Attention in Games: An Experimental Study*

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Abstract

A common assumption in game theory is that players concentrate on one game at a time. However, in everyday life, we play many games and make many decisions at the same time and have to decide how best to divide our limited attention across these settings. In this paper we ask how players solve this attention-allocation problem. We find that players' attention is attracted to particular features of the games they play and how much attention a subject gives to a given game depends on the other game that the person is simultaneously attending to.

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1 Introduction

When studying or teaching game theory we typically analyze a player's behavior in the Prisoner's Dilemma, the Battle of the Sexes, or more sophisticated dynamic games in isolation. But in everyday life we make many decisions and we have to decide how to split our limited attention across all these settings. In this paper we ask: how do people solve this attention-allocation problem? In particular, what characteristics of games attract people's attention? Do people concentrate on the problems that have the greatest downside or the ones that have the greatest upside payoffs? Do they pay more attention to games that, from a game-theoretical point of view are more complicated, or do the payoff characteristics of games trump these strategic considerations? In addition to these questions, we investigate whether our subjects' attention-allocation behavior is consistent. For example, are the attention allocation choices transitive in the sense that if a subject reveals that they would want to allocate more attention to game G_i when it is paired with game G_j and game G_j when it is paired with game G_k, then they also would allocate more attention to game G_i when it is paired with game G_k?

To answer these questions, we conduct an experiment in which we present subjects with a sequence of pairs of matrix games that are shown to them on a screen for a limited amount of time (10 seconds). The main task in the experiment is not to have the subjects play games; instead, we present them with pairs of games and ask them to allocate a fixed and unknown budget of contemplation time between them.[1] These time allocations determine how much time the subjects will have to think about these games when they play them at the end of the experiment. After subjects have made all the allocation decisions, they proceed to play the games against an opponent who has made their choice without any time limit. We design the experiment in this way so that when our subjects engage in attention allocation, they do not try to predict the allocation of their opponent and respond to that. In this paper, we are interested in eliciting which games subjects think are more worthy of attention and identifying the game features that lead subjects to such conclusion.

The time allocation in this experiment can be thought of as "planned attention," because the allocation represents how much time a subject expects or predicts that he will need to efficiently make a choice in each game. In a follow-up paper, Avoyan et al. (2019), we employ eye-tracking tools to examine whether the planned attention chosen by the subjects is well calibrated to the actual attention the subjects pay to these games when they play them. In this paper, however, we focus on planned attention.

We presume that two factors determine behavior in any given game. First, how much attention a player decides to devote to a game, given the other games they are simultaneously facing. Second, how the player behaves given this self-imposed attention constraint. While this paper

[1] We do not tell the subjects the amount of time available to them because if subjects perceive the time to be long enough that they could fully analyze each game before time was up, they might feel unconstrained and allocate 50% to each game. Or the other extreme would be that subjects perceive given time to be too short and allocate all of it to one of the two games. Avoiding these types of strategies is important since what we are interested in is the relative amounts of attention subjects would like to allocate to each game.

concentrates on the first question, we can rely on some empirical findings to discuss how subjects behave given their time allocation which we summarize below.

Agranov et al. (2015) allow players two minutes to think about engaging in a beauty contest game. Each second the player can change his or her strategy, but at the end of the two minutes one of the seconds is be chosen at random, and the choice at that time will be payoff relevant. The design makes it incentive compatible for the subject to enter his best guess as to what choice is likely to be the most beneficial.[2] These authors show that as time goes on, players who do not act randomly (level-zeros, perhaps) change their strategies in the direction of the equilibrium. Hence, the results of Agranov et al. (2015) suggest either that the level-k chosen is a function of contemplation time or that, as Rubinstein (2016) proposes, as more time is spent on the game people switch from an intuitive to a more contemplative strategy.

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

One corollary to our analysis is that we describe how the behavior of a player who is engaged in one specific game is affected by the type of other game in which they are simultaneously interacting. Our results indicate that the level of sophistication one employs in a game is determined endogenously and depends on the constellation of other games the person engages in and the resulting attention they allocate to the game under consideration. In other words, if one aims to explain the behavior of a person playing a game in the real world, one must consider the other games in which that person is involved in. Choi (2012) and Alaoui and Penta (2015) have provided models of the endogenous determination of sophistication within one game.[5] This result follows naturally from our study of attention allocation in games.

1.1 A Summary of Our Results

In this paper, we present evidence that supports the idea that when two games vie for the attention of a decision maker, then the game with the largest maximum payoff attracts more attention, as

[2] This design was used in Avoyan et al. (2019) in various matrix games.

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

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

[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).

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

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

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 the subjects were students recruited from the general NYU student population. The experiment lasted about one hour and thirty minutes and subjects received an average of $21 for their participation. The experiment consists of a set of tasks that we describe below.

2.1 Task 1: Comparison of Games

Comparisons of Pairs. In the first task of the time-allocation treatment, there were 45 rounds. In the first 40 rounds, subjects were shown a pair of matrix games (almost always 2×2 games) on their computer screen. Each matrix game presented a situation in which two players had to choose actions that jointly determined their payoffs. At the beginning of each round a pair of matrix games appeared on their screen for 10 seconds. Subjects were asked not to play these games but to decide how much time they would like to allocate to thinking about the games if they were offered a chance to play them at the end of the experiment. To make this allocation subjects had to decide what fraction of X seconds they would allocate to Game 1 (the remaining fraction would be allocated to Game 2). The value of X was not revealed to them at this stage. They were told that X would not be a large amount of time and that in Task 1 they needed to identify the ***relative amounts*** of time they would like to spend contemplating these two games if they were to play them at the end of the experiment. We did not tell subjects how large X was since we wanted them to anticipate being somewhat time constrained when they played these games. In other word, we wanted the shadow price of contemplation time to be positive in the

[6] Instructions used in our experiment can be found in online Appendices.

minds of each subject. We feared that if subjects perceived X to be so large that they could fully analyze each game before deciding, they might feel unconstrained and allocate 50% to each game. Avoiding this type of strategy was important since what we are interested in is the *relative amounts* of attention they would like to allocate to each game. We wanted to know which game they thought they needed to attend to more. This procedure seems well suited for the purpose.

To indicate how much time each subject wanted to allocate to each game he or she had to write a number between 0 and 100 to indicate the percentage of time that he or she wanted to allocate to thinking about the game called "Game 1" on their screen. The remaining time was allocated to "Game 2." Subjects had 10 seconds to view each pair of games and then they had 10 seconds to enter their percentage. We limited subject to 10 seconds of viewing time because we did not want to give them enough time to actually try to solve the games. Instead, we wanted them to identify the game that *appeared* most worthy of their attention. We expected them to view the games, evaluate their features, and identify the relative amounts of attention they would like to allocate to these games if they were to play them later on.

On the screen that displayed the games a counter appeared in the right-hand corner (see a sample screen shown to subject in appendix A, Figure 5). The counter indicated how much time a subject had left before the screen went blank and they would be asked to enter their attention percentage in a subsequent screen, which also had a counter in the right-hand corner.

The constraints we imposed on our subjects are not artificial (although in the real world we typically have more than 10 seconds to think before allocating attention). They are meant to mimic the process of "planned attention" in which we decide today, when we are time constrained or face cognitive load and can not spend the time to seriously think about a problem, how much attention we plan to allocate to various decisions or games in the future when we have time to stop and think about them. Since we are time constrained today, we are forced to base our time allocation for tomorrow on relatively superficial aspects of the games we face that are easily detectable such as the properties of the payoffs in each game and their seeming complexity.

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

2.1.1 Games

In choosing the games for the experiment, we selected 4 core classes of games—Prisoner's Dilemma, Constant Sum, Battle of the Sexes, Pure Coordination—that cover a variety of interesting cases. Within each of these classes of games we systematically changed the features that we wanted to test (maximum, minimum, zeros, inequity, complexity). In addition, we included some games that are outside of these core four classes to introduce interaction and variation in the features to allow the regression analysis to capture the effects that are not convenient to examine with controlled comparisons. For example, the interaction between the maximum and the minimum payoffs. All of the games used to make comparisons are presented in Tables 1, 4, 7, 2, 15, and 16. Thirty of the total 34 games were 2×2 games, two games 2×3 and two games 3×3.

There is a set of 10 games within which each game in the set is compared to every other game. This set, called the *comparison set* $\mathcal{G}$ (Table 1), is of special interest since it allows us to compare how any two games attract attention when compared to the same set of other games. Games in the comparison set $\mathcal{G}$ let us hold compared games constant when evaluating whether one game attracted more attention than another.

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

PC_{800}

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

PC_{500}

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

BoS_{800}

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

BoS_{500}

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

CS_{800}

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

CS_{500}

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

CS_{400}

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

PD_{800}

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

PD_{500}

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

PD_{300}

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

2.1.2 Strategic Attributes: Payoff-Rearrangement

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

Let us consider the numbers 800, 500, 50, and 10. When these number are arranged as in Figure 2a, we have a Pure Coordination game (albeit with positive off-diagonal payoffs), whereas the arrangement in Figure 2b leads to a Battle of the Sexes game. Arranging numbers as in Figure 2c generates a Prisoner's Dilemma game.[7] If the amount of time allocated to these games differs when they are compared either to each other or to all other games in the comparison set $\mathcal{G}$, we conclude that this outcome supports the claim that game class affects the allocation of attention.

Table 2: Rearranged Games

(a) PC_{RA}

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

(b) BoS_{RA}

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

(c) PD_{RA}

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

2.2 Task 2: Playing Games and Payoffs

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

Subjects were told that they would not play these games against other subjects in the experiment. Rather, they were told, in a separate experiment these games had been played by a different set of subjects, who played the games without any time constraints against each other.[8] Current subject's payoff would be determined by both their strategy choice and the strategy choice of one of these other subjects, who had been chosen randomly.

The reason behind having the current subjects play against outside opponents was the following: 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

[7] We thank Guillaume Fréchette for suggesting such payoff rearrangement.

[8] In a separate experiment, we had 20 subjects make a choice in each of the games without any time constraint (they played these games against each other). In the main treatment, for each game, we randomly picked a subject (one of the 20) and used their choice that was coded in the time allocation treatment as the "outside opponent's" choice.

contemplation time to a particular game thinking that their opponent would allocate little to that game. The focus of this paper is to study which game subjects thought was more worthy of attention and why; hence, we 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 of one of the subjects in Group 1. 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, I would receive my payoff in that game while my opponent's payoff would be randomly given to a subject in Group 2.

This procedure was used because although we wanted subjects to play against an outside opponent, we also wanted the payoffs they chose to have consequences for subjects in the experiment. One of the question in the paper concerns the equity in the payoffs of the games and we wanted these distributional consequences to be real for subjects in the lab. Hence, they played against outside opponents, and their actions had payoff consequences for subjects in the lab. Since subjects chose their strategies before they knew which group they would be in, their strategy choice was incentive-compatible in the sense that it was a dominant strategy to play in a manner that maximized the utility payoff in the game. This is true since either their choice would directly determine their payoff or, if placed in Group 2, they would be given the payoff of some outside opponent in which case the strategy they chose would be irrelevant.

