Social Norms and Coordination in a Threshold Public Good Game with Increasing Group Sizes*

Yuting Chen†

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Abstract

Social norms can help coordinate within groups. When the group size increases with uncertainty, existing coordination may be unstable. This project employs a laboratory experiment to investigate the persistence of social norms and their influence on coordination behaviors in a threshold public good game with increasing group size. Participants first choose one out of two norms that they think is more socially appropriate. Then they are randomly assigned a role and placed in a group of four. A group starts with one member, and a new member joins with a 25% chance until the group size reaches four. Members A and B agree on the same norm in treatment groups, while A and B differ in norm choices in control groups. Members C and D's norm choices are unknown in both cases. In each round, current members participate in a public goods game with a threshold of one investment, while observers remain inactive. I found that there's no significant difference in public goods provision rates between the treatment and control groups. The norm persistence rates start higher in the treatment groups but decline more rapidly when group size increases. Also, the overinvestment rate increases with group size, and it is higher when conditional on no investment in the previous round. Finally, differences in response rates among group members are the key reason a social norm persists for a shorter time. For a social planner aiming to establish a social norm that helps people coordinate as the group expands, the norm must be good in the sense that people accept it to a similar degree, so that it can persist longer.

Keywords: *Social norms, coordination, group size, threshold public goods*

JEL Classification: *D41, H71*

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†Purdue University, Department of Economics; chen4442@purdue.edu

1 Introduction

Social norms are shared standards of acceptable behavior in the group, which can be informal understandings and formal rules such as laws (Lapinski and Rimal, 2005; Finnemore, 1996). The establishment of a social norm requires common knowledge among all players. However, when the group sizes vary instead of being fixed, existing social norms may change in the transmission because some group members may be unwilling to follow their previous strategies.

Threshold public goods represent a particularly important category of collective action problems due to their ubiquity in everyday contexts. Unlike continuous public goods, these require aggregate contributions to reach or exceed a specific threshold before generating any benefit. Common examples include community initiatives requiring critical mass participation and public works projects that proceed only after securing sufficient resources. This threshold feature creates unique coordination challenges when group composition changes, as established contribution norms may no longer be optimal or sustainable. This experiment on threshold public goods provides insights into how social norms evolve when groups face uncertainty about membership and must reconcile existing norms with changing circumstances.

Several real-life situations involve contributions to public goods by only one group member or community. Turns can be a way of assigning this contribution. For example, undergraduates in a shared dormitory room usually take turns to do clean-up activities. In a neighborhood watch program, residents take turns patrolling their area to deter crime and report suspicious activities. In other cases, people follow other commonly acknowledged rules to assign contributions. For example, it is common practice for the newest employee to fetch coffee daily for the entire team in some workplaces. On campus, new faculty members might organize departmental events or seminars to help integrate them into the department while providing valuable services for all members.

However, one immediate problem is that the group size could be different and unstable. People come and go for various reasons, and the previously established social norms (if any) may be unstable and unable to continue. For example, the cycle of taking turns can be broken if new members enter the community. The different lengths of time a newcomer in a group may cause unfairness in distributing contributions or duties.

This paper addresses this research question: **Will social norms persist as the group size increases in the threshold public goods game?** The primary analysis will focus on whether group members follow the established social norm in the group and for how long, whether previous overinvestment or non-investment will impact later investment behaviors,

whether treatment effects differ on "Founders" and "Followers", and whether the size of treatment effects correlates with people's risk preferences or social value orientations.

2 Literature Review

Public goods are defined by their non-excludability and non-rivalry (Mankiw, 1998). All group members can consume public goods collectively, and this collective consumption violates the assumption of the private nature of the goods in the Arrow–Debreu competitive economy (Myles, 1995). These characteristics of public goods may lead to market failures where private markets cannot efficiently allocate resources to produce and maintain these goods. Formal analysis of public goods began with Samuelson (1954), who derived the rule characterizing efficient levels of provision. Following the nature of public goods, researchers have been using experiments with public goods games to study important aspects such as cooperation, punishment, free-riding, and the efficacy of mechanisms encouraging contributions.

2.1 Threshold Public Goods

Among various classes of public goods, threshold public goods occupy a prominent place due to their prevalence in real-world scenarios. The threshold public good is a special case of public goods in which a threshold (provision point) must be reached to provide the public good.

Early studies on threshold public goods may not have the same name. This kind of public good was called "lumpy" (Taylor and Ward, 1982; Taylor, 1987), "pure step" (Hampton, 1987), "step-level" (Rapoport, 1987; Rapoport and Eshed-Levy, 1989; Erev and Rapoport, 1990), or "discrete" (Palfrey and Rosenthal, 1984, 1988; Ferejohn et al., 1993). Among them, (Palfrey and Rosenthal, 1984) is the first formal study to examine Nash equilibria in "discrete" public goods games with and without refund rules. They found that refund mechanisms expand the set of equilibria and lead to higher expected contributions in mixed strategies, particularly when the number of players is small. Subsequently, Bagnoli and Lipman (1989) developed a provision-point mechanism that implements core allocations for threshold public goods and tested its predictions experimentally, which lays a classic theoretical foundation for voluntary provision via private contributions under a threshold rule.

Existing literature on threshold public goods has extensively explored various aspects of voluntary contribution mechanisms. An important feature is the delivery of contributions.

Some studies have examined binary contributions (Van de Kragt et al., 1983; Dawes et al., 1986; Spiller and Bolle, 2017; Reischmann and Oechssler, 2018; Chen et al., 2021), while others consider continuous contributions, allowing participants greater flexibility in deciding how much to contribute (Cadsby and Maynes, 1998; Suleiman and Rapoport, 1992; Suleiman et al., 2001). These differing methods can significantly influence the strategic behavior and efficiency of resource allocation within groups.

Another prominent feature is the predictors of voluntary contributions from the perspective of marginal benefit. In linear public goods, the marginal payoff to an individual from a public good significantly affects contribution behavior. Isaac et al. (1984) first formalized and referred to as Marginal Per-Capita Return (MPCR), which captures the private value of moving one unit of resources from an individual's private consumption to the public good. Analogous to the MPCR in linear public goods, Croson and Marks (2000) constructed a Step Return (SR) concept applicable to threshold public good games. SR captures the aggregate benefits to a community from a public goods project relative to the costs of that project. Compared to the Net Reward (difference in the payoffs between contributing and not contributing when the threshold is met), which shows inconsistent effects on contribution behavior (Cadsby and Maynes, 1999), the Step Return has demonstrated greater predictive power across diverse experimental contexts (Croson and Marks, 2000).

The impact of uncertainty on threshold public goods provision has also attracted considerable attention. Researchers have examined various forms of uncertainty, including threshold uncertainty (Au, 2004; McBride, 2006), uncertainty regarding the costs of contributions (Nitzan and Romano, 1990), and uncertainty about group size (Chen et al., 1996; Au et al., 1998; Au, 2004). Generally speaking, uncertainty makes coordination harder to achieve and can reduce efficiency in achieving the threshold, affecting participants' strategic considerations.

Other dimensions of uncertainty and their implications for cooperation are also examined. Hillenbrand and Winter (2018) showed that population uncertainty in the volunteer's dilemma scenario enhances cooperation compared to known group sizes. Similarly, Dannenberg et al. (2015) illustrated that ambiguity regarding threshold values significantly reduces public good provision compared to known thresholds, highlighting the critical role of clear information and credible commitments. İriş et al. (2019) analyzed the role of delegation under uncertainty, revealing that elected representatives facing mild public pressure tend to adopt more conservative contributions, exacerbating coordination problems. McBride (2006, 2010) investigated how threshold uncertainty affects public good provision, finding non-monotonic relationships where increased uncertainty can either enhance or diminish contributions depending on the public good's value. Gangadharan and Nemes (2009) further examine the

role of environmental versus strategic uncertainty, demonstrating that participants respond differently depending on where uncertainty is located, with strategic uncertainty generally reducing contributions more severely.

This paper contributes to the literature by focusing on group size uncertainty in threshold public goods games under simultaneous decision-making. In contrast to the sequential settings studied by Au et al. (1998) and Au (2004), where participants can observe others' decisions before acting, simultaneous settings offer no such feedback. A key implication is that individuals cannot adjust their behavior in response to others, making coordination more difficult. More details on group sizes are discussed in Section 2.3.

2.2 Volunteer's Dilemma

Studies on volunteer's dilemma have foundational roots established by Diekmann (1985) that under the equilibrium strategy, the probability of supplying a collective good is a decreasing function of the group size N, but the reverse is true for superra- tional players. Diekmann (1993) extends this analysis to an asymmetric setting, allowing variation in either the valuation of the public good or the cost of volunteering across players. While the symmetric mixed-strategy equilibrium makes counterintuitive predictions at odds with empirical behavior, the paper shows that alternative theories—such as focal points and Harsanyi–Selten risk dominance—better explain observed outcomes, especially when players differ in their incentives or sense of responsibility.

Recent literature has extended the foundational Diekmann models by relaxing symmetry assumptions and incorporating individual heterogeneity in costs and preferences. For example, Goeree et al. (2017) examined asymmetric costs and showed that traditional predictions based on Nash equilibria often fail to capture observed behavior. Instead, models that incorporate bounded rationality, reinforcement learning, or quantal response equilibria offer more accurate descriptions of how individuals navigate situations with unequal costs of volunteering. Similarly, Healy and Pate (2018) explored how cost heterogeneity affects contribution patterns. They found that players tend to coordinate around individuals with lower costs, reinforcing unequal responsibility in collective action contexts.

Institutional arrangements that mitigate coordination failures in the volunteer's dilemma have practical significance. Franzen (1995) investigated how cost-sharing arrangements among volunteers can increase public good provision. Diekmann and Przepiorka (2016) examined how reputation mechanisms and repeated interactions influence cooperation in the volunteer's dilemma. These approaches suggest potential institutional design mechanisms to enhance cooperative outcomes in social dilemma scenarios.

In addition, social and demographic dimensions also shape who volunteers. Babcock et al. (2017) showed that women are significantly more likely to volunteer for tasks with low visibility and limited career benefit—so-called "non-promotable" tasks—in workplace environments. This behavior persists even when women anticipate the cost and recognize the inequity, suggesting that internalized social norms and anticipatory role expectations play a key role. This paper takes on the question listed in the first experiment in Babcock et al. (2017), that if one member volunteers (invests in the group account), his payoff will be lower than if he doesn't volunteer but someone else volunteers; if no one volunteers, the payoff will be the lowest.

2.3 Group Sizes and Decision-making

Group size is a crucial aspect when studying public goods. In many real-life cases, people only have a rough idea about the group size instead of a precise number. Few studies discussed group size uncertainty and its influences on coordination and provision outcomes in threshold public goods games. Au (2004) demonstrated that fixing the provision point at three yields higher provision rates with a certain group size (n=5) compared to an uncertain group size (n=4, 5, 6), emphasizing the difficulty of coordination under uncertainty with sequential observations and decisions.

However, this small branch of literature used sequential rather than simultaneous settings. When contributions cannot be retrieved, contributions can sometimes be redundant once the threshold is met. Such threshold public goods include dikes, lighthouses, bridges, or initial investments in organizing the fundraising (Plott and Smith, 2008). Studies with sequential settings could not discuss overcontribution properly because individuals strategically adjust their contributions upon observing contributions from previous individuals. Therefore, I use simultaneous settings in this paper because overcontribution, which resulted from miscoordination, is one of my interests.

Few other papers have studied group size change in other forms of games. Early experimental work by Franzen (1995) tested four different games and concluded no group-size effects in the one-shot Prisoner's Dilemma and the one-shot Chicken game. However, group size negatively affects the cooperation rate in the Volunteer's Dilemma and the Assurance game. Weber (2006) explored coordination through minimum effort games, finding that large fixed groups (n=12) typically fail to achieve efficient coordination. In contrast, groups gradually growing from small to large sizes (from n=2 to n=12) can tacitly coordinate efficiently, particularly when historical information is available. Additionally, Arifovic et al. (2023) studied bank run scenarios and found that larger groups (n=75 to 90) exhibit more

frequent withdrawals than smaller groups (n=10), particularly in riskier environments. Other studies have explored decisions on voting to exclude group members, exiting groups, or merging groups, highlighting further coordination complexities (Charness and Yang, 2014; Otten et al., 2024).

The literature addressing group size in (threshold) public goods games usually fixes it. Different treatment groups differ in group sizes to compare cooperation or free-riding behaviors, but the size is stable within each group. Li et al. (2022, 2023) looked into enhancing provision in the threshold public goods game with large group sizes, providing evidence that certain pricing and rebate mechanisms can mitigate the negative impacts of group size and threshold uncertainty, facilitating higher levels of coordination and contribution even in large groups.

