Behavioral Spillover in Cooperation Games*

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Abstract

Previous literature has established that spillover effects exist when multiple games are played simultaneously, whether facing the same partner(s) or not. This study experimentally investigates behavioral spillovers between two social dilemma type games. In our experiments, subjects play Prisoner's Dilemma game (PD) and Public Goods game (PGG) simultaneously, where the opponents of the two games do not overlap. We vary the level of strategic uncertainty in PD game and test how this affects subject's contributing behavior in PGG, which is held constant across treatments. We find that behavioral spillover exists in our setting and comes in an asymmetric form. When people are in an environment where cooperation is easy to sustain in the PD game, the PGG contributions do not increase much, compared to the baseline treatment when the PGG is played alone. However, when in the setting where cooperation is difficult to sustain in the PD game, PGG contributions decrease significantly.

Keywords: behavioral spillover, indefinitely repeated games, public goods game, indefinitely repeated prisoner's dilemma, strategic uncertainty

JEL Codes: C91, H41, C73

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1 Introduction

In our daily lives, we frequently encounter diverse social interactions with individuals or groups in various strategic contexts. These interactions may involve distinct settings, such as group decision-making scenarios or one-on-one encounters. The intriguing question arises: how does our experience in one particular setting influence our behavior in another setting? Consider the following scenario as an illustrative example: Imagine an individual who starts their day with a distressing encounter at the Department of Motor Vehicles (DMV), where they have an unpleasant experience with an officer. Later, at their workplace, a colleague unintentionally makes a mistake. In this situation, it is likely that the individual, influenced by their negative encounter at the DMV, will be less forgiving towards their colleague's mistake than if they had not experienced the earlier negative interaction. This example highlights the relevance and interest in understanding how experiences in one setting can affect behaviors in different contexts.

This study aims to explore the impact of experience in one strategic game, particularly the Prisoner's Dilemma (PD) game, on the behavior of individuals in a simultaneously played game, namely the Public Goods game (PGG), where the partners involved in the two games do not overlap. Specifically, the research question addressed is as follows: How does the experience gained in the PD game, particularly in a highly cooperative environment compared to a difficult-to-cooperate environment, influence the contributing behavior of agents in the PGG? By examining the influence of different game experiences on behavior in a distinct but simultaneous game, this study aims to shed light on the dynamics of behavioral spillover and the interplay between two social dilemmas.

The concept of behavioral spillover is central to understanding the observed differences in individual or group behavior when a game is played together with other games, compared to when the same game is played alone (Cason et al., 2012). Spillover effects have been identified in situations where multiple games are played simultaneously or sequentially (Bednar et al., 2012; Cason et al., 2012; Savikhin and Sheremeta, 2013; Cason and Gangadharan, 2013; Godoy et al., 2013; McCarter et al., 2014). Furthermore, treating one game can have spillover effects on an untreated game. Previous studies have examined spillover effects in the context of the same two public goods games, such as attempting to change agents' contributing behavior in one game through different incentive schemes (Krieg and Samek, 2017) or enforcing cooperation through an institution, which then spills over to an untreated game (Engl et al., 2021). Other studies have explored spillover effects across different games but in a sequential manner, demonstrating how changing the nature of one game can influence subjects' behavior in a subsequent game (Cassar et al., 2014; Peysakhovich and Rand, 2016; Stagnaro et al., 2017). This study contributes to the existing literature by providing empirical evidence of spillover effects across simultaneously played games, offering insights into the dynamics of behavioral spillover in this specific context.

In addition to the literature on behavioral spillover, this study is also relevant for research on the Public Goods game experiments. Previous studies have investigated various mechanisms to improve contribution levels in a single PGG, including recognition (Andreoni and Petrie, 2004; Savikhin Samek and Sheremeta, 2014), sanctions (Fehr and Gächter, 2000; Andreoni et al., 2003; Masclet et al., 2003; Sefton et al., 2007), and altering the cost of contributing (Palfrey and Prisbrey, 1997; Goeree et al., 2002). However, the spillover effects of these effective mechanisms to another untreated PGG remain understudied. Krieg and Samek (2017) found that bonus incentives conditioned on contributions in a treated game did not spill over to an untreated game. Moreover, periods where recognition had a positive effect on contributions in the treated game were associated with a negative effect on contributions in the untreated game. The sanctioning mechanism in the treated game had a negative spillover effect on the untreated game. This study contributes to this body of literature by exploring an effective mechanism to indirectly influence contributing behavior in an untreated Voluntary Contribution Mechanism (VCM) Public Goods game (PGG).

To answer the research question, we designed our experiment to include a single game treatment (*PGG-only*) and two simultaneous treatments (*Sim-Easy* and *Sim-Difficult*) where participants make decisions for both the PGG and PD games at the same time. The difference between the two simultaneous treatments lies in the difficulty to sustain cooperation in the PD game. We adopted an indefinitely repeated setting, which closely resembles real-life interactions and guards against potential end-game effects that could arise in finitely repeated interactions.

In terms of our main results, we find compelling evidence of spillover effects between the PD game and the PGG. To determine the direction of spillover in our study, we employed the entropy measure, as initially proposed by Bednar et al. (2012), which allowed us to investigate the flow of influence between two simultaneously played games. More extensive details regarding this measure will be discussed later. Interestingly, the direction of spillover is unidirectional, with influences flowing from the PD game to the PGG. Specifically, high levels of cooperation in the PD game do not generate a corresponding positive spillover effect on PGG contribution, while low levels of cooperation in the PD game have a negative spillover effect on PGG contribution.

These findings shed light on the interconnected nature of strategic decision-making across different game settings and highlight the influence of cooperative or non-cooperative behavior in one game on behavior observed in another game, particularly in the context of simultaneous game play. Furthermore, our methodological approach, which involves both single-game and simultaneous-game treatments within an indefinitely repeated framework, represents a novel contribution to the literature on Public Goods Games. To our knowledge, this approach has only been explored in prior studies such as Lugovskyy et al. (2017) and Kawamura and Tse (2022). It is worth noting that the distinction lies in the complexity of the Public Goods Games, as their models involve binary choices, in contrast to ours, which encompass a more expansive strategy space.

In summary, our study contributes to the understanding of how experiences in one game impact behavior in another simultaneously played game, providing insights into the dynamics of strategic decision-making and the potential spillover effects between different game environments.

The remainder of the paper is structured as follows: Section 2 summarizes the related literature on behavioral spillover and the Public Goods game experiments. Section 3 describes the experimental design and procedures. Section 4 presents the hypothesis development to test our research question. Section 5 provides the results of the study, elucidating the spillover effects and its directionality. Finally, Section 6 concludes the paper, summarizing the key findings, discussing their implications, and suggesting avenues for future research.

2 Related Literature

Behavioral spillover refers to the phenomenon where the behavior and decision-making in one context influence and spill over to another context. In the field of economics, understanding behavioral spillover across different games played simultaneously has gained significant attention. While previous research has explored spillover effects between sequentially played games (Albert et al., 2007; Cason et al., 2012; Cason and Gangadharan, 2013; Cassar et al., 2014; Peysakhovich and Rand, 2016; Stagnaro et al., 2017; Cason et al., 2019; Engl et al., 2021), there is a growing interest in investigating spillover effects when games are played simultaneously, particularly when the group members of the games do not overlap. Our study is most related with Bednar et al. (2012), Falk et al. (2013), McCarter et al. (2014), Krieg and Samek (2017) and Angelovski et al. (2018).

Bednar et al. (2012) conducted an experimental study to investigate behavioral spillover and cognitive load in a class of infinitely repeated two-person binary action games with overlapping player sets. By positioning four players on a circle and measuring behavioral variance using entropy, they found that cognitive load had the greatest effect in games with high entropy, while games with low entropy generated the largest spillovers onto games with high entropy. The study sheds light on the interplay between cognitive factors and behavioral spillover in simultaneous game play, providing insights into decision-making processes and the mechanisms through which behaviors spill over across games.

Falk et al. (2013) conducted a study examining social interaction effects in a coordination game and a cooperation game. The cooperation game consisted of two identical linear three-person public good games with one common player interacting repeatedly with two different co-player sets. While the authors observed evidence of social interaction effects, with participants tending to contribute more to the group that had contributed more in the previous period, they did not find a statistically significant difference in average contributions between their two-group design and the control treatment with a single group. It is worth noting that their study differed from our setting as participants were not aware of being part of a larger matching group and the games played are identical.