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

3 Results

In this section we present results to answer the following research questions:

1. What features of games attract people's attention leading them to allocate more time to some games rather than others?

2. Are subject's attention-allocation choices consistent, e.g., are these time allocation decisions transitive?

3.1 Game Features

In this section we examine which features of games attract subjects' attention. We focus on the following features: maximum and minimum payoffs, presence of zeros, equity concerns, and complexity. It is our aim to introduce game features in a ceteris paribus manner to directly determine how these attributes impact attention allocation. In some cases, however, there are only a small set of games that allow such clean comparison. To compensate for this we conclude this section with a regression analysis that explains time allocation in an environment that utilizes all of our data.

3.1.1 Maximums

Certain features of games are bound to attract one's attention, e.g. the maximum payoff in a matrix. Take two games, $G_1$and G_2, in which the maximum payoff in G_2 is greater than that of G_1 and other attributes that we consider are equal. Making the type of ceteris paribus changes we desire is not always possible when we change the maximum payoff in a matrix because many times this change also increases inequality. It is not a concern, however, in Pure Coordination games because in these games such issues can be avoided.

For example, consider the following two Pure Coordination games:

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

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

Note that in moving from PC_{500} to PC_{800} we increase the maximum payoff in PC_{800} but not other characteristics that we focus on; i.e., the minimum is still zero in both matrices, the number of zeros in either matrix is the same, the inequity of payoffs in any cell is zero, and both games are pure coordination games. Since game PC_{800} in some sense is more desirable, we will conjecture that in a comparison with PC_{500} more attention will be allocated to PC_{800}. In addition, it will be our conjecture that when these two games are paired with any other game in comparison set $\mathcal{G}$, the attention allocated to PC_{800} will be higher than attention allocated to PC_{500}.

Table 3 presents the results of the direct comparison between PC_{500} and PC_{800} as well as the average planned attention allocated to PC_{500} and PC_{800}, when these games were compared to each of the games in comparison set $\mathcal{G}$, which we designate as $\overline{PC}_{500}$ and $\overline{PC}_{800}$. We find that subjects allocated 45.4% of their total attention to PC_{500} when it was directly compared to PC_{800}. Hence less attention is allocated to the game with the lower maximum in the direct comparison. In addition, the game that has the lower maximum is allocated a lower fraction when compared to all other games in $\mathcal{G}$. The average planned attention allocated to PC_{500} when it was compared to each of the games in comparison set $\mathcal{G}$, is 43.73%, which is significantly lower than 46.10. Further support for this result is presented in Section 3.1.6, which demonstrates that when we run a pooled regression using all the games, change in the maximum payoff in a game leads to an increase in the amount of time allocated to that game.

Result 1 *If the maximum payoff in game G_i is strictly greater than the maximum in game G_j, and the other considered attributes across these games are identical, then subjects allocate more attention to the game with the greater maximum both in direct comparison, and when the two games are compared to other games in comparison set $\mathcal{G}$.*

Table 3: Maximum Hypothesis

Pair	%	p-value
PC_{500} vs PC_{800}	45.40	0.006
$\overline{PC}_{500}$	43.73	0.042
$\overline{PC}_{800}$	46.10	

Note: % presents the percentage of planned attention allocated to the first game. The bar on top of the game represents the average planned attention allocated to that game when it was compared to each of the games in comparison set $\mathcal{G}$.

3.1.2 Zeros and Minimums

Psychologically a matrix with zero payoffs, can be perceived in many different ways. First, zeros, perhaps like negative payoffs, may be scary numbers since they involve zero earnings. If this is the case, zero payoffs are things to be avoided, but avoiding them may require some consideration, and thus, more attention. On the other hand, having zero payoffs can simplify the matrix game by making it look less cluttered, which in turn can highlight strategic considerations. In this case, we would expect less attention to be allocated to games that have zero entries. However, lowering a previously positive payoffs in a game with strictly positive payoffs to zero does two things. First it takes a game without zeros and introduces them into the matrix while also lowering the previous minimum payoff in the game from a positive number to zero. These two effects are confounds since they may work independently but in the same direction to affect attention.

To separately identify the impact of zero and minimum payoffs we use the set of games in Table 4. Looking across the rows in this table we see a different set of three games taken from a specific game class, (i.e., PC games, BOS games, CS games and PD games). For example, looking across the first row we see three pure-coordination games which differ only in their off-diagonal payoffs. PC_0 is identical to PC_{50} and PC_{100} except for the fact that its off-diagonal elements are lowered to zero from their previous positive value of 50 and 100. Note, however, while our goal is to, whenever possible, to make ceteris paribus changes, that is not always possible. For example, across the last two rows of Table 4, while we make the same zero and minimum changes, because of the nature of the game class, we are simultaneously altering the inequality of the game's payoffs.

To test the effect of the minimum and zeros in controlled manner we have taken a game G_0 with a minimum of zero, and increased it to 50 and then 100, let us call the resulting games G_{50} and G_{100}, respectively. Our subjects make binary comparisons between all three games as depicted in Figure 1. Note that the comparison 2 delivers pure minimum effect. If the allocation between G_{50} and G_{100} is different from 50%, then the difference is due to a pure change in the minimum.

Figure 1: Comparisons to identify minimum and zero effects

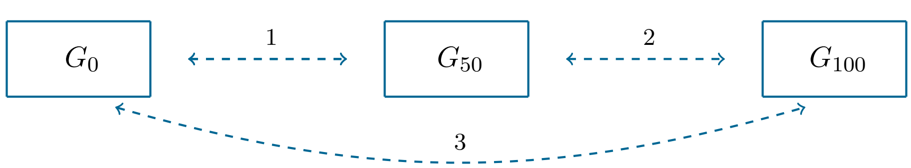


Table 4: Games for identifying min and zero effect

PC_0

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

PC_{50}

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

PC_{100}

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

BoS_0

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

BoS_{50}

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

BoS_{100}

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

CS_0

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

CS_{50}

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

CS_{100}

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

PD_0

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

PD_{50}

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

PD_{100}

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

By looking at a difference between comparisons 1 and 2, we can test whether there is an effect of zeros. If the allocation to G_0 in comparison 1 is different than the allocation to G_{50} in comparison 2, the change is due to the discontinuous effect of the minimum around zero, since in comparison 1 the minimum is increased by 50 points same as in comparison 2, where the minimum is also increased by 50 points.

Table 4 presents the results of the comparisons outlined in Figure 1 and the p-values of the test results comparing comparisons 1 and 2 (column p-value). Table 4 indicates that if we increase game's already positive minimum payoff and leave everything else the same (comparison 2), subjects allocate more attention to the game with higher minimum. This result is true for all four classes of games. By comparing games with positive minimum payoffs, we avoid a conflict with the zero effect. Now, let us look at the difference between comparisons 1 and 2. For pure coordination and constant sum games, we see that there is an effect of zero, so that when minimum is reduced to zero, the game with the zero is planned to be attended less. Regression analysis done using the entire data set support the conclusions we report here using the controlled changes.

Result 2 *If game G_j is derived from game G_i by lowering minimum payoff in game G_i keeping the game class the same, then subjects allocate more attention to the game with higher minimum payoff.*

Result 3 *If game G_j is derived from game G_i by changing a positive minimum payoff in game G_i to zero, then subjects allocate less attention to the game with zeros.*

The result on the zero effect is not a priori obvious. As mentioned above, when a payoff in a game is increased from zero to something positive, one might expect that the game will be "safer" in the respect that no matter what happens the player will at least avoid a zero payoff. One might also conclude that less attention is needed to play these games, but this is not the case. Subjects believe that matrices that have zero payoffs are simpler to play and, hence, deserve less attention. As Table 18 in Appendix A indicates, this result is true for a wide variety of situations not presented in Table 5. Indeed, it is also corroborated by the regression results.

Table 5: Minimum and Zero Effect

Comparison 1		Comparison 2		Comparison 3		1 - 2
Pair	%	Pair	%	Pair	%	p-value
PC_0 vs PC_{50}	42.4***	PC_{50} vs PC_{100}	46.9	PC_0 vs PC_{100}	42.0***	0.026
BoS_0 vs BoS_{50}	41.5***	BoS_{50} vs BoS_{100}	41.2***	BoS_0 vs BoS_{100}	42.3***	0.933
CS_0 vs CS_{50}	43.4***	CS_{50} vs CS_{100}	42.5***	CS_0 vs CS_{100}	41.3***	0.000
PD_0 vs PD_{50}	44.0**	PD_{50} vs PD_{100}	45.9**	PD_0 vs PD_{100}	42.7***	0.460

Note: % presents the percentage of planned attention allocated to the first game; The significance stars present the Wilcoxon test results of the planned attention being equal to 50%; the last column, is Wilcoxon test p-values of the test between comparisons 1 and 2; Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

3.1.3 Equity

There is evidence that subjects take longer to make decisions when equity concerns are present (see Rubinstein (2007)). In addition, there is a large literature that indicates that inequity aversion and other altruistic concerns weigh heavily on people's decisions (see Fehr and Schmidt (2000), Bolton and Ockenfels (2000)). However, our focus is not decision time but planned attention, i.e., do games with greater inequality attract more attention? To investigate this question, we say that game G_i contains more inequality than game G_j if the maximum inequality in the cells of game G_i is greater than the maximum inequality in the cells of game G_j. This implies that when subjects look across game matrices what pops out at them is the maximum payoff difference in the two games. Consistent with finding in Rubinstein (2007) that subjects take longer to make decisions in games that have unequal payoffs, we expect to observe subjects allocating more planned attention to games that have greater inequity in payoffs. This is true for the following reason: in addition to the strategic variables that a player considers, inequality, when added to the mix, inserts a moral dimension that also must be considered. Despite this conjecture we did not find any significant relationship in the direct comparisons, however, the regression analysis provides a different insight.

Note that a pure increase in inequality would be change in this maximum inequality that leaves all other attributes that we control for the same. However, for such changes it is often the case that when we increase inequality in one game we change the game class we are looking at. For example, consider the Pure Coordination game PC_{800} and the Constant Sum game CS_{800}:

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

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

According to our definition, the PC_{800} game has zero inequality in payoffs ($800-800 = 0-0 = 0$). Now we consider the second game, CS_{800}, which is a constant sum game. These two games have identical maximums, the same number of zeros, identical minimums, and are of the same size (2 by 2 matrix games). They differ in the respect that there is payoff inequality in CS_{800} and none in PC_{800}. Note, however, that by rearranging the payoffs in PC_{800} we have changed the game from a Pure Coordination game to a Constant Sum game.