The literature seldom examines public goods provision in settings where group size evolves dynamically. Yet in many real-world contexts, group formation is not static, and the timing and sequence of arrivals are uncertain. Such dynamics can introduce perceived unfairness in responsibility or opportunity, potentially altering individuals' willingness to contribute. This paper addresses this gap by introducing a novel experimental design in which group size increases over time with stochastic arrival. This allows for a clean investigation of how dynamic group formation under uncertainty affects coordination and contribution behavior. Doing so advances our understanding of threshold public goods provision in more realistic and previously understudied environments.

2.4 Social Norms

A social norm is delicate in its definition. In 1965, Jack Gibbs identified three basic normative dimensions that all concepts of norms could be subsumed under: a) collective evaluation of behavior in terms of what it ought to be; b) a collective expectation as to what behavior will be; c) particular reactions to behavior including attempts sanction or induce certain conduct (Gibbs, 1965).

Social norms can be confounded with similar terms, such as conventions, personal, and descriptive norms. A social norm differs from a convention in that conventions are behavioral regularities when what one does depends on what one expects others to do and vice versa (Gaus and Thrasher, 2021). Additionally, social norms have the feature of *Normative Expectations* that almost everyone expects you should conform to the convention, either because they have some normative belief that violating the norm is wrong or because they expect to be punished if they break the norm (Bicchieri, 2005). Social norms are also distinguished from other types of norms, such as descriptive and personal norms. Table 2.1 summarizes

how social norms differ from all other similar terminology. The distinct factors of social norms are mutual expectations, conditional preferences, and normative expectations.

Table 2.1: Bicchieri (2005): Taxonomy of Norms

		Conditional Preferences?			
		No	Yes		
Mutual Expectations?	No	Personal Norm	Descriptive Norm		
	Yes	Moral Norm	Convention	No	**Normative Expectations?**
			Social Norm	Yes	

2.4.1 Social Norms Elicitation

Several alternative approaches to norm elicitation have emerged in recent literature. Bicchieri and Xiao (2009) developed a sequential matching task that distinguishes between descriptive norms (common behaviors) and injunctive norms (behaviors that ought to be performed) and measured both expectations about others' behavior and beliefs about what others think should be done.

Krupka and Weber (2013) introduced an incentivized elicitation method for identifying social norms that uses simple coordination games. They measured the extent to which actions are socially appropriate or inappropriate by presenting respondents with a description of a choice environment. In this way, researchers can yield precise and testable predictions regarding the behavior of a new sample of participants by eliciting social norms from one set of individuals. A similar rating mechanism is seen in Lane et al. (2023), where they employed incentivized vignette experiments to directly measure social norms related to actions subject to legal thresholds. Participants are presented with hypothetical scenarios involving behaviors near legal limits (e.g., speeding just above or below a speed limit) and are asked to rate the social appropriateness of these actions. To ensure incentive compatibility, participants are rewarded based on how closely their ratings align with the modal response of others, encouraging them to reveal their true perceptions of societal norms. Other studies have also applied similar incentivised methods to elicit an individual's norm preference in lab settings. Kimbrough and Vostroknutov (2018) introduced an incentivised norm-following task and showed that the proportion of balls placed in the low-payoff but rule-instructed bucket constitutes a proxy for individuals' propensity to follow norms.

Recent work has also demonstrated that norm compliance is not merely an individual trait but is conditional on beliefs about others' rule-following. McBride and Ridinger (2021) showed that an individual's willingness to follow norms depends significantly on their beliefs

about others' norm compliance, suggesting a social feedback mechanism in norm adherence. This finding complements earlier work by Kimbrough and Vostroknutov (2016), who emphasized heterogeneity in norm sensitivity as a key driver of differences in prosocial behavior. To formally incorporate this idea into models of behavior, Kimbrough and Vostroknutov (2016) propose a norm-dependent utility framework, building on the work of Bicchieri (2005). In this framework, each individual i is characterized by a parameter k_i, which captures their sensitivity to a particular norm or rule R. This structure allows for predicting equilibrium behavior based on both the prevailing social norm and the distribution of norm sensitivity across individuals.

The robustness of norm elicitation methods has also been investigated. König-Kersting (2024) found that the method used in Krupka and Weber (2013) paper produces remarkably consistent results even with variations in task wording and incentive salience. Similarly, **?** demonstrated that norm elicitation is robust to order effects in within-subject designs, suggesting that eliciting norms before behavioral tasks does not systematically affect subsequent choices.

In this paper, individuals will first choose between two norms. By pairing the first two members with the same choice and displaying their choices to the entire group, a social norm is established as the "Founders" jointly agree that a norm is more socially appropriate. If the first two members choose different norms, then the group has no established social norm. The research question is whether social norms will persist as group sizes increase. Thus, the analysis focuses on whether the followers (since the third member) follow the established social norm.

2.5 Experimenter Demand Effects

The elicitation of social norms can be problematic if the design has Experimenter Demand Effects (EDE). The Experimenter Demand effects refer to the changes in behavior by experimental subjects due to cues about what constitutes appropriate behavior, which can be social or purely cognitive. Social Experimenter Demand Effects involves pressure from the experimenter as an authority, while cognitive EDE arises from how subjects interpret the task based on the information they receive. Zizzo (2010) argues that when EDE may exist, it crucially matters how they relate to the true experimental objectives. It will be a potential confound only when they are positively correlated with the predictions of the true experimental objectives.

In this paper, participants will first choose one of two norms: which norm they think is more socially appropriate. To minimize the experimenter demand effect, the norm part is

placed before they are assigned a role (knowing their positions in the group) and put into a group. People with different roles may favor a particular norm. However, having them choose a norm before they know which role they are assigned to prevents them from having a preference for a specific norm based on a specific role. Therefore, when selecting a norm, the participants are choosing completely unconditionally. More details can be found in Sections 3.1 and 3.2.

3 Experimental Design and Hypothesis

All laboratory sessions are conducted at the Vernon Smith Experimental Economics Laboratory (VSEEL) at Purdue University, with experimental software implemented using oTree 5.11 (Chen et al., 2016). Subjects are Purdue undergraduate students across different disciplines recruited by email using ORSEE (Greiner, 2015). Each subject participates in only one session. Each session lasts approximately 60 minutes, including time for instructions and payment distribution. So far, I have conducted 8 sessions with 128 participants. Section 4 discusses the results in detail.

To illustrate the volunteer's dilemma and the potential for miscoordination, participants will first complete a practice task. They will play a single-round threshold public goods game with a fixed group size of four. Participants will be randomly assigned to groups of four and asked to independently respond to the same question: "Will you invest in the group account?" If participants choose "Yes," they will earn three tokens. If they choose "No," their payoff depends on others' decisions: they earn five tokens if at least one other group member invests, and one token if no one else invests. The investment question is the same as Babcock et al. (2017)'s volunteer question. On the subsequent page, participants will review their group's choices and individual payoffs, gaining insight into the volunteer's dilemma. Participants will be paid for this practice round.

3.1 Choices of Social Norms

Participants will then be informed that the group size is no longer fixed at 4. Instead, the group size starts at 1 and grows over time, with members joining one by one until there are 4 members. Based on the order of arrival, the four members will be named Members A, B, C, and D, indicating the first, second, third, and fourth members who join the group, respectively. Member A joins in Round 1, and Member B joins in Round 2. Starting in Round 3, there's a 25% probability that a new member joins the group. To help participants coordinate when facing uncertain group size, I introduce two social norms that suggest which

member should invest in each round. Participants should then choose which of the two norms they believe is more socially appropriate.

Newcomer: The newest member is suggested to invest until another new member joins the group. E.g.): When A and B are the current members while C and D are observers, B is suggested to invest in the group account until C joins.

Random Dice: A computerized dice will randomly suggest one current member to invest. E.g.): When A and B are the current members while C and D are observers, the dice will randomly suggest A or B to invest in the group account.

3.2 Indefinitely Repeated Threshold Public Good Game

After submitting their choices of norms, participants will play 4 Blocks of investment decisions. Each Block has three stages: Role Assignment, Grouping, and Investment Decision. The computer determines Stages 1 (Role Assignment) and 2 (Grouping), while Stage 3 (Investment Decision) is for participants to make multiple rounds of decisions. Stage 3 is a repeated Threshold public goods game with increasing group size for t rounds.

[Stage 1: Role Assignment]

Participants are randomly assigned a role among Members A, B, C, and D, i.e., the first, second, third, and fourth members to join the group. The rate of being assigned to each role is 25%. All role assignments are independent of participants' norm choices. Roles will be randomly reassigned after each Block.

[Stage 2: Grouping]

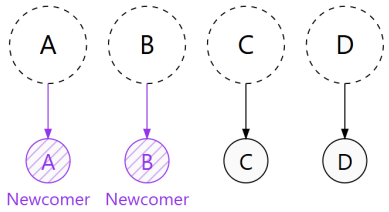
Participants are then randomly grouped into four. In each group, Members A and B's norm choices are revealed, while C and D's norm choices are not. Participants are randomly re-grouped after each Block. There are four combinations of A and B's norm choices, i.e., four different group types, which are shown below. The Newcomer and Random Dice groups are treatments, where there's an established social norm within the group, as A and B chose the same norm. The two mixed-type groups are controls, where there's no social norm within the group. Mixed-NC-RD stands for A chose Newcomer norm and B chose Random Dice norm. Mixed-RD-NC stands for A chose Random Dice norm and B chose Newcomer norm. By assigning roles first and then forming groups, it's explicit to participants that C and D's norm choices are completely random.

I assign roles before grouping to prevent participants from forming beliefs about the likely responses of Roles C and D, given the salient 50-50 framing of social-norm choices. If

participants are first grouped into fours and then randomly assigned to Roles A, B, C, and D, they may think that two members chose Newcomer and 2 chose Random Dice in Part 1. With Members A and B's social-norm choices revealed, they may infer C and D's choices from this information. For instance, in a Newcomer group where Members A and B are known to have selected Newcomer in Part 1, participants might infer that C and D are more likely to have chosen the other norm, Random Dice, in Part 1. Such beliefs could influence their subsequent investment decisions, and that's what I want to avoid.

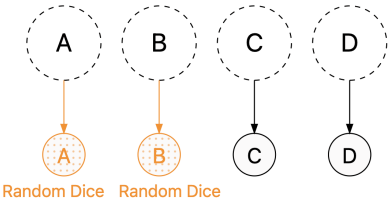
Treatment: Newcomer

- Member A chose ***Newcomer***.
- Member B chose ***Newcomer***.
- Member C is randomly selected from all C role participants, independently of their choice of social norms.
- Member D is randomly selected from all D role participants, independently of their choice of social norms.



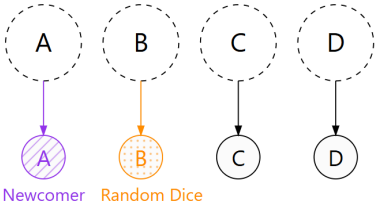
Treatment: Random Dice

- Member A chose ***Random Dice***.
- Member B chose ***Random Dice***.
- Member C is randomly selected from all C role participants, independently of their choice of social norms.
- Member D is randomly selected from all D role participants, independently of their choice of social norms.



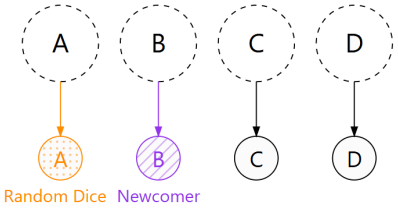
Control: Mixed-NC-RD

- Member A chose ***Newcomer***.
- Member B chose ***Random Dice***.
- Member C is randomly selected from all C role participants, independently of their choice of social norms.
- Member D is randomly selected from all D role participants, independently of their choice of social norms.



Control: Mixed-RD-NC

- Member A chose ***Random Dice***.
- Member B chose ***Newcomer***.
- Member C is randomly selected from all C role participants, independently of their choice of social norms.
- Member D is randomly selected from all D role participants, independently of their choice of social norms.



By assigning roles first and then forming groups, we make it explicit to participants that the social norm choices of Members C and D are completely random. Participants are

informed that C and D's choices of social norms cannot be inferred from the observed choices by Members A and B. Below is detailed information on the five group types, respectively. The logic for Members A and B differs, while the logic for Members C and D is the same across group types: Role assignments of C and D are independent of their choice of Newcomer or Random Dice in Part 1.

