or games it is compared to. There is behavioral inter-game dependence.

Suppose, an agent focuses a fraction $\alpha(i, j)$ of his total attention on game $G_i$ when it is compared to game $G_j$. Now replace game $G_j$ with game $G_m$, so that $a^j \neq a^m$, i.e., the payoff attributes of game $G_j$ differ from those of game $G_m$. An agent is now comparing game $G_i$ and game $G_m$, and needs to decide how much attention to focus on game $G_i$, (i.e., he must now determine $\alpha(i,m)$). Given that the attributes of game $G_j$ and game $G_m$ are not identical, $a^j \neq a^m$, our focus-weighted attention score for game $G_i$ when compared to game $G_j$ will differ from focus-weighted attention score for game $G_i$ when compared to game $G_m$, that is $T^{ij} \neq T^{im}$. Therefore, when we changed the opposing game, the attention focus on the same game, game $G_i$, changed from $\alpha(i,j)$ to $\alpha(i,m)$, with $\alpha(i,j) \neq \alpha(i,m)$. As a result, varying the second game in consideration from game $G_j$ to game $G_m$ affected the attention focused on game $G_i$ and hence, the behavior of our subjects in game $G_i$. This yields a simple conjecture:

**Conjecture 1** ***Interdependent Games:*** *The way an agent behaves in a game is dependent on the other game or games that agent is simultaneously engaged in.*

We will restate this conjecture as a hypothesis and test it in the Results section of this paper.

## 4.2 Strategic Attributes

When looking across types of games like Prisoners' Dilemma games, Pure Coordination games, Battle of the Sexes games or Constant Sum games, there may be a general view that some of these games are easier to play than others and hence will attract less attention. In terms of our model, such games would imply a smaller game-class variable $\theta(\Gamma)$. For example, it may be that across the four types of games just listed we might, on average, think that people would spend more of their time attending to Prisoners' Dilemma games as opposed to say Pure Coordination games. Likewise, since in Pure Coordination games people's interests are aligned while in the Battle of the Sexes games they are not, we might expect more time to be allocated to the later than the former. It becomes more difficult to conjecture about the relative contemplation times for our other games since, while some, like the Battle of the Sexes game, contain equity issues, others, like the Prisoners' Dilemma, contain a trade-off between domination and efficiency. Which class of games involve a larger additive constant, $\theta(\Gamma)$, is ultimately an empirical question but our a priori expectations are summarized in the following conjecture.

**Conjecture 2** ***Game Class Ordering:*** *Let $\bar{PD}$, $\bar{CS}$, $\bar{BoS}$, $\bar{PC}$ represent the mean time allocated to all of the Prisoners' Dilemma Games, Constant Sum Games, the Battle of the Sexes Games and Pure Coordination Games, respectively, when compared to all other games in $\mathcal{G}$. We expect these times to be ordered as: $\bar{PD} > \bar{CS} > \bar{BoS} > \bar{PC}$.*

As mentioned above, an algorithm or a trained game theorist performing our experiment might conclude that once they can classify a game presented into a game class, there would be no need to think more about it since strategically all games in that class are equivalent. This would imply that the fraction of time allocated to such problems when compared to any other game in the set $\mathcal{G}$ should be identical. In addition, if two games in the same game class are compared directly, then the allocation of time should be same – equal to 50%. However, given our model, if we have two games, $G_i$ and $G_j$ from the same class of games, $\theta(G_i) = \theta(G_j)$, then payoff attributes, $a_i$ and $a_j$, will determine the fraction of time allocated to each game, $\alpha(i, j)$. These considerations yield the two conjectures stated below, and tested in the results section.

**Conjecture 3** ***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 for any comparisons made in the set $\mathcal{G}$.*

**Conjecture 4** ***Within Class Payoff Irrelevance:*** *For any two games $G_i$ and $G_j$ in the same game class, when these games are compared to each other, each should be allocated 50% of the available time no matter what their payoffs are.*

## 4.3 Payoff Attributes

Some of the features of games that attract attention concern the game's payoff attributes. Lucrative games (defined appropriately) might cause you to think that the marginal benefit of attending to that game is higher than a game with lower payoffs and hence might attract attention. Games that look risky for various reasons, might also attract attention as might games with negative or zero payoffs. The conjectures below are concerned with these features. What we will be interested in investigating is how the time allocated to a problem changes when we change one feature of the game's payoffs.

However, since we are interested in ceteris paribus changes, we want to make sure that the changes we introduce do not change the type of game being played. Hence, in several of our conjectures we will require that whatever change we make in the game it remains in the class of games we started with.

For example, take the following Pure Coordination game and change this game by adding positive payoffs in the off-diagonal cells to yield Prisoners' Dilemma game

| $PC_{\substack{800\\500}}$ | $A$ | $B$ |
|---|---|---|
| $A$ | $800, 800$ | $0, 0$ |
| $B$ | $0, 0$ | $500, 500$ |

| $PD_{800}$ | $A$ | $B$ |
|---|---|---|
| $A$ | $800, 800$ | $100, 1000$ |
| $B$ | $1000, 100$ | $500, 500$ |

The second game is identical to the first with the exception that we have replaced zero's in $PC_{\substack{800\\500}}$ with some positive payoffs. However, note that $PD_{800}$ is a Prisoners' Dilemma game and hence outside of the game class we started with. As we will see later, if we impose a monotonicity assumption that says that when two games are identical except that one has strictly higher payoffs than the other, a subject will allocate more time to the game with the higher payoffs, we may want to require that after the payoff change the game still remains in the same class of games it started out in. We impose this requirement because if the game type changes because of the payoff increase, subjects may allocate more time to the second game not because the payoffs have increased, but because they feel it is strategically more complicated. In order to avoid such confounds we will, wherever possible, restrict such changes to games within a same game class.

Given our model in Section 3, if we have two games, $G_i$ and $G_j$ from the same class of games so that $\theta(G_i) = \theta(G_j)$, then payoff attributes, $a_i$ and $a_j$, alone will determine the fraction of time allocated to each game. Now, let payoffs in each cell of game $G_i$ be at least as large as in game $G_j$ and strictly greater in at least one cell. When these two games are compared to each other, the focus weighted attention score of $G_i$ is going to be greater than the focus weighted attention score of $G_j$.[9] Therefore, $\alpha(i,j)$—the fraction of attention allocated to $G_i$—is going to be greater than $\alpha(j,i)$—the fraction of attention allocated to $G_j$. However, note that the model doesn't necessarily predict a higher fraction allocated to $G_i$ than to $G_j$ when both are compared to any $G_m \in \mathcal{G}$. As we will see later, this fact will be responsible for a large fraction of the inconsistencies in time allocation. The discussion above yields the Monotonicity conjecture below.

**Conjecture 5** ***Monotonicity:*** *If games $G_i$ and $G_j$ are in the same class of games and if the payoffs in game $G_i$ are at least as large as the payoffs in game $G_j$ in all cells and strictly greater in at least one cell, then subjects will allocate more time to game $G_i$ than $G_j$ when they are compared to each other or other game in the Comparison Set $\mathcal{G}$.*

Our next conjecture is concerned with the presence of zeros in a game matrix. The question we ask is if game $G_j$ is derived from game $G_i$ by changing positive payments in game $G_i$ to zeros, keeping all other payoffs the same, how will that affect the attention allocated to game $G_i$ when compared to game $G_j$? This is not obvious. The conjecture below is predicated on the idea that people might think that game $G_j$ is more risky than game $G_i$ since in $G_i$ it is never possible to receive anything other than a positive payoff

[9] Note that $g_k$ weights are going to be the same for both games, however, $t_k(a_k^i) \geq t_k(a_k^j)$ as $a_k^i \geq a_k^j$. Hence, $T^{ij} > T^{ji}$ and finally, $\alpha(i,j) > \alpha(j,i)$.

while in $G_j$ it is. If zeros are considered scary payoffs then, in order to avoid receiving them, subjects might want to think longer about game $G_j$ before deciding what strategy to choose. On the other hand, some people may think that because in creating game $G_j$ from game $G_i$ we have made elements of $G_i$ zero, game $G_j$ has become simpler to analyze and hence requires less time, i.e., there is less clutter in game $G_i$, and hence, it is easier to process. There is no particular a priori reason to prefer one of these explanations to the other. However, we can examine this statement using our model.

Suppose games $G_i$ and $G_j$ are from the same game class, $\theta(G_i) = \theta(G_j)$, and let $G_i$ be identical to $G_j$ except that all zeros in $G_j$ are replaced by strictly positive payoffs, keeping all other attributes unchanged. This will imply that the minimum of $G_j$ is lower than in $G_i$, while all other payoff and strategic attributes identical. Therefore, when games $G_i$ and $G_j$ are compared to each other, the higher minimum in $G_i$ will result in higher focus weighted attention score for game $G_i$ than the one for game $G_j$. Hence, more attention will be payed to the game without zeros. However, note that if only some zeros are replaced with positive payoffs but at least one of them is left unchanged that will keep the minimums the same. Even though, the attention model doesn't give a definitive direction in this scenario, we are still able to test this case using our data.

**Conjecture 6** ***Zeros:*** *If game $G_j$ is derived from game $G_i$ by changing some positive payments in game $G_i$ to zeros while keeping the game class unchanged, then a subject should allocate more time to game $G_i$ than game $G_j$ when they are compared to each other.*

The logic behind our next conjecture follows from the fact that games with unequal payoffs are assumed to be more ethically charged and therefore more likely to draw our attention. Certainly, such might be the case if our decisions makers have inequality averse preferences. Such a result was found already by Rubinstein (2007) in the context of decision times where he discovered that decisions involving unequal payoffs take more time to make than those where payoffs are more equal. The implication is that if moral considerations are added to an already complicated strategic situation, we might think that this is likely to lead to greater time allocations.

Consider two games, $G_i$ and $G_j$ and let them have identical equilibria, except that the equilibrium payoffs in $G_i$ are unequal while those in $G_j$ are equal. This will imply that inequality index of $G_i$ is higher than in $G_j$, while all other payoff and strategy attributes are the same. Therefore, when $G_i$ and $G_j$ are compared to each other, larger inequality index in game $G_i$ will result in higher payoff focus weighted attention score for $G_i$ than the one for game $G_j$. However, depending on which class of games these games are in and the game class variable constants, more or less attention will be paid to the game with unequal equilibrium payoffs.

**Conjecture 7** ***Equity:*** *If two games, $G_i$ and $G_j$ are identical and have identical equilibria except that the equilibrium payoffs in game $G_i$ are unequal while those in $G_j$ are equal, then a subject will allocate more time to game $G_i$ with unequal payoffs when these games are compared to each other.*

Our final conjecture concerns complexity. One might think that one of the major features of games that attract a player's attention is their complexity. Unfortunately, there is very little consensus as to what exactly makes a game complex and no commonly agreed to standard. Despite this difficulty, there are situations where one might agree that game $G_i$ is more complex than game $G_j$ and in our design we think we have such a situation. 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:

$PD_{800}$

| | |
|---|---|
| 800, 800 | 100, 1000 |
| 1000, 100 | 500, 500 |

$LLPD_1$

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

$LLPD_2$

| | | |
|---|---|---|
| 800, 800 | 100, 1000 | 0, 0 |
| 1000, 100 | 500, 500 | 0, 100 |
| 0, 0 | 100, 0 | 0,0 |

**Table 4** – Prisoners Dilemma and Its Transformations

Games $LLPD_1$ and $LLPD_2$ are derived from $PD_{800}$ by the addition of two dominated strategies one for the column chooser (column 3) and one for the row choose (row 3). As a result, we consider $LLP1$ and $LLP2$ to be more complex that $PD_{800}$ for two reasons. First they involve more strategies and hence are simply larger but, more importantly, despite the fact that all three games have identical unique equilibria, the equilibria in $LLPD_1$ and $LLPD_2$ are reached by a more complicated strategic process that involves recognizing not only dominance but iterative dominance. Since the equilibria for these three games are identical and unique, we might want to consider $LLPD_1$ and $LLPD_2$ to be a pure increases in complexity compared to $PD_{800}$. As such, we would intuitively conclude that in a binary comparison between $PD_{800}$ and $LLPD_1$ or $LLPD_2$, we would expect more time to be allocated to the larger more complex games. This yields our last conjecture.

**Conjecture 8** *If Game $G_i$ is derived from game $G_j$ by adding a strictly dominated strategy to both the row and column player's strategy set, then a subject will allocate more time to game $G_i$ than game $G_j$.*

# 5 Results

In this Section we will start our discussion by investigating the conjectures presented above. We split our analysis into two parts, one dealing with the question of the behavioral inter-dependence of games and one on time allocation and consistency issues.

## 5.1 Interrelated Games

It is our claim in this paper that the time you allocate to thinking about any given game depends on the other games you are simultaneously engaged in. However, since 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 will investigate these two issues.

**Hypothesis 1** ***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 1 is easily rejected. To give a simple illustration of how the amount of time allocated to a game is affected by the other games a subject faces, consider Figures 8a-d which present the mean amount of time allocated to the $PC_{800}$, $BoS_{500}$, $CS_{800}$, and $PD_{300}$ games respectively as a function of the other games the subject was engaged in.

<Figure 8>

Looking at Figure 8a first, we see 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, on average subjects allocate less that 40% of their time to $PC_{800}$ when they also play $PD_{800}$ while they allocate nearly 55% of their time to this game when also facing $PC_{500}$. For Figure 8b we see a similar pattern with subjects allocating close to 52% of their time to that game when also facing the $PC_{500}$ game but only around 40% to it when simultaneously facing $PD_{800}$. The same results hold in Figures 8c and 8d.

Table 5 presents the mean time allocated to each game in our Comparison Set $\mathcal{G}$ as a function of the other game that game was paired with. Looking across each row, we test the 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 which is what our null hypothesis suggests. As we can see, while for some comparisons the difference is insignificant, by and large there is a distinct pattern of the time allocated to a given game depending on the other game a subject is simultaneously considering. This is supported by a Friedman test that for any game in $\mathcal{G}$ we can reject the part one of the Hypothesis 1.

The second step in our analysis on interrelated games is to connect the time allocated to a game type of strategy chosen. In other words, the question here is whether subjects change the type of behavior they exhibit as the time allocated to a given game changes. If this is true, and if the time allocated to a game depends on the other games 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.

We look for evidence of a function describing the relationship between contemplation time and strategic choice except that given our design, we will have to content ourselves with aggregate rather than individual level data. Figures 9a-c present such results.