McCarter et al. (2014) investigated how individuals behave when facing multiple simultaneous public goods games. The study compared the divided-loyalty hypothesis and the conditional-cooperation hypothesis and found support for the latter. Their study suggested that interacting with different group members provided an opportunity for participants to shift their cooperative behavior from less cooperative to more cooperative groups.

Krieg and Samek (2017) examined the effects of competition among charities in simultaneous public goods games experiments. They varied the incentives for contributing in one of the games and measured the effect on contributions in both games. The study showed that conditional bonuses increased contributions in treated game did not spillover to the untreated game, while non-monetary incentives such as recognition and sanctions had mixed effects.

Angelovski et al. (2018) studied behavioral spillovers across public goods games with different MPCRs. They explored the contributions between structurally independent public goods games shared with left and right neighbors in a circular neighborhood. Their study confirmed through behavioral spillovers that individual contributions were anchored on the public goods game with the smaller free-riding incentive, promoting higher levels of voluntary cooperation in another public goods game.

Less related are the study across different types of games but are sequentially played. Cason and Gangadharan (2013) examined the occurrence of behavioral spillovers between a cooperative setting, characterized by a threshold public good game, and a competitive environment represented by a double auction market. They found that in the absence of communication, cooperation levels in the provision of public goods are diminished when subjects had a previous experience in double auction market. However, there is no observable evidence suggesting that cooperation in the public good game has a subsequent impact on price competition. Peysakhovich and Rand (2016) conducted an experiment where participants were exposed to environments that either facilitated or hindered cooperation through repeated Prisoner's Dilemma games. Subsequently, the researchers evaluated the participants' intrinsic prosocial tendencies in one-shot games. Their findings indicated that individuals who were exposed to cooperative environments displayed higher levels of prosocial behavior, were more inclined to punish selfishness, and exhibited greater overall trust. This study differs from the above studies in that we employed an indefinitely repeated setting and the two games are played simultaneously. This allows us to investigate both the spillover and the learning effect of it without suffering from the end-game effect.

3 Experimental environment, design and procedures

In this section, we describe the games included in our study and then provide a detailed description of our experimental procedures.

3.1 Prisoner's dilemma and public goods games

The aim of this study is to examine behavioral spillover effects between related games when they are played simultaneously. Specifically, we investigate whether players' behavior in the Public Goods game is influenced by their simultaneous play of the Prisoner's Dilemma game. Additionally, we are interested in exploring the impact of different levels of cooperation in the Prisoner's Dilemma game on players' behavior in the Public Goods game. For these reasons, we consider the following Public Goods game and Prisoner's Dilemma game.

In the Public Goods game (PGG), we consider a simple linear Voluntary Contribution Mechanism (VCM) where a group of N agents each receives an endowment of e tokens at the beginning of a period. Each agent decides how much of their endowment to allocate to a public account, denoted by m_i, and how much to a private account, denoted by $e - m_i$, where $m_i = 0, 1, ..., e$. An agent receives a payoff of 1 point for each token they allocate to their private account, and their contribution m_i to the public account is multiplied by a marginal per-capita return ($MPCR$) parameter, which distributes the total contribution to the public account equally among all N individuals in the group. Hence, an agent's total payoff in points is determined as follows:

$$\Pi_i(m_1, m_2, ..., m_N) = e - m_i + MPCR * \sum_{j=1}^{N} m_j$$

For our experiment, we set the parameters of the Public Goods game to $N = 4$, $e = 25$, and $MPCR = 0.4$. Hence, the payoff of player i is given by:

$$\Pi_i = 25 - m_i + 0.4 * \sum_{j=1}^{4} m_j$$

In the Prisoner's Dilemma (PD) game, the payoffs in the stage game are presented in Table 1 in points. The payoff for cooperation takes one of two values: R=32 or R=48.

Table 1: stage game payoffs for prisoner's dilemma game

	C	D
C	R, R	12, 50
D	50, 12	25, 25

In our experiment, both the the Public Goods game and Prisoner's Dilemma (PD) game were played within the context of an indefinite time horizon. In this setting, the games will continue with a predetermined probability after each round. More details regarding implementation specifics will be provided later.

3.2 Experimental procedures

The experiment was conducted at the Vernon Smith Experimental Economics Laboratory (VSEEL) at Purdue University (PU) using the software o-Tree (Chen et al., 2016). All the subjects were students recruited from the general PU undergraduate population. A total of 192 subjects participated 24 sessions, with 8 participants in each session. Experimental sessions lasted about one hour and thirty minutes and subjects received an average payment of $20 for their participation. Instructions were read out loud by the experimenter at the beginning of each session (see Appendix B for instructions). Subjects then answered a set of incentivized quiz questions to examine and reinforce their understanding of the instructions. In each session, subjects participated in two tasks, where the first task is the main task of our experiment and the second task elicited their risk attitudes using a multiple price list consists of 5 simple lotteries. At the end of each experimental session, one out of the 5 lottery decisions was randomly selected for payment.

We conducted three treatments as summarized in Table 2: a control treatment where the subjects only play PGG in the main task (*PGG-only*), two treatments in which PGG and PD game were played simultaneously (*Sim-Easy* and *Sim-Difficult*). The only difference *between* *Sim-Easy* and *Sim-Difficult* was the mutual cooperation payoff (R) of the PD games.

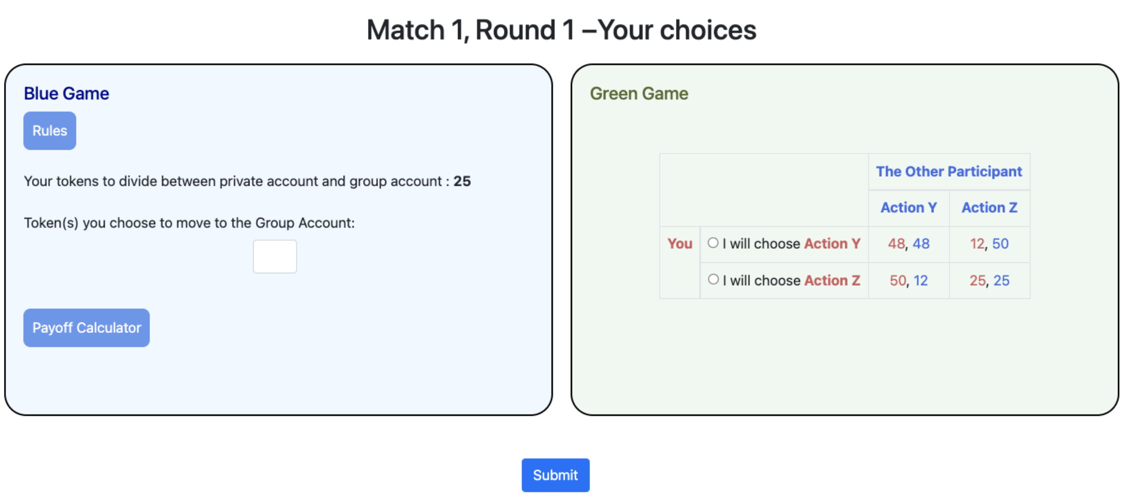
Table 2: Summary of treatments

Treatment	Game 1	Game 2	# of sessions	# of subjects
Sim-Easy	Easy PD (R=48)	PGG	10	80
Sim-Difficult	Difficult PD (R=32)	PGG	10	80
PGG-only	n/a	PGG	4	32

We induce infinitely repeated game in the lab by using Block Random Termination (BRT) method (Fréchette and Yuksel, 2017) with $\delta = 0.75$ and block size = 4. Subjects play the game(s) in blocks of 4 rounds. The probability that any of these 4 rounds are payoff relevant is given by the geometric distribution with δ. If the match does not end within the first block of 4 rounds, then an additional block of 4 rounds is played, and so on. The BRT method allows us to observe longer interactions but did not alter subjects behavior much (Fréchette and Yuksel, 2017).

In PGG, subjects were randomly assigned to a group of n=4 players at the beginning of each match. The groups were reshuffled after each match. This matching protocol applies to the public goods game in all treatments. In simultaneous treatment *Sim-Easy* and *Sim-Difficult*, subjects were also randomly paired with a participant to play PD game at the beginning of each match and new pair is randomly assigned for the next match. We explicitly told subjects and ensured that the opponent of the PD game did not overlap with any of the group members in the PGG for a certain match.