[**Stage 3: Investment Decisions**]

Stage 3 consists of several rounds of decision-making. If a member has joined the group, he's **a current member**. The number of current members is the group size. In each round, all current members make the investment decision independently, the same investment question they saw during the practice. If a member hasn't joined the group yet, he's **an observer** and does nothing in this round.

In Round 1, only Member A is a current member (group size is 1). In Round 2, Member B joins as a current member (group size is 2). Starting Round 3, there is a 25% chance that a new member will join the group. After the group size reaches 4, the Block will continue with a new round with a 25% probability. In the lab experiment, the 25% probability can be achieved by randomly picking a card from four cards: one Red Heart and three Black Spades. After current members have made and submitted their decisions, all group members will see a summary of the round and its history, including the suggested member by each social norm, who invested in the group account, and token earnings. At the end of the experiment, total token earnings from all rounds will be converted to USD for payment.

Participants' norm choices can not be changed for the first 4 Blocks; there will be a fifth Block with the same design, except that participants can choose between the two norms again before this Block. This design aims to see whether participants prefer a particular social norm after gaining enough experience. Additionally, I will elicit their beliefs on the investment behaviors of other current members after they make investment decisions in each round. Bonuses are added to the payment if their beliefs turn out to be correct.

3.3 Risk Preference and Social Value Orientation

Part 3 uses a gamble game to elicit participants' risk preferences. Participants will be shown five gambles and asked to choose the one they prefer. Each gamble has 2 two possible outcomes, both with equal (50%) chance of occurring. The expected payoff of each gamble is \$2, \$2.25, \$2.5, \$2.75, and \$3. The payment from this task will depend on which gamble they choose and which outcome occurs.

Eliciting risk preferences has long been studied in experimental economics literature, with methods typically involving participants choosing between lottery pairs with varying

probabilities and payoffs, allowing researchers to infer individual risk aversion levels. This can be useful to capture individual heterogeneity in risk attitudes. I include a gamble game to elicit risk preference to see whether treatment effects are correlated with participants' risk attitudes.

Part 4 is a test for Social Value Orientation (SVO). The measurement of SVO that I used in this study was first introduced by Murphy et al. (2011), which captures individuals' concerns for others when making decisions involving interdependent outcomes. This measurement consists of six slider tasks with discrete choices of payoff allocation between the participant and the counterpart. Each of the six slider tasks well defines a continuum of joint payoffs. Participants are randomly paired in 2 and randomly assigned as the Sender or the Receiver. One of the six tasks will be randomly selected for payment. The allocation choice made by the Sender will be enforced for payment.

In the context of volunteer dilemmas and threshold public goods games, Social Value Orientation (SVO) helps explain heterogeneity in individual willingness to bear costs for the benefit of the group. Prosocial individuals are more likely to contribute or volunteer, driven by preferences aligned with collective welfare. A meta-analysis conducted by Pletzer et al. (2018) showed that relative to proselfs (individualists and competitors), prosocials expect more cooperation from others in social dilemmas. In contrast, individualists and competitors do not significantly differ in their expectations. These expectations partially mediate the well–established relationship between social value orientation and cooperative behavior in social dilemma. I include the SVO as a part of this experiment, hoping to examine whether the proportion of prosocials within a group correlates with the persistence of the established social norm.

3.4 Hypothesis

H1a: The provision rate of the public good decreases as group size increases.
H1b: The provision rate of the public good is higher in the treatment groups compared to the control groups.

The first set of hypotheses addresses the provision rate of the public good. Treatment groups have a social norm to guide coordination. Following the social norm is an equilibrium and efficient. It's reasonable to presume that the provision rate of the public good is higher in the treatment groups. However, with the fixed threshold and increasing group size, provision may be more likely to fail.
H2a: The norm-persistence rate decreases as group size increases for all groups.
H2b-NC: The persistence rate of the Newcomer norm is higher in the Newcomer treatment

groups compared to control groups.

H2b-RD: The persistence rate of the Random Dice norm is higher in the Random Dice treatment groups compared to control groups.

The second set of hypotheses addresses the research question: Will social norms persist as group size increases? If the member suggested by a norm actually invests, then the norm persists. In other words, the persistence rate of a norm is the rate at which people follow the norm. Since the threshold is always 1, more group members increase the number of ways to distribute the burden, making coordination more difficult. H2b-NC and H2b-RD further address the persistence rate of each norm when it's a social norm and when it's not.

H3a: The rate of overinvestment increases as group size increases.

H3b: The rate of overinvestment is higher in control groups compared to treatment groups.

The third set of hypotheses looks into the behavior of overinvestment. Since it's a threshold public good game, any investment exceeding the threshold is considered inefficient. Having a social norm as group guidance may help them coordinate and reduce the possibility of overinvesting.

H4a: Members A and B will be more likely to invest compared to C and D if they are suggested by their own choices of norms, regardless of whether there's a group social norm.

H4b: Members A and B will be more likely to invest compared to C and D if they are suggested by the group social norm, regardless of their own choices of norm.

The fourth set of hypotheses examines different situations in which members are guided by the group social norm or by their own choice of norm. Since Members A and B's own norm choices are revealed to the entire group, they are more likely to behave. On the other hand, Members C and D are more likely to be free riders since their own choices are never revealed.

4 Results

4.1 Overview of the participants

This experiment has eight sessions with 128 participants, conducted during the Fall semester of 2025 at the Vernon Smith Experimental Economics Laboratory (VSEEL) at Purdue University, utilizing experimental software implemented with oTree 5.11 (Chen et al., 2016). Participants were recruited via email using ORSEE (Greiner, 2015). Each participant participated in only one session. The average session duration was 60 minutes, and the average payment per participant was $25.07. Table 4.1 shows demographic information of the 128 participants. For simplicity, gender will be coded as 1 = male, 0 = not male; ethnicity as 1

= White, 0 = not White; and major as 1 = related to econ/business, 0 = otherwise.

Table 4.1: Participant demographics

Gender	**N**	**%**
Female	57	45%
Male	64	50%
Others	3	2%
Prefer not to say	4	3%
Ethnicity	**N**	**%**
Asian	76	59%
Black	2	2%
Hispanic	8	6%
White	32	25%
Others	7	5%
Prefer not to say	3	2%
Econ related major	**N**	**%**
Yes	35	27%
No	88	69%
Prefer not to say	5	4%
Total	128	100%

Table 4.2 shows the number of rounds for each group size for each block. For example, in the first Block, Member B joins at Round 2, followed by Member C joining at Round 8, Member D joining at Round 11, and the Block has 14 Rounds in total. Since Member A has a dominant strategy to invest when he or she is the only member in the group, the first round of each Block will be excluded from the following analysis.

Table 4.2: Number of rounds by group sizes in 5 Blocks

Block	A (N=1)	AB (N=2)	ABC (N=3)	ABCD (N=4)	Total
1st	1	6	3	3	14
2nd	1	2	4	2	10
3rd	1	5	7	4	18
4th	1	3	2	4	11
5th	1	4	4	2	12

Each session has five blocks, and participants form groups of four for each block. The eight sessions give us 160 groups in total, as shown in Table 4.3. More participants chose the Random Dice norm over the Newcomer norm, resulting in more Random Dice groups, which comprised 69% of the total groups.

Table 4.4 shows the detailed choices of social norms among 128 participants. 16% chose the Newcomer norm, and 84% chose the Random Dice norm, and these choices hold for Blocks

Table 4.3: Number of treatment and control groups

	Groups	N	%
Treatment	Newcomer	5	3%
	Random Dice	111	69%
Control	Mixed-NC-RD	21	13%
	Mixed-RD-NC	23	14%
	Total	160	100%

1-4. Participants have a second chance to choose the social norms, and the proportions are changed to 23% Newcomer and 77% Random Dice. For participants who chose Newcomer before, only 40% stayed in the same norm, whereas for participants who chose Random Dice before, 80% stayed in the same norm. The post-experiment survey shows that some participants change their choices of social norms because they are not satisfied with the current choice, while others simply wanted to see what would happen on the other side.

Table 4.4: Choices of social norms

Choices for Blocks 1-4	Choices before the fifth Block		Total
	Newcomer	Random Dice	
Newcomer	8	12	20 (16%)
Random Dice	22	86	108 (84%)
Total	30 (23%)	98 (77%)	128 (100%)

Table 4.5: Risk Preference and Social Value Orientation

Risk Preference	**N**	**%**
Risk neutral	17	13%
Risk-seeking	55	43%
Extremely risk-seeking	56	44%
Average Payoff	$2.30	
Social Value Orientation	**N**	**%**
Altruistic	–	–
Prosocial	73	57%
Individualistic	54	42%
Competitive	1	1%
Average Payoff	$3.61	
Total	128	100%

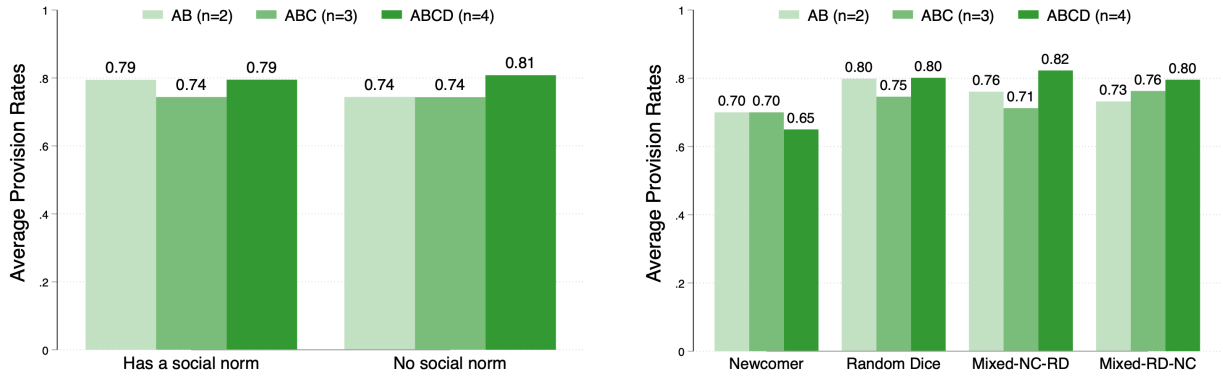
Table 4.5 displays risk preference and social value orientation results. There are five gamble options in the risk-preference section, each is a combination of two dollar amounts with a 50-50 chance. Risk neutral is defined as choosing Gamble 1 with 50% $2 and 50% $2. Extremely risk-seeking is defined as choosing Gamble 5 with 50% $6 and 50% $0. The

Gambles 2 to 4 in between are defined as risk-seeking. As for the social value orientation, no participants are altruistic. For simplicity of analysis, the only competitive participant will be coded as the individualistic type in the regression.

4.2 Provision Rates of the Public Good

Following the social norm is an equilibrium of coordination. Therefore, the provision rate of the public good is expected to be higher in treatment groups with a social norm. However, provision rates in treatment groups are no higher than those in control groups, as shown in Panel A of Figure 4.1. The left bars are the treatment groups, and the right bars are the control groups. Each side has three bars with gradient colors, representing group sizes of 2, 3, and 4. Note that data for group size 1 (when Member A is the only group member) are excluded, since there's a dominant strategy to invest. No difference in the provision rates across different group sizes between the treatment and control groups.

When the provision rates are broken down by group types, as shown in Panel B, the picture becomes clearer: the provision rates are very low in the Newcomer treatment groups. One possible reason is that "Founders", Members A and B, favor the Newcomer norm, whereas "Followers", Members C and D, say otherwise. Asking a newly joined member to take the burden of investing after waiting for many rounds seems quite unfair. Another possible reason lies within the control groups: the absence of a guide boosts distrust among other members. Fearing that no one would invest, one may invest more often, regardless of whether the investment is norm-suggested. These two underlying reasons possibly drive up the provision rates among control groups, so that we don't observe a clear difference between the treatments and controls.



Panel A. By treatment

Panel B. By group type

Figure 4.1: Provision rates of the public good

Table 4.6 shows the linear regression results of the provision rates of the public good.

Columns (1) to (3) look into the Newcomer norm, comparing the Newcomer treatment groups (which have a social norm) to the control groups (which don't have a social norm). The provision rates of the public good are significantly lower in the Newcomer treatment groups compared to the control groups, where there is no social norm. Also, provision rates decrease as group size increases. The results hold when adding the group size, risk preference, and social value orientation, and also the demographics.

Columns (4) to (6) look into the Random Dice norm, comparing the Random Dice treatment groups to the control groups. As in the figures, the provision rates in the Random Dice treatment groups do not differ significantly from those of the control groups. Note that, compared with the prosocial type, the individualistic type is less likely to coordinate on investment, and this holds for all 8 columns. Based on the figures and the regression results, **H1b** is not verified, and **H1a** holds only in the Newcomer treatment group.