<Figure 9>

In these figures we present decision time on the horizontal axis divided into two segments for those subjects spending less or more than the mean time of all subjects playing this game. We put the fraction of subjects choosing strategy A in a given game on the vertical axis. More simply, 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).[10]

In Figure 9a, which looks at the $CS_{400}$ game, the fraction of subjects choosing strategy A who think relatively little about it is dramatically different from those who think a longer time. For example, more than 76% of subjects who decide quickly in that game choose A while, for those who think longer, this fraction drops to 43%. A similar, but more dramatic pattern is found in Figure 9b for the $PD_{300}$ game. Here the drop in the

[10] The results are similar when we use the median instead of the mean.

fraction of subjects choosing strategy A (the cooperative strategy) is from 93% to 33% indicating that quick choosers cooperate while slow choosers defect. Finally, in Figure 9c we see that for some games choice is invariant with respect to decision time. Here, for the game $PC_{\substack{800\\500}}$ we see that all subjects choose A no matter how long they think about the game. Note that this is a coordination game with two Pareto-ranked equilibria one where each subject receives a payoff of 800 and the other where the payoff is 500 (off diagonal payoffs are 0). Choice in this game appears to be a no-brainer with all subjects seeing that they should choose strategy.

The import of these figures for our thesis in this paper should be obvious. The time allocated to a given game depends on the other game a subject is facing and choice in a game typically depends on the time spent on it.

## 5.2 Attention Allocation

### 5.2.1 Preliminaries

In the remainder of this section we look in more depth at the time allocation problem. Before we continue, it is important to consider the data we have. In total we ran four sessions where sessions 1 and 2 we had subjects make 45 comparisons while sessions 3 and 4 we had them make 40 distinctly different ones. We ran sessions 3 and 4 to derive a set of 11 games for which all games in the set were paired with each other. For 11 games in the set

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

we have a full set of 55[11] comparisons such that each game in this set is compared to every other game. This allows us to hold the comparison set constant and compare how time is allocated between each game and every other game in set the $\mathcal{G}$, thus, we are able to make controlled comparisons.

For many of the comparisons we make we will concentrate on these 11 games. For others we will focus on binary comparisons of games where either only one game is in $\mathcal{G}$ or where both games are outside of $\mathcal{G}$.

To make our comparisons we will use two metrics: *mean time* and *fraction*. The *mean time metric* is exactly as it sounds. Here for any game $G_i \in \mathcal{G}$ we know that it was compared to each of the ten games in the set $\mathcal{G}$. We calculate the mean percentage of time allocated to the game $G_i$ over all ten comparisons in $\mathcal{G}$. We do this for each of the eleven games so each will have a mean score representing the mean fraction of time allocated to this game when compared to each other game in $\mathcal{G}$ (Table 5).

[11] All combination of two games out of eleven without replacement and order – $C_2^{11} = 55$.

The *fraction metric* records, for each comparison of games, what percentage of subjects allocated strictly more than 50% of their time to a given game out of all subjects (we exclude subjects who allocated exactly 50% to both games). For example, in Table 6 take $PD_{800}$ and $PD_{500}$, both Prisoners' Dilemma games. The number in the intersection of $PD_{800}$ row and $PD_{500}$ column, 0.69, means that 69% of subjects allocated more than 50% to the first $PD$ game and only 31% to the second game, when they were directly compared to each other.

Tables 5 and 6 present these two metrics for all eleven games in the comparison set $\mathcal{G}$. One reads this table across the rows. For instance, in Table 5 which presents our mean metric, we see that in the comparisons between $PC_{800}$ and $PC_{500}$, on average, subjects devoted 54.1% of their available time to the $PC_{800}$ game and consequently, only 45.9% to the $PC_{500}$ game when these two games were compared directly. In other words, when comparing $PC_{800}$ to $PC_{500}$ subjects felt they would like to spend more time contemplating $PC_{800}$ before making a choice. If we were to look at the same comparison in the Table 6, where we present our fractions metric, we see that when the $PC_{800}$vs $PC_{500}$ comparison was presented to subjects, 88% of them wanted to use more time thinking about $PC_{800}$ than $PC_{500}$.

<Table 5> <Table 6>

### 5.2.2 Strategic Attributes

In discussing our conjectures we will discuss the impact of strategic considerations on time allocation before we move on to the impact of payoffs. Since we investigate primarily four basic types of games our first questions will concern whether more time was allocated to certain types of games in aggregate. In other words, on average, was more time allocated to $PD$ games than $PC$ games etc. when compared to other games in the set $\mathcal{G}$. Here we are taking the average across the set of games in $\mathcal{G}$ that each of our four types of games were compared to, and then aggregating within each game class. This determines our first null hypothesis:

**Hypothesis 2a** ***Game Class Ordering (mean):*** *Let $\bar{PD}, \bar{CS}, \bar{BoS}, \bar{PC}$ represent the mean time allocated to all of the PD, CS, BoS, and the PC games when they are compared with all other games in the set $\mathcal{G}$. We test $\bar{PD} = \bar{CS} = \bar{BoS} = \bar{PC}$.*

**Hypothesis 2b** ***Game Class Ordering (fraction):*** *Let $\tilde{PD}, \tilde{CS}, \tilde{BoS}, \tilde{PC}$ represent the mean fraction of the PD, CS, BoS, and the PC games when they are compared with all other games in the set $\mathcal{G}$. We test $\tilde{PD} = \tilde{CS} = \tilde{BoS} = \tilde{PC}$.*

<Table 7>

Table 7 presents data that allows us to test hypothesis 2a and 2b. It presents the mean and the fraction metric for our classes of games and clearly indicates that both hypothesis can be rejected. For example, it appears clear that as a class of games subjects allocated more time to $PD$ games (56.58%) followed by $CS$ games (49.54%) then $BoS$ games (46.62%) and finally $PC$ games (45.40%). A set of binary Wilcoxon signed-rank tests indicates that these differences are statistically significant for all comparisons ($p < 0.01$) except $PC$ and $BoS$ games where $p > 0.05$. A test of our null hypothesis, that the mean attention time paid to games is equal across all game types, i.e., that $\bar{PD} = \bar{PC} = \bar{CS} = \bar{BoS}$, is also rejected with $p < 0.01$ using a Friedman test.[12]

Similar results appear when we look at the fraction metric where $PD$ games were allocated more time on average, 78% of the time, compared to $CS$ games (51%), $BoS$ games (34%), and $PC$ games (26%). Again, a set of binary test of proportions indicate that these mean fractions are significantly different except for $PC$ and $BoS$ classes. A test of null hypothesis 2b that $\tilde{PD} = \tilde{CS} = \tilde{BoS} = \tilde{PC}$, is also rejected with $p < 0.01$. Note that there is consistency between our two metrics in the sense that they order the class of games in an identical manner as to which games attract more attention.

This result suggests that strategic factors are important in describing what types of games attract attention. By and large, our subjects seem to be more concerned about playing $PD$ games as opposed to other types and least concerned about Pure Coordination games. As we will see later, however, game class is not the only determining factor and other, payoff-related, attributes of the game will also be important.

While Hypotheses 2a and 2b discuss attention issues aggregated across classes of games, we can look within each game class and ask if there are differences in the attention paid to games individually when compared to games in other classes. Here, of course, since the games are from the same class, if subjects pay different amounts of attention to them it must be because they have different payoff features. For example, let's consider the following hypothesis:

**Hypothesis 3** ***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 for any comparisons made in the set $\mathcal{G}$.*

[12] The Friedman test is a non-parametric alternative to the one-way ANOVA with repeated measures. We will use Friedman test throughout this paper to test hypothesis involving more than two groups. For one or two group analysis, we use Wilcoxon signed-rank test. In case of multiple hypothesis testing, as in Table 7, we use Bonferroni correction to adjust significance thresholds.

Hypothesis 3 is a way to look inside any class of games and look at how much attention was allocated to each of these games when they were compared to games in the set $\mathcal{G}$ outside their own class (i.e. we do not compare $PD$ games with each other). We hypothesis that the same attention will be paid to each of these games regardless their payoffs. As we can see from Table 8, this hypothesis is rejected. For example, for $PD$ games depending on which $PD$ game we look at, the mean fraction of time allocated to that game for all out-of-class comparisons differs. While on average the mean percentage of time allocated to $PD_{800}$ when facing non-PD games in the set $\mathcal{G}$ was 58.52%, it was only 54.36% for $PD_{300}$ indicating that these two games, despite being $PD$ games, were not viewed as identical. Table 8 supports this result.

<Table 8>

Looking more broadly we see that for no class of games can we accept the null hypothesis of equality of mean time allocations across games within the same class. This clearly indicates that payoff features must be important when subjects decide how to allocate attention across games.

If all games within a class are considered equivalent, we might expect that when they are paired with each other in a binary comparison we should observe that each is allocated an equal amount of time. For example, when comparing two $PD$ games with different payoffs it might be the case that since strategically they present identical trade-offs, a subject might devote 50% to each no matter what their payoffs. These considerations yield the following hypothesis.

**Hypothesis 4** ***Game Class Payoff Irrelevance:*** *For any two games $G_i$ and $G_j$ in the same game class, when these games are compared to each other, each should be allocated* 50% *of the available time no matter what their payoffs are.*

<Table 9>

As we can see, from the Table 9, there is little support for Hypothesis 4. In Table 5 we present the mean time allocated to the Row game when paired with the Column game along with the standard errors in parenthesis. What we are interested in is testing the hypothesis that the mean in any cell is statistically different from 50%. As we can see, this hypothesis is violated in almost all situations. For example, when $BS_{800}$ is matched with $BoS_{\substack{800\\0}}$, subjects allocate 60.74% of their time to $BoS_{800}$ which is significantly different than the hypothesized 50% at the $p < 0.01$. Similarly, when $BoS_{\substack{800\\0}}$ is matched with $BoS_{\substack{800\\100}}$, it only attracts 42.78% of the time which is also significantly different than 50%

at the $p < 0.01$ level. The biggest exception to the rule is the class of Prisoners' Dilemma games where except for $PD_{800}$ all other games seem to allocate a percentage of time not significantly different to both games in any binary comparison. For example, when $PD_{300}$ is compared to $PD_{\substack{800\\0}}$ subjects allocated on average 48.67% to $PD_{300}$ which is not significantly different from 50% ($p = 0.38$).

In summary it appears that strategic considerations alone are not sufficient to explain the attention that subjects pay to games. This indicates that subjects consider both strategic as well as payoff features of games when deciding how much time to devote to them. The implication therefore is that payoffs must matter. In the next section we investigate exactly what it is about a game's payoffs that attracts the subjects' attention.

### 5.2.3 Payoff Attributes

Certain features of games are bound to attract one's attention. We start with the most natural attribute, monotonicity. In the context of our experiment this means that if we make a game more attractive by increasing one or more of its payoffs leaving all other payoffs the same and keeping the game in the same class of games it started out in, then that game should attract more attention and hence be allocated more contemplation time.

Let's consider an example of two games where one of them is a monotonic transformation of the other, look at $PC_{500}$ and $PC_{800}$:

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

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

The second game is a monotonic transformation of the first since we have left all zero payoffs intact but increased all non-zero payoffs by 300. In addition, note that the game remains a coordination game.

Likewise, consider $PD_{800}$ and $PD_{500}$:

| $PD_{800}$ | $A$ | $B$ |
|---|---|---|
| $A$ | $800, 800$ | $100, 1000$ |
| $B$ | $1000, 100$ | $500, 500$ |

| $PC_{800}$ | $A$ | $B$ |
|---|---|---|
| $A$ | $500, 500$ | $50, 800$ |
| $B$ | $800, 50$ | $100, 100$ |

Note, $PD_{800}$ is a monotonic transformation of $PD_{500}$ since each payoff is higher in $PD_{800}$ than in $PD_{500}$. We call both of these operations monotonic transformations of games. This yields the following null Hypothesis:

**Hypothesis 5** ***Monotonicity:*** *If game $G_i$ is a monotonic transformation of game $G_j$, then the amount of time allocated to game $G_i$ should be the same as the amount of time allocated to game $G_j$ when they are compared to each other or other game in the Comparison Set $\mathcal{G}$.*

<Table 11>

We can see from Table 11 we must reject this hypothesis for all relevant games. In Table 11 we present the mean amount of time allocated to the first game in each pair. This is the game whose payoffs are smallest so that the second game is a monotonic transformation of the first. To explain our result, consider the comparison of $PD_{500}$ and $PD_{800}$ presented above. We see that when these two games were compared subjects, on average, allocated 45.73% of their time to $PD_{500}$ (the game with the smaller payoffs) and hence 54.27% to game $PD_{800}$. Similarly for all other comparison the mean percentage of time allocated to the game with the smaller payoffs was significantly different (less) from the fraction allocated to the game with larger payoffs at less than 5% significance level.

The results above demonstrate that when one game is a monotonic transformation of another and those two games are compared directly, more time is allocated to the game with the higher payoffs. For our Monotonicity Hypothesis, however, we can actually dig deeper since all of the games that are relevant for comparison are in the Comparison Set $\mathcal{G}$. This means that in addition to the binary comparison made above we can actually see how much time was allocated to each of these games when they were compared against all of the other games in the set $\mathcal{G}$. Such comparisons are interesting since if a game $G_i$ is a monotonic transformation of the game $G_j$ and therefore, we expect it to be allocated more time when a binary comparison is made, this does not imply that it will be allocated more time when these games are compared to other games that they are commonly matched with, especially since such games are not required to be in the same class as our original game. This comparison is presented in Figure 10.

<Figure 10>

In this figure we take every pair of games in Table 11 and look to see how different the amounts of time allocated to them were when they were compared to the same set of games in the set $\mathcal{G}$. Figure 10 presents the mean difference in the fraction of time allocated to Game 1 (the monotonic transform) compared to Game 2 whose payoffs are smaller. When more time is allocated to the game with the smaller payoffs, the bar in the figure is negative.

As we can see in general when any pair of these games are compared to other games in the set $\mathcal{G}$, the game with the higher payoff typically receives more attention in the sense that it is allocated more time. There are a number of interesting exceptions, however. For example, when $PD_{800}$ and $PD_{500}$ are individually compared to $CS_{500}$ and $CS_{800}$, we see that more time is allocated to $PD_{500}$ than $PD_{800}$ in both comparisons indicating that when compared to these constant-sum games subjects allocated more time to the $PD$ game with the smaller payoffs. One possible explanation may be that as the payoffs in a $PD$ game get larger, even if one gets the sucker payoff, the consequences are not that bad. Hence, one may not need to think that long when the other alternative is a constant sum game since even if you get double crossed you still may end up doing OK. For example, in $PD_{800}$ the smallest payoff is 100 while in $PD_{500}$ it is 50. In $CS_{500}$ and $CS_{800}$ the lowest payoffs are 0. Since 100 is significantly larger than 0 (and larger than 50) it may be that subjects don't think spending much time on $PD_{800}$ is worth while since they can guarantee themselves 100. Further, in $PD_{800}$ 6 of the 8 payoffs are greater than or equal to 500 while in $PD_{500}$ only two are.