In *Sim-Easy* and *Sim-Difficult* treatments, the PD game and the PGG were displayed side by side on the same screen, as shown in Figure 1. Subjects chose an action for the prisoner's dilemma game and typed their public goods contribution, and clicked "submit" at the bottom of the screen. The results of each game were also displayed side by side on the same screen - the opponent's choice and earning were displayed for the PD game, and the group total contribution and earning were displayed for the PGG.



Note: This figure shows how two games were displayed side-by-side on the same screen. The Sim-Easy treatment decision screen is displayed. The game at left is the PGG while the game at right is the PD game.

Figure 1: Screenshot of the games (Sim-Easy Treatment Decision Screen)

At the end of the experiment, earnings from all payoff-relevant rounds were summed up and paid. Subjects also completed a demographic questionnaire at the end of each session.

4 Hypothesis Development

This section first provides theoretical predictions of the public goods game and prisoner's dilemma game when played alone. Next, since formal theoretical models do not provide precise predictions for potential behavioral spillovers, we proceed by providing some conjectures based on previous studies.

4.1 Indefinitely repeated public goods game

The unique Nash Equilibrium for this game is everyone in the group contributing zero when it is played one-shot. Furthermore, backward induction implies that contributing zero in each round is also the unique subgame-perfect Nash Equilibrium (SPE) of the finitely repeated game. Imposing a probabilistic ending can be seen as an infinite repetition of the stage game. Not contributing is still a SPE outcome of the infinitely repeated game. Suppose sum of group endowments ($Ne = K$) is common knowledge, it's possible to show that if agents are patient enough, full cooperation (contributing all tokens to public account) can be supported as a SPE outcome if agents are patient enough and use the following grim-trigger strategy:[1]

"*Start by contributing all of your tokens to the group account. Contribute fully as long as you observe that the total contribution to the group account is equal to K. If you observe that the total contribution is less than K, contribute 0 to the group account forever after.*"

To prove that this strategy is a SPE, we need to show that no agent has an incentive to deviate on and off the equilibrium path. On the equilibrium path, if agent i follows the

[1]This strategy is first proposed by (Lugovskyy et al., 2017)

strategy, his payoff is given by:

$$\Pi_C = \frac{MPCR \sum_{j=1}^{N} e}{(1-\delta)}$$

If he deviates, he receives a one-shot gain followed by lower future payoffs:

$$\Pi_D = (e + MPCR \sum_{j \neq i} e) + \frac{\delta}{1-\delta} e.$$

Hence, an agent has no incentive to deviate on the equilibrium path if $\Pi_C > \Pi_D$ or

$$\delta \geq \frac{(1-MPCR)}{MPCR(N-1)} = \delta^{SPE}.$$

In our choice of parameters ($MPCR = 0.4, N = 4$), the δ^{SPE} that supports cooperation as SPE is 0.5, which is smaller than the chosen $\delta = 0.75$. Furthermore, whether the grim-trigger strategy is supported as an risk-dominant equilibrium (RDE) or not can be a good predictor of the cooperation trend in infinitely repeated Prisoner's Dilemma game experiments (Dal Bó and Fréchette (2018); Blonski et al. (2011)). The threshold value of the continuation probability for grim-trigger to be supported as RDE δ^{RD} is 0.786 for the indefinitely repeated public goods game in our experiment.[2] In summary, cooperation is subgame-perfect Nash Equilibrium (SPE) but not risk-dominant (RD) in the Public Goods game chosen.

4.2 Indefinitely repeated prisoner's dilemma game

Table 3: Prisoner's Dilemma Row Player's Payoffs

	Original			Normalized	
	C	D		C	D
C	R	S	C	$\frac{R-P}{R-P} = 1$	$\frac{S-P}{R-P} = -l$
D	T	P	D	$\frac{T-P}{R-P} = 1+g$	$\frac{P-P}{R-P} = 0$

[2]The procedure to calculate the δ^{RD} is shown in Appendix A

We could normalize the payoff matrix of any prisoner's dilemma game according to table 3, which reduces the payoff parameters to only two: g represents the gain from defection when partner cooperates and l is the loss from cooperation when partner defects. The minimum δ required to support mutual cooperation in a SPE can be calculated as the following (Dal Bó and Fréchette, 2018):

$$\delta^{SPE} = \frac{g}{1+g}$$

Furthermore, the condition for cooperation to be part of a risk-dominant equilibrium (RD) of the normalized game is given by:

$$\delta \geq \delta^{RD} = \frac{g+l}{1+g+l}$$

Table 4: Cooperation as Equilibrium (SPE) and Risk Dominant (RD) Action

	R=32	R=48
δ^{SPE}	0.72	0.08
δ^{RD}	0.82	0.39
$\delta = 0.75$	SPE	SPE and RD

Table 4 shows the games under which cooperation can be supported as SPE or RD. Dal Bó and Fréchette (2018) finds that when cooperation is risk dominant average cooperation is substantially higher. Our Hypothesis 1 follows from that:

Hypothesis 1 *Cooperation rate for R=48 Prisoner's Dilemma game in Sim-Easy treatment is larger than the cooperation rate for R=32 Prisoner's Dilemma game in Sim-Difficult treatment.*

4.3 Direction of behavioral spillover

Spillover occurs when there is a noticeable change in behavior, whether at an individual or group level, when a game is played in conjunction with other games, as opposed to when it is played in isolation. When two games are played simultaneously, behavior in one game can spill over to another (Bednar et al., 2012; Savikhin and Sheremeta, 2013; Falk et al., 2013; Cason et al., 2012; Godoy et al., 2013; McCarter et al., 2014; Krieg and Samek, 2017; Angelovski et al., 2018; Engl et al., 2021). A question to be addressed first is the direction of the spillover. To be more specific, it is important to determine whether it is the Prisoner's Dilemma game influencing agents' contribution behavior in Public Goods game or vice versa. In this section, we will provide two potential conjectures regarding the direction of the behavioral spillover based on previous literature.

Behavioral Spillover Conjecture

The PD game and the PGG are similar since they are both social dilemmas where the Nash Equilibria are not Pareto optimal outcomes. However, the PD game has smaller strategy space (2 versus 25 in PGG) and fewer agents to interact with (1 versus 3 in Public Goods game). This leads to significant differences in perceived strategic uncertainty by the agents between the two games, which could have implication for spillovers. Bednar et al. (2012) introduce entropy as an empirical measure of cognitive load which captures the outcome distributions as a dimension of the behavioral variation, or strategy uncertainty, in a game. The entropy of a random variable X with a probability density function, $p(x) = Pr(X = x)$, is defined by

$$H(X) = -\sum_{x} p(x) \log_2 p(x)$$

A higher level of entropy is associated with greater strategic uncertainty. The entropy level of a specific game can be assessed after experimental data have been gathered. Following Bednar et al. (2012), we propose a conjecture that games characterized by lower entropy exhibit a more pronounced behavioral spillover effect on other games with higher entropy. This proposition stems from the notion that learning a strategy or comprehending others' strategies in a game with lower entropy demands less cognitive load.

The entropy of the PD game, regardless of its parameters, ranges from 0 to 2, while the entropy of the PGG with an endowment of 25 ranges from 0 to 6.66. To establish a conjecture regarding the direction of behavioral spillover, it is essential to compare the relative levels of entropy between the two games examined in this study. To accomplish this, we estimated the entropy of the PD games using data from Dal Bó and Fréchette (2011), and the entropy of the PGG using data from Lugovskyy et al. (2017).

Table 5: Entropy for Prisoner's Dilemma game (PD) and Public Goods game (PGG)

	PD ($\delta = 0.75$)		PGG ($\delta = 0.8$)
	$R = 32$	$R = 48$	$n = 4, e = 25, MPCR = 0.3$
Obs	6448	6284	992
Mean	20.3%	76.4%	20.5%
Std. dev.	0.40	0.43	19.46
Entropy	**1.36**	**1.34**	**5.52**

Data source: Entropy of PD is calculated using data from Dal Bó and Fréchette (2011), and PGG used data from Lugovskyy et al. (2017).

As shown in 5, calculations from similar previous games played in isolation suggest that the entropy for the Public Goods game is higher than both of the Prisoner's Dilemma games. Hence, we conjecture that the behavior in the Prisoner's Dilemma game would spill over to the Public Goods game when the two games are played simultaneously in the *Sim-Easy* and *Sim-Difficult* treatments.