Table 4.6: Linear regression results of the Provision rates of the public good

	Newcomer			Random Dice		
	(1)	(2)	(3)	(4)	(5)	(6)
Has a social norm	-0.081**	-0.091**	-0.095**	0.018	0.018	0.019
(1=Yes, 0=No)	(0.040)	(0.040)	(0.040)	(0.013)	(0.013)	(0.013)
Group size	0.026**	0.026**	0.026**	0.010	0.010	0.010
	(0.011)	(0.011)	(0.011)	(0.007)	(0.007)	(0.007)
Risk preference		0.025*	0.022*		0.001	-0.002
		(0.014)	(0.013)		(0.009)	(0.008)
Social value orientation		-0.045**	-0.047**		-0.034***	-0.034***
(1=Individualistic)		(0.019)	(0.018)		(0.012)	(0.012)
Male			0.010			0.006
			(0.017)			(0.012)
White			-0.025			0.011
			(0.020)			(0.012)
Econ-related major			0.044**			0.031**
			(0.021)			(0.013)
Constant	0.686***	0.677***	0.671***	0.735***	0.750***	0.737***
	(0.036)	(0.042)	(0.044)	(0.025)	(0.028)	(0.029)
Observations	2,364	2,364	2,364	7,440	7,440	7,440
R-squared	0.006	0.009	0.012	0.001	0.002	0.004

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

4.3 Persistence Rates of Social Norms

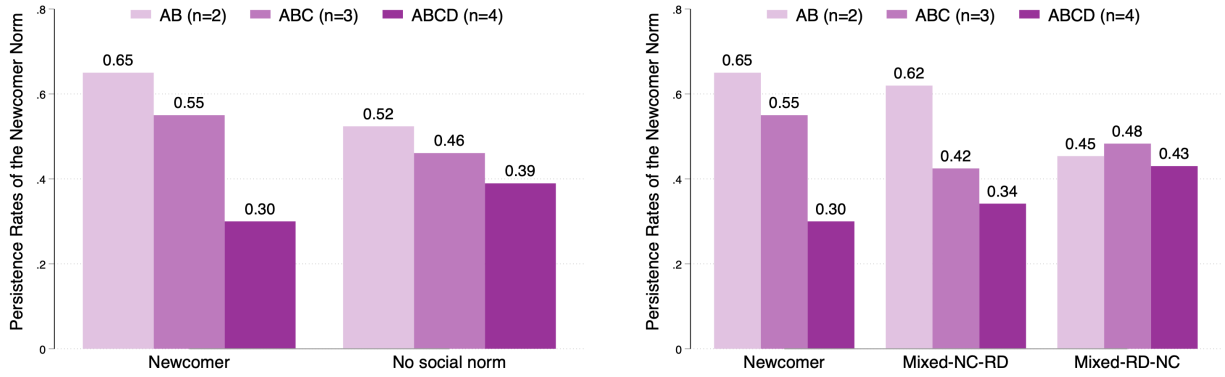
Next, let's look into the persistence rates of the social norms. If a group member is suggested to invest in this round by a norm and he does invest, then the norm is successfully persisted.

In other words, persistence rates of social norms are the rates at which norms are followed.

4.3.1 The Newcomer norm

The Newcomer norm suggests that the newest member invest in each round until another new member joins the group. It's somewhat fair in that every member has been the newest member before. However, an uncertain arrival time for a new member may reduce ex post fairness.

Figure 4.2 demonstrates the norm persistence rates of the Newcomer norm. Panel A demonstrated the difference between the Newcomer treatment groups and the control groups. The purple gradient represents group sizes of 2, 3, and 4. The norm persistence rate decreases as group size increases, consistent with **H2**. Compared with the control groups, the norm-persistence rates in the Newcomer treatment groups start higher when the group size is 2, but decrease more rapidly thereafter. When group size becomes 4, the norm-persistence rate in the Newcomer treatment groups is even lower than that in the control groups. Panel B. breaks the control groups into two group types. The Mixed-NC-RD groups exhibit patterns similar to those of the Newcomer treatment groups, whereas the Mixed-RD-NC groups show more complex patterns. This phenomenon could result from the fact that Member A chose the Newcomer norm in Mixed-NC-RD, setting somewhat, though not official, standards of "who should invest" for the rest of the group members. In the other control group, the member who chose the Newcomer group is boxed around by other members, and it's highly likely that Members C and D also chose the Random Dice norm. In this case, B has little say in the group, partly explaining why the persistence rate of the Newcomer norm starts low with group size 2.



Panel A. By treatment *Panel B. By group type*

Figure 4.2: The rates of following the Newcomer norm

To verify the results shown in the figures, I use a linear regression model as in Equa-

tion (1). The regression results are shown in Table 4.7.

$$\begin{aligned} \text{NC\_persist}_{igt} = {} & \alpha^{NC} + \beta_1^{NC}\,\text{Treatment}_g^{NC} + \beta_2^{NC}\,\text{GroupSize}_{gt} \\ & + \beta_3^{NC}\left(\text{Treatment}_g^{NC} \times \text{GroupSize}_{gt}\right) + \gamma_1^{NC}\,\text{Risk}_i + \gamma_2^{NC}\,\text{SVO}_i \\ & + \boldsymbol{\delta}^{NC\prime} X_i + \varepsilon_{igt}^{NC} \end{aligned} \tag{1}$$

Table 4.7: Persistence of the Newcomer Norm

	(1)	(2)	(3)	(4)
	NC_persist	NC_persist	NC_persist	NC_persist
Treatment	0.042	0.365**	0.348**	0.348**
(1=Newcomer, 0=Control)	(0.059)	(0.170)	(0.169)	(0.170)
Group size		-0.067***	-0.068***	-0.068***
		(0.015)	(0.015)	(0.015)
Treatment × Group size		-0.108**	-0.105**	-0.104**
		(0.050)	(0.049)	(0.049)
Risk preference			0.019	0.022
			(0.030)	(0.030)
Social value orientation			-0.087**	-0.090**
(1=Individualistic, 0=Prosocial)			(0.035)	(0.035)
Male				-0.019
				(0.034)
White				-0.003
				(0.046)
Econ-related major				0.041
				(0.044)
Constant	0.458***	0.660***	0.678***	0.675***
	(0.020)	(0.052)	(0.065)	(0.066)
Observations	2,364	2,364	2,364	2,364
R-squared	0.001	0.019	0.027	0.028

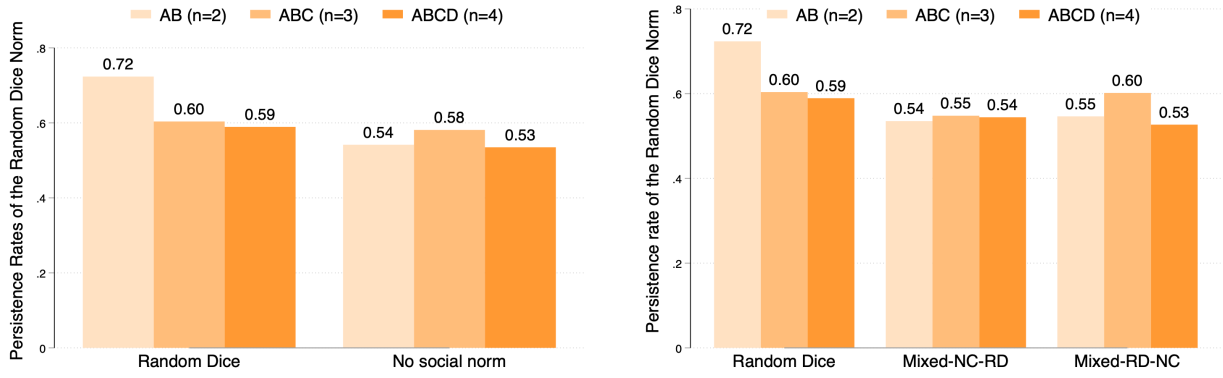
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

From the regression table, we can see that the persistence rate of the Newcomer norm is significantly higher in the Newcomer treatment groups compared to the control groups for columns (2) to (4). This is consistent with the intuition that the Newcomer norm is the social norm in the Newcomer treatment groups. Group members have a guideline to follow and to coordinate efficiently. However, the negative signs of the intersection terms between Treatment and group size indicate that the persistence rate of the Newcomer norm declines more quickly in the Newcomer treatment groups, suggesting that the Newcomer norm won't last very long. The maximum group size is 4 in this experiment. We can anticipate that, should the group size continue to grow, the Newcomer norm will die out

quickly and eventually end completely. Also, individualistic people are less likely to follow the Newcomer norm. In all, both **H2** and **H2b-NC** holds true.

4.3.2 Random Dice

The Random Dice randomly selects a current member and suggests that he invest in that round. If the Random Dice norm suggests a member and actually invests, we say the Random Dice norm has successfully persisted. This norm is also fair in the sense that current members have equal chances of being suggested to invest. However, a member may be selected by the Random Dice norm for several rounds, which introduces ex post unfairness. Based on Table 4.3, we already know that more participants chose the Random Dice norm. It's reasonable to predict that having Random Dice as a social norm within the group should help members coordinate to invest more effectively than under no social norm or under the Newcomer norm.



Panel A. By treatment *Panel B. By group type*

Figure 4.3: The rates of following the Random Dice norm

Figure 4.3 demonstrates the norm persistence rates of the Random Dice norm. Panel A demonstrated the difference between the Random Dice treatment groups and the control groups. The orange gradient represents group sizes of 2, 3, and 4. The norm persistence rate decreases as group size increases, consistent with **H2**. Compared with the control groups, the norm-persistence rates in the Random Dice treatment groups start higher when the group size is 2, but decrease more rapidly thereafter. The persistence rate of the Random Dice norm shows a mixed pattern in the control groups. Panel B. breaks the control groups into two group types. The persistence rates of the Random Dice norm don't seem to change much when group size increases in the Mixed-NC-RD groups, while the rates increase first and then decrease in the Mixed-RD-NC groups. Given the fact that more participants chose

the Random Dice norm, it's highly likely that the Mixed-NC-RD groups may actually be NC-RD-RD-RD, meaning that the Random Dice norm can persist among more group members at a steady pace. The mixed pattern in the Mixed-RD-NC needs further discussion.

To verify the results shown in the figures, I use a linear regression model as in Equation (2). The regression results are shown in Table 4.8.

$$\begin{aligned} \text{RD\_persist}_{igt} = {} & \alpha^{RD} + \beta_1^{RD}\,\text{Treatment}_g^{RD} + \beta_2^{RD}\,\text{GroupSize}_{gt} \\ & + \beta_3^{RD}\left(\text{Treatment}_g^{RD} \times \text{GroupSize}_{gt}\right) + \gamma_1^{RD}\,\text{Risk}_i + \gamma_2^{RD}\,\text{SVO}_i \\ & + \boldsymbol{\delta}^{RD\prime} X_i + \varepsilon_{igt}^{RD} \end{aligned} \tag{2}$$

Table 4.8: Persistence of the Random Dice Norm

	(1)	(2)	(3)	(4)
	RD_persist	RD_persist	RD_persist	RD_persist
Treatment	0.086***	0.276***	0.271***	0.272***
(1=Random Dice, 0=Control)	(0.018)	(0.059)	(0.059)	(0.059)
Group size		-0.004	-0.004	-0.004
		(0.015)	(0.015)	(0.015)
Treatment × Group size		-0.064***	-0.063***	-0.063***
		(0.018)	(0.018)	(0.018)
Risk preference			0.022	0.021
			(0.015)	(0.015)
Social value orientation			-0.043**	-0.041**
(1=Individualistic, 0=Prosocial)			(0.020)	(0.020)
Male				0.012
				(0.021)
White				0.024
				(0.020)
Econ-related major				0.020
				(0.019)
Constant	0.554***	0.564***	0.558***	0.541***
	(0.015)	(0.051)	(0.055)	(0.055)
Observations	7,440	7,440	7,440	7,440
R-squared	0.006	0.016	0.018	0.019

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

From the regression table, we can see that the persistence rate of the Random Dice norm is significantly higher in the Random Dice treatment groups compared to the control groups for all four columns. This is consistent with the intuition that the Random Dice norm is the social norm in the Random Dice treatment groups. Group members have a guideline

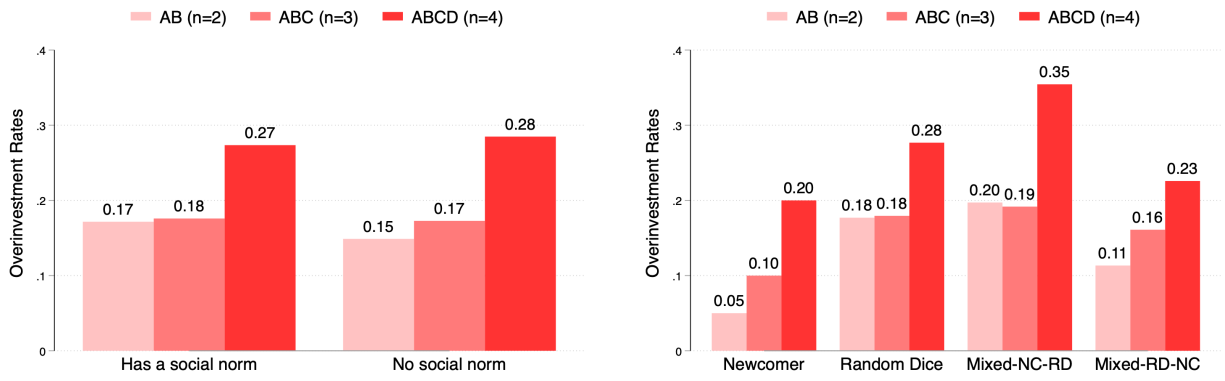
to follow and to coordinate efficiently. However, the negative signs of the intersection terms between Treatment and group size indicate that the persistence rate of the Random Dice norm declines more quickly in the Random Dice treatment groups. Contrary to the soon-die-out Newcomer norm, the deline rate in the Random Dice treatment group is small and cannot cancel out the difference in the persistence rate of the Random Dice norm between the Random Dice treatment groups and the control groups. Therefore, the Random Dice norm will have a good chance to survive, even if we further extend the group sizes. Also, individualistic people are less likely to follow the Random Dice norm. In all, **H2b-RD** holds, and the Random Dice norm has a better chance to survive than the Newcomer norm.