There are other similar outcomes where games which are monotonic transformations of other games are allocated less time when compared to game outside of their class. One would have to go case by case to offer an explanation for each.

Let's consider another payoff attribute - zero payoffs. Unlike monotonic transformation reducing positive payoffs to zero may not have clear-cut consequences for behaviour. Zero payoffs, perhaps like negative payoffs, may be perceived many different ways. First they may be scary numbers. As such, zero payoffs are things to be avoided but avoiding them may require time and attention. On the other hand, especially in matrix games, having zero payoffs may simplify the game by making the game matrix look less cluttered and therefore, highlight the true strategic considerations involved. If this is true, then we would expect less time to be allocated to games with zero entries. These considerations lead us to the following null hypothesis.

**Hypothesis 6** ***Zeros:*** *If game $G_j$ is derived from game $G_i$ by changing some positive payments in game $G_i$ to zeros and keeping the game class unchanged, then a subject should allocate more time to game $G_i$ than game $G_j$ when they are compared to each other.*

To investigate the Zero Hypothesis, we compare pairs of games where one of the games is identical to the other except for the fact that some payoffs have been decreased from positive numbers to zeros. More precisely, we compare $PD_{800}$ and $PD_{\substack{800\\0}}$, $BS_{\substack{800\\100}}$ and $BS_{\substack{800\\0}}$, $PC_{\substack{800\\500}1}$ and $PC_{\substack{800\\500}}$, $PC_{\substack{800\\100}}$ and $PC_{800}$, $PC_{\substack{500\\100}}$ and $PC_{500}$. We make these binary comparison since not all of these games are in the Comparison Set $\mathcal{G}$ where all games are compared to all others.

To illustrate the type of comparison we are making, consider $PC_{\substack{800\\100}}$ and $PC_{800}$:

| $PC_{\substack{800\\100}}$ | $A$ | $B$ |
|---|---|---|
| $A$ | $800, 800$ | $100, 100$ |
| $B$ | $100, 100$ | $800, 800$ |

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

As it is clear, $PC_{800}$ is generated by taking the off-diagonal payoffs in $PC_{\substack{800\\100}}$ and reducing them from 100 to 0. One might think that there is less need to think about $PC_{\substack{800\\100}}$ than $PC_{800}$ since no matter what happens in $PC_{\substack{800\\100}}$ a player will never receive a payoff less than 100 and in that sense the game is safer. In $PC_{800}$, however, the strategic aspects of the game are highlighted since it is now clear that the only task of the players is to coordinate either on the top left or the bottom right hand equilibria. In a direct comparison between these two games, subjects allocated a significantly larger percentage of time to $PC_{\substack{800\\100}}$ than $PC_{800}$ (57.22% versus 42.4%, $p < 0.01$). In other words, subjects allocated less time to games with zero payoffs.

More generally, Table 10 presents the percentage of time allocated to all games relevant to the Zero Hypothesis. In the table, for each pair of games the second game listed is derived from the first by making some positive payoffs zero. Hence the first game listed has fewer zeros than the second but is otherwise identical. We call the first game the Original Game and the second the Zero Game. As we can see from Table 10, there is a systematic effect that having zeros in a game matrix decreases the amount of time allocated to thinking about that game. In all of our relevant comparisons, more time is allocated to the original game and in all cases these differences are significant at less than the 1% level. This result was found for every class of game we examined. Hence, it would appear that introducing zeros into a game leads subjects to attend to those games less.

<Table 10>

One additional hypothesis concerns the impact of equity considerations on attention. As mentioned above, 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 the decisions that people make (see Fehr and Schmidt (2000), Bolton and Ockenfels (2000)). If this is true we might expect that when subjects are faced with two games which are identical except that one has equilibrium payoffs that are symmetric while the other has equilibrium payoffs that are asymmetric, the time allocated to these games should be different. If the attention allocated to games is correlated to the decision times allocated to equity-infused choices, then we might expect that subjects will pay more attention to those games whose equilibria are asymmetric. This yields the following hypothesis:

**Hypothesis 7** ***Equity:*** *If two games, $G_i$ and $G_j$ are identical and have identical equilibria except that the equilibrium payoffs in game $G_i$ are unequal while those in $G_j$ are equal, then a subject will allocate more time to game $G_i$ with unequal payoffs when these games are compared to each other.*

The game pairs of relevance are $PC_{500}$ versus $BoS_{500}$ and $PC_{800}$ versus $BoS_{800}$. In the first pair we have

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

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

while in the second we have

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

| $BoS_{800}$ | $A$ | $B$ |
|---|---|---|
| $A$ | $800, 500$ | $0, 0$ |
| $B$ | $0, 0$ | $500, 800$ |

As you can see, the $BoS$ games are "transformations" of the $PC$ games and hence involve both coordination and equity concerns while the $PC$ games only have coordination issues. We might therefore expect more time to be allocated to the $BoS$ games. This turns out not to be the case. To illustrate this consider Table 12.

<Table 12>

In this table we have the mean amount of time allocated to the first game listed in any row when compared to the second. As we see, despite the fact that both $BoS$ games have asymmetric equilibrium payoffs compared to their paired $PC$ games, there is no significant difference in the amount of time allocated to the first game.

### 5.2.4 Regressions

In this section we present a regression analysis that tries to summarize our results above. In this analysis we run a random effects regression where the left hand variable is the amount of time allocated to a particular game (Game 1) in a two-game comparison. In choosing our right hand variables we wanted to choose variables that would represent both the payoff attributes as well as the strategic attributes of the games. To do this we included variables such as the type of game being played in Game 1 (game class variables: $PD, CS, BS, PC$, $Chance$[13]), the maximum and minimum payoffs in both Game 1 and Game 2, the size of the matrix (only the size of second matrix was different), and two dummy variable indicating whether the payoffs in any cell of Game 1 or Game 2, respectively, are unequal. We also included some interactions of above mentioned variables and subjects' personal information: their gender, whether they've taken a game theory course or not, and their self-reported GPA. We ran this regression as a pooled regression pooling over all subjects in all sessions as well as over all game pairs and we clustered the standard errors by subjects. Our regression results are presented in Table 14.

<Table 14>

The regression results are supportive of the conclusions we reached above. For example, the coefficients before the Maximum in Game 1 and Maximum in Game 2 variables are of different sign with Maximum in Game 1 being positive and Maximum in Game 2 being negative. This obviously indicates that if the maximum payoff in Game 1 increases then more time is allocated to Game 1 while if the maximum payoff in Game 2 increases, then less time is allocated to Game 1. This is a rough correlate to our Monotonicity Hypothesis and supports our earlier results. The coefficient for Minimum in Game 1 and Minimum in Game 1 are positive and negative respectively indicating that as the minimum payoffs increase in Game 1 the amount of time allocated to that game decreases while the opposite is true for Game 2. This supports our Zero Hypothesis.

Strategic considerations also enter into the determination of attention or consideration time. In the regression the $PC$ game is the default. Hence, the positive coefficient in front of the $PD$ dummy indicates that if Game 1 is a $PD$ game, then we can expect the time allocated to it to increase over what it would be if Game 1 were the default $PC$ games.

Personal variables like GPA, gender and familiarity with game theory when interacted with other terms are insignificant. In addition, while the between subjects order of the

[13] Chance game always appeared as a second game, thus, Chance = 1, means the second game is a Chance game. While $PD$, $CS$, $BoS$, $PC = 1$, means that the first game is of that class.

comparisons was randomized, the subject order may still matter. However, we don't find an order effect in our experiment.

Finally note that our regression results comment on our last Conjecture concerning complexity stated as the following hypothesis:

**Hypothesis 8** *If game $G_i$ is derived from game $G_j$ by adding a strictly dominated strategy to both the row and column player's strategy set, then a subject will allocate more time to game $G_i$ than game $G_j$.*

Support for this hypothesis comes in two ways. First note that in the regression when the number of cells in Game 2 increases, less time is allocated to Game 1. This clearly suggests that larger game matrices strike our subjects as more complicated (even when the added strategies are dominated) and hence deserving of more time. Further, as we can see in Table 13 in a binary comparison between $PD_{800}$ and either $LLPD_1$ or $LLPD_2$, a higher fraction of time, 64.5 and 59.4, respectively, is allocated to the more complex game. These differences are significant at the $p < 0.01$ level.

<Table 13>

Finally, it is important to point out we have only touched on this complicated issue of complexity and certainly do not consider these results as definitive. The role of complexity in the determination of attention is a complicated matter that should be dealt with in a systematic manner.

## 5.3 Consistency

In this section of our paper we focus on whether the time-allocation decisions of our subjects were consistent. While consistency of behavior has been studied with respect to choice, it has rarely been looked 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 very clever interface that allows them to test the GARP and WARP axioms. In our setting we would be interested in discovering whether the subject choices, made both within and across classes of games, are consistent. To do this we will specify a set of consistency conditions that we think are reasonable and investigate whether our data supports them.

Our attention allocation function $\alpha(i, j)$ can be used to define a binary relation on $\mathcal{G}$ 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 can specify four consistency conditions.

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

Clearly, transitivity is the workhorse of rational choice and hence is a natural starting point here. All that this condition says is that if a subject allocates more time to $G_i$ in the $G_i - G_j$ comparison, and more time to $G_j$ in the $G_j - G_m$ comparison, then he should allocate more time to $G_i$ in the $G_i - G_m$ comparison.

Our model predicts transitivity to be satisfied if the weighting function is assumed to be some constant $g_k = c$.[14] However, for general increasing weighting function and attribute contemplation time functions, the transitivity condition will depend on game-class variable constants $t(\theta(G_i))$ associated with each game classes.

**Condition 2** ***Baseline Independence (BI):*** *If $\alpha(i,x) \geq \alpha(j,x)$, then $\alpha(i,y) \geq \alpha(j,y)$, for any game $G_x$ and $G_y \in \mathcal{G}$.*

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

A variant of our Baseline Independence condition (which is already included in it)[15] is what we call Baseline Consistency which can be stated as follows:

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

This condition says that if game $G_i$ is indirectly revealed more worthy of time than game $G_j$ when each is compared to the same baseline game $G_x$, then it should be revealed more worthy of time when they are compared directly to each other. Since *BI* assumes the condition holds for all $G_z \in \mathcal{G}$, it also holds when $G_y = G_j$, so in this sense condition *BC* is already nested in condition *BI*. However, since it is a more direct and transparent condition we are specifying it separately.

Finally, in some of our comparisons, which we have not talked about yet, subjects are asked to allocate time between three games instead of two. Such three way comparisons allows us to specify our final consistency condition. For this condition we need

[14] For constant $g_k$, $\alpha(i,j) \geq \alpha(j,i)$ and $\alpha(j,m) \geq \alpha(m,j)$ yields $T^{ij} \geq T^{ji}$ and $T^{jm} \geq T^{mj}$. That is $\sum_{k=1}^{K} g_k t_k(a_k^i) \geq \sum_{k=1}^{K} g_k t_k(a_k^j)$ and $\sum_{k=1}^{K} g_k t_k(a_k^j) \geq \sum_{k=1}^{K} g_k t_k(a_k^m)$. Then, $\sum_{k=1}^{K} g_k t_k(a_k^i) \geq \sum_{k=1}^{K} g_k t_k(a_k^m)$, thus $\alpha(i,m) \geq \alpha(m,i)$.

[15] In Condition 2 take $G_x = G_j$, 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.

the additional notation indicating 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* $\alpha(i,j,k) \geq \alpha(j,i,k)$.

This condition states that if game $G_i$ is revealed more worthy of time than game $G_j$ when they are compared directly in a two-game comparison, then 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 more worthy of time than game $G_j$ in the three-game comparison.

Let us look at these consistency conditions one at a time.

### 5.3.1 Transitivity[16]

Our subjects prove themselves to be quite consistent in terms of transitivity. More precisely, transitivity is defined for every connected triple of games that we have data on. 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 will 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 11a were we look at all of our subjects and portray the fraction of subjects making intransitive choices in the 28 triangles they faced in Sessions 1 and 2 and the 20 triangles they faced in Sessions 3 and 4. As we can see, over all sessions more than 79% of subjects exhibited either 0 or 1 intransitivity while 91% exhibited strictly less than 3. A similar pattern exists when we look at the individual sessions. For example, in Sessions 1 and 2, 92% present of subjects exhibited strictly less that 3 intransitivities with no subject exhibiting more than 4. For Sessions 3 and 4 the corresponding percentage is 91%. In short, our *more-worthy-than* relationship has proven itself to be largely transitive.

### 5.3.2 Baseline Independence (BI)

Transitivity is the easiest of our conditions to satisfy since all comparisons are direct comparisons where the subject chooses between say games $G_i$ and $G_j$ directly then $G_j$ and $G_k$ directly and then $G_k$ and $G_i$. For our other conditions the comparisons are

[16] In Appendix A, Figure 14 presents consistency results of our experimental data versus randomly generated data.

indirect and hence 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 $G_x$, then it should be more time worthy when compared to any other game $G_y$ in the set of all games $\mathcal{G}$. This condition is more likely to meet with inconsistencies since in the comparisons above, game $G_y$ may be in a different game class than game $G_x$ so what is more time worthy when $G_i$ and $G_j$ are compared to game $G_x$ may not be considered as relevant when they are compared to game $G_y$.

This conjecture turns out to be true. In Figure 11b we present a histogram indicating 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 number of such violations is 46 and 33 respectively. As we can see, there were an extremely large number of violations of our Baseline Independence Condition. For example, the mean and median number of violations per subjects were 10.7 and 10.5. Only 6 out of 92 subjects (6.5%) had 1 or fewer violations compared to over 79% for our Intransitivity condition.

### 5.3.3 Baseline Consistency (BC)

We might expect that Baseline Consistency would be easier to satisfy than Baseline Independence since under our consistency condition if game $G_i$ is revealed to be more worthy of time than $G_j$ when both of them are compared to game $G_x$, then $G_i$ should be revealed to be more worthy of time when $G_i$ and $G_j$ are compared directly. *BI* requires that $G_i$ be revealed more worthy of time for all possible other comparisons that could be made. This is a far more stringent condition since 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 all with varying payoff configurations while under *BC* we only compare it directly to game $G_j$. Note that even Baseline Consistency is more difficult to satisfy than Transitivity as *BC* implies Transitivity but the converse is not true.[17]

As we can see in Figure 11c, our results are consistent with this intuition. For example, only 20 subjects (21%) exhibited 1 or fewer violations of our Baseline Consistency condition as compared to 79% for Transitivity and 6.25% for Independence. 36 subjects (38%) exhibited 5 or more violations of Consistency compared to 1 (1%) who violated Transitivity that many times and 43 (89%) who had that many violations of Independence.