Hypothesis 2a *The average contribution level of the Public Goods game in Sim-Easy treatment will be **higher** than that of the Sim-Difficult treatment.*

Moral Licensing Conjecture

Moral licensing, extensively examined in the field of psychology, refers to the phenomenon where individuals, having recently performed virtuous acts, exhibit a greater propensity for subsequent morally compromised behavior (Blanken et al., 2015). If this holds true, a higher cooperation observed in the Prisoner's Dilemma game could potentially lead to diminished contributions in the Public Goods game.

Hypothesis 2b *The average contribution level of the Public Goods game in Sim-Easy treatment will be **lower** than that of the Sim-Difficult treatment.*

In summary, Hypotheses 2a and 2b represent two competing conjectures derived from existing literature, and our experimental investigation will serve to determine which of these hypotheses holds true in the context of behavioral spillover in our study.

5 Results

5.1 Main results – behavioral spillover

This section aims to address our primary research question, namely whether the experience of participating in a PD game that is easy to cooperate with or difficult to cooperate with would have an impact on an agent's contribution behavior in the simultaneously played PGG. Our findings reveal that the experience of playing the PD game does indeed affect the PGG contribution level of the participants. Specifically, we observed that in a less cooperative PD environment (Sim-Difficult treatment), the participants' contribution level to the PGG is significantly lower than the baseline PGG-only treatment. However, we did not detect any discernible effect on their contribution behavior when the agents were in the Sim-Easy treatment. Thus, we conclude that the behavioral spillover effect is asymmetrical in nature.

Upon analyzing the average PGG contribution and PD cooperation across treatments, as depicted in Figure 2, we identified the following significant results. Firstly, the PD cooperation rate in the *Sim-Easy* treatment was significantly higher than that of the *Sim-Difficult* treatment, which aligns with Hypothesis 1. Hypothesis 1 predicts that the cooperation rate will be higher when cooperation is risk-dominant. In our study, cooperation is risk-dominant in the *Sim-Easy* treatment (R=48) but not in the Sim-Difficult treatment (R=32).

RESULT 1 *PD cooperation has the following relationship in simultaneous treatments: Sim-Easy* $>^{***}$ *Sim-Difficult.* [3]

Secondly, in terms of PGG contribution rates, we observed a significant relationship across

[3]Test between treatments are carried out using Wilcoxon rank-sum test. Mean PD cooperation of a participant is one observation. Number of observations is 80 for both simultaneous treatments.

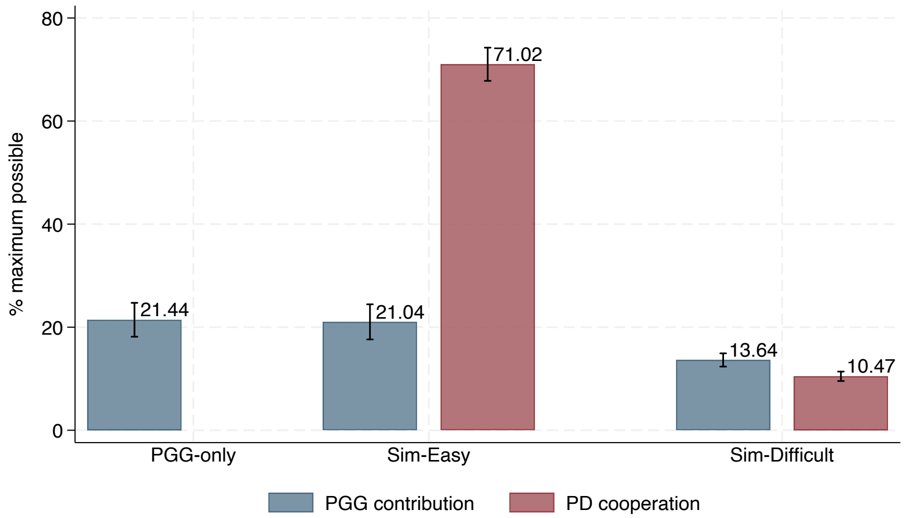


Figure 2: Average PD cooperation and PGG contribution across treatments (all rounds). *Notes*: Error bars are bootstrapped.

treatments. The *PGG-only* treatment displayed no significant difference of PGG contribution rates to the *Sim-Easy* treatment, while the *Sim-Easy* treatment exhibited significantly higher PGG contribution rates compared to the *Sim-Difficult* treatment[4]. These findings are consistent with Hypothesis 2a derived from existing experimental literature on behavioral spillover. Hypothesis 2a posits that when cooperation in the PD game is higher, the PGG contribution rate will also be higher, as behavior in the PD game spills over to the PGG.

RESULT 2 *PGG contribution has the following ranking in treatments:*
PGG-only $\backsim$ *Sim-Easy* $>^{***}$ *Sim-Difficult.* [5]

When examining the round 1 contribution rate in the PGG over all twenty matches, several notable patterns emerge. First, Figure 3 illustrates a distinct declining trend in the

[4] We aggregated average PGG contribution over matches by treatments and carried out Mann-Whitney tests of pairwise difference between treatments. Difference of PGG contribution between Sim-Easy and Sim-Difficult are statistically significant at 1 percent level whereas PGG-only and Sim-Easy are not statistically different. One match is one observation, number of observations is 200 for both simultaneous treatments and 80 for PGG-only.

[5] Test between treatments are carried out using Wilcoxon rank-sum test. Mean PGG contribution of a participant is one observation. Number of observations is 80 for both simultaneous treatments and 32 for PGG-only treatment.

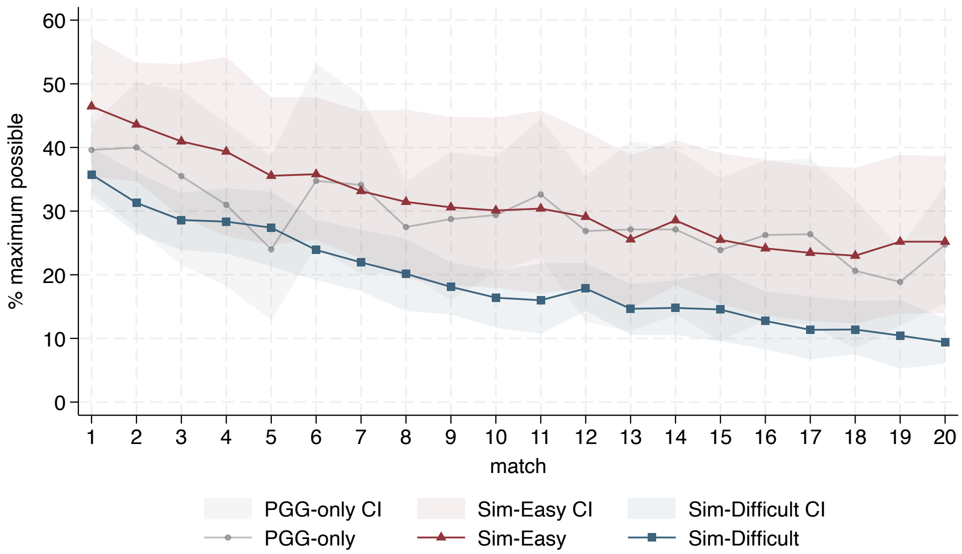


Figure 3: First round PGG contribution over matches: percentage of maximum possible. *Notes*: 95% bootstrapped confidence intervals are superimposed.

PGG contribution rate for all treatments. This indicates a general decrease in contributing trend as the matches progress. Second, it is evident from the data that the difference in round 1 PGG contribution between the Sim-Easy and Sim-Difficult treatments is noticeable from the first match and remains consistent throughout the twenty matches. This highlights a persistent difference in contributing behavior between the two treatments. Third, it is worth noting that the gap in contribution rates between the two treatments remains relatively stable over the entire duration of the experiment. This suggests that learning from past PD games does not substantially influence participant's contributing decision; otherwise the gap would become larger as matches proceed.

RESULT 3 *Round 1 PGG contribution:*

a. declines over matches for both simultaneous treatments;

b. is different between Sim-Easy and Sim-Difficult.[6]

[6]Test between treatments are carried out using Wilcoxon rank-sum test. Mean PGG contribution of a participant in first rounds is one observation. Number of observations is 80 for both simultaneous treatments. Test result is statistically significant at 5% level.

Table 6: Average PGG contribution condition on PD decision

	mean PGG contribution		
PD decision	Sim-Easy		Sim-Difficult
Defect	0.128	$\backsim$	0.124
	(0.017)		(0.010)
Cooperate	0.251	$\backsim$	0.256
	(0.011)		(0.005)
Total	0.210	$>^{***}$	0.136
	(0.010)		(0.004)

Notes: Bootstrapped standard error in parentheses.