Likewise, consider

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

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

These games have identical maximums, identical minimums, and an equal number of zeros but they differ in the respect that there is payoff inequality in BoS_{500} and none in PC_{500}. They also are in different game classes, but this is unavoidable because by definition there is inequality in Battle of the Sexes games and none in a symmetric Pure Coordination games. Therefore, to investigate equity feature we compare a Pure Coordination and a Battle of the Sexes games, such as PC_{500} and BoS_{500} or PC_{800} and BoS_{800}. The results of this comparison are displayed in Table 6, which presents binary comparisons of both PC_{500} and BoS_{500} and PC_{800} and BoS_{800}. The table also compares the average fraction of planned attention to each of two the games, when they are compared to all other games in the comparison set G.

Despite the greater inequality in the payoffs of the BoS's games, there is no significant difference in the amount of planned attention allocated to BoS_{500} or BoS_{800} when they are compared directly to PC_{500} and PC_{800}. The only statistically significant result is that when PC_{800} and BoS_{800} are compared to all games in G, BoS_{800} is allocated greater amount of planned attention at the significance level of 5%. The result on the effect of equity concerns on planned attention becomes more clear when we use all the data and conduct a regression analysis: we find that more time is allocated to games with unequal payoffs.

Table 6: Equity Effects

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

Note: % presents the percentage of planned attention allocated to the first game.

Result 4 *If game G_i (BoS game) contains a larger maximum inequality than does game G_j (PC game), there is no significant difference in the amount of planned attention allocated across these two games when they are directly compared to each other.*

3.1.4 Complexity

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

Table 7: Prisoners Dilemma and Its Transformations

PD_{800}

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

CPD_1

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

CPD_2

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

Games CPD_1 and CPD_2 are derived from PD_{800} by the addition of two dominated strategies: one for the column chooser (column 3) and one for the row chooser (row 3). We consider CPD_1 and CPD_2 more complex than PD_{800} for two reasons. First, CPD_1 and CPD_2 involve more actions and, hence, are simply larger. Second, despite the fact that all three games have identical unique equilibria, the equilibria in CPD_1 and CPD_2 are reached by a more complicated strategic process that involves recognizing both dominance and iterative dominance. Given that the equilibria for all three games are identical and unique, we might want to consider CPD_1 and CPD_2 to involve more pure increases in complexity compared to PD_{800}. As such, we would intuitively conclude that in a binary comparison between PD_{800} and either CPD_1 or CPD_2, planned attention will higher on more complex games. Table 8 presents the results.

Table 8: Complexity Hypothesis

Pair	%	p-value
PD_{800} vs CPD_1	35.5	0.000
PD_{800} vs CPD_2	40.6	0.001

Note: % presents the percentage of planned attention allocated to the first game.

Table 8 suggests that as games get more complex in the manner just described, subjects allocate more and more time to them. In the case of the comparisons made here, this effect is extremely strong in the respect that subjects on average allocate only 35.5% and 40.6% of their time to PD_{800}. These percentages are lower than in any other of the many comparisons we make. Adding a dominated strategy to the PD_{800} game dramatically lowers the amount of attention subjects pay to it when that game is compared to its new and larger cohort.

Result 5 *If game G_i is derived from game $G_j$by adding a strictly dominated strategy to the row and column player's strategy set, then a subject allocates more attention to the more complex game.*

3.1.5 Strategic Aspects

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

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

Recall that in this treatment we take the payoffs 800, 500, 50, and 10 and rearrange them to form three classes of games: Pure Coordination, Battle of the Sexes, and Prisoner's Dilemma, denoted as PC_{RA}, BoS_{RA} and PD_{RA} (since there is no way to rearrange the payoffs to generate a constant-sum game without dropping some payoffs that game class is omitted).

Table 9: Direct Comparisons of Rearranged Games

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

Note: % presents the percentage of planned attention allocated to the first game.

Table 9 presents the results of a set of binary comparisons that compare the planned attention allocated to each of our three games when they are pair wise matched. Except for the comparison between PC_{RA} and PD_{RA} there are no statistically significant differences in planned attention allocation in the three games.[9]

This result does not imply that strategic elements are not relevant. Indeed, other comparisons do indicate that our rearrangement is not innocuous. For example, instead of comparing the planned attention allocated to these games when they are compared directly to each other in a pair wise manner, we can compare the average planned attention allocated to them when they are compared to all games in the comparison set $\mathcal{G}$. In Table 9, compared to all games in $\mathcal{G}$, the BoS_{RA} game receives on average higher planned attention compared to PD_{RA} and PC_{RA}. These

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

Table 10: Rearranged Games vs $\mathcal{G}$

Pair	%	Comparison	p-value
$\overline{BoS_{RA}}$ vs $\mathcal{G}$	55.29	$\overline{BoS_{RA}}$ vs $\overline{PC_{RA}}$	0.030
$\overline{PD_{RA}}$ vs $\mathcal{G}$	53.65	$\overline{PD_{RA}}$ vs $\overline{BoS_{RA}}$	0.064
$\overline{PC_{RA}}$ vs $\mathcal{G}$	52.64	$\overline{PC_{RA}}$ vs $\overline{PD_{RA}}$	0.364

Note: % presents the percentage of planned attention allocated to the first game.

differences are significantly different (at the 5% and 10% level of significance, respectively) when we compare the BoS_{RA} and PC_{RA} games as well as BoS_{RA} and PD_{RA} games, but they are insignificantly different for the PC_{RA} and PD_{RA} games. This suggests that the BoS_{RA} game attracts more attention because it stands out strategically. Note that the comparisons in Table 10 are averaged over all games in comparison set $\mathcal{G}$. In Appendix G Table 19 presents individual comparisons of rearranged games with each game in comparison set $\mathcal{G}$.

Finally, a third, albeit less controlled, comparison investigates how strategic considerations affect planned attention. Let $\overline{PC}$, $\overline{BoS}$, $\overline{CS}$, and $\overline{PD}$ represent the average planned attention allocated to all the Prisoner's Dilemma games, Constant Sum games, Battle of the Sexes games, and Pure Coordination games, respectively, when these are compared to all other games in $\mathcal{G}$. Unlike the games in our payoff-rearrangement treatment, the payoffs in these games vary within and across games and game classes. Hence, they are not held constant. Nonetheless, the comparisons suggested above can be informative. Table 11 clearly indicates that strategic elements are important. For example, subjects clearly allocated the most of the available attention to PD games (56.60%), then to CS games (48.75%), then BoS games (46.27%), and PC games (44.93%). A set of binary Wilcoxon signed-rank tests corrected for multiple hypotheses testing indicate that these differences are statistically significant for all comparisons $(p < 0.01)$ except PC and BoS games where $p > 0.05$. A Friedman test rejects our null hypothesis of not difference with $p < 0.01$ that the mean attention time paid to games is equal across all game types: i.e. $\overline{PC} = \overline{BoS} = \overline{CS} = \overline{PD}$.[10]

Table 11: Game Class Ordering in $\mathcal{G}$

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

Note: % presents the percentage of planned attention allocated to the first game.

Result 6 *The rearrangement of payoffs in game matrices to generate games of different game types does not affect the the time allocated to these games when they are paired with each other in a binary manner or*

[10] The Friedman test is a non-parametric alternative to the one-way ANOVA with repeated measures. We use Friedman test throughout the paper to test hypotheses that involve more than two groups. For one- or two-group analysis, we use Wilcoxon signed-rank tests. In cases of multiple hypotheses testing, such as in Table 12, we use the Bonferroni correction to adjust significance thresholds.

when they are compared to all the games in the comparison set $\mathcal{G}$. However, on an aggregate level, planned attention allocated to games in different game classes is ranked: PD games $>$ CS games $>$ BoS games $\geq$ PC games.

A different but associated question on the impact of strategic factors on attention allocation is motivated by the idea that if strategic aspects are the only important factor for attention allocation, then there should not be any difference in attention allocated to different games within a game class. In other words, a game theorist might suggest, once a player can identify the type of game he is playing, then the amount of attention he allocates to it should not be affected by the game's payoffs because strategically speaking, all games in the same game class are equivalent.

Table 12: Game Class Effect (p-values are adjusted for multiple hypothesis testing)

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

Note: % presents the percentage of planned attention allocated to the first game compared to all other games in $\mathcal{G}$ that are not of the same game-class.

Table 12 presents results of comparing a game to all other games outside of its game class. For example, the average planned attention allocated to PD_{800} when the subject faces non-PD games in the set $\mathcal{G}$ was 58.52%, but in the case of PD_{300} it was 54.36%. This indicates that although both games are PD games, subjects regarded them different. Table 12 supports this result for all the four classes of games that we consider. Thus, payoff features are important to subjects when they decide how to allocate their attention across games.

Result 7 *The planned attention allocated to a games within a game class is not the same and it depends on the payoffs in the individual game.*

3.1.6 Regression Analysis

In the results section, the effects of game features on attention allocation decisions are explored in a controlled manner. In this section, we incorporate all the data to examine the effects considered in the previous section as well as some other effects we could not capture in a controlled manner. We model the time allocation decision as a function of relevant game attributes and individual characteristics. For game attributes, we use the maximum and minimum payoff in a game, whether there are equity concerns in the comparison, number of zeros, complexity, and some interactions between these variables.[11] We estimate the following regression

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

[11] See appendix C, where we explore additional explanatory variables.

where $x_{1,jk}$ is the difference between the maximum payoffs in two games; $x_{2,jk}$ is the difference in the minimum payoffs between the two games; $y_{1,jk}$ and $y_{2,jk}$ are zero and equity variables that take values 1, 2, or 3 and $y_{3,jk}$ is a complexity dummy variable. If there are more zeroes in game G_k than in G_j, $y_{1,jk} = 1$; if there are more zeroes in game G_j, then $y_{1,jk} = 3$; otherwise we have $y_{1,jk} = 2$. If there is an 'equity concern'—that is, if payoffs differ only in game G_k but not in G_j—then $y_{2,jk} = 1$; if there is an equity concern only in G_j, then $y_{2,jk} = 3$; otherwise we have $y_{2,jk} = 2$. Finally, $y_{3,jk}$ is a complexity variable that equals 1 when the second game, G_k, is larger than a 2×2 game, that is, it is 2×3 or 3×3; $\mathbf{Z}_i$ is a vector of subject-specific characteristics;[12] and $\varepsilon_{i,jk}$ is an idiosyncratic error. Table 13 presents results for the regression with standard errors clustered at the subject level.

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

The full effect of increasing the maximum payoff difference on planned attention is given by:

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

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

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

Although the test of equity feature effect on planned attention left us with a negative result, the regression results tell a different story. If we move from having equity concerns in the second

[12] The subject specific characteristics we considered where gender, GPA, familiarity with game theory and their interactions with attributes. We dropped them from our discussion since they did not lead to any systematic effects on the attention allocation.