[17] 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 finally, $G_i, G_j$ gets 25-75%. We have a set $\{(k,i),(k,j),(j,i)\}$ which satisfies transitivity, however, it violates consistency as game $G_i$ appears more time valuable than $G_j$ when compared to $G_k$, nevertheless, when compared directly to game $G_i$ is allocated less time than game $G_j$.

### 5.3.4 Independence of Irrelevant Alternatives (IIA)

Our final consistency measurement concerns our *IIA* condition. Given our design there were only 24 subjects in Session 1 that were presented with the type of three-game comparisons that will allow us to test our *IIA* condition. For each subject there were 13 relevant comparisons or situations where we could detect an *IIA* violation. As Figure 11d 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 was 3.9 and 4 respectively. The modal number of violations was 5 with 3 out of 24 subjects violating *IIA* in 9 out of 13 occasions. 3 subjects had no 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. As we suggested, it is difficult for our subjects to maintain consistency when the comparisons they face span different types of games with varying payoffs. While transitivity is likely to be violated when goods are multidimensional we found that to the contrary transitivity was the consistence condition that fared well.

<Figure 11>

## 5.4 Preference Treatments

When a subject decides to pay more attention to some game rather than other, what does that imply about his preferences over these games? Are preferences and attention correlated and if so in what direction?

All of these questions will be answered in this section of our paper. To do this we will use the data generated by our Preference Treatment and compare it to the data generated by our Time-Allocation Treatment. We will proceed by asking how the time allocated to a game is related to the preference for playing that game. 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 when compared to another with the fraction of subjects stating 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 we can compare this variable to one that takes a value of 1 when a subject states he prefers game $G_i$ over game $G_j$ and zero otherwise in our Preference Treatment. We will exploit this feature repeatedly.

### 5.4.1 Preferences and Attention

In this subsection 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 may actually hate baseball and is only obsessing about it because it is a source of great anxiety as he may fear humiliation in front of his friends.

To get a look into this relationship we took each of the 11 games in the Comparison set $\mathcal{G}$ minus the Chance game and looked at both the time that was allocated to this game when compared to the other 9 games and also how often this game was preferred to the game it was paired with. For each game we then split the game comparisons into four subsets depending on the time allocated and the preference stated in each comparison.

To explain this more fully, take one of the 10 games in $\mathcal{G}$ minus Chance game, say $PD_{800}$. This game was compared to each of the other 9 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 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 was also preferred by more than 50% of them, those where the opposite was true, i.e., more than 50% of the subjects allocated less time to this game and it was preferred by less than 50% of subjects, and the two mixed cases where 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 can not make these calculations subject by subject but must aggregate across all subjects).

<Figure 12>

Figure 12 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 indicating 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 12 indicating that $PD$ games attract a lot of attention and also are preferred to their comparison games. More precisely, for the $PD_{800}$ game in 9 of the 9 comparisons it faced more than 50% of subjects allocated more time to it and also stated they preferred it to the game it was being compared to. This was also true for 8 of the 9 comparison made for the $PD_{500}$ game and 6 of the 9 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 12 while 7 such entries occur 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. For $PC_{800}$ we see that in 6 of 9 comparisons more than 50% of subjects listed 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 are interesting since these are games which appear to be unpopular and to which subjects choose to allocate less time to. For example, $BoS_{500}$ and $CS_{500}$ seem to be the least popular games in the sense 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 also allocated less time to it. 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 on the off diagonals. $PC_{800}$ is the same game but with payoffs of 800. As can be seen, possibly 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 not paid much attend to (in only 3 of 9 comparisons did more than 50% of subjects allocate more time to it). There are relatively few mixed cases, i.e., entries in the off-diagonal cells in Figure 12, where subjects either prefer a game but allocate less time to it or do not prefer the game but spend a lot of time thinking about it.

The punch line of Figure 12, 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 actually prefer (or do not prefer) playing that game rather than its comparison game.

Finally we ask how consistent were our subjects' preferences across games in the sense that if they stated a preference for game $G_i$ over game $G_j$ and to game $G_j$ over game $G_k$, did they also state 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 13 suggests, our subjects were far more consistent in their time allocations than they were with respect to their preferences.

<Figure 13>

For example, the fraction of subjects violating transitivity less than 2% (4%) of the time is far greater in the Attention Treatment than in the Preference Treatment. More precisely, while 47.3% (66.7%) of subjects in the Attention Treatment violated transitivity less than 2% (4%), 6.5% (17.4%) violated transitivity that often in the Preference Treatment. The distribution of intransitivities in the Attention Treatment first-order stochastically dominates that of the Preference Treatment.

# 6 Conclusions

In this paper we examine the question of why do people behave in games the way they do. In answering this question we have extended the set of concerns players have when playing a game to include attentional issues which derive from the fact that people do not play games in isolation but rather 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 full inter-game or general equilibrium problem they face.

We have posited a two step decision process in games. First is an attentional stage which prescribes how much time players should allocate to any given game when they are faced with several games to play simultaneously. To help us structure our thinking about this stage, we adopted KS model of focus-weight attention. After this problem is solved then our subjects 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, subjects devote time to thinking about games as a function of their payoffs and their strategic properties in comparison to the other games they are simultaneously playing. As payoffs in a given game increase, *ceteris paribus*, subjects allocate more time to it. As the number of zeros in a game increase, subjects tend to want to think less about it. Finally, while payoffs impact attention the strategic aspects of the games being compared also matter in the sense that people tend, on average, to allocate more time to Prisoners' Dilemma games followed by Constant Sum games and the Battle of the Sexes game and, finally, Pure Coordination games.

In terms of behavior, our results strongly support the idea that how people play in any given game depends on the other game (or games) they are simultaneously dividing their attention among. This can help explain why some people can look very sophisticated in their behavior in some parts of their lives but rather naive in others since, given the demands on their time, they rationally choose to attend to some situations and not 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 that he or she is unknowing but rather, optimally responding to the constraints in their life. Put differently, our analysis might be useful in constructing a endogenous theory of level-k analysis where, unlike Alaoui and Penta (2015), subjects use a cost-benefit analysis within a given game to decide on how sophisticated they want to be in their play (what level of cognition or level-k they should employ given their beliefs about others) the amount of attention allocated across games define how sophisticated a player is in any given game.

Our results also 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 Prisoners' Dilemma games. One might conclude, therefore, that they do so because these games present them with the most intricate strategic situation and 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 instead, but this is not what they do. Subjects indicate a preferences for playing Prisoners' Dilemma games even as their payoffs vary and their equilibrium (and out of equilibrium) payoffs decreases.

While subjects behave in a transitive manner with respect to the time they allocate to games their behavior is less consistent when we examine other 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 is their stated preferences.

Finally, this paper should be taken as a first step in trying to introduce attention issues into game theory. This is, to our knowledge, the first paper to look at how behavior in games are interrelated given an attention constraint.[18] There are clearly more things to be done in this regard.

[18] Kloosterman and Schotter (2015) also look at a problem where games are inter related but their set up is dynamic where games are played sequentially instead of simultaneously.

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# Appendix

## A Figures

**Figure 6** – Sample Screen

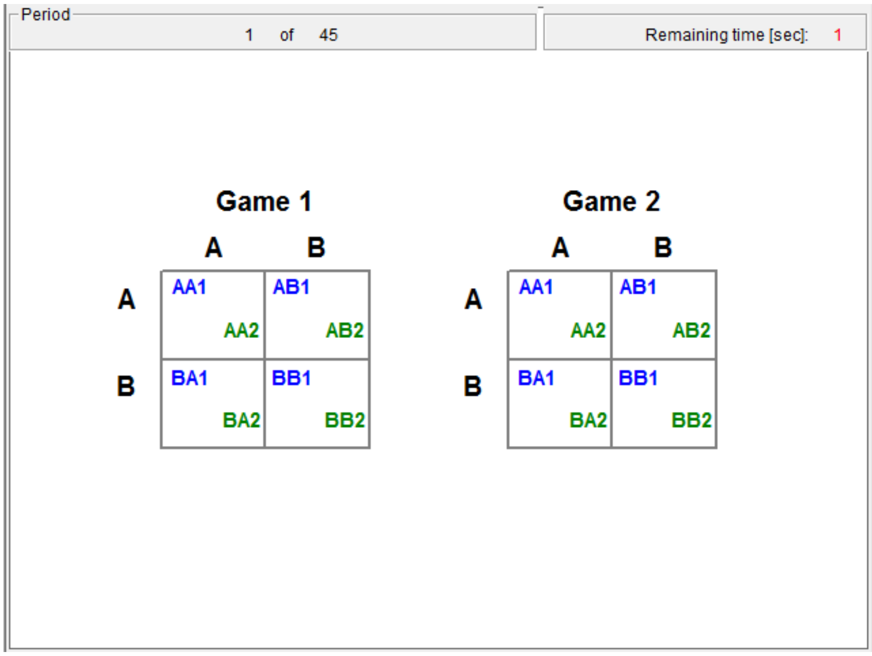



**Figure 7** – Sample Chance Screen

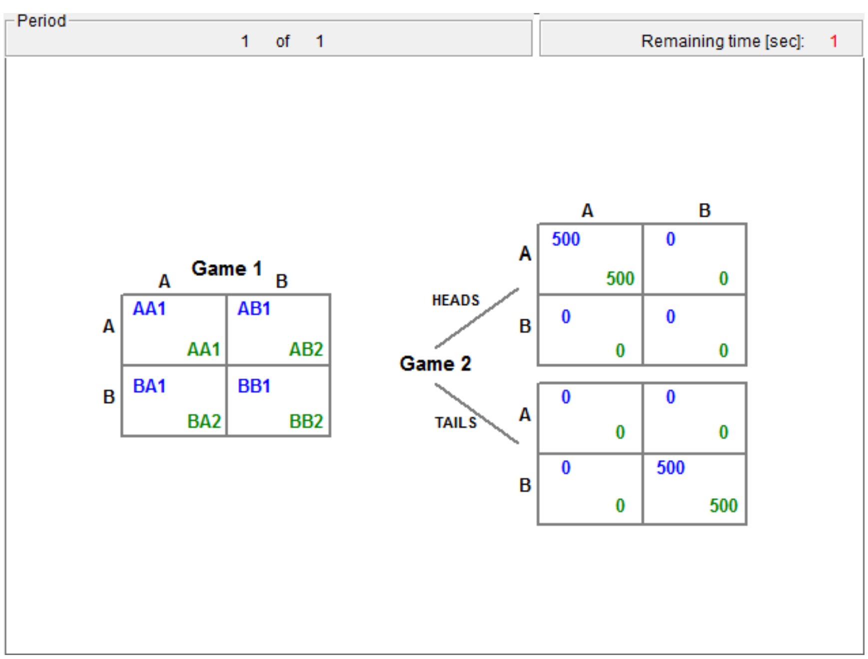


**Figure 8** – Average Time Allocation

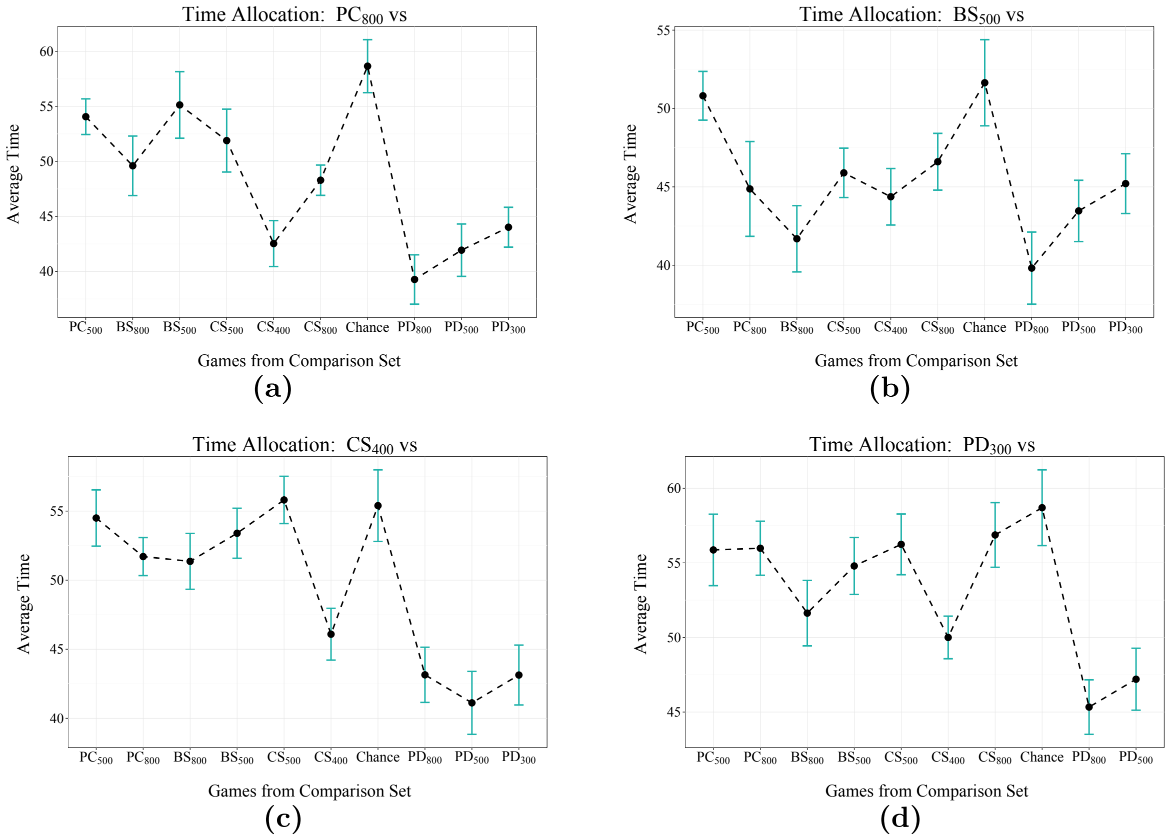



**Figure 9** – Time Taken and Strategy Relation

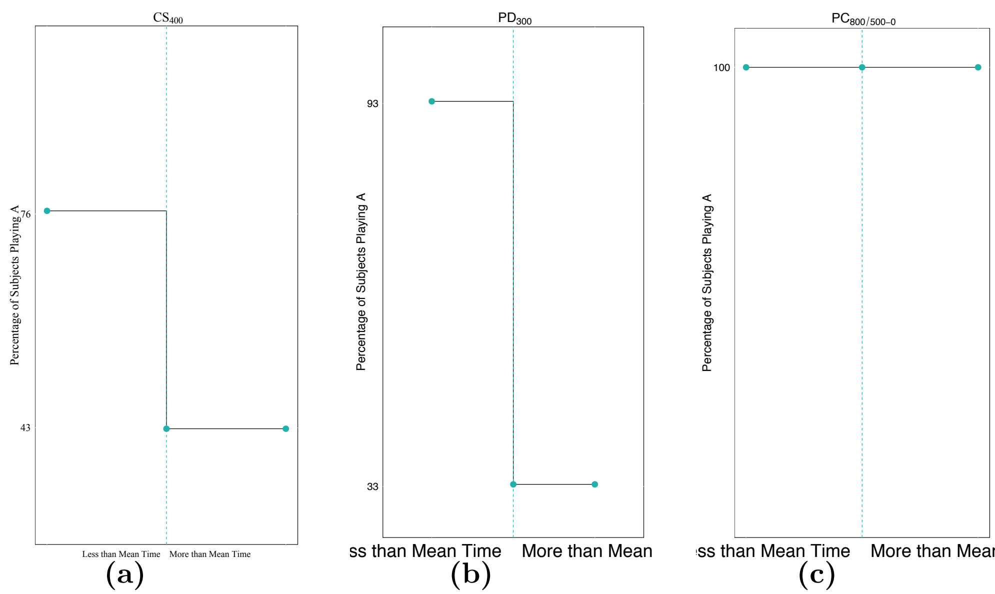
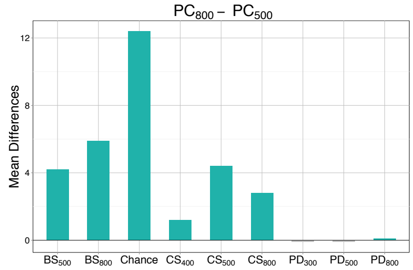
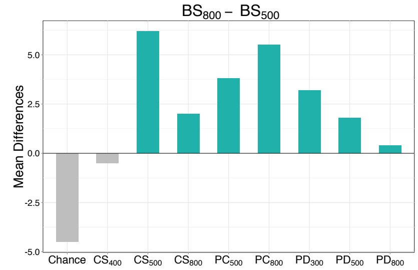