Tests between comparison were carried out using Wilcoxon ranksum test.

$\backsim$ denotes no significant difference.

$>^{***}$ denotes significant difference at the 1% level.

The average contribution in the PGG across all treatments, and its relationship with subjects' decisions in the prisoner's dilemma game, as shown in Table 6, reveals two noteworthy findings. Firstly, regardless of their treatment assignment, subjects tend to exhibit higher average contributions in PGG when they choose to cooperate in the PD game. This suggests a positive association between cooperative behaviors in the two games. Secondly, conditioning on subject's PD decision, there is no significant difference in average PGG contribution rate between Sim-Easy or Sim-Difficult treatments. This seems to suggest that the correlation between PD decision and PGG contribution is very high. It is the different proportion of subjects choosing cooperate of defect in the PD game driving the difference of PGG contribution in these two treatments.

RESULT 4 *The mean PGG contribution is higher when subjects choose to cooperate in PD game for both simultaneous treatments.*

To alleviate potential bias arising from the simultaneity between the dependent variable, current PGG contribution, and one of the predictor variables, current PD choice, we employed a two-stage least squares (2SLS) estimation to investigate other factors that influence PGG contribution level. In the first stage of our 2SLS analysis, we utilized instrumental variables to model and predict the current PD decision. These instrumental variables, including opponent PD decision in the last period, the length of the match, and my own PD decision in the first round of a match, were chosen for their capacity to independently predict current PD decisions while minimizing the influence of unobserved factors that may simultaneously impact current PGG contributions. In addition, Dal Bó and Fréchette (2018) found these to be good predictors for PD choice. The second stage of the 2SLS estimation regressed the current PGG contribution on the predicted current PD decision derived from the first-stage regression, in addition to other covariates. These covariates incorporated other group members' PGG contributions in the last period and subject's PGG contribution in the first round of a match.

Table 7: Determinants of Contributing Behavior (PGG Contribution)

	Sim-Difficult	Sim-Easy	Sim-Difficult	Sim-Easy
Panel A: First Stage (Dependent variable: PD decision)				
Other cooperation	0.248***	0.328***		
	(0.029)	(0.033)		
Other previous cooperation	0.312***	0.495***		
	(0.044)	(0.034)		
Length of last match	0.001	-0.001		
	(0.001)	(0.001)		
Constant	0.031***	0.117***		
	(0.011)	(0.024)		
Panel B: Second Stage				
PD Choice (Instrumented)	0.119**	0.009	0.109**	0.014
	(0.048)	(0.016)	(0.047)	(0.017)
Others previous contribution	0.483***	0.690***	0.488***	0.684***
	(0.057)	(0.064)	(0.051)	(0.061)
Round 1 PGG Contribution	0.111***	0.081**	0.101***	0.063*
	(0.034)	(0.035)	(0.035)	(0.035)
Risk Preference			✓	✓
Gender			✓	✓
Constant	0.005	-0.010	-0.032	0.025
	(0.013)	(0.017)	(0.024)	(0.037)
Observations	7440	7440	7440	7440

Notes: Clustered standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The regression analysis results from Table 7 indicates that individual contribution decisions in PGG were influenced by various factors. Specifically, the current round PGG contribution choice was significantly positively influenced by the average PGG contribution level of other group members in the previous round, suggesting the presence of conditional cooperation. The magnitude of this effect is bigger for the Sim-Easy treatment than the Sim-Difficult treatment. Moreover, the influence of round 1 PGG contribution decision was significant. In both treatments, participants who initially chose to contribute a greater amount in round 1 of a match exhibited persistent contribution decisions that are different from zero in subsequent rounds. Moreover, a participant's cooperation in the current round of PD game did increase his/her PGG contribution in the same round. However, this effect is only statistically significant for Sim-Difficult treatment. Overall, the regression analysis show that own current PD game choice, own round 1 PGG contribution choice and others previous PGG choice have significant impact on participant's current PGG contributing behavior.

5.2 Direction of behavioral spillover

After showing the results that behavioral spillover exists across two simultaneously played games in previous section, we now aim to determine the direction of spillover in two different ways. Firstly, we calculated the entropy of the Public Goods Game (PGG) using data from the *PGG-only* treatment, finding an entropy value of 5.64. This figure aligns with the findings in Lugovskyy et al. (2017) and exceeds the upper bound entropy of the Prisoner's Dilemma (PD) game with any payoff parameters, which is 2. Bednar et al. (2012) conducted laboratory experiments to examine behavioral spillover in indefinitely repeated two-person binary action games. They introduced the entropy metric to measure behavioral variation in normal-form games and found that games with low entropy produced significant spillover effects onto games with high entropy. Therefore, in our study, the direction of spillover is deduced to be from PD game to PGG.

Secondly, to account for the potential influence of the simultaneous PGG play on PD decisions, we compare our $R = 48$ (from Sim-Easy treatment) and $R = 32$ (from Sim-

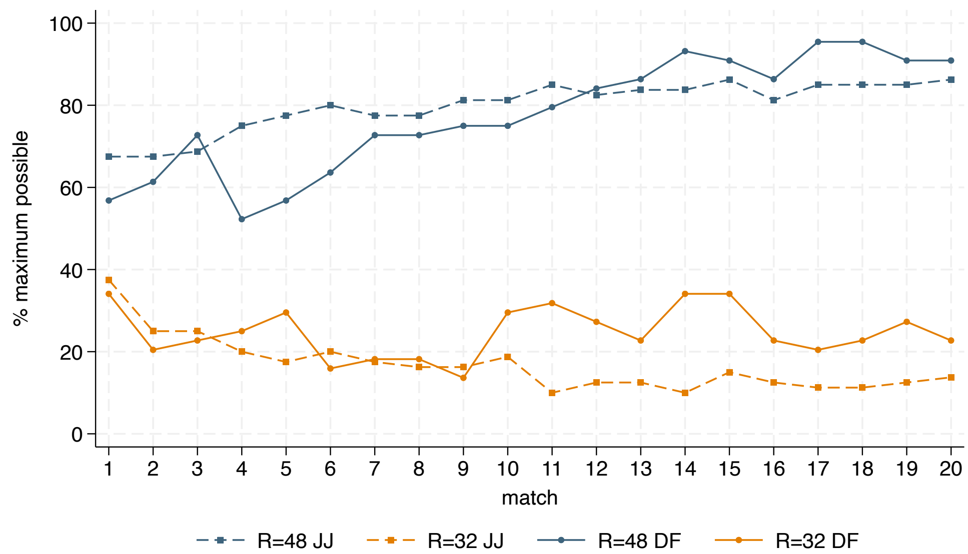


Figure 4: First rounds PD average cooperation trend comparison. *Notes:* JJ stands for this paper and DF means Dal Bó and Fréchette (2011)

Table 8: Determinants of Evolution of Behavior (Round 1 Cooperation)

	Marginal Effects		
	(1)	(2)	(3)
	Pooled Data	JJ	DF
Paper = JJ	-0.032		
	(0.034)		
RD	0.246***	0.249***	0.215***
	(0.032)	(0.037)	(0.059)
Match × RD	0.011***	0.006***	0.022***
	(0.002)	(0.002)	(0.005)
Match × Not RD	-0.003	-0.005**	0.002
	(0.002)	(0.002)	(0.003)
Length of previous Match - E(Length)	0.001	-0.001	0.002
	(0.002)	(0.002)	(0.002)
Other's coop in previous match	0.131***	0.167***	0.042
	(0.019)	(0.026)	(0.026)
Observations	4712	3040	1672

Notes: Clustered standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. JJ denotes this paper and DF denotes Dal Bó and Fréchette (2011).

Difficult treatment) PD data with the $(R = 48, \delta = 0.75)$ treatment and $(R = 32, \delta = 0.75)$ treatment in Dal Bó and Fréchette (2011) respectively. Figure 4 demonstrates that both the

PD games at $R = 48$ and $R = 32$ in both our study (referred to as JJ) and the study by Dal Bó and Fréchette (2011) (referred to as DF) exhibit similar patterns. This observation suggests that the PD game dynamics in our experiment do not seem to be significantly influenced by the concurrent presence of the PGG. To further substantiate this, we employed a probit regression model, as shown in Table 8. Drawing inspiration from Dal Bó and Fréchette (2018), model (1) investigates the effect of several key regressors on round 1 PD choice in each match. Notably, it includes: (i) a paper dummy variable to distinguish between this study and Dal Bó and Fréchette (2011); (ii) a risk dominance indicator (equals 1 if $R = 32$ and 0 if $R = 48$); (iii) trend-related regressors, such as the match number when cooperation is risk-dominant and the match number when cooperation is not risk-dominant; (iv) other relevant variables, including the difference between the length of the previous match and the expected length of a match (set at 4 here) and whether the opponent chose to cooperate in the first round of the previous match. Model (2) and (3) assesses the same relationship (excluding the paper dummy) using data from this study and Dal Bó and Fréchette (2011) respectively.