4.4 Overinvestment rates

Given that this experiment is a threshold public-good game, any investment exceeding the threshold is considered inefficient. This part examines overinvestment behaviors to see under what circumstances group members will overinvest.

4.4.1 Unconditional overinvestment rates

Figure 4.4 shows the unconditional rates of overinvestment by treatment (Panel A) and by group type (Panel B). Here, the word "unconditional" refers to average levels with no additional requirements. The overinvestment rate increases with group size, indicating a less secure emotional state among members as the group scales up. No difference is found between treatments and controls.



Panel A. By treatment *Panel B. By group type*

Figure 4.4: Unconditional rates of overinvestment

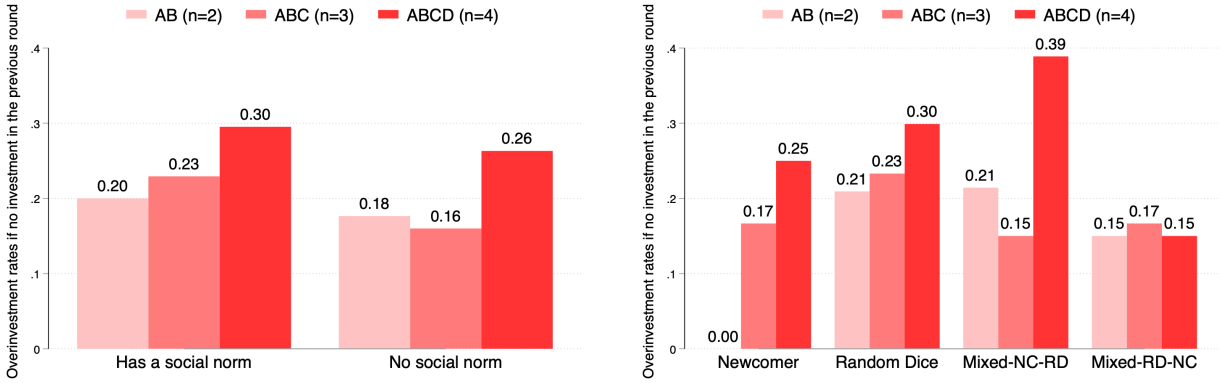
Patterns differ when we break them down by group type. Specifically, the Newcomer treatment groups and the Mixed-RD-NC control groups are alike, while the Random Dice

treatment groups and the Mixed-NC-RD control groups are alike. In any case, there's a substantial increase in the climb when the group size moves from 3 to 4. One possible reason is that when the group size is 3, it's relatively easy to infer the composition of group members, given the fact that Members A and B's norm choices are revealed. However, the last member to join the group introduces additional sources of uncertainty and creates more tension among group members. Fearing that other "unknown-type" members won't invest, members may invest even when it's not their turn, thereby increasing the average overinvestment rate. Therefore, **H3a** holds but **H3b** doesn't hold.

4.4.2 Overinvestment rate conditional on no investment in the previous round

No investment in the previous round signals to the group members that their peers are less likely to coordinate and more likely to be free riders. Knowing this, group members may choose to invest regardless of whether it's their turn. Under these circumstances, a social norm within the group intended to serve as coordination guidance may have little or no effect if members value the public good highly. Thus, resulting in more investment than necessary.

Figure 4.5 shows the rates of overinvestment conditional on no investment in the previous round by treatment (Panel A) and by group type (Panel B). Overall, the overinvestment rates are higher compared to the unconditional overinvestment rates displayed in Figure 4.4. This is consistent with the intuition that knowing other members are more willing to be free riders, the participant will invest more likely, regardless of whether it's his turn to invest. Thus, increasing the overinvestment rates. In the treatment groups, the rates increase with group size. In the control groups, the rates are about the same for group sizes 2 and 3, but increase steeply when the group size increases to 4.



Panel A. By treatment

Panel B. By group type

Figure 4.5: Rates of overinvestment when no investment in the previous round

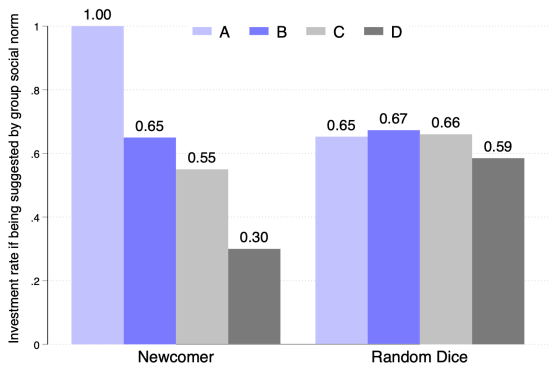
Among the group types in Panel B, the Mixed-NC-RD groups stand out for exhibiting

a distinct pattern: overinvestment rates first decrease and then increase. Examining all possible combinations of suggestions from the two norms, we find that 3 out of 9 occasions will result in no investment if everyone follows only their chosen norm (since there's no social norm in the group). In the other control group, the Mixed-RD-NC group, 2 out of 9 occasions result in no investment, and 2 out of 9 result in two investments. More discussion and examination is needed to figure out why the Mixed-NC-RD group stands out in the conditional overinvestment pattern.

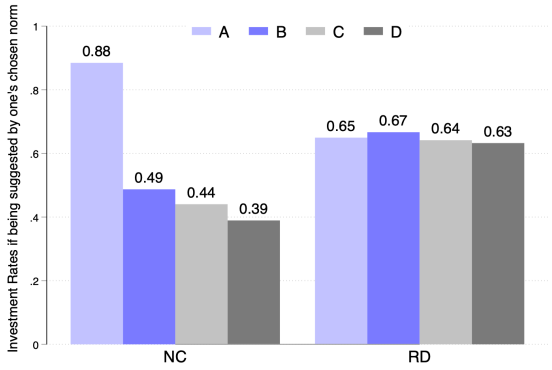
4.5 Response Rate of Social Norms

From previous results, we know that the Random Dice norm is more popular among participants and lasts longer than the Newcomer norm. But why is that? Also, when facing a call from the group's social norm (if any) and a call from one's own chosen norm (if it differs from the group's social norm), which will the participant answer?

Figure 4.6 demonstrates the response rates of being suggested by the group social norm (Panel A) and being suggested by one's own chosen norm (Panel B) by each group member. It's evident that in both cases, group members respond very differently to the Newcomer norm: Member A loves it, while the rest of the members don't fancy it, especially Member D. The significant difference is part of the reason the Newcomer norm cannot last long. On the contrary, although the response rates are not as high as 0.8 or 0.9, they are similar across all group members, indicating that everyone values it at about the same level. This helps the Random Dice norm to persist longer. Both **H4a** and **H4b** hold for the Newcomer norm, but not the Random Dice norm. In other words, if we wish to have a social norm that persists as long as possible when the group is expanding, it must be the case that every group member accepts it at approximately the same level. Otherwise, the social norm cannot persist long.



Panel A. Being suggested by group social norm



Panel B. Being suggested by one's chosen norm

Figure 4.6: Rates of investing if being suggested by the norm

5 Discussion

There are four main findings of this experiment. First, contrary to intuition, there's no significant difference in the provision rates of public goods between the treatment groups with a social norm and the control groups without a social norm. This is because the Newcomer treatment groups have significantly lower provision rates than the control groups, so the treatment groups as a whole do not have significantly higher provision rates.

Second, the norm persistence rates decrease as the group size increases. Both the persistence rates of the Newcomer norm and those of the Random Dice norm start higher and decline more rapidly than those of the control groups. The difference is that, for the Newcomer norm, the persistence rate in the treatment group declines so rapidly that it's even lower than that of the control group by the end of the day (group size 4). In contrast, the persistence rate of the Random Dice norm is still higher than that in the control group. This tells us that having a social norm within the group is not sufficient, since different social norms exhibit different persistence (die-out) rates.

Third, the overinvestment rate increases with group size, and it is higher when conditional on no investment in the previous round. This indicates that even when a social norm exists within the group, the "free-rider" signal embedded in the history of group members' behavior may hinder the social norm's ability to help group members coordinate.

Last but not least, different response rates among group members are the key reason why a social norm is not welcomed and cannot persist long. From the social planner's perspective, to have a social norm that can help people coordinate when the group is expanding, it must be a good norm in the sense that people accept it at a similar level.

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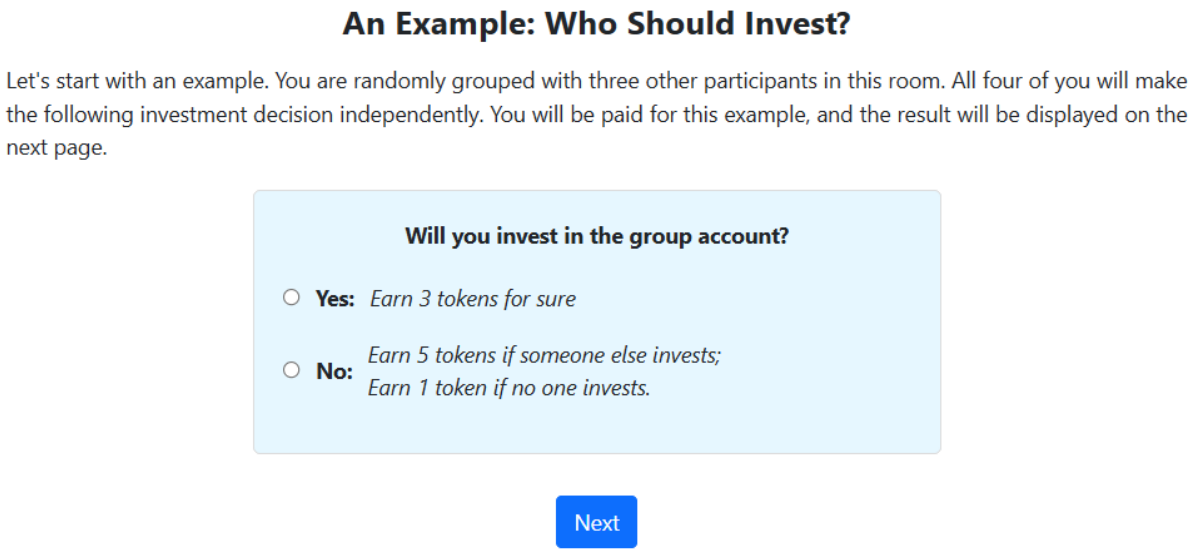
Appendix A1: Experimental Instructions

This experiment studies decision-making and is expected to last around 60 minutes. Your final earnings will depend on your own decisions, the decisions of other participants, and some elements of chance. Some earnings are in the form of tokens, a currency that is used only in this experiment. **1 Token = 0.08 US Dollar**. You will be paid in cash privately at the end of the experiment.