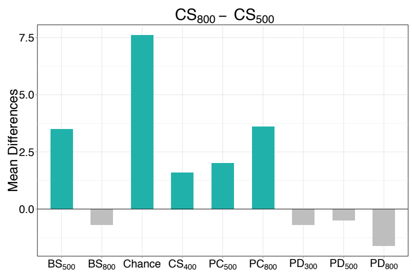
**Figure 10** – Mean Differences



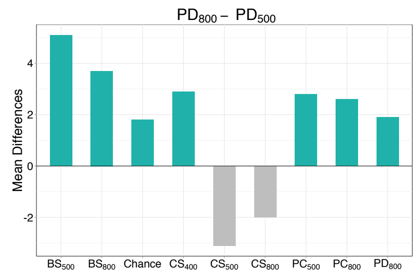

**(a)** Pure Coordination




**(b)** Battle of the Sexes

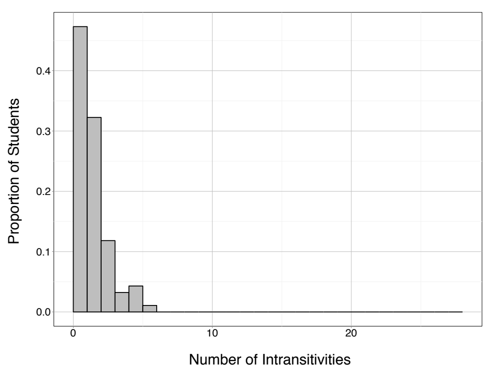



**(c)** Constant Sum

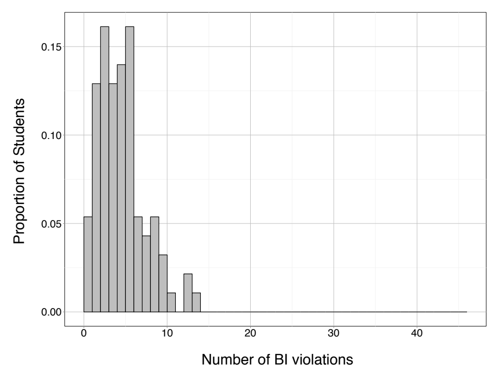



**(d)** Prisoners' Dilemma

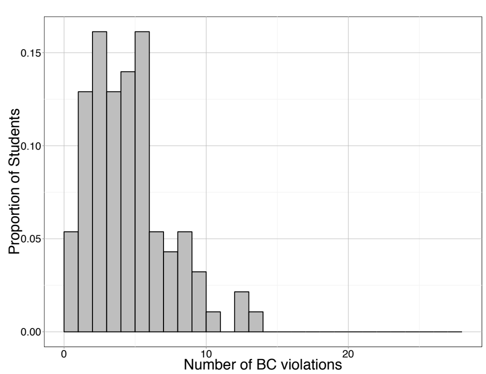
**Figure 11** – Consistency Histograms



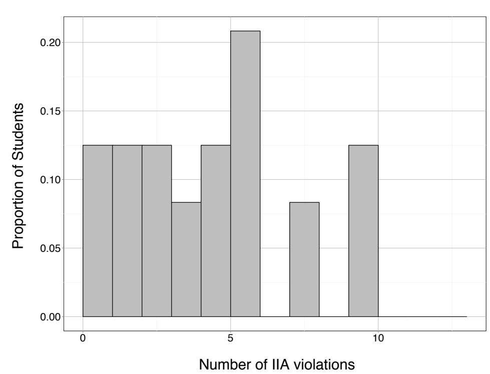

**(a)** Transitivity




**(b)** Baseline Independence




**(c)** Baseline Consistency




**(d)** IIA

**Figure 12** – Time Allocation and Preferences Combined

| *Mean Treatment* \ *Preference Treatment* | **More than** 50 | **Less than** 50 |
|---|---|---|
| **More than** 50 | $PC_{800}$, $PC_{800}$, $PC_{800}$;<br>$BoS_{800}$, $BoS_{800}$, $BoS_{800}$;<br>$CS_{800}$, $CS_{800}$, $CS_{800}$;<br>$CS_{400}$, $CS_{400}$, $CS_{400}$, $CS_{400}$, $CS_{400}$;<br>$PD_{800}$, $PD_{800}$, $PD_{800}$, $PD_{800}$, $PD_{800}$, $PD_{800}$, $PD_{800}$, $PD_{800}$, $PD_{800}$;<br>$PD_{500}$, $PD_{500}$, $PD_{500}$, $PD_{500}$, $PD_{500}$, $PD_{500}$, $PD_{500}$, $PD_{500}$;<br>$PD_{300}$, $PD_{300}$, $PD_{300}$, $PD_{300}$, $PD_{300}$, $PD_{300}$; | $BoS_{800}$;<br>$BoS_{500}$;<br>$CS_{500}$, $CS_{500}$;<br>$CS_{800}$, $CS_{800}$;<br>$CS_{400}$; |
| **Less than** 50 | $PC_{500}$, $PC_{500}$;<br>$PC_{800}$, $PC_{800}$, $PC_{800}$;<br>$BoS_{800}$;<br>$BoS_{500}$;<br>$CS_{800}$;<br>$PD_{300}$; | $PC_{500}$,$PC_{500}$,$PC_{500}$,$PC_{500}$,$PC_{500}$,$PC_{500}$, $PC_{500}$;<br>$PC_{800}$, $PC_{800}$, $PC_{800}$;<br>$BoS_{800}$,$BoS_{800}$,$BoS_{800}$,$BoS_{800}$;<br>$BoS_{500}$,$BoS_{500}$,$BoS_{500}$,$BoS_{500}$,$BoS_{500}$,$BoS_{500}$,$BoS_{500}$;<br>$CS_{500}$, $CS_{500}$, $CS_{500}$, $CS_{500}$, $CS_{500}$, $CS_{500}$, $CS_{500}$;<br>$CS_{800}$, $CS_{800}$, $CS_{800}$;<br>$CS_{400}$, $CS_{400}$, $CS_{400}$;<br>$PD_{500}$;<br>$PD_{300}$, $PD_{300}$; |

**Figure 13** – Transitivity: Time Allocation and Preference Treatment

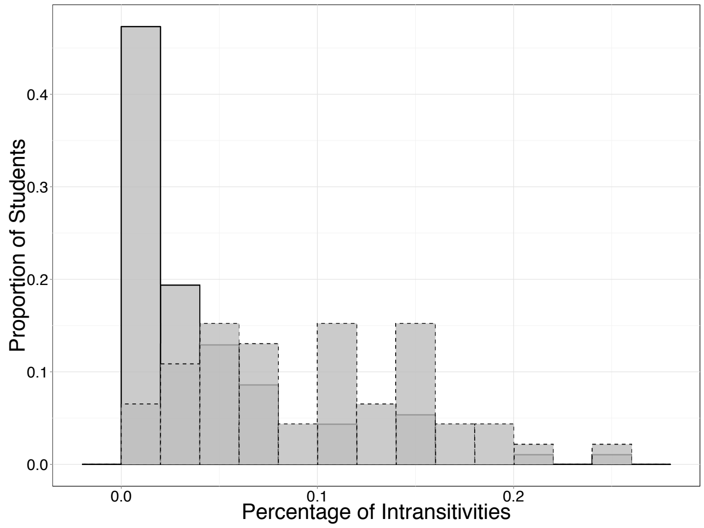



**Figure 14** – Experiment Histograms vs Random Choice

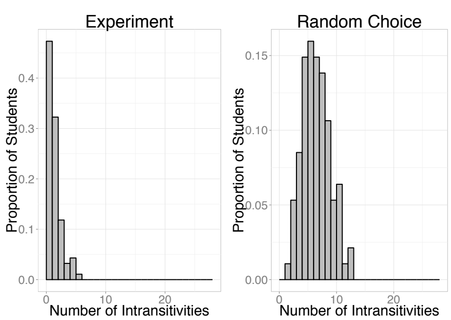



Figure a

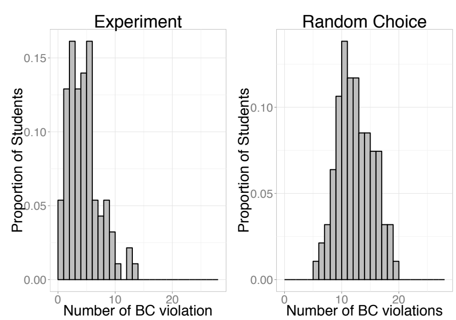



Figure b

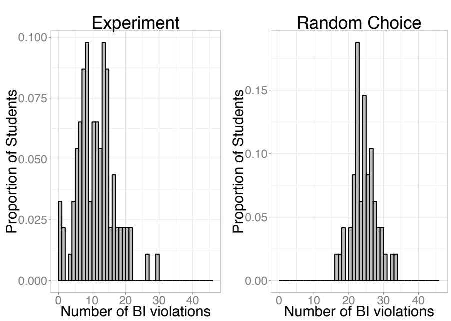



Figure c

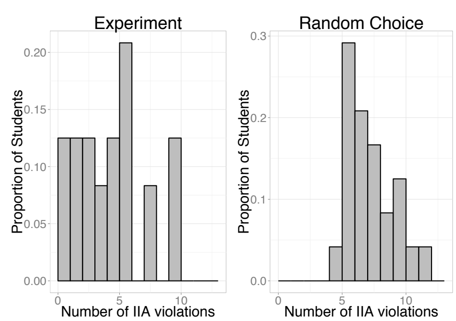



Figure d

# B Tables

**Table 5** – Mean Allocation Times (time allocated to the row game when compared to the column game)

| | $PC_{500}$ | $PC_{800}$ | $BoS_{800}$ | $BoS_{500}$ | $CS_{500}$ | $CS_{800}$ | $CS_{400}$ | $PD_{800}$ | $PD_{500}$ | $PD_{300}$ | Chance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $PC_{500}$ | | **45.9** | **45.4** | 49.2 | 47.5 | **45.5** | **41.3** | **39.2** | **42.0** | **44.1** | 46.3 |
| | | (1.62) | (1.48) | (1.55) | (1.70) | (1.96) | (1.99) | (2.06) | (2.06) | (2.24) | (2.11) |
| $PC_{800}$ | **54.1** | | 49.6 | 55.1 | 51.9 | **48.3** | **42.5** | **39.3** | **41.9** | **44.0** | **58.7** |
| | (1.62) | | (2.79) | (3.09) | (2.92) | (1.38) | (2.16) | (2.24) | (2.46) | (1.81) | (2.46) |
| $BoS_{800}$ | **54.6** | 50.4 | | **58.3** | 52.1 | **48.6** | **43.9** | **40.2** | **45.3** | 48.4 | 47.1 |
| | (1.48) | (2.79) | | (2.18) | (1.95) | (2.05) | (2.53) | (2.47) | (1.97) | (2.24) | (2.40) |
| $BoS_{500}$ | 50.8 | 44.9 | **41.7** | | **45.9** | **46.6** | **44.4** | **39.8** | **43.5** | **45.2** | 51.6 |
| | (1.55) | (3.09) | (2.18) | | (1.58) | (1.81) | (1.84) | (2.40) | (2.02) | (1.91) | (2.84) |
| $CS_{500}$ | 52.5 | 48.1 | 47.9 | **54.1** | | **44.2** | **44.5** | 44.7 | **41.6** | **43.8** | 47.8 |
| | (1.70) | (2.92) | (1.95) | (1.58) | | (1.73) | (1.75) | (2.49) | (2.05) | (2.08) | (2.54) |
| $CS_{800}$ | **54.5** | 51.7 | 51.4 | **53.4** | **55.8** | | **46.1** | **43.1** | **41.1** | **43.1** | **55.4** |
| | (2.04) | (1.38) | (2.05) | (1.81) | (1.73) | | (1.92) | (2.00) | (2.41) | (2.21) | (2.74) |
| $CS_{400}$ | **58.7** | **57.5** | **56.1** | **55.6** | **55.5** | **53.9** | | **44.1** | 47.0 | 50.0 | 52.3 |
| | (1.99) | (2.16) | (2.53) | (1.84) | (1.75) | (1.92) | | (2.25) | (2.59) | (1.43) | (2.49) |
| $PD_{800}$ | **60.8** | **60.7** | **59.8** | **60.2** | 55.3 | **56.9** | **55.9** | | **54.3** | **54.7** | **59.3** |
| | (2.14) | (2.24) | (2.47) | (2.40) | (2.49) | (2.00) | (2.25) | | (1.75) | (1.83) | (2.41) |
| $PD_{500}$ | **58.0** | **58.1** | **54.7** | **56.5** | **58.4** | **58.9** | 53.0 | **45.7** | | 52.8 | **57.5** |
| | (2.06) | (2.46) | (1.97) | (2.02) | (2.05) | (2.41) | (2.59) | (1.75) | | (2.14) | (2.53) |
| $PD_{300}$ | **55.9** | **56.0** | 51.6 | **54.8** | **56.2** | **56.9** | 50.0 | **45.3** | 47.2 | | **58.7** |
| | (2.47) | (1.81) | (2.24) | (1.91) | (2.08) | (2.21) | (1.43) | (1.83) | (2.14) | | (2.59) |
| Chance | 53.7 | **41.3** | 52.9 | 48.4 | 52.2 | **44.6** | 47.7 | **40.7** | **42.5** | **41.3** | |
| | (2.11) | (2.46) | (2.40) | (2.84) | (2.54) | (2.74) | (2.49) | (2.41) | (2.53) | (2.59) | |

Standard errors are in parenthesis. 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.