The results derived from this regression analysis provide no evidence of any statistically significant differences between the PD games in our paper and those reported in Dal Bó and Fréchette (2011). This lends further support to the notion that the concurrent PGG gameplay does not exert a substantial impact on the dynamics of the PD game, as the behaviors remain consistent between the two studies.

By considering these two approaches, we gain confidence in deducing the direction of behavioral spillover is from PD to PGG in our study, while also establishing that PD decisions in our experiment are not significantly influenced by the simultaneous presence of the PGG.

RESULT 5 *The direction of behavioral spillover is from PD game to PGG.*

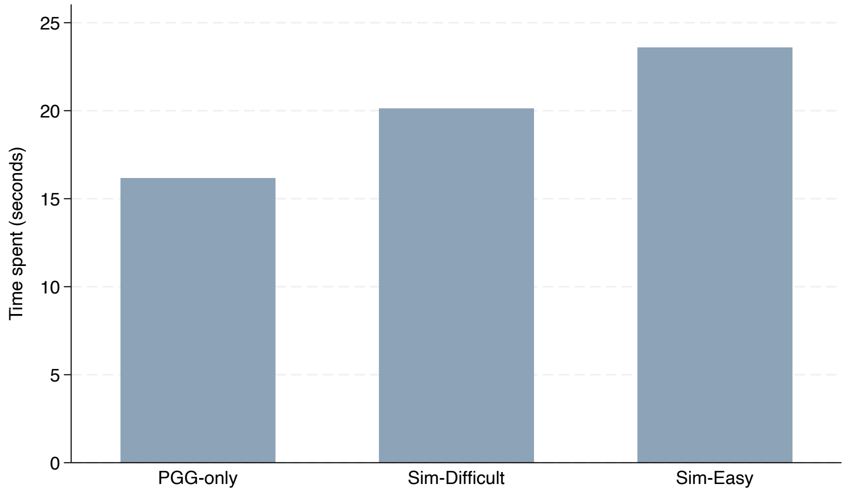


Figure 5: Average seconds spent in each round across treatments

5.3 Secondary results: Time allocation and contributor types

In this section, we present some secondary results. For the first secondary result, when examining the average time spent in each round, differences among treatments were observed. As depicted in Figure 5, subjects allocated significantly less time to the *PGG-only* treatment compared to the *Sim-Difficult* treatment, while the *Sim-Difficult* treatment showed significantly less time allocation compared to the *Sim-Easy* treatment. Since subjects in *PGG-only* treatment make decisions only for one game in each round, it is not surprising that this treatment takes the least time. This discrepancy in time allocation between the two simultaneous treatments can be attributed to the fact that cooperation is not the risk-dominant strategy in the Sim-Difficult treatment , leading more subjects to defect initially in the PD game and defection was quickly spread to the whole session. When observing that everyone is defecting, it is a fast decision to make for subjects to choose defect in a round.

The second secondary result focuses on the distribution of different PGG contributor types. Figure 6 shows the distributions across treatments, revealing an interesting pattern. Specifically, the distribution of the *Sim-Difficult* treatment exhibits a greater skewness towards the left, indicating a higher proportion of subjects contributing less than 25% of their endowment compared to both the *PGG-only* and *Sim-Easy* treatments. This finding sug-

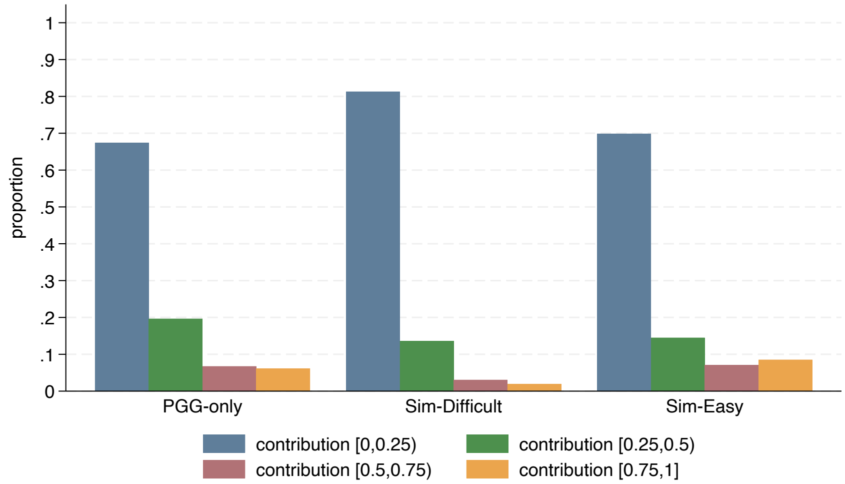


Figure 6: Distribution of PGG contributor types

gests that the experience of encountering a low level of cooperation in the PD game may have influenced subjects to contribute less even when they voluntarily chose to contribute in the PGG. In other words, the exposure to a environment with reduced cooperation decreases the level of contribution of contributors.

6 Conclusion

In conclusion, this study explored the phenomenon of behavioral spillover in the context of two simultaneously played games, specifically the Prisoner's Dilemma (PD) game and the Public Goods (PGG) game. The findings provide empirical evidence of behavioral spillover effects across different games played at the same time. We observed that the experience of cooperation or defection in the PD game had a significant influence on participants' contribution decisions in the PGG game. Importantly, the effect of behavioral spillover was asymmetric; while high cooperation in the PD game did not positively impact PGG contribution, low cooperation in the PD game led to a significant negative spillover effect on PGG contribution. These results contribute to our understanding of behavioral spillover across different games in indefinitely repeated settings. This study extends the existing literature on the Public Goods game by exploring the indirect mechanisms that influence contribution behavior in the PGG. It offers insights into the spillover effects of different incentive schemes and demonstrates that the impact of these mechanisms on untreated games may not align with expectations. The findings contribute to our understanding of behavioral spillover and have implications for designing effective mechanisms to promote cooperation in various social and economic settings.

The current study has limited variation of parameters in PD games, and the PGG is consistent across treatments. Future research could explore a broader range of parameter variations in the PD games and consider diverse settings for the PGG to investigate potential additional results and insights. Another limitation is that this study did not employ a strategy frequency estimation method, a common approach in the literature of indefinitely repeated Prisoner's Dilemma games (Fudenberg et al., 2012; Dal Bó and Fréchette, 2011, 2018, 2019; Romero and Rosokha, 2018, 2023). While Kawamura and Tse (2022) has utilized this method for indefinitely repeated PGGs, it focused on binary PGG decisions. As the PGG decisions in our experiment are not binary, similar methods could not be applied. This limitation is notable since the PGG-only treatment and Sim-Easy treatment displayed very similar results at an aggregate level. Investigating the specific strategies employed by participants in different settings may provide valuable insights and is worth exploring in the domain of indefinitely repeated settings. For future research, a treatment featuring binary PGG decisions could be a valuable addition.

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Appendices

A Calculation of the risk dominant threshold[7]

Using Kim (1996)'s method of calculating the expected payoff , we show the expected payoff using UD and GRIM under the same probability to find the possible RDE strategies that can minimize strategic risk.

Let's consider a game with two pure SPE strategies: UD and GRIM. The possible situations for a given agent are thus all the combinations of that agent playing GRIM or UD against three partners, with k partners playing GRIM and (3-k) playing UD, for any $0 \leq k \leq 3$. We denote the payoff when a player plays GRIM against k partners playing GRIM by α_k and the payoff when a player plays UD against k partners playing GRIM by β_k.