Table 13: Estimation with Clustered SEs[a]

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

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

game to no equity concerns, or from no equity concerns to equity concerns in the first game, then attention allocated to the first game increases. Recall that 'equity' here is a variable that takes values in $\{1, 2, 3\}$ depending on whether there are equity concerns and in which game they occur (the order of the games matters). The results in Table 13 suggest that games that feature equity concern get more attention allocated to them than games without equity concerns.

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

In summary, our regression neatly summarizes the results tested in a more controlled manner. The attention subjects allocate to a game depends on the relative magnitude of its maximum and minimum payoffs, whether there is equity concern in the game, the number of zero payoffs in the game, and how complex it is.

3.1.7 Interrelated Games

In this paper we investigate how the amount of attention allocated to a given game is affected by the other game or games vying for our attention.[13] If the amount of attention we devote to thinking about a game is part of the solution to an attention-allocation problem, then attention devoted to different games are interrelated and vary depending on the specific games that are paired together. Pair a game with a different game and we get different amount of attention allocated to it and hence potentially different choice made. This section of the paper investigates if games are interrelated in this way through attentional constraint.

Result 8 *The amount of attention allocated to a given game depends on the other game that the subject is simultaneously contemplating.*

To illustrate how the attention paid to a given game is influenced by the other games recall that we have a set of 10 games, such that each game in the set is paired with every other game in the set.

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

Since any game $G_i \in \mathcal{G}$ has been compared to each of the other nine games in the set $\mathcal{G}$ we calculate the percentage of planned attention to the game G_i over all the comparisons in $\mathcal{G}$. We do this for each of the 10 games so that each will have an average score that represents the fraction of planned attention allocated to this game when compared to every other game in $\mathcal{G}$.

Table 14 presents the results. For instance, when subjects compared PC_{800} and PC_{500}, they devoted an average of 54.1% of their available time to the PC_{800} game and consequently, only 45.9% to the PC_{500} game. In other words, when subjects compared PC_{800} to PC_{500} they decided that they would like to spend more time contemplating PC_{800} before making a choice. However, when the subjects were faced with a choice between PC_{800} and PD_{800} they only allocated an average of 39.3% of their attention to PC_{800} indicating that planned attention allocated to PC_{800} is clearly affected by the other game the subjects have to share their attention with.

This phenomenon can be seen when we look at other games as well. As we move across any given row of Table 14 we see a large variation in the amount of attention allocated to any particular game. Looking across each row, we test the hypothesis that there is no difference in the fraction of attention allocated to any given game as a function of the "other game" the subject is playing. Although for some individual comparisons the difference is insignificant, by and large there is a distinct pattern in the attention allocated to a given game, and that pattern is a function of the other game a subject is simultaneously considering. test.

We can also present these results in a graph for visual examination. Let is look at Figure 2, which presents the average fraction of planned attention allocated to the PC_{500} , BoS_{500} , CS_{500} , and PD_{500} games, respectively, as a function of the other games the subject was pursuing.

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

Table 14: Planned Attention Allocation[a] (attention allocated to the row game when compared to the column game)

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

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

Looking at Figure 2a, we see that there is a large variation in the amount of attention allocated to PC_{500} as we vary the other game that subjects who are engaged in this game faced. For example, subjects on average allocate less than 40% of their attention to PC_{500} when they also play PD_{500}, whereas they allocate nearly 55% of their attention to this game when also face PC_{500}. In Figure 2b we see a similar pattern wherein subjects allocating close to 52% of their attention to that game when they also face the PC_{500} game but they allocate only about 40% to it when they simultaneously face PD_{500}. The same results hold in Figures 2c and 2d. To illustrate the robustness of these results, in Appendix D we present similar graphs for all games in the comparison set $\mathcal{G}$.[14]

These differences in time allocation would be unimportant if they did not influence the way subjects play these games conditional on the time they allocate to them. Hence, the second step in our analysis of interrelated games is to connect the type of strategy chosen to contemplation times. We look for evidence of a function that describes the relationship between contemplation time and strategic choice, but given our design, we have to content ourselves with aggregate rather than individual level data. Figure 3 presents the results.

In these figures, we present decision time on the horizontal axis divided into two segments

[14] Most of the analysis in the results section focuses on average planned attention allocated to a given game. In appendix H we present the distribution of attention choices in every comparison (Figures 9, 10 and 11).

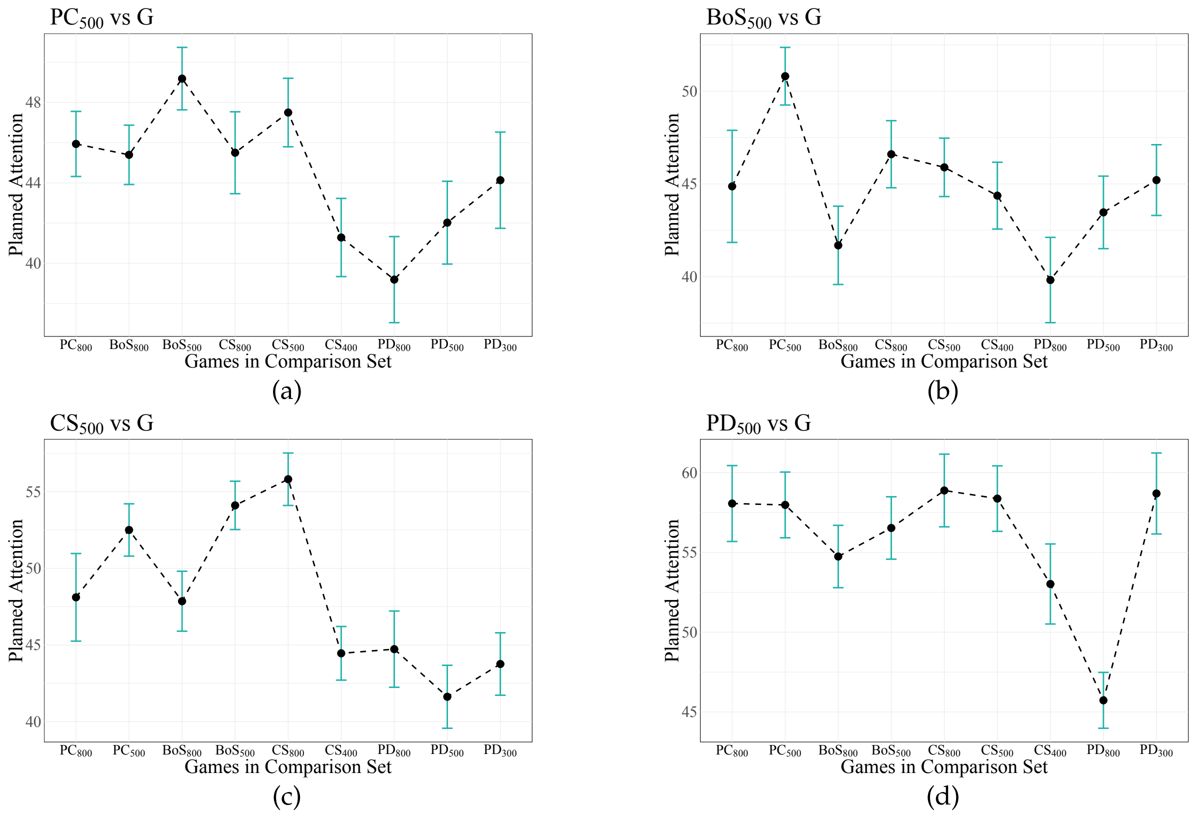
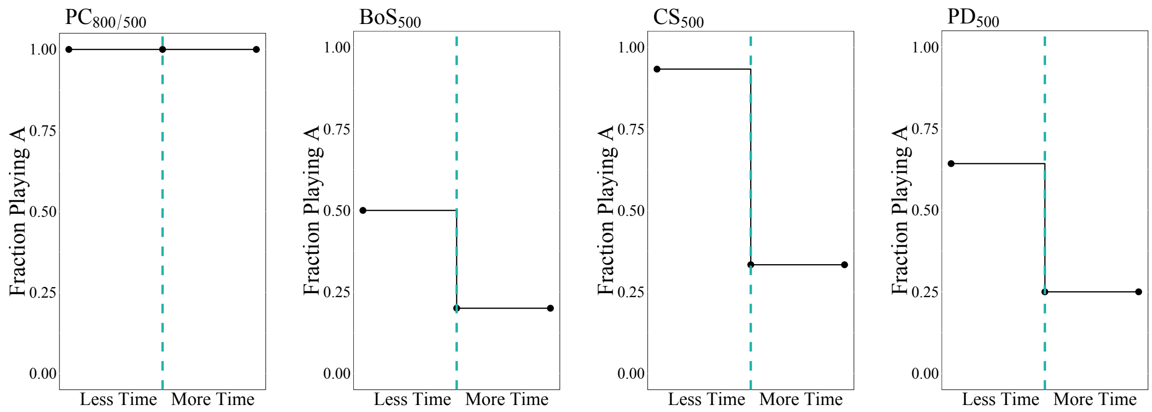


Figure 2: Planned Attention Allocation

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

In Figure 3d, which looks at the PD_{500} game, the fraction of subjects choosing Action A who think relatively little about this game is dramatically different from those who think for a longer time. For example, more than 64% of subjects who decide quickly in that game choose Action A while, for those who think longer, this fraction drops to 25%. This indicates that quick choosers cooperate while slow choosers defect. A similar, but more dramatic pattern is found in Figure 3c for the CS_{500} game. Here the fraction of subjects who choose Action A drops from 93% to 33%. Finally, we see in Figure 3a that for some games choice is invariant with respect to response time. In the case of the game PC^{800}_{500} all subjects choose Action A no matter how long they think about the game. Note that this is a coordination game that has two Pareto-ranked equilibria: in one each subject receives a payoff of 800; in the other the payoff is 500 (off-diagonal payoffs are 0, see Table 15). Choice in this game appears to be straightforward: all subjects see that they should coordinate on Action A. Similar graphs for all games that the subjects played are in Appendix E.



(a) PC (b) BoS (c) CS (d) PD

Figure 3: Response Time and Choice

In summation, our results clearly demonstrate that the amount of attention allocated to a given game (or decision problem in general) depends on the other games or problems that the decision maker is simultaneously contemplating. In addition, since the choices that subjects make in these games are a function of their self-imposed attention constraints, we have established a direct link between attention and choice with the punch line that one cannot fully understand choice without considering how much attention was allocated to it.