**Table 6** – Percentage (share of students who allocated strictly greater than 50% to the row game)

| | $PC_{500}$ | $PC_{800}$ | $BoS_{800}$ | $BoS_{500}$ | $CS_{500}$ | $CS_{800}$ | $CS_{400}$ | $PD_{800}$ | $PD_{500}$ | $PD_{300}$ | Chance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $PC_{500}$ | | **0.12** | **0.22** | 0.41 | **0.17** | **0.29** | **0.07** | **0.12** | **0.15** | **0.26** | 0.43 |
| | | (0.08) | (0.08) | (0.10) | (0.09) | (0.09) | (0.05) | (0.06) | (0.06) | (0.08) | (0.08) |
| $PC_{800}$ | **0.88** | | 0.35 | 0.53 | 0.52 | 0.41 | **0.13** | **0.20** | **0.13** | **0.27** | **0.78** |
| | (0.08) | | (0.09) | (0.09) | (0.10) | (0.12) | (0.06) | (0.07) | (0.06) | (0.07) | (0.08) |
| $BoS_{800}$ | **0.78** | 0.65 | | **0.94** | 0.50 | 0.36 | **0.30** | **0.13** | **0.18** | 0.32 | 0.39 |
| | (0.08) | (0.09) | | (0.06) | (0.10) | (0.09) | (0.08) | (0.06) | (0.07) | (0.08) | (0.08) |
| $BoS_{500}$ | 0.59 | 0.47 | **0.06** | | **0.24** | **0.27** | **0.17** | **0.07** | **0.21** | **0.28** | 0.58 |
| | (0.10) | (0.09) | (0.06) | | (0.09) | (0.09) | (0.07) | (0.05) | (0.08) | (0.08) | (0.10) |
| $CS_{500}$ | **0.83** | 0.48 | 0.50 | **0.76** | | **0.14** | **0.21** | 0.33 | **0.15** | **0.23** | 0.35 |
| | (0.09) | (0.10) | (0.10) | (0.09) | | (0.07) | (0.08) | (0.08) | (0.06) | (0.08) | (0.09) |
| $CS_{800}$ | **0.71** | 0.59 | 0.64 | **0.73** | **0.86** | | **0.29** | **0.25** | **0.19** | **0.21** | 0.67 |
| | (0.085) | (0.12) | (0.09) | (0.09) | (0.07) | | (0.09) | (0.08) | (0.08) | (0.08) | (0.09) |
| $CS_{400}$ | **0.93** | **0.87** | **0.70** | **0.83** | **0.79** | **0.71** | | 0.31 | **0.27** | 0.55 | 0.49 |
| | (0.05) | (0.06) | (0.08) | (0.07) | (0.08) | (0.09) | | (0.09) | (0.09) | (0.11) | (0.08) |
| $PD_{800}$ | **0.88** | **0.80** | **0.87** | **0.93** | 0.67 | **0.75** | 0.69 | | 0.69 | **0.81** | **0.77** |
| | (0.06) | (0.07) | (0.06) | (0.047) | (0.08) | (0.08) | (0.09) | | (0.09) | (0.08) | (0.07) |
| $PD_{500}$ | **0.85** | **0.87** | **0.82** | **0.79** | **0.85** | **0.81** | **0.73** | 0.31 | | 0.71 | **0.84** |
| | (0.06) | (0.06) | (0.07) | (0.08) | (0.06) | (0.08) | (0.09) | (0.09) | | (0.10) | (0.07) |
| $PD_{300}$ | **0.74** | **0.73** | 0.68 | **0.72** | **0.77** | **0.79** | 0.45 | **0.19** | 0.29 | | **0.77** |
| | (0.08) | (0.07) | (0.08) | (0.08) | (0.08) | (0.08) | (0.11) | (0.08) | (0.10) | | (0.07) |
| Chance | 0.57 | **0.22** | 0.61 | 0.42 | 0.65 | 0.33 | 0.51 | **0.23** | **0.16** | **0.23** | |
| | (0.08) | (0.08) | (0.08) | (0.10) | (0.09) | (0.09) | (0.08) | (0.07) | (0.07) | (0.07) | |

Standard errors are in parenthesis. Every element of this table is tested to be equal to 0.50 and the bold elements represent rejection of the null hypothesis at the 5% significance level.

**Table 7** – Cross Game-Class Ordering

| Game Class | Mean Time | Percentage ($f$) | Pair | p-value (M) | p-value ($f$) |
|---|---|---|---|---|---|
| PC | 45.40 | 26.03 | PC, BoS | 0.07 | 0.06 |
| BS | 46.62 | 34.00 | PC, CS | 0.00 | 0.00 |
| CS | 49.54 | 51.24 | PC, PD | 0.00 | 0.00 |
| PD | 56.58 | 77.50 | BoS, CS | 0.00 | 0.00 |
| | | | BoS, PD | 0.00 | 0.00 |
| | | | CS, PD | 0.00 | 0.00 |

**Table 8** – Game Ordering (outside their own class)

| Game | Mean | Percentage($f$) | Comparison | p-value (M) | p-value ($f$) |
|---|---|---|---|---|---|
| $PC_{500}$ | 43.73 | 20.89 | $PC_{500}$ vs $PC_{800}$ | 0.04 | 0.05 |
| $PC_{800}$ | 46.10 | 30.93 | | | |
| $BoS_{800}$ | 47.82 | 38.86 | $BoS_{800}$ vs $BS_{500}$ | 0.01 | 0.12 |
| $BoS_{500}$ | 44.73 | 29.02 | | | |
| $CS_{500}$ | 47.07 | 42.33 | $CS_{500}$ vs $CS_{800}$ | 0.95 | 0.99 |
| $CS_{800}$ | 46.48 | 46.24 | $CS_{800}$ vs $CS_{400}$ | 0.00 | 0.63 |
| $CS_{400}$ | 52.70 | 64.92 | $CS_{500}$ vs $CS_{400}$ | 0.00 | 0.01 |
| $PD_{800}$ | 58.52 | 79.73 | $PD_{800}$ vs $PD_{500}$ | 0.21 | 0.85 |
| $PD_{500}$ | 56.89 | 81.90 | $PD_{500}$ vs $PD_{300}$ | 0.00 | 0.32 |
| $PD_{300}$ | 54.36 | 70.67 | $PD_{800}$ vs $PD_{300}$ | 0.00 | 0.41 |

**Table 9** – Within Game-Class Binary Comparisons

**Pure Coordination**

| | $PC_{800}$ | $PC^{800}_{500}$ | $PC^{800}_{500}1$ |
|---|---|---|---|
| $PC_{500}$ | **45.94** | **42.39** | **37.17** |
| | (1.62) | (2.57) | (2.48) |
| $PC_{800}$ | | 52.83 | **43.76** |
| | | (2.32) | (2.21) |
| $PC^{800}_{500}$ | | | **41.89** |
| | | | (2.14) |

**Battle Of The Sexes**

| | $BoS_{500}$ | $BoS^{800}_{0}$ | $BoS^{800}_{100}$ |
|---|---|---|---|
| $BoS_{800}$ | **58.31** | **60.74** | **54.67** |
| | (2.18) | (2.61) | (2.26) |
| $BoS_{500}$ | | **55.82** | 47.27 |
| | | (2.33) | (1.55) |
| $BoS^{800}_{0}$ | | | **42.78** |
| | | | (2.45) |

**Prisoner's Dilemma**

| | $PD_{500}$ | $PD_{300}$ | $PD^{800}_{0}$ |
|---|---|---|---|
| $PD_{800}$ | **54.27** | **54.67** | **54.50** |
| | (1.75) | (1.83) | (2.09) |
| $PD_{500}$ | | 52.80 | 47.59 |
| | | (2.15) | (2.35) |
| $PD_{300}$ | | | 48.67 |
| | | | (2.43) |

**Constant Sum**

| | $CS_{800}$ | $CS_{400}$ |
|---|---|---|
| $CS_{500}$ | **44.19** | **44.46** |
| | (1.73) | (1.75) |
| $CS_{800}$ | | **46.09** |
| | | (1.92) |

**Table 10** – Original vs Zero Game

| Comparisons | Mean | p-value |
|---|---|---|
| $PD_{800}$ vs $PD_{\substack{800\\0}}$ | 54.50 | 0.018 |
| $BoS_{800}$ vs $BoS_{\substack{800\\0}}$ | 60.74 | 0.000 |
| $BoS_{\substack{800\\100}}$ vs $BoS_{\substack{800\\0}}$ | 57.22 | 0.006 |
| $PC_{\substack{800\\500}1}$ vs $PC_{\substack{800\\500}}$ | 58.11 | 0.000 |
| $PC_{\substack{800\\100}}$ vs $PC_{800}$ | 57.22 | 0.009 |

**Table 11** – Monotonicity Within Game Classes

| Comparison | Mean | p-value |
|---|---|---|
| $PC_{500}$ vs $PC_{800}$ | 45.94 | 0.009 |
| $BoS_{500}$ vs $BoS_{800}$ | 44.19 | 0.002 |
| $CS_{500}$ vs $CS_{800}$ | 41.69 | 0.001 |
| $PD_{500}$ vs $PD_{800}$ | 45.73 | 0.043 |

**Table 12** – Equity Hypothesis

| Comparison | Mean | p-value |
|---|---|---|
| $PC_{500}$ vs $BoS_{500}$ | 49.19 | 0.215 |
| $PC_{800}$ vs $BoS_{800}$ | 49.60 | 0.336 |

**Table 13** – Complexity Hypothesis

| Comparisons | Mean | p-value |
|---|---|---|
| $PD_{800}$ vs $LLPD_1$ | 35.5 | 0.000 |
| $PD_{800}$ vs $LLPD_2$ | 40.6 | 0.001 |

**Table 14** – Time Allocation Regression[a,b]

| | *Time allocated to Game 1* | Coef. | s.e. |
|---|---|---|---|
| *Payoff* | Constant | 62.75*** | (2.188) |
| | Maximum in Game 1 | 0.01*** | (0.002) |
| | Maximum in Game 2 | −0.01*** | (0.002) |
| | Minimum in Game 1 | 0.02*** | (0.006) |
| | Minimum in Game 2 | −0.01** | (0.005) |
| | Equity 1 | −2.88 | (1.831) |
| | Equity 2 | −4.36*** | (0.827) |
| *Strategic* | PD | 7.87*** | (1.675) |
| | CS | 4.33*** | (1.501) |
| | BoS | 1.16 | (1.584) |
| | Chance | −2.00 | (1.326) |
| | Number of Cells | −2.16*** | (0.442) |
| *Subjects* | Gender | — | — |
| | Game Theory | — | — |
| | GPA | — | — |
| | N = 3760 | | |

[a] **Notes:** Standard Errors are clustered by subject.

[b] **Notes:** * $p < 0.10$, ** $p < 0.05$ , *** $p < 0.01$

# C List of Comparisons in Each Session

**Sessions 1 and 2 (Time Allocation)**

1. $BoS_{800}, PC_{500}$
2. $PC_{500}, PC_{800}$
3. $PC_{500}, BS_{500},$
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. $CS_{800}, BS_{800}$
11. $PD_{800}, PC_{800}$
12. $PD_{300}, PC_{800}$
13. $CS_{800}, PC_{800}$
14. $PD_{300}, BS_{500}$
15. $CS_{500}, BS_{500}$
16. $CS_{800}, BS_{500}$
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. $CS_{\substack{900\\100}}, PD_{500}$
32. $CS_{800}, PC_{\substack{500\\100}}$
33. $CS_{500}$, $LLPD_1$
34. $PD_{800}$, Ch1
35. Ch2, $LPD1$
36. Ch2, $LPD2$
37. Ch1, $LPD1$
38. $PD_{800}$, $LLPD_1$
39. $PD_{800}$, $LLPD_2$
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. $BoS_{500}, BS_{800}$
4. $PD_{800}, BS_{800}$
5. $PD_{800}, BS_{500}$
6. $PD_{500}, PC_{800}$
7. $PD_{500}, BS_{500}$
8. $PD_{300}, PC_{500}$
9. $PD_{300}, BS_{800}$
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. $CS_{400}, BS_{800}$
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. $BoS_{\substack{800\\0}}, BS_{800}$
27. $BoS_{\substack{800\\100}}, BS_{800}$
28. $BoS_{\substack{800\\0}}, BS_{500}$
29. $BoS_{500}, BS_{\substack{800\\100}}$
30. $BoS_{\substack{800\\0}}, BS_{\substack{800\\100}}$
31. $PC_{\substack{800\\500}}, PC_{800}$
32. $PC_{\substack{800\\500}}, PC_{500}$
33. $PC_{500}, PC_{\substack{800\\500}}1$
34. $PC_{800}, PC_{\substack{800\\500}}1$
35. $PC_{\substack{800\\500}}1, PC_{\substack{800\\500}}$
36. $PD_{800}, PD_{\substack{800\\0}}$
37. $PD_{\substack{800\\0}}, PD_{500}$
38. $PD_{300}, PD_{\substack{800\\0}}$
39. $PC_{\substack{800\\100}}, PC_{800}$
40. $PC_{\substack{800\\100}}, PC_{\substack{800\\500}}1$

**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. $PD_{300}, BS_{800}$
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. $PD_{500}, PD_{300}$

# D Time Allocation Treatment

**Instructions**

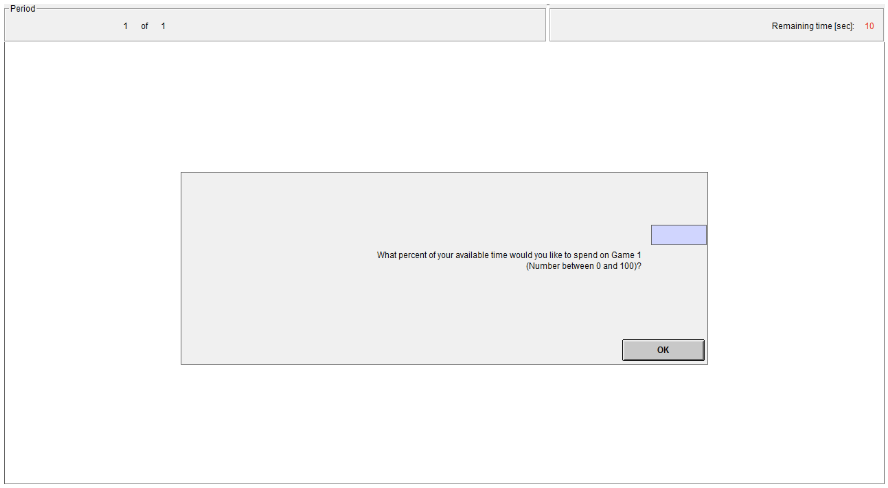
This is an experiment in decision making. Funds have been provided to run this experiment and if you make good decisions you may be able to earn a substantial payment. The experiment will be composed of two tasks which you will perform one after the other.