Please remain silent during the experiment. Do not talk to other participants. Cell phones and smart devices are not allowed. If you have a question, raise your hand for assistance.

Agenda of this experiment:

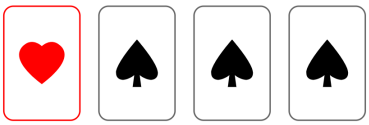
- Instructions of Part 1 and Part 2
- Quiz for Instructions
- Part 1
- Part 2
- Part 3 (with Instructions)
- Part 4 (with Instructions)
- Survey



- If you receive **1** token, it means that no one in your group invested.
- If you receive **3** tokens, it means you invested; in this case, regardless of whether any of your group members invested, you will earn 3 tokens.
- If you receive **5** tokens, it means that at least one group member other than you invested.

Now, imagine the group size is not fixed at four members. Instead, **the group size grows over time**. Let's name the members **A, B, C, and D, in the order they join the group**. It starts with Member A only. Members B, C, and D join the group one by one until there are four people:

- **Round 1:** Only Member A is a current member.
- **Round 2:** Member B becomes a current member.
- **Since Round 3,** the computer will randomly pick one card out of 1 Red Heart and 3 Black Spades at the beginning of each round.
  - The first time a Red Heart is picked, Member C will become a current member since that round.
  - The second time a Red Heart is picked, Member D will become a current member since that round.
  - The third time a Red Heart is picked, the Block will immediately stop.



If you have joined the group, you are called **current member**. The number of current members is the group size. Otherwise, you are called **n observer**. In each round, all current members independently make the investment decision shown in the previous example. There's nothing for the observers to do.

Part 1: Choices of Social Norms

In each round, **all current members independently make the investment decision shown in the previous example**. It would be challenging to make investment decisions given that the group size varies across rounds.

We will introduce two ideas (social norms) to help you decide whether to invest in the group account when facing uncertain group sizes. A social norm is a shared standard of acceptable behavior by a group. The definition and example of each social norm are shown below.

Which of the two norms do you think is more socially appropriate?

Newcomer: The newest member is suggested to invest until another new member joins.

Example: When A and B are in the group, B is suggested to invest in the group account until C joins.

Random Dice: A computerized dice will randomly suggest one current member to invest.

Example: When A and B are in the group, the dice will randomly suggest A or B to invest in the group account.

Next

(This page is for viewing only. You will make your choice after finishing the Quiz for Instructions.)

Part 2: Four Blocks of Decisions

Part 2 consists of four Blocks. Each Block has three stages: Role Assignment, Grouping, and Investment Decision. Role Assignment and Grouping are determined by the computer, while Investment Decision is for you to make multiple rounds of decisions.

[Stage 1: Role Assignment]
The computer will randomly assign you a role from A, B, C, and D with equal probabilities (i.e., 25%). This assignment is independent of your answer from Part 1 - Choice of Social Norms. You will be randomly re-assigned a role after each Block.

[Stage 2: Grouping]
After your role is assigned, you will be randomly placed into a group of four. Group information will be provided to you before and during Stage 3. You will be randomly re-grouped after each Block.

[Stage 3: Investment Decision]
Stage 3 consists of several rounds of decision-making. In each round, **all current members independently make the investment decision shown in the previous example** while the observers make no decision.

At the end of each round, you will see a summary of current members, suggestions by the two norms (the member who is suggested to invest), who invested in the group account, your decision, and your token earnings in this round. At the end of the experiment, your total token earnings from all 4 Blocks will be converted to USD for payment.

Summary

- **Duration and Payment:** The experiment will last around 60 minutes. You will receive $0.5 each for correct answers in the Quiz, and all token earnings (**1 token = 0.08 USD**), paid in cash privately at the end of the experiment.
- **Part 1: Which of the following norms do you think is more socially appropriate?**

Newcomer: *The newest member is suggested to invest until another new member joins.*	***Random Dice:*** *A computerized dice will randomly suggest one current member to invest.*

- **Part 2: 4 Blocks of Decision-making**
  - **Role Assignment:** You are randomly assigned a role as A, B, C, or D.
  - **Grouping:** You will be randomly placed into a group of four. Group information will be provided.
  - **Investment Decision:** In each round, **all current members independently make the investment decision** while the observers make no decision.

Appendix A2: Quiz of Instructions

The following six questions test your understanding of the Instructions. You will be paid \$0.5 for each correct answer. Your score and payment will be revealed at the end of the experiment.

1. What's your probability of being assigned a C role in any Block?

- 25%
- 40%
- 50%
- 75%

2. In Round 1, only Member A was a current member. At the end of Round 1, the computer randomly picked one out of four cards (1 Red Heart + 3 Black Spades) and the result was Red Heart. How many current members will there be in Round 2, and who are they?

- 1; Member A
- 2; Members A and B
- 3; Members A, B, and C
- We don't know for sure.

3. Suppose you are Member C, and now it's Round 10. The current members are A, B, and C(You), but only you invest in the group account. How many tokens will you earn in Round 10?

- 0
- 1
- 3
- 5

4. Suppose the group has three current members: A, B, and C, where Member C joins most recently. Which member is suggested to invest in the group account in this round under the social norm of ***Newcomer***?

- Member A
- Member B
- Member C
- Member D

5. Suppose the group has three current members: A, B, and C. The computerized dice randomly pick Member B. Which member is suggested to invest in the group account in this round under the social norm of ***Random Dice***?

- Member A

- Member B
- Member C
- Member D

6. The following statements are from a participant's perspective. Which of the following is FALSE?

- I will choose 1 out of 2 social norms first, and then be randomly assigned a role in a group.
- My assigned roles in Part 2 are independent of (i.e., have no connection with) my choice of social norm in Part 1.
- It's possible that I will be assigned an A role in both Blocks 1 and 2.
- There could be six members in a group.