3.2 Consistency

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

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

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

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

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

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

A variant of our Baseline Independence condition is what we call Baseline Consistency, which can be stated as follows:[15]

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

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

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

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

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

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

3.2.1 Transitivity

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

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

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

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

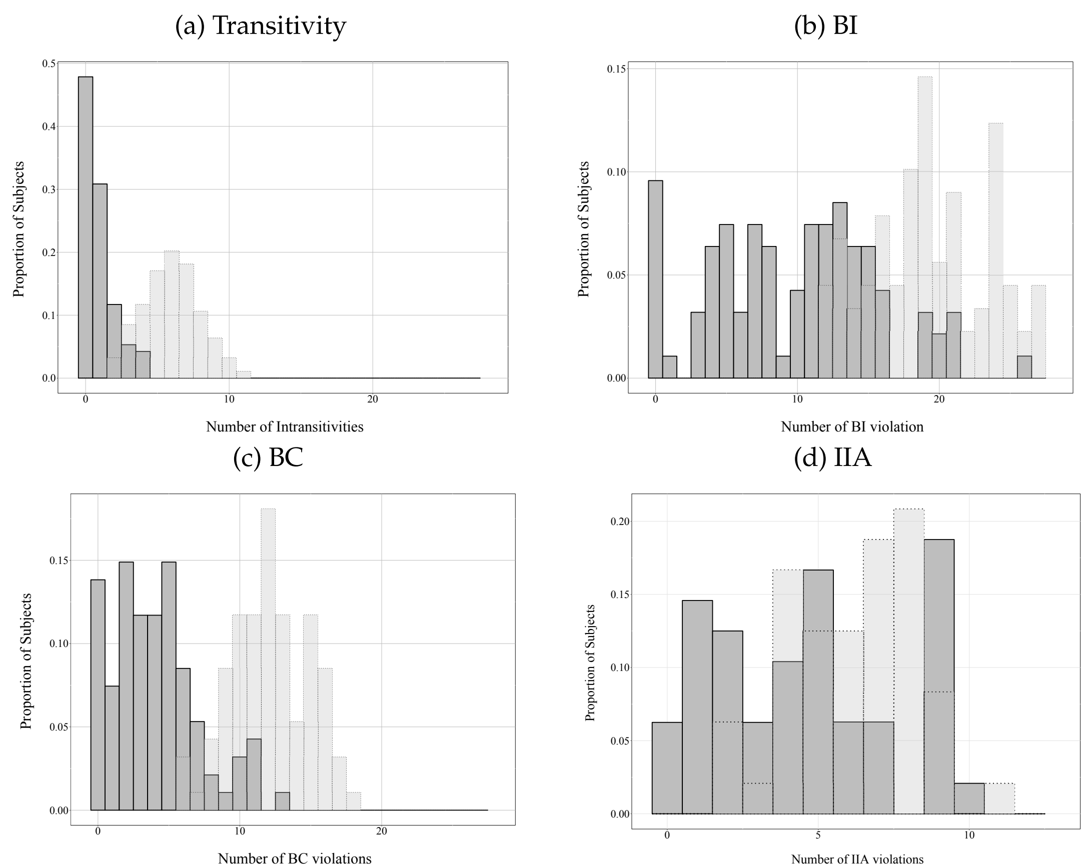


Figure 4: Consistency histograms

3.2.2 Baseline Independence (*BI*)

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

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

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

3.2.3 Baseline Consistency (*BC*)

We might expect that Baseline Consistency would be easier to satisfy than Baseline Independence given that, under our consistency condition, if game G_i is revealed to be more worthy of time than G_j when both are compared to game G_k, then G_i should be revealed to be more worthy of time when G_i and G_j are compared directly. *BI* requires that G_i must be revealed to be more worthy of time in all possible other comparisons that could be made. This is a far more stringent condition given that when we make these other comparisons we will be comparing game G_i to a variety of games inside and outside of its own game class. In contrast, under *BC* we only compare it directly to game G_j. Note that Baseline Consistency is more difficult to satisfy than Transitivity as *BC* implies Transitivity but the converse is not true.[16]

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

3.2.4 Independence of Irrelevant Alternatives (*IIA*)

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

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

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

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

4 Conclusions

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

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

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

The subjects behave in a remarkably transitive manner when they plan their attention; however, their behavior is less consistent when we examine other more stringent consistency conditions.Finally, the paper constitutes a first step to introduce attention issues into game theory. To our knowledge, this paper is the first to look at how behavior in games is interrelated given an attentional constraint. Clearly there is more to be done in this regard.

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Appendix

A Additional Figures and Tables

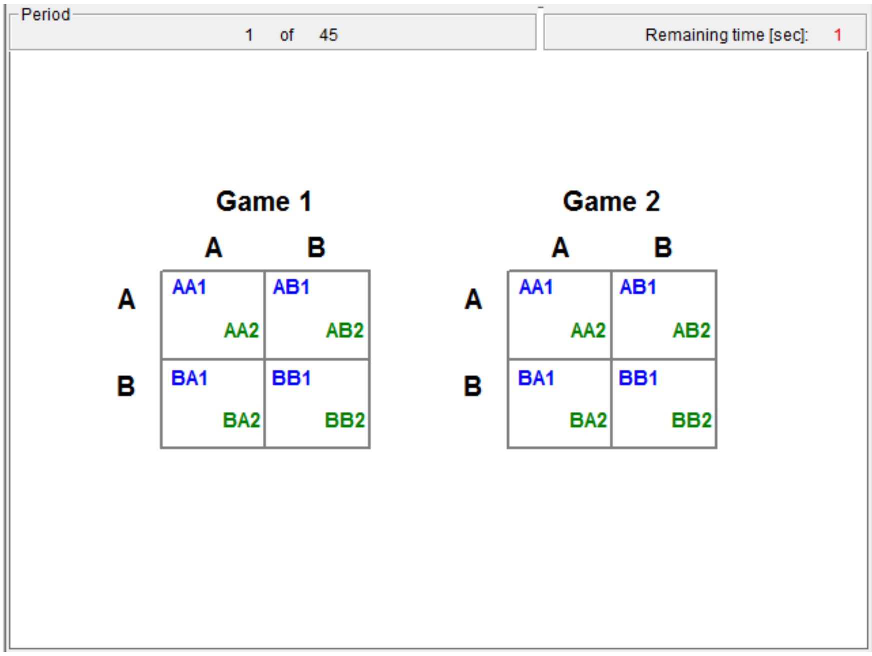


Figure 5: Sample screen

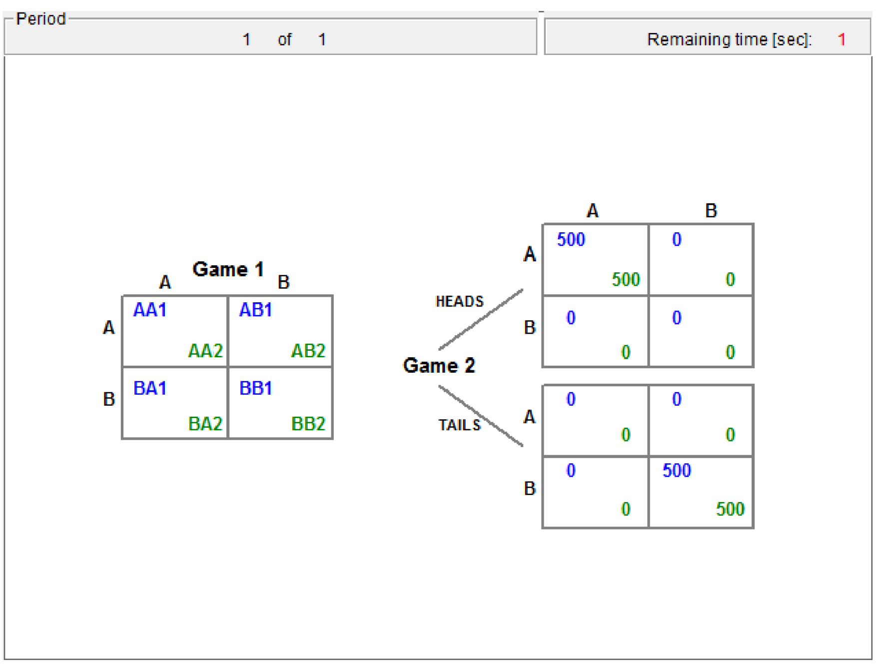


Figure 6: Sample chance screen

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

Table 15: List of 2×2 Games outside comparison set $\mathcal{G}$

PC^{500}_{100}

500, 500	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

Ch_1

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

Ch_2

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

$Chance$

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

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

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

Table 16: List of 2×3 Games

LC_1

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

LC_2

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

C Additional Explanatory Variables

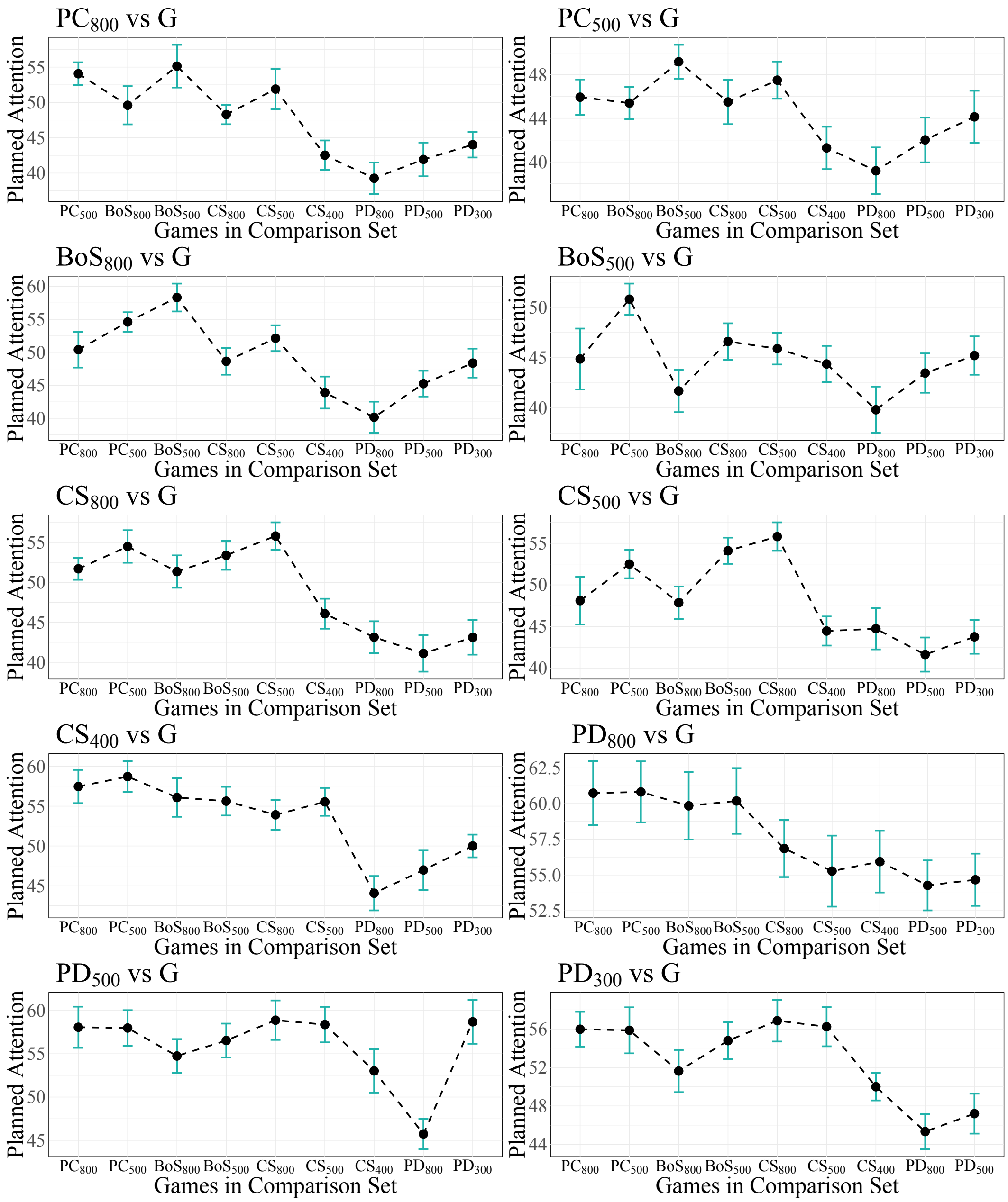
Table 17: Estimation with Clustered SEs[a]