**Task 1: Time Allocation**

Your task in the experiment is quite simple. In almost all of the 45 rounds in the experiment you will be presented with a description of two decision problems or games, Games 1 and 2. (Actually, in the last 5 rounds you will be presented with some decision problems where there are three games). Each game will describe a situation where you and another person have to choose between two (or perhaps 3) choices which jointly will determine your payoff and the payoff of your opponent. In the beginning of any round the two (or three) problems will appear on your computer screen you will be given 10 (20) seconds to inspect them. Let's assume that two problems appear. When the 10 seconds are over you will not be asked to play these games by choosing one of the two choices for each of the games, but rather you will be told that at the end of the experiment, if this particular pair of games you are looking at is chosen to be played, you will have X minutes to decide on what choice to make in each of them. ***Your task now is to decide what fraction of these X minutes to allocate to thinking about Game 1 and what fraction to allocate to thinking about Game 2.*** To do this you will need to enter a number between 0 and 100 representing the percentage of the X minutes you would like to use in thinking about what choice to make in Game 1 (the remaining time will be used for Game 2).

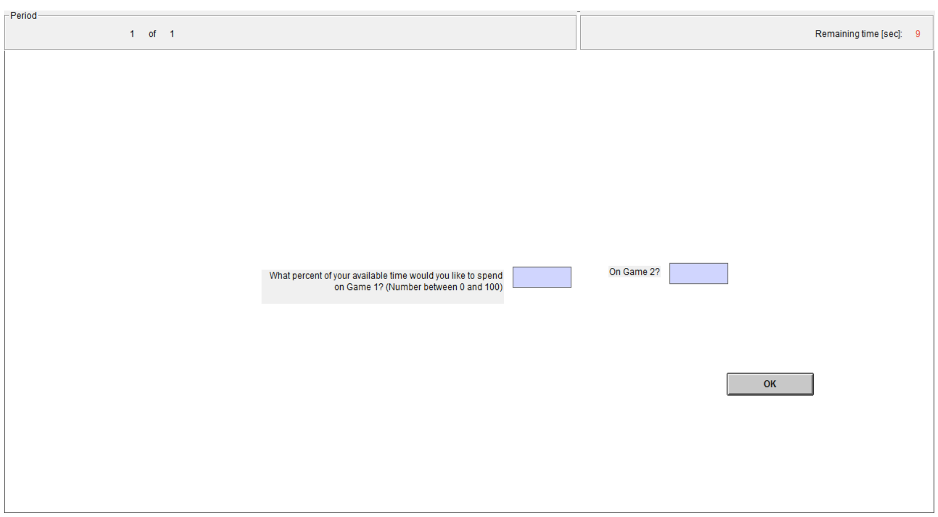
You will be given 10 seconds to enter this number and remember this will represent the fraction of the X minutes you want to use in thinking about Game 1. If there are two games and you allocate 70 for Game 1, then you will automatically have 30 for Game 2. (If there are ever three games on the screen, you will be asked to enter two numbers each between 0 and 100 whose sum is less than 100 but need not be 100 exactly and you will be given 20 seconds to think about this allocation and 20 seconds to enter your numbers). The first number will be the fraction of X you want to use in thinking about Game 1, the second will be the fraction of the X minutes you want to use in thinking about Game 2, and the remaining will be allocated automatically to thinking about Game 3. For example, if you allocate 30 to Game 1, 45 to Game 2, then you will have 25 left for Game 3, if there are three games. If you do not enter a number within the 10 (or 20) second limit, you will not be paid for that game if at the end this will be one of the games you are asked to play. In other words, ***be sure to enter your number or numbers within the time given to you.***

To enter your time allocation percentages, after the screen presenting the games has closed, you will be presented with a new screen where you can enter your percentage allocations. If you have been shown two games, the screen will appear as follows:




In this screen you will need to enter a number between 0 and 100 representing the percentage of your time X that you will want to devote to thinking about Game 1 when it is time for you to play that game if it is one of those chosen.

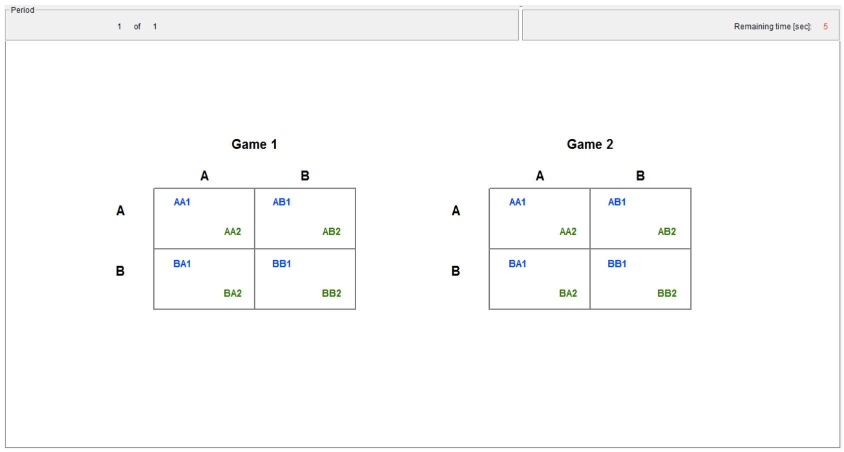
If you were shown three games your entry screen will appear as follows:




Here you will need to enter two numbers. The first is the percentage of your time X you will devote to thinking about Game 1 before making a choice; the second is the percentage of your time you want to allocate to thinking about Game 2. If the first two number you enter sum up to less than 100, the remaining percentage will be allocated to Game 3.

The amount of time you will have in total, X minutes, to think about the games you will be playing, will not be large but we are not telling you what X is because we want you to report the relative amounts of time you'd like to use of X to think about each problem.

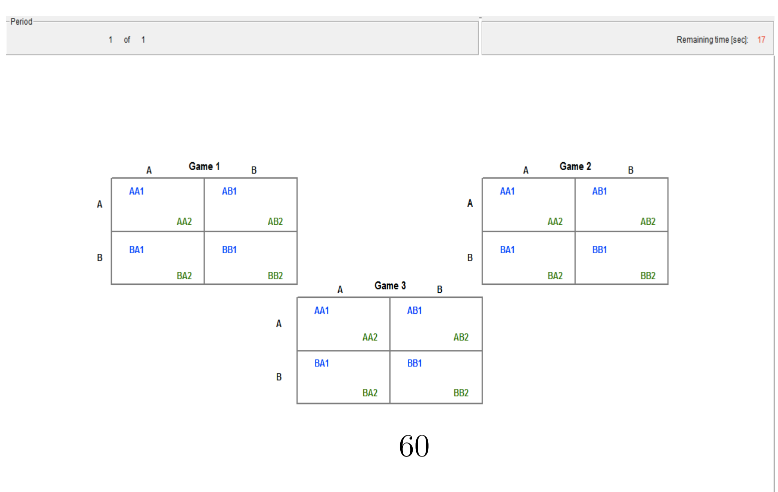
As we said above, in the first 40 rounds you will be asked to allocate time between two games represented as game matrices which will appear on your computer screen as follows:




In this screen we have two game matrices labeled Game 1 and Game 2. Each game has two choices for you and your opponent, A and B. ***You will be acting as the Row chooser in all games so we will describe your payoffs and actions as if you were the Row player.***

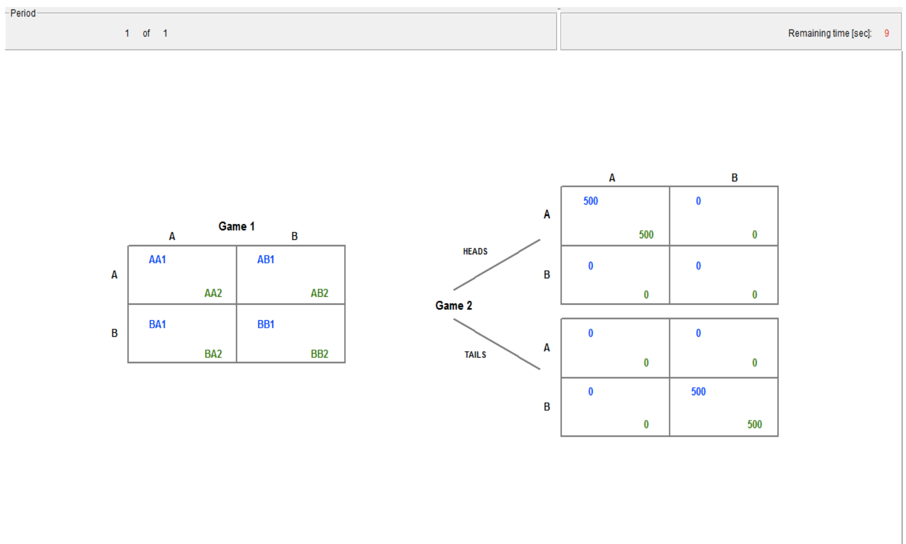
Take Game 1. In this game you have two choices A and B. The entries in the matrices describe your payoff and that of your opponent depending on the choice both of you make. For example, say that you and your opponent both make choice A. If this is the case the cell in the upper left hand corner of the matrix is relevant. In this cell you see letters AA1 in the upper left hand part of the cell in and AA2 in the bottom right corner. The first payoff in the upper left corner is your (the Row chooser's) payoff (AA1), while the payoff in the bottom right hand corner (AA2) is the payoff to the column chooser, your opponent. The same is true for all the other cells which are relevant when different choices are made: the upper left hand corner payoff is your payoff while the bottom right payoff is that of your opponent's payoff. Obviously in the experiment you will have numbers in each cell of the matrix but for descriptive purposes we have used letters.

If you will need to allocate your time between three games, your screen will appear as follows



After you are finished with making your time allocation for a given pair (or triple) of games, you will be given 5 seconds to rest before the next round begins. ***Please pay attention to your screen at all times since you will want to be sure that you see the screen when a new pair or triple of games appear.***

Finally, in very few situations you will have to think about a different type of game which we can call a "Lottery Game". When you have to choose between two games, one being a lottery game, your screen will appear as follows:



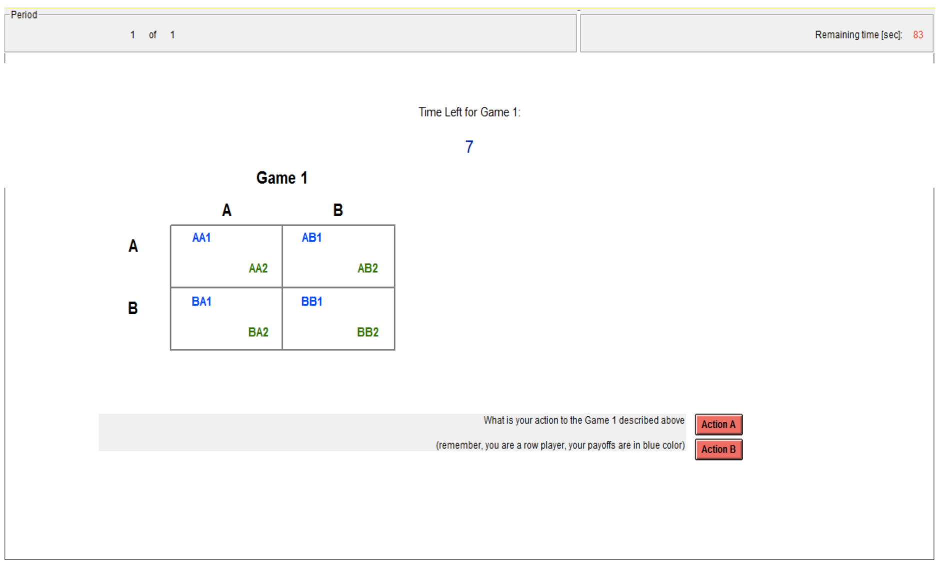

What this says is that you will need to decide between allocating your time between Game 1, which is a type of game you are familiar with, or Game 2 which is our Lottery Game. Game 2 is actually simple. It says that with probability ½ you will play the top game on the screen and with probability ½ you will be playing the bottom game. However, when you play the Lottery Game you must make a choice, A or B, before you know exactly which of those two games you will be playing, that is determined by chance after you make your choice.

***For any phase of the experiment, (i.e., when you are allocating time to games or actually choosing) you will see a timer in the upper right hand corner of the screen.*** This timer will count down how much time you have left for the task you are currently engaged in. For example, on the screen shown above it says you have 6 seconds left before the screen goes blank and you are asked to make a time allocation.

**Task 2: Game Playing**

When you are finished doing your time-allocation tasks, we will draw two pairs of games and ask you to play these games by making a choice in each game. In other words you will make choices in four games (or possibly more if we choose a triple game for you to play). What we mean by this is that before you entered the lab we randomly chose two of the 45 game-pairs or triples for you to play at the end of the experiment. You will play these games sequentially one at a time starting with Game 1 and you will be given an amount of time to think about your decision equal to the amount of time you allocated to it during the previous time allocation task. So if in any game pair we choose you decided to allocate a percentage y to thinking about Game 1, you will have $\text{Time}_{\text{Game1}} = y \cdot X$ minutes to make a choice for Game 1 before that time elapses and the remaining time, $\text{Time}_{\text{Game2}} = X - y \cdot X$, left when Game 2 is played. We will have a time count down displayed in the upper right hand corner of your screen so you will know when the end is approaching.

When you enter your choice the following screen will appear.




To enter your choice you simply click on the "Action A" or "Action B" button. ***Note the counter will appear at the top of the screen which will tell you how much time you have left to enter your choice.*** (If the game has 3 choices, you will have three action buttons, A, B and C.