Appendix A3: Experiment Interfaces

A3.1 Part 1: Choice of Social Norm

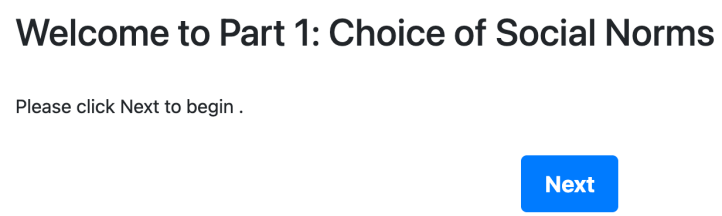


Figure A3.1.1: Welcome Page

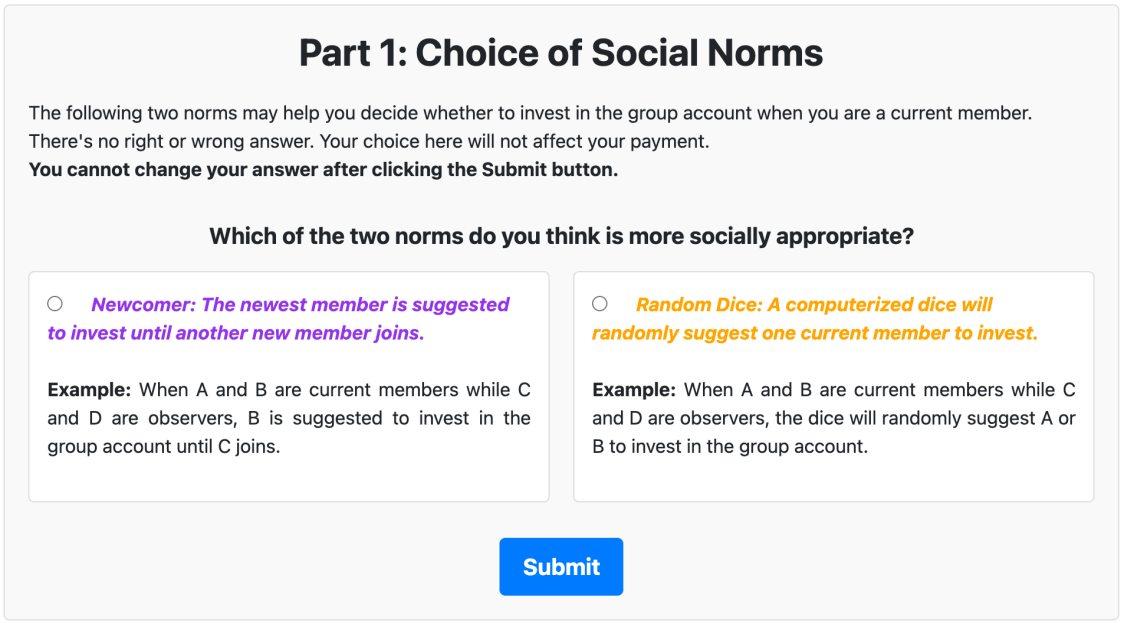


Figure A3.1.2: Choice Page

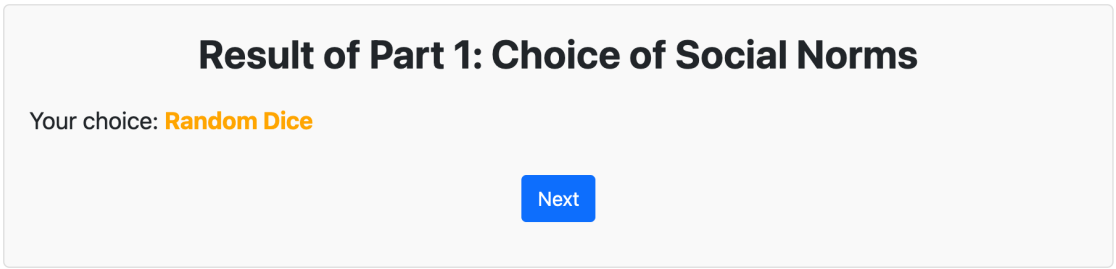


Figure A3.1.3: Result Page

A3.2 Part 2: 5 Blocks of Decision Making

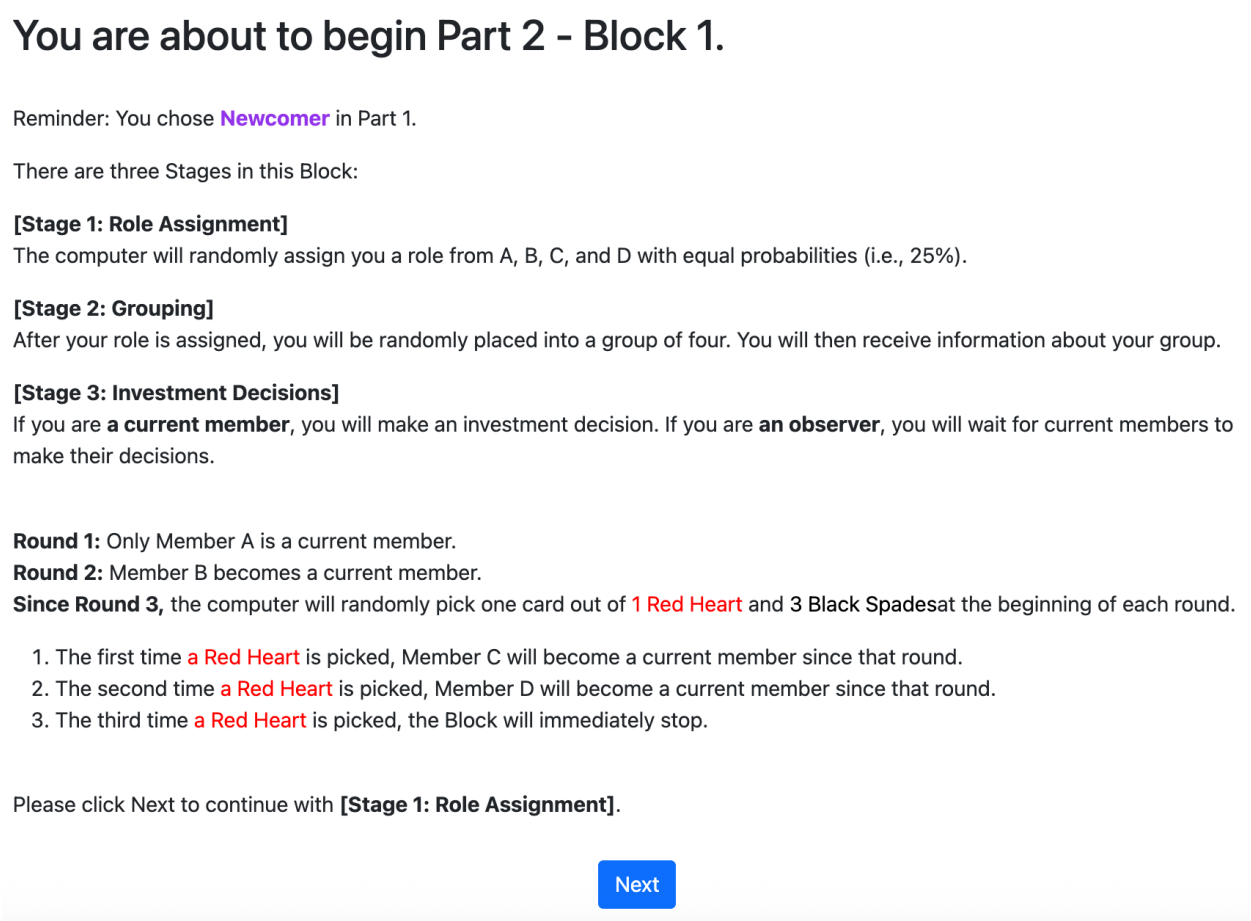


Figure A3.2.1: Information before a Block starts

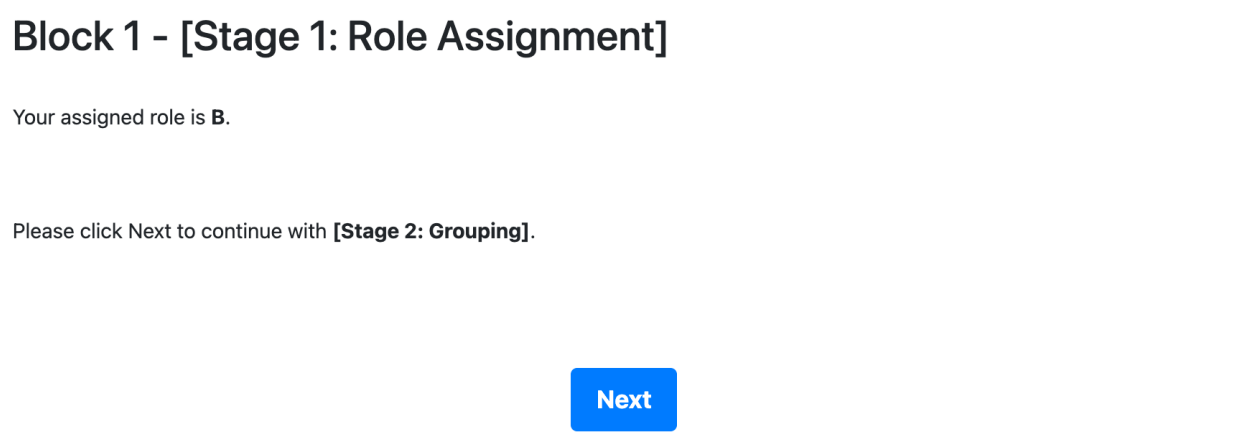
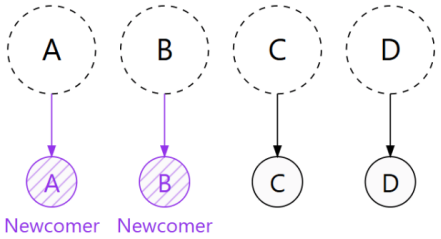


Figure A3.2.2: Stage 1: Role Assignment

Block 1 - [Stage 2: Grouping]

Here is the information about your group:

- Member A chose **Newcomer**.
- Member B chose **Newcomer**.
- Member C is randomly selected from all C role participants, independently of their choice of social norms.
- Member D is randomly selected from all D role participants, independently of their choice of social norms.



Please click Next to continue with **[Stage 3: Investment Decision]**.

Next

Figure A3.2.3: Stage 2: Grouping

The following interfaces for Stage 3: Investment Decisions are from Member B of a Newcomer group. In Round 1, only Member A is a current group member, so B makes no decision.

Round 1

The current member(s) in this round: **A**

Next

Figure A3.2.4: Round 1 - Begin page

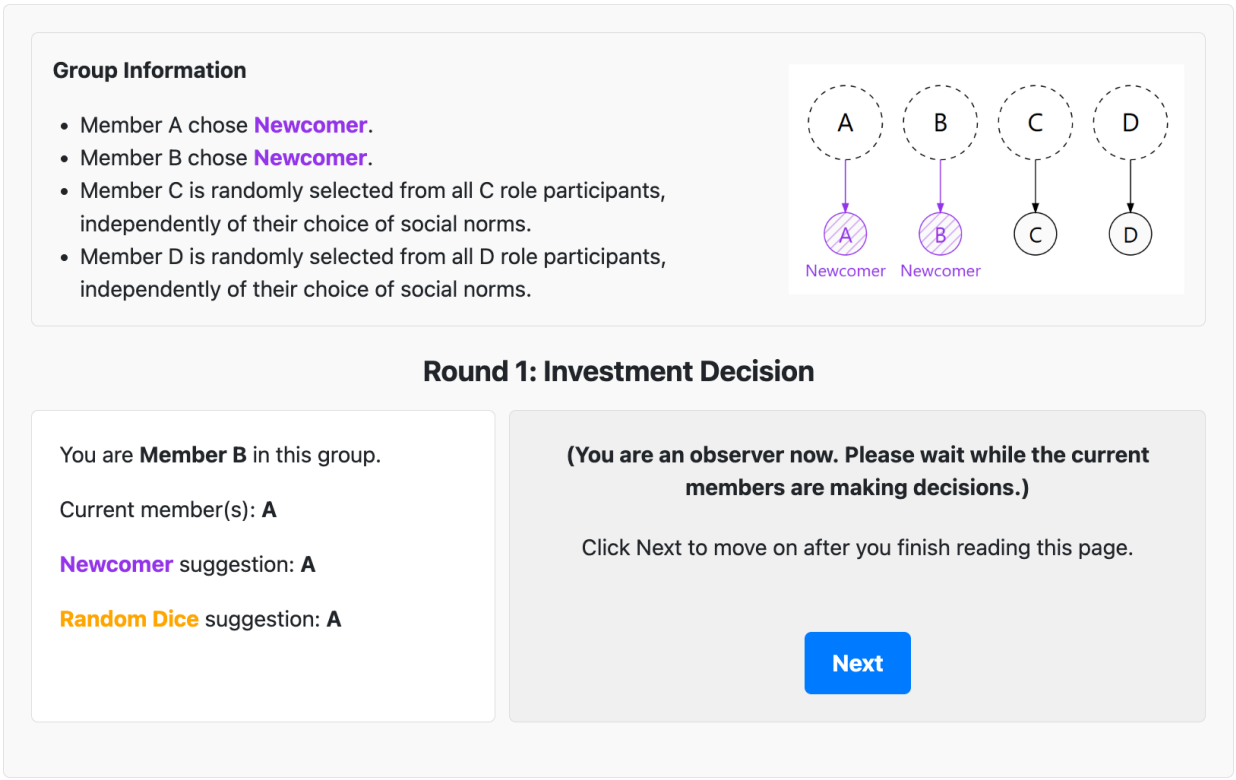


Figure A3.2.5: Round 1 - Decision page

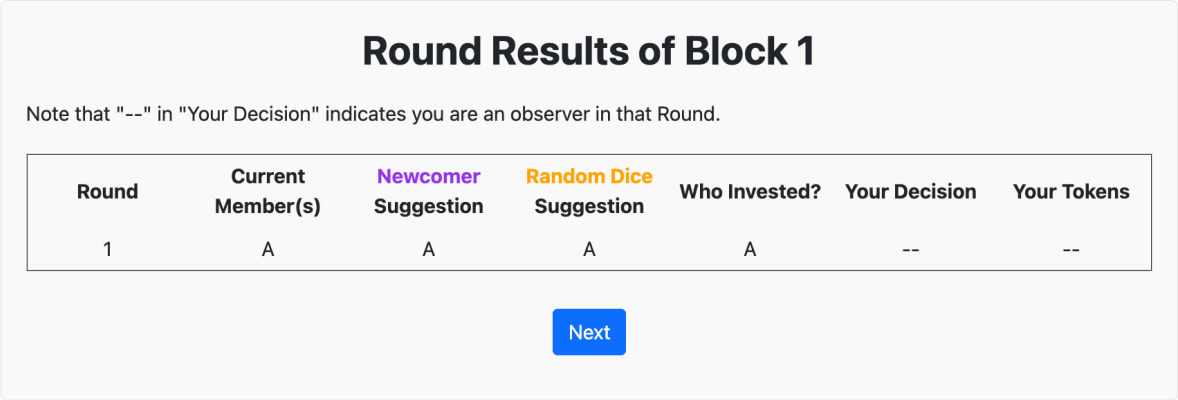


Figure A3.2.6: Round 1 - Result page

Starting from Round 2, Member B is a current group member and makes a decision.