Time allocated to Game 1	(I)	(II)	(III)	(IV)	(V)
ΔMax - ΔMin	0.129***				
	(0.023)				
ΔTotal Sum		0.002***			
		(0.000)			
ΔOwn Payoff Sum			0.004***		
			(0.001)		
ΔOwn Row 1				0.003***	
				(0.001)	
ΔOwn Row 2				0.004***	
				(0.001)	
ΔTotal Row 1					0.002***
					(0.000)
ΔTotal Row 2					0.002***
					(0.001)
Zeros	5.694***	4.907***	4.890***	4.890***	4.927***
	(0.721)	(0.676)	(0.675)	(0.676)	(0.680)
Equity	2.494***	1.995***	1.992***	1.947***	1.994***
	(0.692)	(0.709)	(0.709)	(0.704)	(0.711)
Complexity	-10.855***	-12.299***	-11.950***	11.340***	-12.395***
	(1.668)	(1.648)	(1.654)	(1.705)	(1.624)
Constant	33.148***	35.952***	35.982***	36.085***	35.917***
	(1.846)	(1.772)	(1.771)	(1.751)	(1.760)
# of obs.	6190	6190	6190	6190	6190

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

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

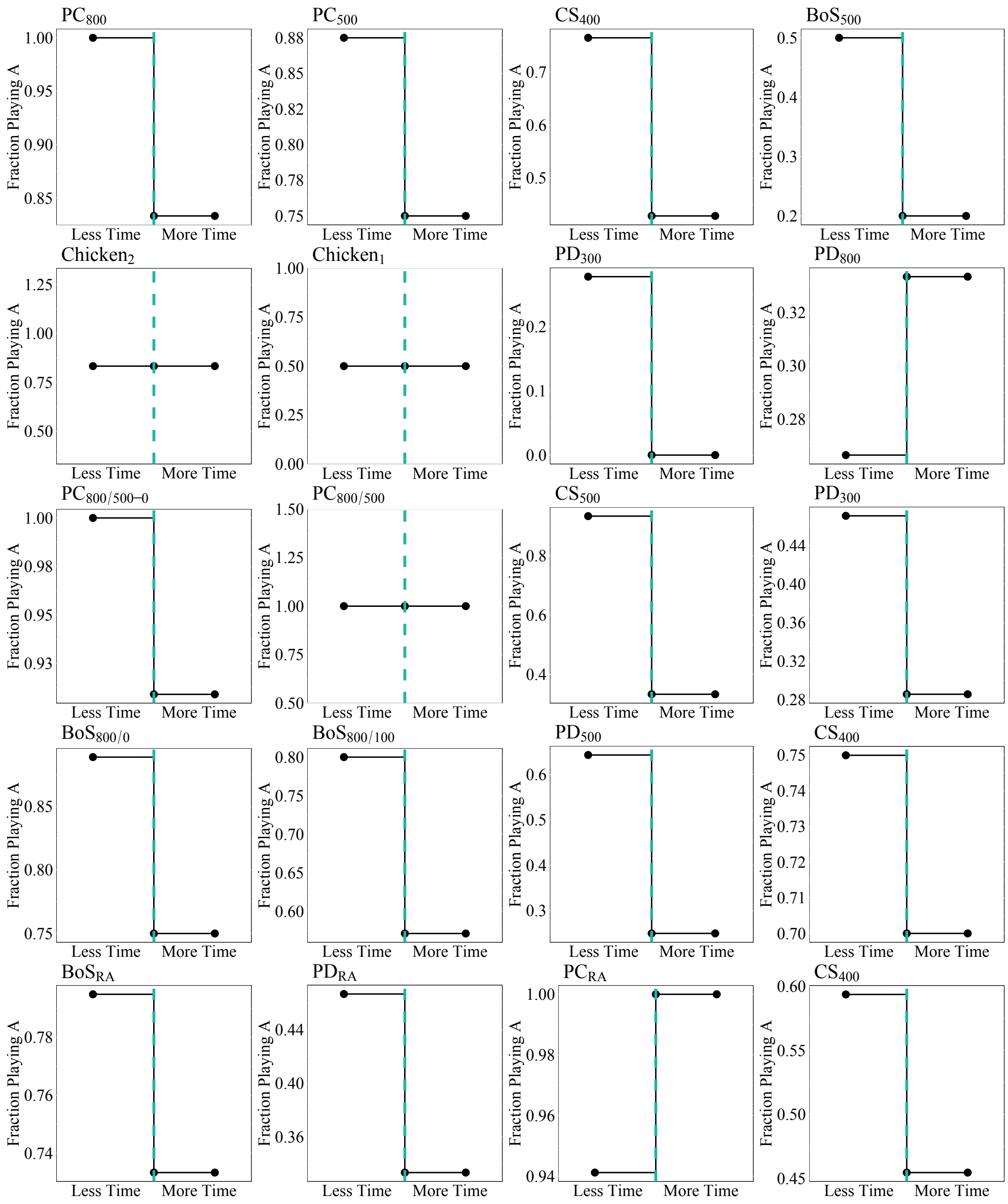
Figure 7: Time Allocation



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

E Response Times and Choices

Figure 8: Response Times and Actions



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

F List of Comparisons in Each Session

Sessions 1 and 2

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

Sessions 3 and 4

1. BoS_{800}, PC_{800}
2. BoS_{500}, PC_{800}
3. BoS_{500}, BoS_{800}
4. PD_{800}, BoS_{800}
5. PD_{800}, BoS_{500}
6. PD_{500}, PC_{800}
7. PD_{500}, BoS_{500}
8. PD_{300}, PC_{500}
9. PD_{300}, BoS_{800}
10. CS_{500}, PC_{800}
11. CS_{500}, PD_{300}
12. CS_{800}, PD_{500}
13. CS_{800}, PD_{300}
14. CS_{400}, PC_{500}
15. CS_{400}, PC_{800}
16. CS_{400}, BoS_{800}
17. CS_{400}, PD_{800}
18. PD_{500}, CS_{400}
19. CS_{800}, CS_{400}
20. PC_{800}, Chance
21. BoS_{500}, Chance
22. PD_{500}, Chance
23. PD_{300}, Chance
24. CS_{800}, Chance
25. PD_{500}, PD_{300}
26. $BoS_{\substack{800\\0}}, BoS_{800}$
27. $BoS_{\substack{800\\100}}, BoS_{800}$
28. $BoS_{\substack{800\\0}}, BoS_{500}$
29. $BoS_{500}, BoS_{\substack{800\\100}}$
30. $BoS_{\substack{800\\0}}, BoS_{\substack{800\\100}}$
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

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

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31. PD_{RA} vs PC_{RA}
32. BoS_{RA} vs PD_{RA}
33. PC_{RA} vs BoS_{RA}

—

34. BoS_0 vs BoS_{50}
35. BoS_{50} vs BoS_{100}
36. BoS_{100} vs BoS_0
37. PC_{50} vs PC_0
38. PC_0 vs PC_{100}
39. PC_{100} vs PC_{50}
40. PD_0 vs PD_{50}
41. PD_{50} vs PD_{100}
42. PD_{100} vs PD_0
43. CS_{50} vs CS_0
44. CS_0 vs CS_{100}
45. CS_{100} vs CS_{50}

G Additional Tables

Table 18: Additional comparisons for zero hypothesis

Original vs Zero Game	%	p-value
$PC_{\substack{800\\500}1}$ vs $PC_{\substack{800\\500}}$	58.11	0.000
$PC_{\substack{800\\100}}$ vs PC_{800}	57.22	0.009
BoS_{800} vs $BoS_{\substack{800\\0}}$	60.74	0.000
$BoS_{\substack{800\\100}}$ vs $BoS_{\substack{800\\0}}$	57.22	0.006
PD_{800} vs $PD_{\substack{800\\0}}$	54.50	0.018

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

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

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

H Additional Figures

Figure 9: Planned Attention Distribution (Session 1 and 2)