In total, there are four possible scenarios: all three partners choose GRIM, two partners choose GRIM and one chooses UD, one partner chooses GRIM and two chooses UD, and all three partners choose UD. Suppose each partner chooses GRIM with probability p_{GRIM} and UD with probability p_{UD}, where $p_{UD} = 1 - p_{GRIM}$. Following Dal Bó and Fréchette (2011), we assume that each partner chooses GRIM and UD with the same probability such that $p_{UD} = p_{GRIM} = \frac{1}{2}$. The probability of a given player facing with k players choosing GRIM and $3 - k$ players choosing UD is given by the following formula:

$$propability = \binom{3}{k} * {p_{GRIM}}^k * {p_{UD}}^{3-k} = \binom{3}{k} * \frac{1}{2}^k * \frac{1}{2}^{3-k} = \binom{3}{k} * \frac{1}{8}$$

$\binom{3}{k}$ indicates the combinations of selecting k partners choosing GRIM from all three partners. ${p_{GRIM}}^k$ stands for the combined probability of k partners choosing GRIM. p_{UD} stands for the combined probability of $3 - k$ partners choosing UD. Table 9 shows the expected payoff using US and GRIM against the three partners under all scenarios.

Table 9: Expected payoff using the possible SPE strategies (GRIM and UD)

	Partners			
Player i	3GRIM	2GRIM + 1UD	1GRIM + 2UD	3UD
GRIM	$\frac{40}{1-\delta}$	$30 + \frac{25\delta}{1-\delta}$	$20 + \frac{25\delta}{1-\delta}$	$10 + \frac{25\delta}{1-\delta}$
UD	$55 + \frac{25\delta}{1-\delta}$	$45 + \frac{25\delta}{1-\delta}$	$35 + \frac{25\delta}{1-\delta}$	$\frac{25\delta}{1-\delta}$
Probability	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{8}$

GRIM risk dominates UD if

$$\pi_{GRIM} = \sum_{k=0}^{3} \binom{3}{k} (\frac{1}{8}) \alpha_k \geq \sum_{k=0}^{3} \binom{3}{k} (\frac{1}{8}) \beta_k = \pi_{UD}$$

$$\frac{1}{8}(\frac{40}{1-\delta}) + \frac{3}{8}(30 + \frac{25\delta}{1-\delta}) + \frac{3}{8}(20 + \frac{25\delta}{1-\delta}) + \frac{1}{8}(10 + \frac{25\delta}{1-\delta})$$

[7] Adapted from Kawamura and Tse (2022).

$$\geq \frac{1}{8}(55 + \frac{25\delta}{1-\delta}) + \frac{3}{8}(45 + \frac{25\delta}{1-\delta}) + \frac{3}{8}(35 + \frac{25\delta}{1-\delta}) + \frac{1}{8}(\frac{25\delta}{1-\delta})$$

$$\delta^{RD} = \frac{55}{70} \approx 0.786$$

$$\delta^{RD} \approx 0.786 > 0.75$$

B Supplementary Materials for the Experiment

B.1 Sample Instructions (*Sim-Easy* treatment)

Welcome

You are about to participate in an experiment on decision-making. What you earn depends partly on your decisions, partly on the decisions of others, and partly on chance. Please turn off cell phones and similar devices now. Please do not talk or in any way try to communicate with other participants. The experiment will last for around 90 minutes.

We will start with a brief instruction period. During the instruction period you will be given a description of the main features of the experiment. If you have any questions during this period, raise your hand and your question will be answered so everyone can hear. After this instruction, you will be asked to answer several questions testing your understanding of the instruction. Every correct answer will be rewarded \$0.50.

This experiment has two parts; these instructions are for the first part. Once this part is over, instructions for the second part will be given to you. Your decisions in this part have no influence on the other part.

During the experiment, we will refer to earnings in points. Your entire income will first be calculated in points. The point you earn during the experiment will be converted to US Dollar at the end of the experiment, according to the following conversion rate:

$$400 \text{ points} = \$1$$

General Instructions

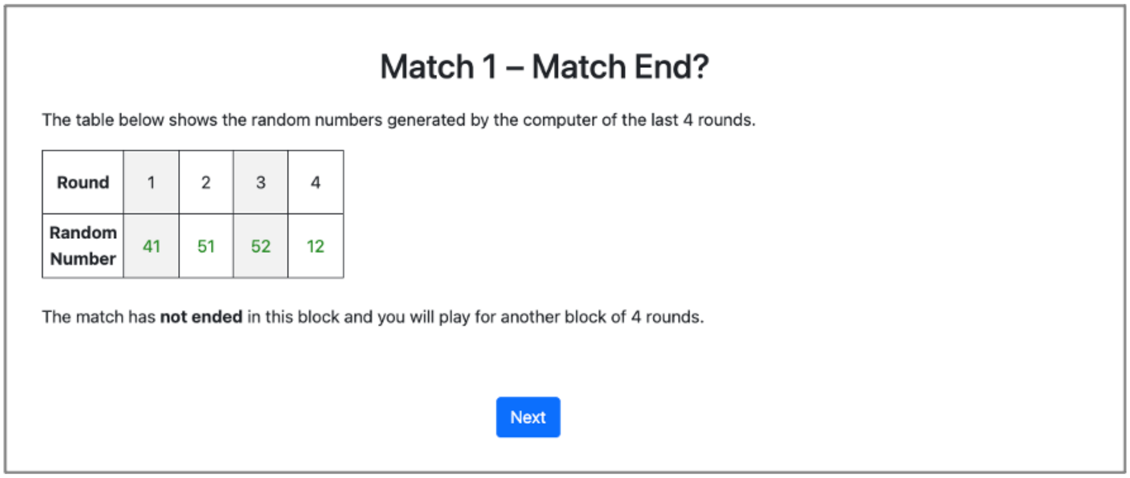
<u>Match</u>

In this experiment you will be repeatedly matched with **four** participants in the room to play two games at the same time, a Blue Game, and a Green Game. During each match, you will be asked to make decisions with the **same four** participants over a sequence of rounds for both games **at the same time**. The Blue Game has 4 participants, you and the **three** participants you matched with. The Green Game has 2 participants, you and the **one** remaining participant you matched with. In each match, the other participant in the Green Game is different from the participants in the Blue Game. The Blue Game and Green Game are different – **the differences between the two games are the participants you are matched with and the rules to play the game.**

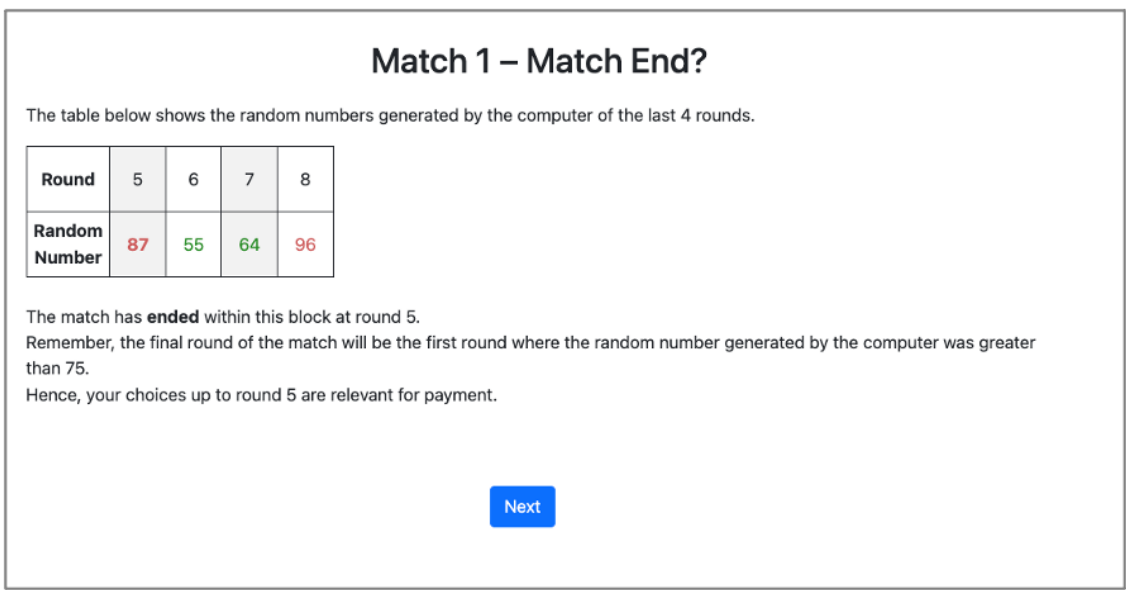
The length of a match, i.e. the number of rounds in a match, is randomly determined as follows: After each round, there is a $\boxed{75\%}$ probability that the match will continue for at least another round. Specifically, after each round, whether the match continues for another round will be determined by a random number between 1 and 100 generated by the computer. If the number is **lower than or equal** to $\boxed{75}$ the match will **continue** for at least another round, **otherwise** it will **end**. For example, if you are in round 2, the probability that there will be a third round is $\boxed{75\%}$ and if you are in round 9, the probability that there will be a tenth round is also $\boxed{75\%}$. That is, at any point in a match, the probability that the match will continue is $\boxed{75\%}$.