You will then play Game 2 and have your remaining time to think about it before making a choice for that game. (If there are three games you will have the corresponding amount of time). If you fail to make a choice before the elapsed time, then your decision will not be recorded for that game and you will receive nothing for that part of the experiment. After you play the first pair of games we will present you with the second pair and have you play them in a similar fashion using the time allocated to them by you in the first phase of the experiment.

**Payoffs**

Your payoff in the experiment will be determined by a three-step process:

1. Before you did this experiment we had a group of other subjects play these games and make their choices with no time constraints on them. In other words, all they did in their experiment was to make choices for these games and could take as much time as they wanted to choose. Call these subjects “Previous Opponents”.
2. To determine your payoff in this experiment, we will take your choice in each pair of games selected and match it against the choice of one Previous Opponent playing the opposite role as you in the game. They will play as column choosers. Remember, the Previous Opponents did not have to allocate time to think about these games as you did but made their choice whenever they wanted to with no time constraint. We did this because we did not want you to think about how much time your opponent in a game might be allocating to a problem and make your allocation choice dependent on that. Your opponent had all the time he or she wanted to make his or her choice.
3. Third, after you have all made choices for both pairs of games, we will split you randomly into two groups of equal numbers called Group 1 and Group 2 and match each subject in Group 1 with a partner in Group 2. We will also choose one of the games you have just played to be the one that will be relevant for your payoffs. Subjects in Group 1 will receive the payoff as determined by their choice as Row chooser and that of their Previous Opponent’s” choice as column chooser. In other words, Group 1 subjects will receive the payoff they determined by playing against a “Previous Opponent”. A subject’s partner in Group 2, however, will receive the payoff of the Previous Opponent. For example, say that subject j in Group 1 chose choice A when playing Game 1 and his Previous Opponent chose choice B. Say that the payoff was Z for subject j and Y for the Previous Opponent. Then, subject j would receive a payoff of Z while subject j’s partner in Group 2 will receive the payoff Y. What this means is if you are in Group 1, although you are playing against an opponent that is not in this experiment, the choices you make will affect the payoff of subjects in your experiment so it is as if you are playing against a subject in this room. Since you do not know which group you will be in, Group 1 or Group 2, ***it is important when playing the game that you make that choice which you think is best given the game’s description since that may be the payoff you receive.***

   Finally, the payoff in the games you will be playing are denominated in units called Experimental Currency Units (ECU’s). For purposes of payment in each ECU will be converted into UD dollars at the rate of 1 ECU = 0.05 $US.

# E Preference Treatment

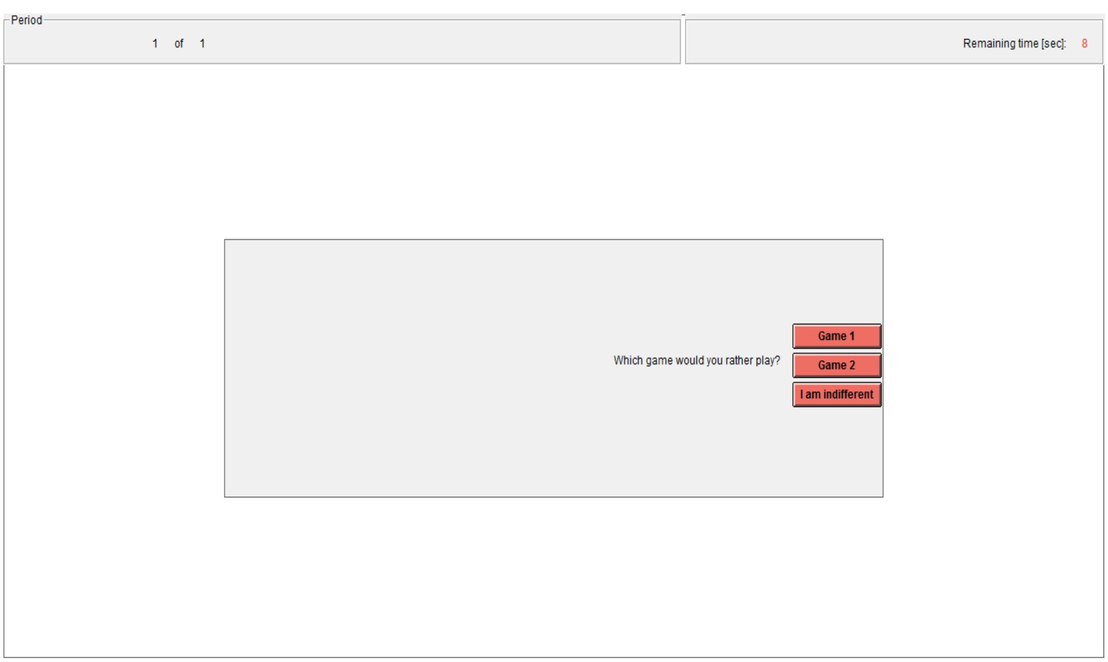
**Instructions**

This is an experiment in decision making. Funds have been provided to run this experiment and if you make good decisions you may be able to earn a substantial payment. The experiment will be composed of two tasks which you will perform one after the other.

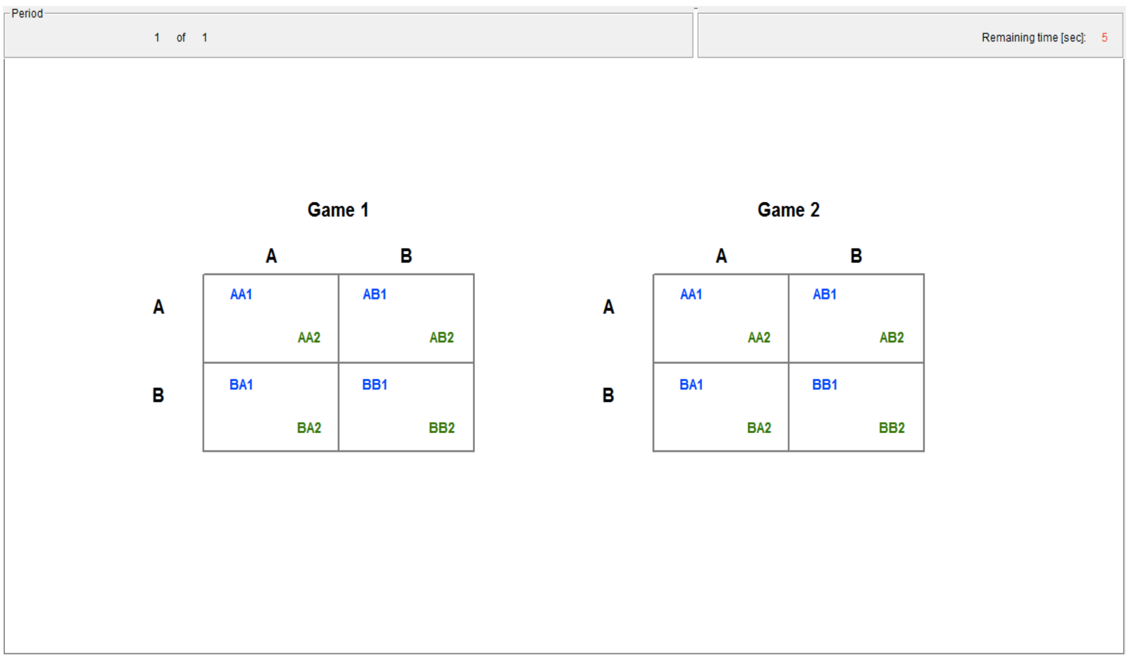
**Task 1: Game Preference**

There will be 45 rounds in the experiment. In all of the 45 rounds you will be presented with a description of two decision problems or games, Games 1 and 2. Each game will describe a situation where you and another person have to choose between two choices which jointly will determine your payoff and the payoff of your opponent. In the beginning of any round the two problems will appear on your computer screen and you will be given 10 seconds to inspect them. ***When the 10 seconds are over you will not be asked play these games by choosing one of the two choices for each of the games, but rather to select that game which you would prefer to play with an opponent.*** At the end of the experiment several of the game-pairs will be chosen for you to play and you will play that game which you said you preferred. So your task now is simply to select one of the two games presented to you in each of the 45 rounds as the game you would prefer to play.

You will be given 10 seconds to enter your preferred game. To do so simply click the button marked Game 1 or Game 2 on the selection screen that appears bellow. If both games look equally attractive to you then click "Indifferent" button and one of the games will be randomly chosen for you.



To illustrate what the games you will be inspecting will look like consider the following screen.




In this screen we have two game matrices labeled Game 1 and Game 2. Each game has two choices for you and your opponent, A and B. ***You will be acting as the Row chooser in all games so we will describe your payoffs and actions as if you were the Row player.***

Take Game 1. In this game you have two choices A and B. The entries in the matrices describe your payoff and that of your opponent depending on the choice both of you make. For example, say that you and your opponent both make choice A. If this is the case the cell in the upper left hand corner of the matrix is relevant. In this cell you see letters AA1 in the upper left hand part of the cell in and AA2 in the bottom right corner. The first payoff in the upper left corner is your (the Row chooser's) payoff (AA1), while the payoff in the bottom right hand corner (AA2) is the payoff to the column chooser, your opponent. The same is true for all the other cells which are relevant when different choices are made: the upper left hand corner payoff is your payoff while the bottom right payoff is that of your opponent's payoff. Obviously in the experiment you will have numbers in each cell of the matrix but for descriptive purposes we have used letters.

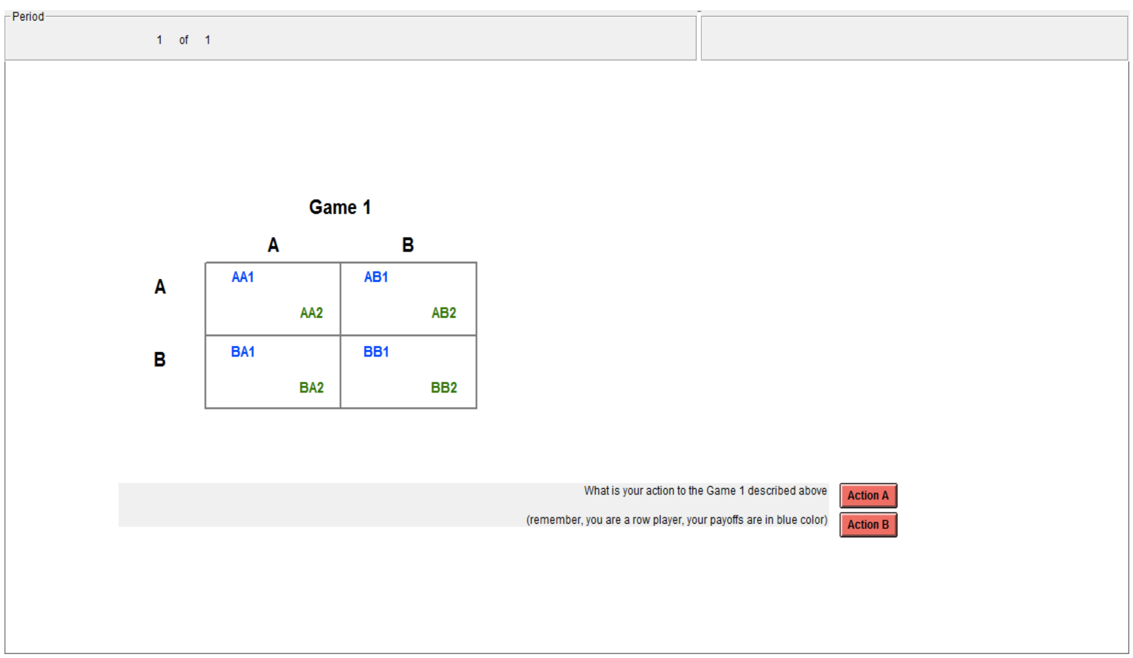
After you are finished deciding on which game you prefer, you will be given 10 seconds to rest before the next round begins. ***Please pay attention to your screen at all times since you will want to be sure that you see the screen when a new pair of games appear.***

For any part of Task 1, (i.e., when you are inspecting games or choosing your preferred game), you will see a timer in the upper right hand corner of the screen. This timer will count down how much time you have left for the task you are currently engaged in. For example, on the screen shown above it says you have 5 seconds left before the screen goes blank and you are asked to make a time allocation.

**Task 2: Game Playing**

When you are finished with Task 1, we will draw two pairs of games and ask you to play the game you said you preferred in Task 1. The other game will not be played so you are best off by choosing that game you truthfully would like to play when given the chance in Task 1. In other words you will make choices in two games. What we mean by this is that before you entered the lab we randomly chose two of the 45 game-pairs for you to play at the end of the experiment. We will then have you play the two games you selected. You will play these games sequentially one at a time.

When you are asked to play a game following screen will appear.




To enter your choice you simply click on the “Action A” or “Action B” button.

After you play the first game we will present you with the second game and have you play it in a similar fashion.  There is no time limit on how long you can take to make a choice in these games.

**Payoffs**

Your payoff in the experiment will be determined by a three-step process:

1. Before you did this experiment we had a group of other subjects play these games and make their choices. Call these subjects “Previous Opponents”.
2. To determine your payoff in this experiment, we will take your choice in each pair of games selected and match it against the choice of one Previous Opponent playing the opposite role as you in the game. They will play as column choosers. Remember, the Previous Opponents did not have to allocate time to think about these games as you did but made their choice whenever they wanted to with no time constraint. We did this because we did not want you to think about how much time your opponent in a game might be allocating to a problem and make your allocation choice dependent on that. Your opponent had all the time he or she wanted to make his or her choice.
3. Third, after you have all made choices for both pairs of games, we will split you randomly into two groups of equal numbers called Group 1 and Group 2 and match each subject in Group 1 with a partner in Group 2.  We will also choose one of the games you have just played to be the one that will be relevant for your payoffs. Subjects in Group 1 will receive the payoff as determined by their choice as Row chooser and that of their Previous Opponent’s” choice as column chooser. In other words, Group 1 subjects will receive the payoff they determined by playing against a “Previous Opponent”. A subject’s partner in Group 2, however, will receive the payoff of the Previous Opponent. For example, say that subject j in Group 1 chose choice A when playing Game 1 and his Previous Opponent chose choice B. Say that the payoff was Z for subject j and Y for the Previous Opponent. Then, subject j would receive a payoff of Z while subject j’s partner in Group 2 will receive the payoff Y. What this means is if you are in Group 1, although you are playing against an opponent that is not in this experiment, the choices you make will affect the payoff of subjects in your experiment so it is as if you are playing against a subject in this room. Since you do not know which group you will be in, Group 1 or Group 2, it is important when playing the game that you make that choice which you think is best given the game’s description since that may be the payoff you receive.

   Finally, the payoff in the games you will be playing are denominated in units called Experimental Currency Units (ECU’s). For purposes of payment in each ECU will be converted into UD dollars at the rate of 1 ECU = 0.05 $US.