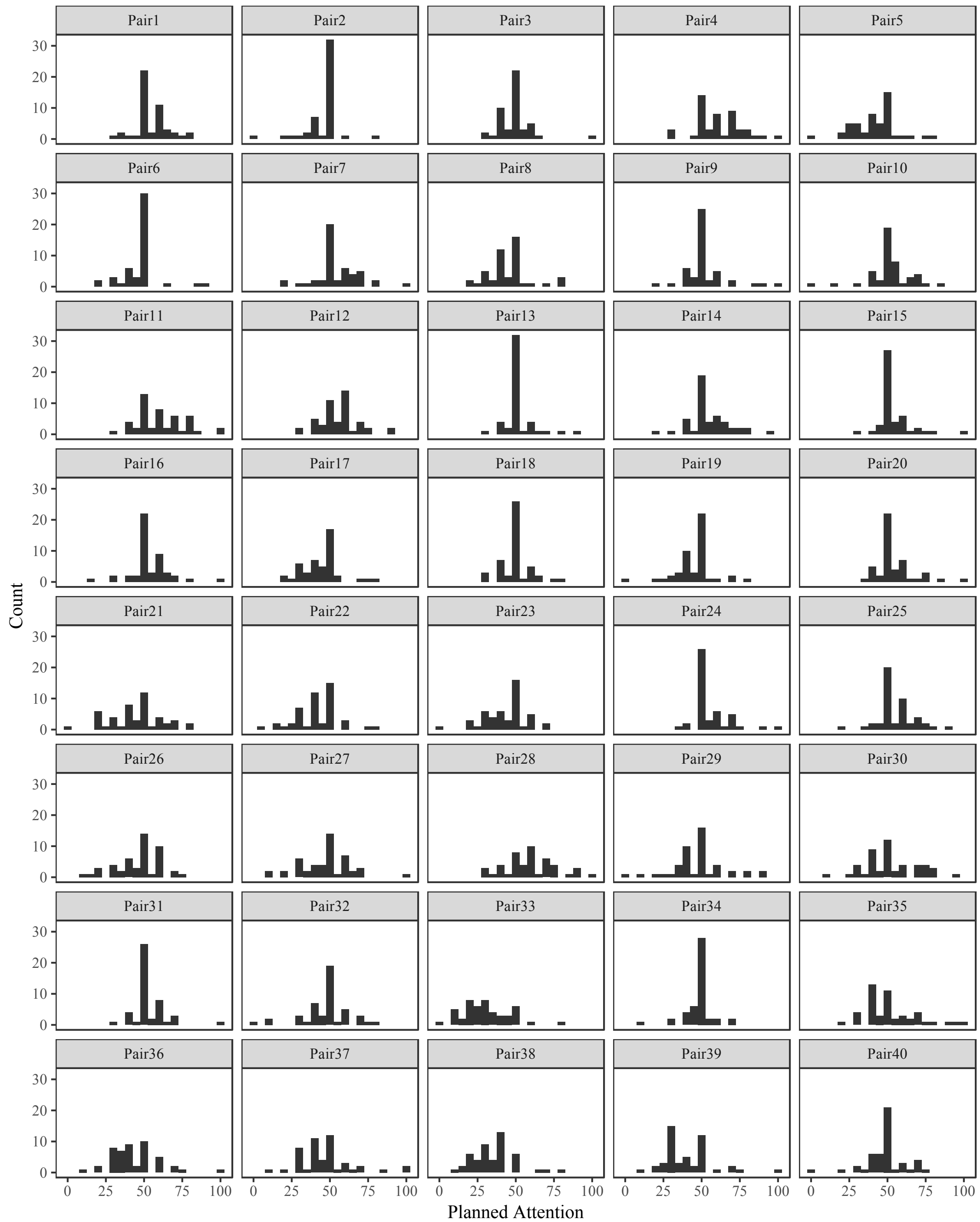


Figure 10: Planned Attention Distribution (Session 3 and 4)

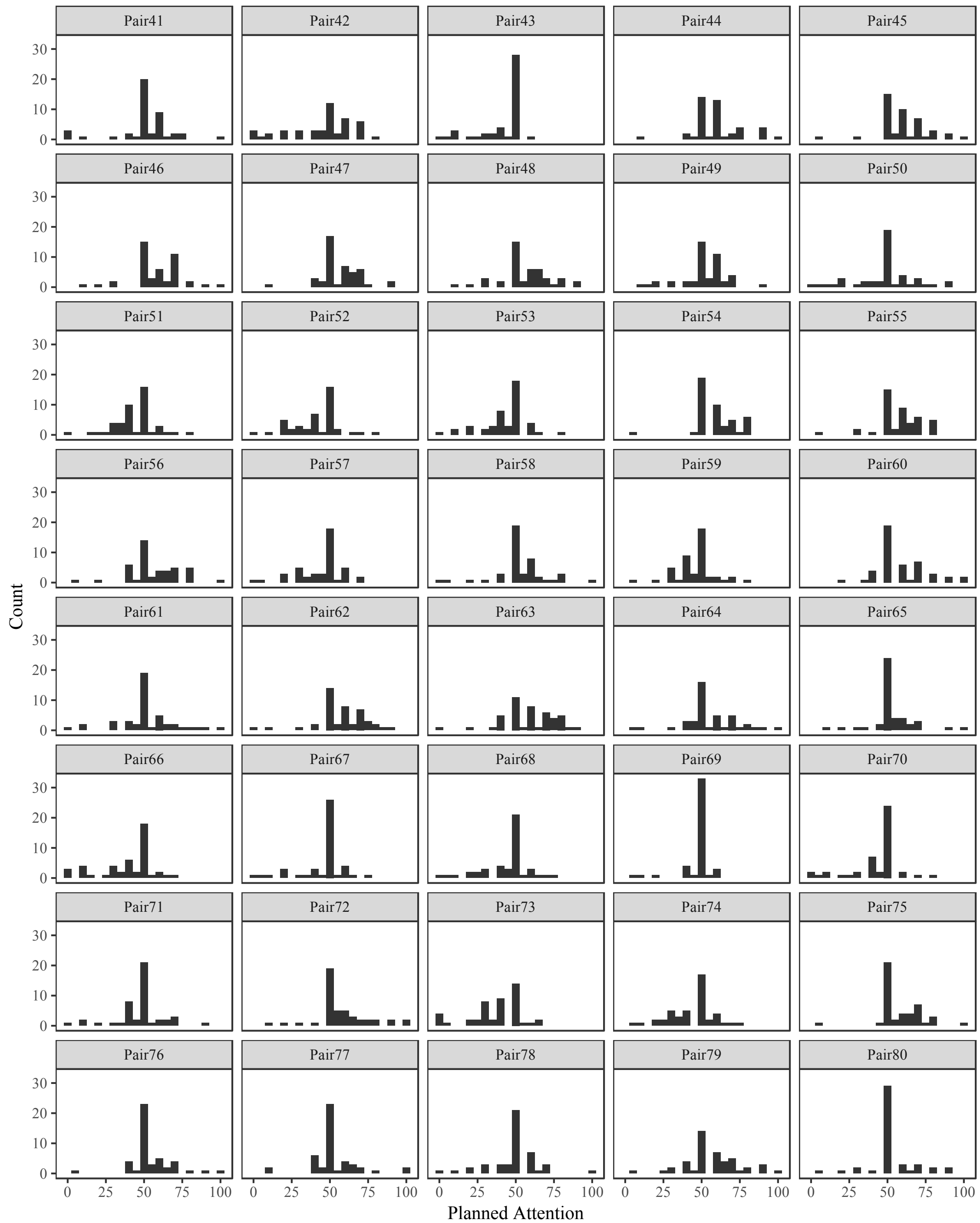


Figure 11: Planned Attention Distribution (Session 5 and 6)

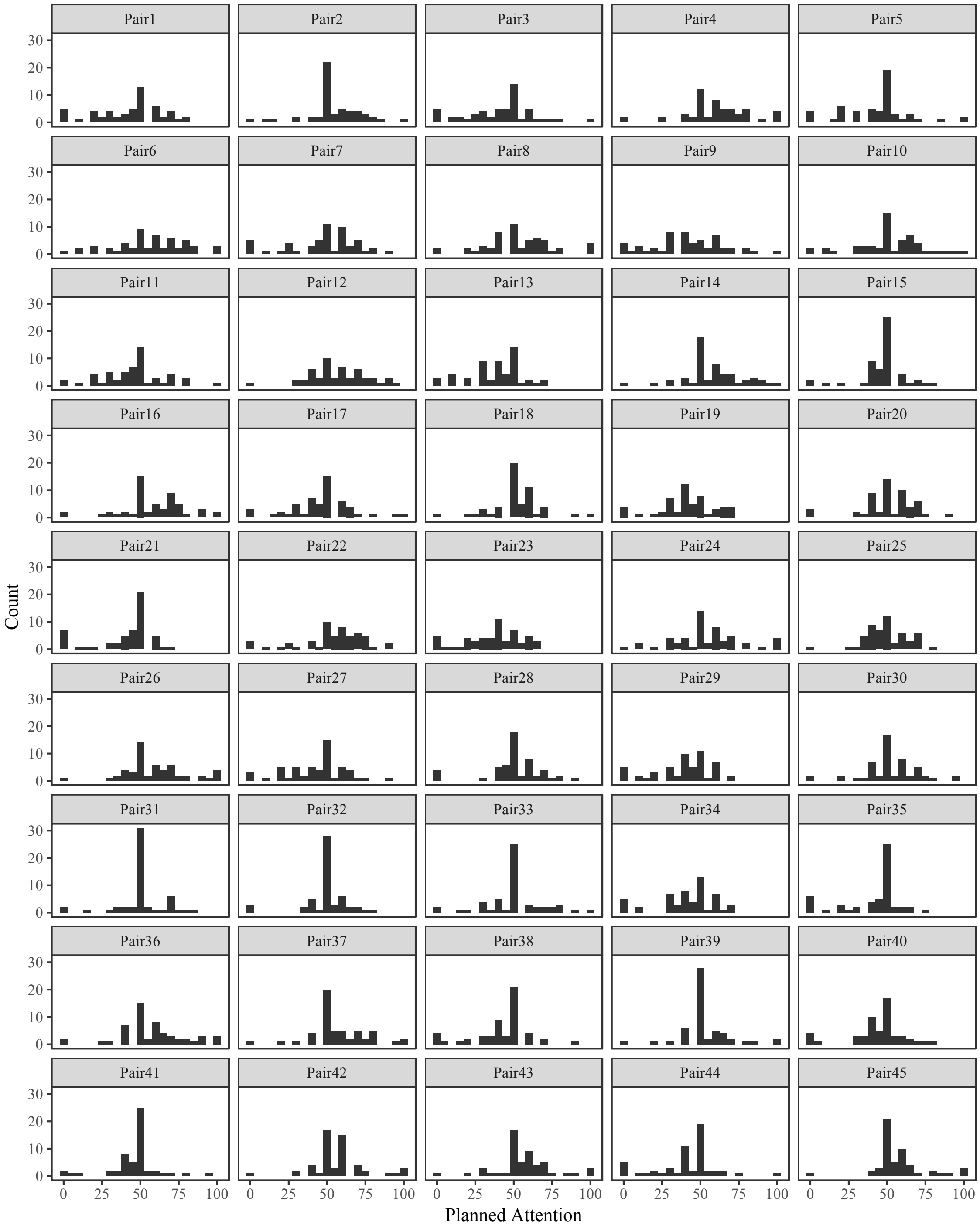
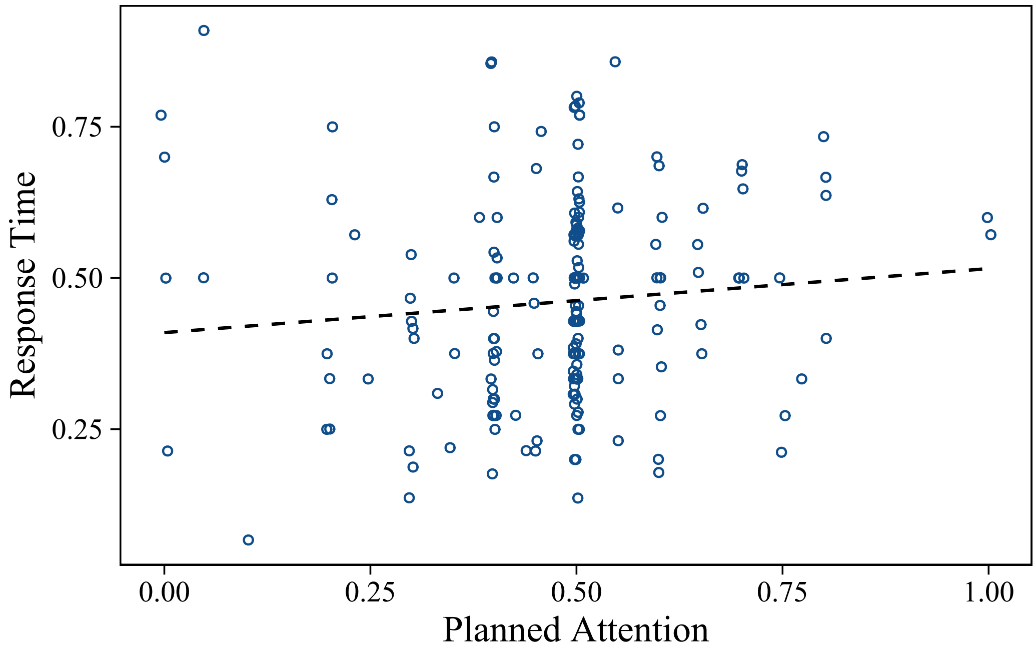