However, you will play every match in blocks of 4 rounds. Hence, you will play at least one block, or 4 rounds, in each match. At the end of each block you will learn if the match ended in the previous block of 4 rounds or not.

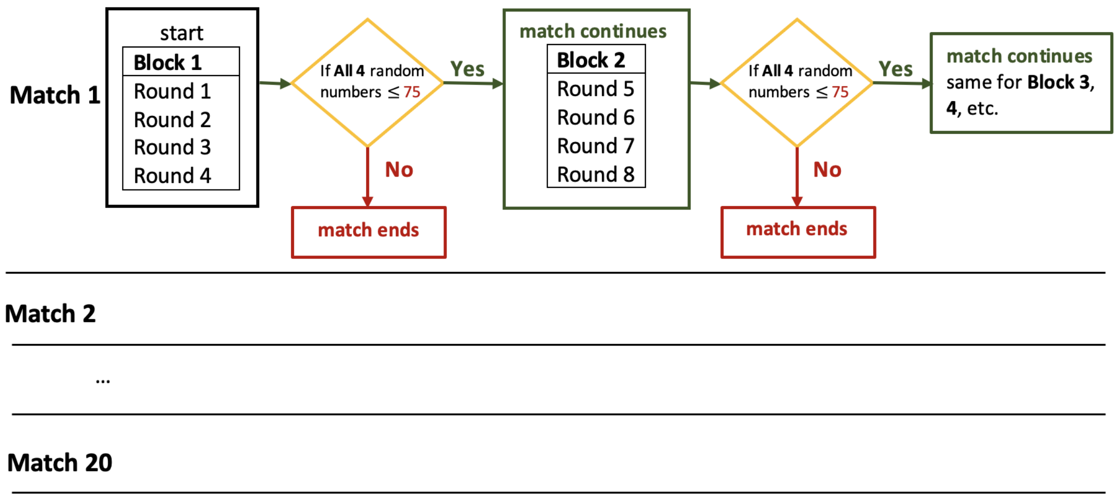
- If it has not, you will play another block of 4 rounds. Below is an example:



- If the match has ended in this block, you will see in which round it had actually ended. In particular, you will be informed of the random numbers generated by the computer for each round at the end of every 4 rounds. The final round of the match will be the first round where the random number generated by the computer was greater than **75**(in bold). Below is an example:



Once a match ends, you will be randomly regrouped with **four** participants for a **new** match. You will not be able to identify who you've interacted with in previous or future matches. There are 20 matches in total. The diagram below shows the relationship between match, block and round.



Rules of the games

The choices and the payoffs for the Blue Game and the Green Game in each round are as follows:

The Blue Game

At the start of each round, each individual will be endowed with 25 tokens. In each round, each individual must decide how to divide their tokens between the Private Account and a Group Account. Each person in the group has a Private Account, however, there is only one Group Account for the entire group.

Your payoffs from the Private Account

For each token you put in your Private Account you earn an income of one point. Nobody except you earns anything from tokens you put in your Private Account.

EXAMPLE: If you put 6 tokens in your private account, you earn 6 points from the Private Account.

Your payoffs from the Group Account

For each token you move to the Group Account you and the other three group members each receive 0.4 point. Note that you will also earn income from the tokens that other group members move to the Group Account. For each group member the income from the Group Account will be determined as follows:

Each group member's income from the Group Account
=0.4 * sum of all tokens moved to the Group Account

Put differently, the total number of tokens in the Group Account will be multiplied by 1.6 and then equally distributed among all **four** group members. This yields, for each group member, 0.4 times the total number of tokens moved to the Group Account. Suppose you move one token to the Group Account. The sum of tokens in the Group Account would then rise by one token. Your income from the Group Account would, thus, rise by $0.4 * 1 = 0.4$ point. The income of each other group member would also rise by 0.4 point. So, moving one token to the Group Account generates total income for the group of $4 * 0.4$ point $= 1.6$ points .

EXAMPLE: If the sum of tokens in the Group Account is 60 tokens, then you and all other 3 group members each earn an income of 0.4 * 60 = 24 points from the Group Account. The total income for the group from the Group Account is 4 * 24 points = 96 points.

Your total payoffs in each round

Your total payoffs of the Blue Game equal the sum of your payoffs from the Private Account and your payoffs from the Group Account.

Total payoffs
= Income from the private account + Income from the group account
= (25– tokens you move to the Group Account) + (0.4 * sum of tokens in the Group Account)

EXAMPLE: If you move 15 tokens to the Group Account while the other 3 participants in total move 50 tokens to the Group Account.
Your total payoff is (25 – 15) + 0.4 * (15 + 50) = 10 + 26 = 36 points

The Green Game

		The Other Participant	
		Action Y	Action Z
You	I will choose Action Y	48, 48	12, 50
	I will choose Action Z	50, 12	25, 25

The first entry in each cell represents your payoff in points, while the second entry represents the payoff of the person you are matched with.
-As you can see, this shows the payoff associated with each choice. Once you and the participant you are paired with have made your choices, those choices will be highlighted and your payoff for the round will appear.
-That is, if:

- (Action Y, Action Y): You select Action Y and the other selects Action Y, you each earn 48.
- (Action Y, Action Z): You select Action Y and the other selects Action Z, you earn 12 while the other earns 50.
- (Action Z, Action Y): You select Action Z and the other selects Action Y, you earn 50 while the other earns 12.
- (Action Z, Action Z): You select Action Z and the other selects Action Z, you each earn 25.

Total payoffs for Part 1

-Total payoffs **of a game** for each match will be the sum of payoffs obtained from each round of that match. You will NOT receive any payoff from rounds you've played within a block after the match had ended. Remember that a match **ends** at the first round where the random number is **greater** than $\boxed{\mathbf{75}}$. At the end of each match, you will be informed the total payoffs of the Blue Game and the Green Game separately.

-Total payoffs **for this part** will be the sum of payoffs for all matches played for both games.

Summary

- The length of a match is randomly determined. After every round there is a $\boxed{75\%}$ probability that the match will continue for another round. However, you will play each match in blocks of **4** rounds; and will be informed of whether the match had ended during the block at the end of these rounds. You will NOT receive any payoff from rounds you've played within a block after the match had ended.
- You will participate in the Blue Game and the Green Game at the same time.
- You will interact with the **same three** participants in the Blue Game, and the **same one** participant in the Green Game for the entire match.
- After a match is finished, you will be randomly rematched with **three** other participants for the Blue Game and **one** other participant for the Green Game in the room for a new match.
- There are **20** matches in total.

Match 1, Round 1 –Your choices

Blue Game

Rules

Your tokens to divide between private account and group account : **25**

Token(s) you choose to move to the Group Account:

Payoff Calculator

Green Game

		The Other Participant	
		Action Y	Action Z
You	I will choose Action Y	48, 48	12, 50
	I will choose Action Z	50, 12	25, 25

Submit

Match 1, Round 1 – Results

Blue Game

The number of tokens you moved to the *Group Account*: 15
Total number of tokens moved to the *Group Account* by the group: 51
Every group member's earning from the Group Account: 0.4 × 51 = 20.4
Your earnings from your *Private Account*: 10

Your earning in this round = 20.4 + 10 = 30.4

Green Game

		The Other Participant	
		Action Y	Action Z
You	Action Y	48, 48	12, 50
	Action Z	**50 , 12**	25, 25

You chose Action Z and the other participant chose Action Y.

Your earning in this round: 60

Next Round

Match 1 - Summary

Below shows the match history. The current match ended at **round 5**. Round(s) after are not relevant for payment.

Blue Game History

Round	Private Acc. Token	Group Acc. Total Token	Your Payoffs
1	2	78	33.2
2	3	41	19.4
3	11	54	32.6
4	15	46	33.4
5	13	44	30.6
6	11	61	35.4
7	5	52	25.8
8	13	51	33.4

Your total earnings in this match: 149.2

Green Game History

Round	Your Choice	Match's Choice	Your Payoffs
1	Action Y	Action Y	48
2	Action Y	Action Y	48
3	Action Y	Action Y	48
4	Action Z	Action Z	25
5	Action Z	Action Z	25
6	Action Y	Action Y	48
7	Action Y	Action Y	48
8	Action Z	Action Z	25

Your total earnings in this match: 194

Next Match