Figure 12: Planned Attention vs Response Time



I Time Allocation Treatment

Instructions

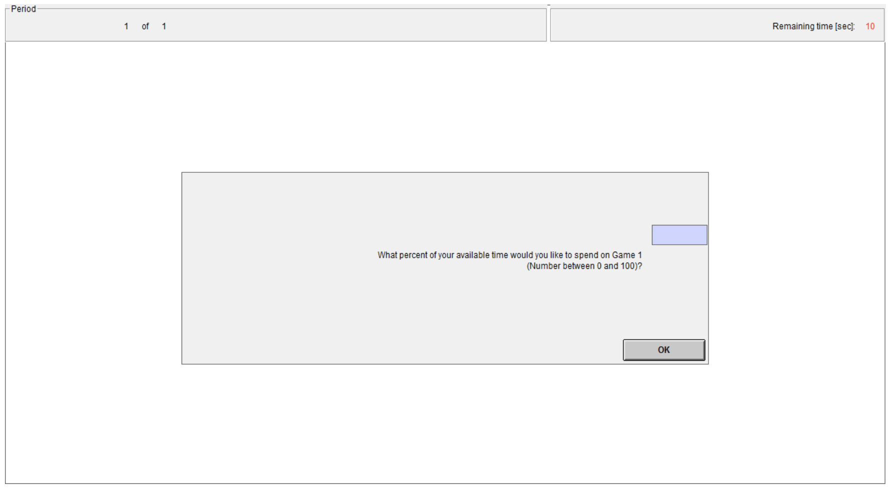
This is an experiment in decision making. Funds have been provided to run this experiment and if you make good decisions you may be able to earn a substantial payment. The experiment will be composed of two tasks which you will perform one after the other.

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).

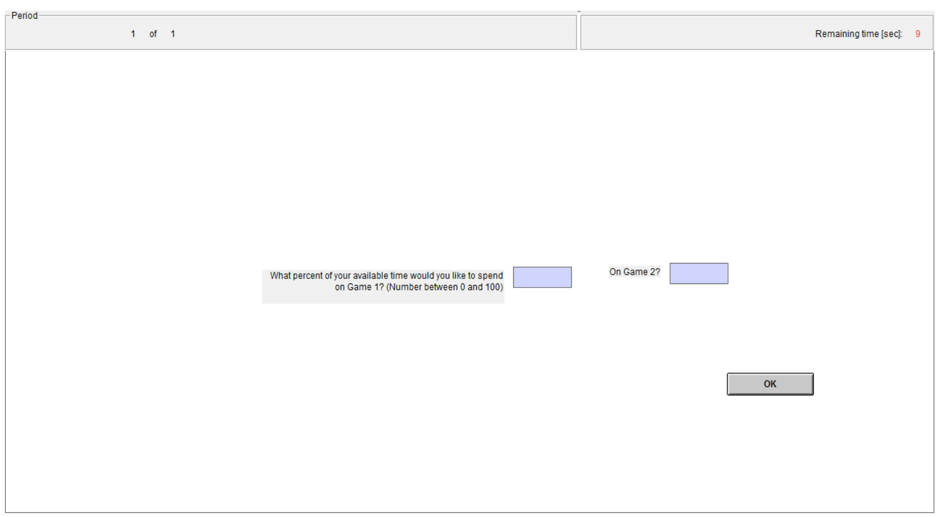
You will be given 10 seconds to enter this number and remember this will represent the fraction of the X minutes you want to use in thinking about Game 1. If there are two games and you allocate 70 for Game 1, then you will automatically have 30 for Game 2. (If there are ever three games on the screen, 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.

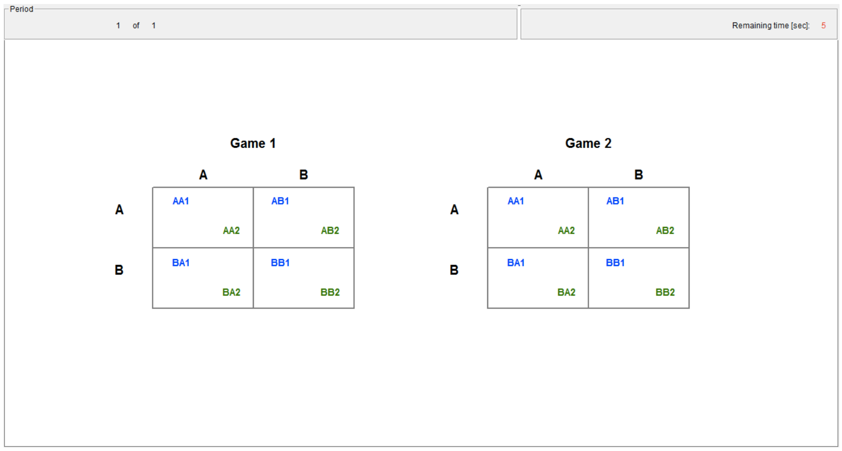
If you were shown three games your entry screen will appear as follows:



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.

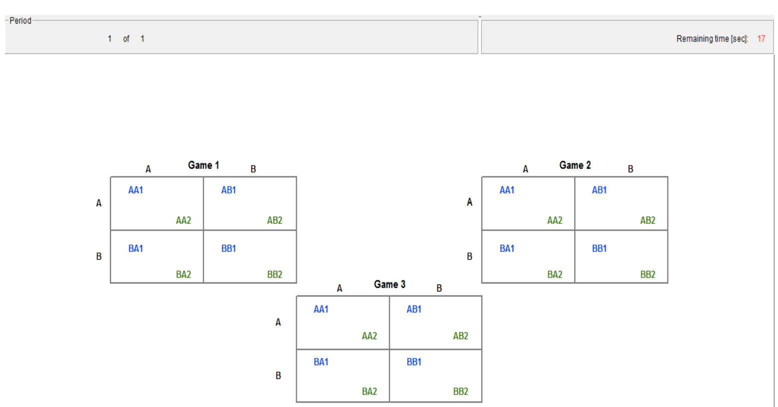
As we said above, in the first 40 rounds you will be asked to allocate time between two games represented as game matrices which will appear on your computer screen as follows:



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.***

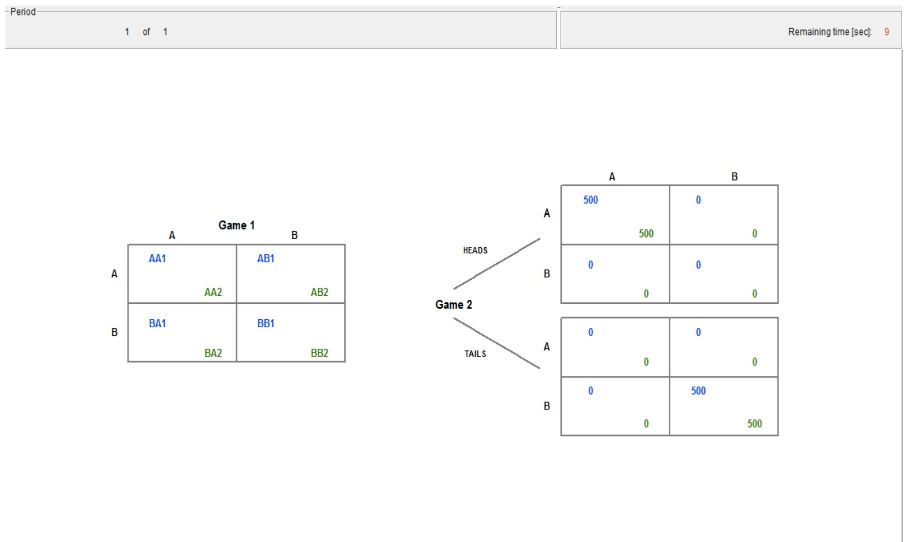
Take Game 1. In this game you have two choices A and B. The entries in the matrices describe your payoff and that of your opponent depending on the choice both of you make. For example, say that you and your opponent both make choice A. If this is the case the cell in the upper left hand corner of the 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:



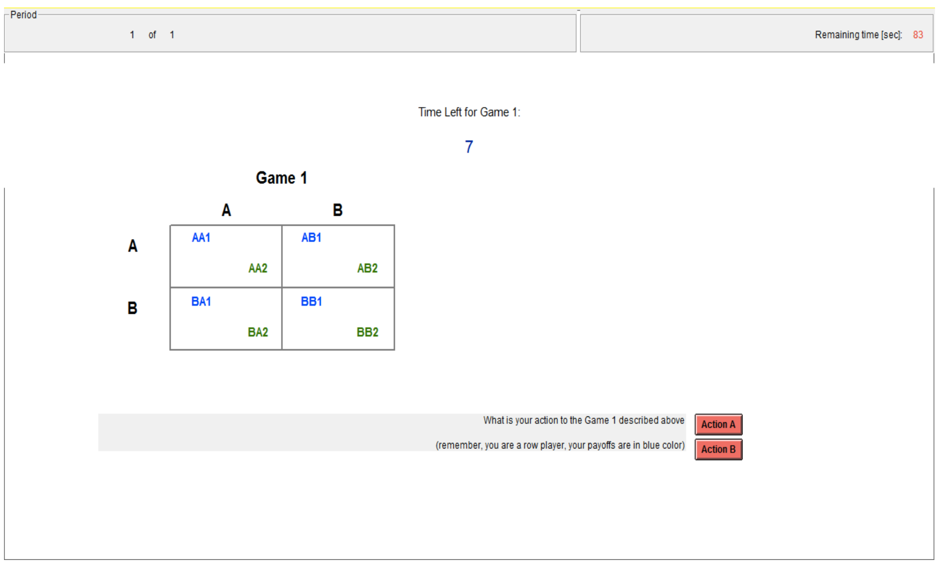
What this says is that you will need to decide between allocating your time between Game 1, which is a type of game you are familiar with, or Game 2 which is our Lottery Game. Game 2 is actually simple. It says that with probability ½ you will play the top game on the screen and with probability ½ you 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.