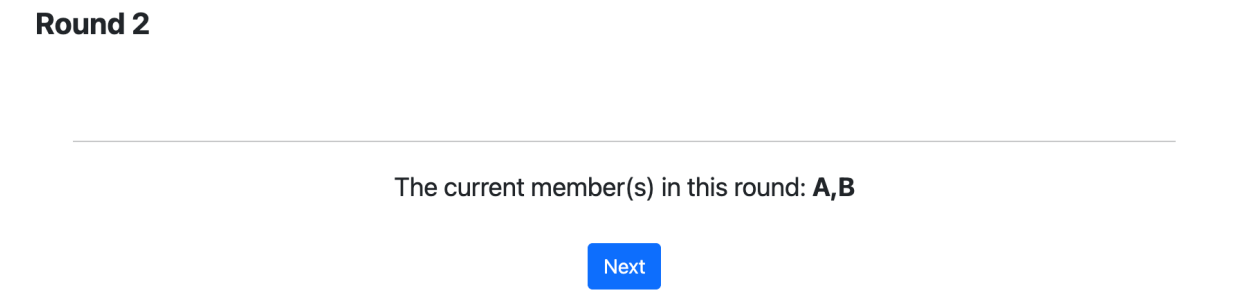


Figure A3.2.7: Round 2 - Begin page

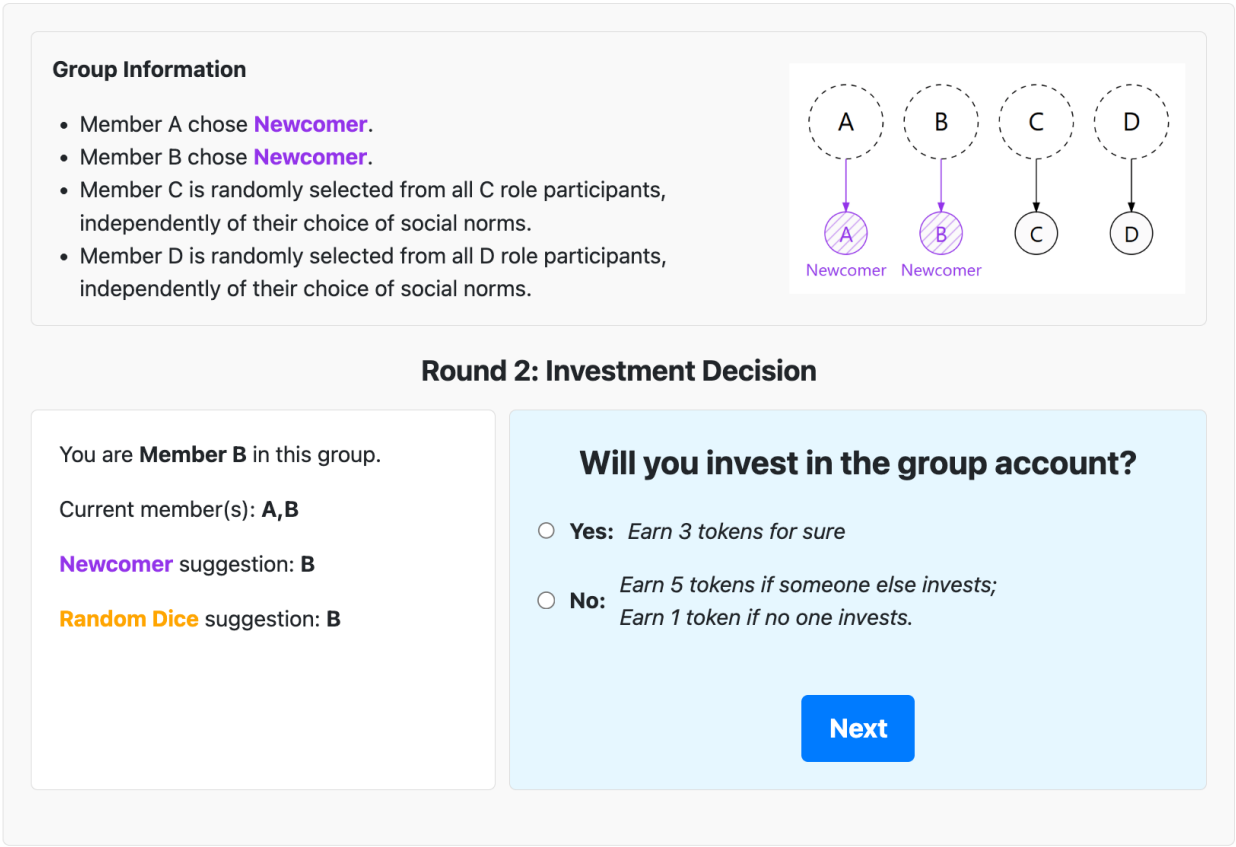


Figure A3.2.8: Round 2 - Decision page

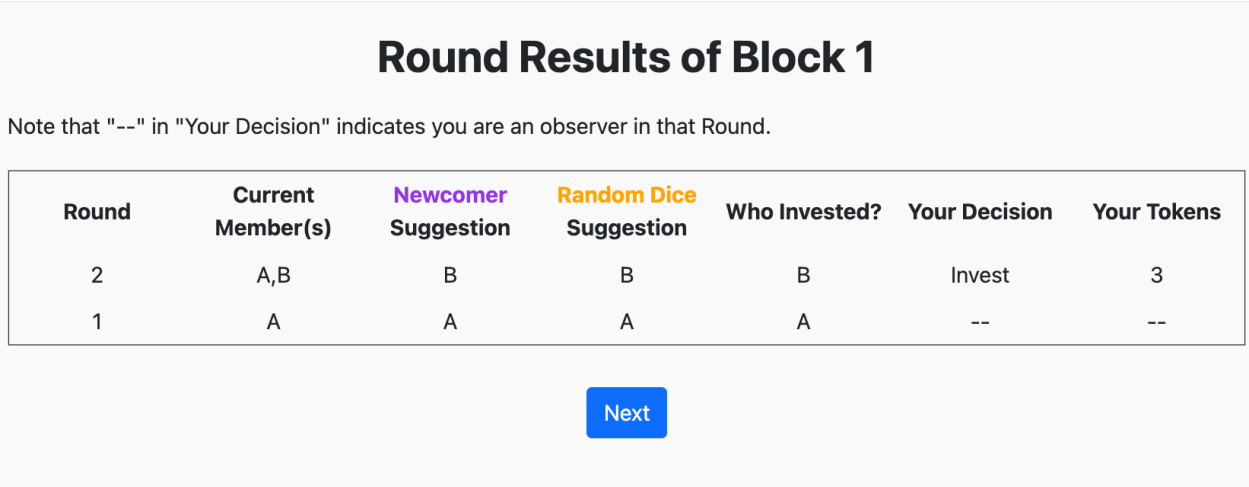


Figure A3.2.9: Round 2 - Result page

Starting from Round 3, a card is randomly picked before seeing the decision page. If it's a red card, then a new member will join as a current member. If it's a black card, the current members remain the same as the previous round. If a red card is picked when there are four current members, the Block stops.

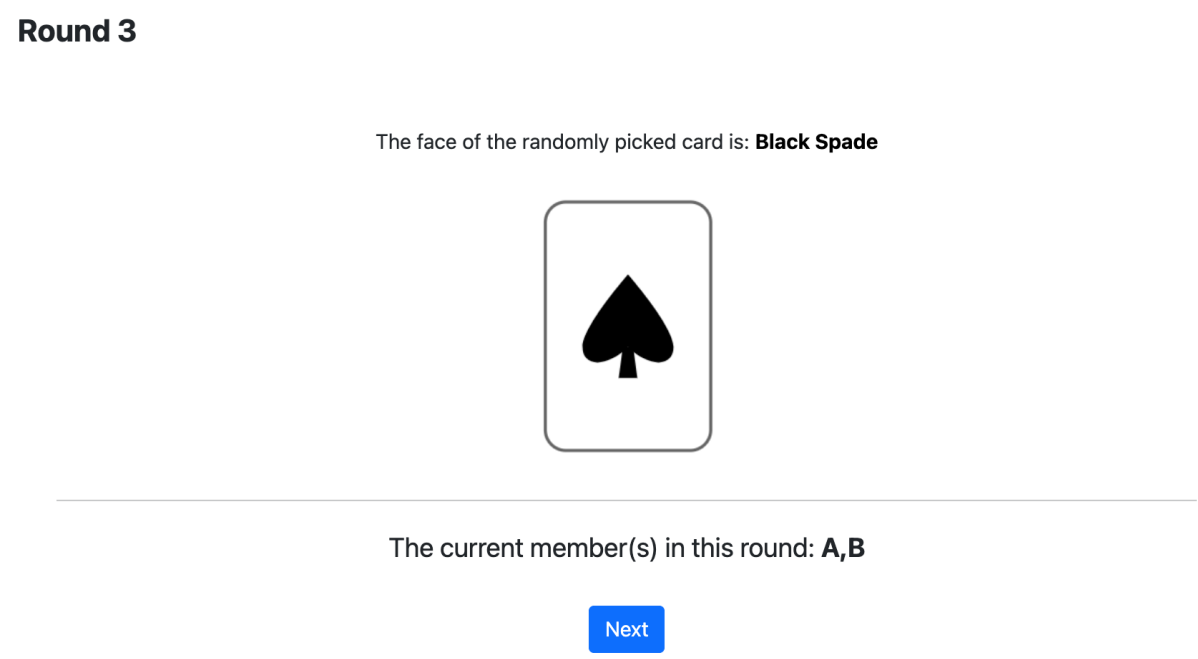


Figure A3.2.10: Black card - members remain the same

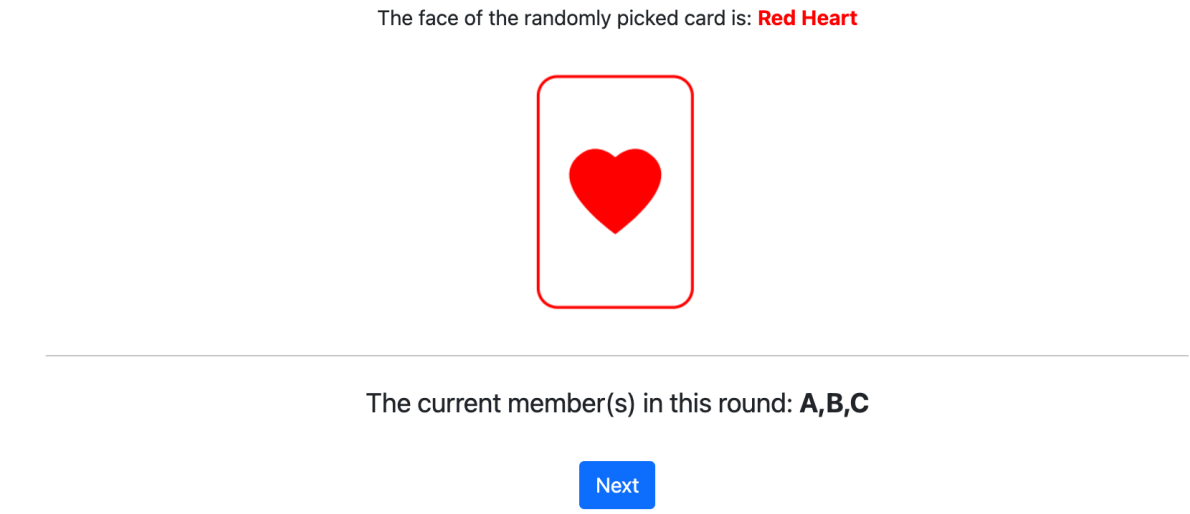


Figure A3.2.11: Red card - New member joins

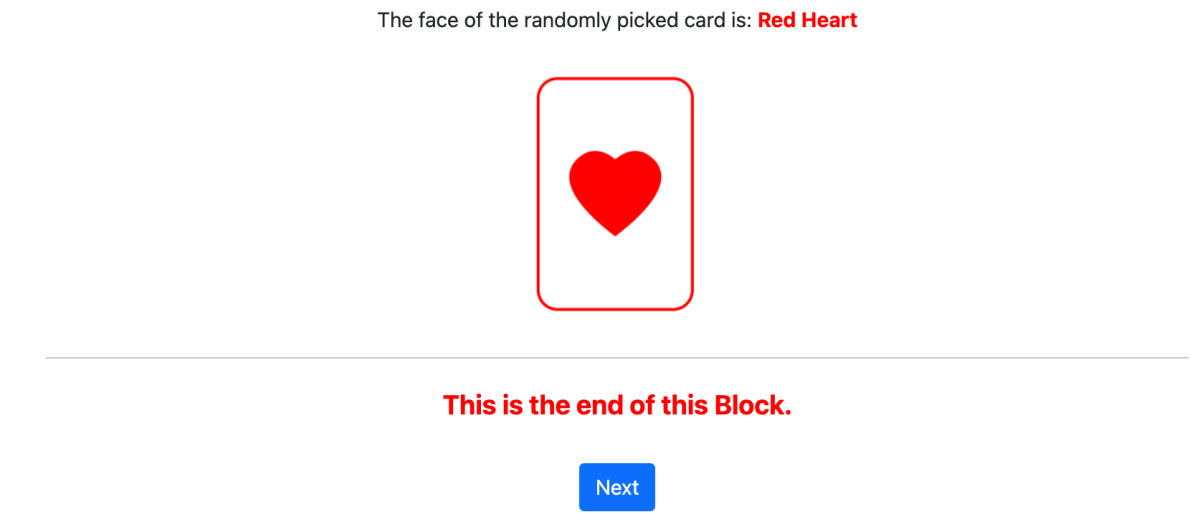


Figure A3.2.12: Red card - Block ends

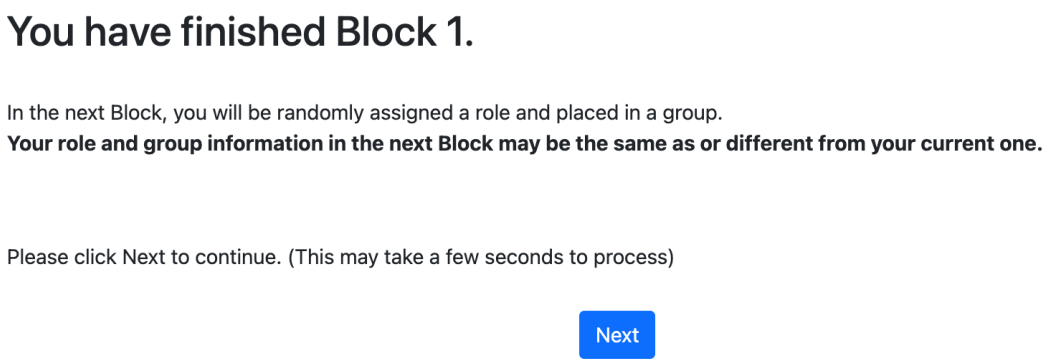


Figure A3.2.13: Block end page

Before Block 5, participants are given a second opportunity to choose their norm.

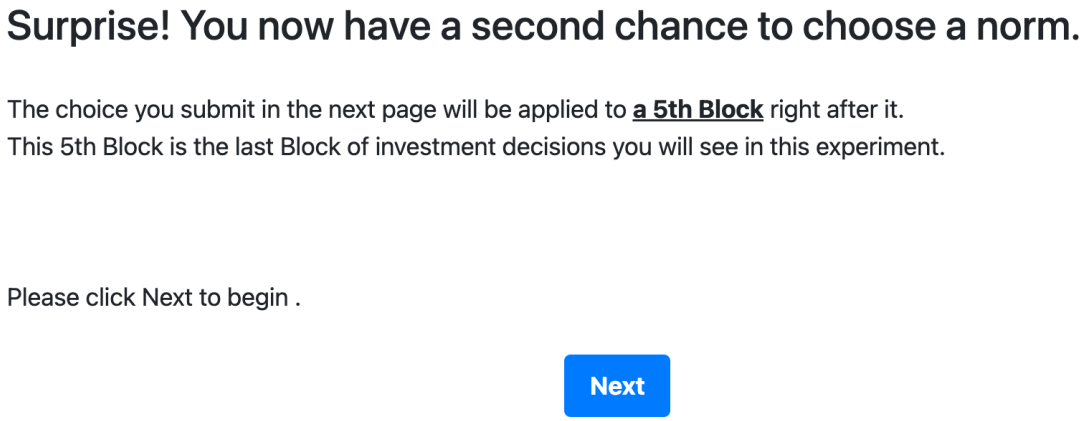


Figure A3.2.14: Information page before Block 5

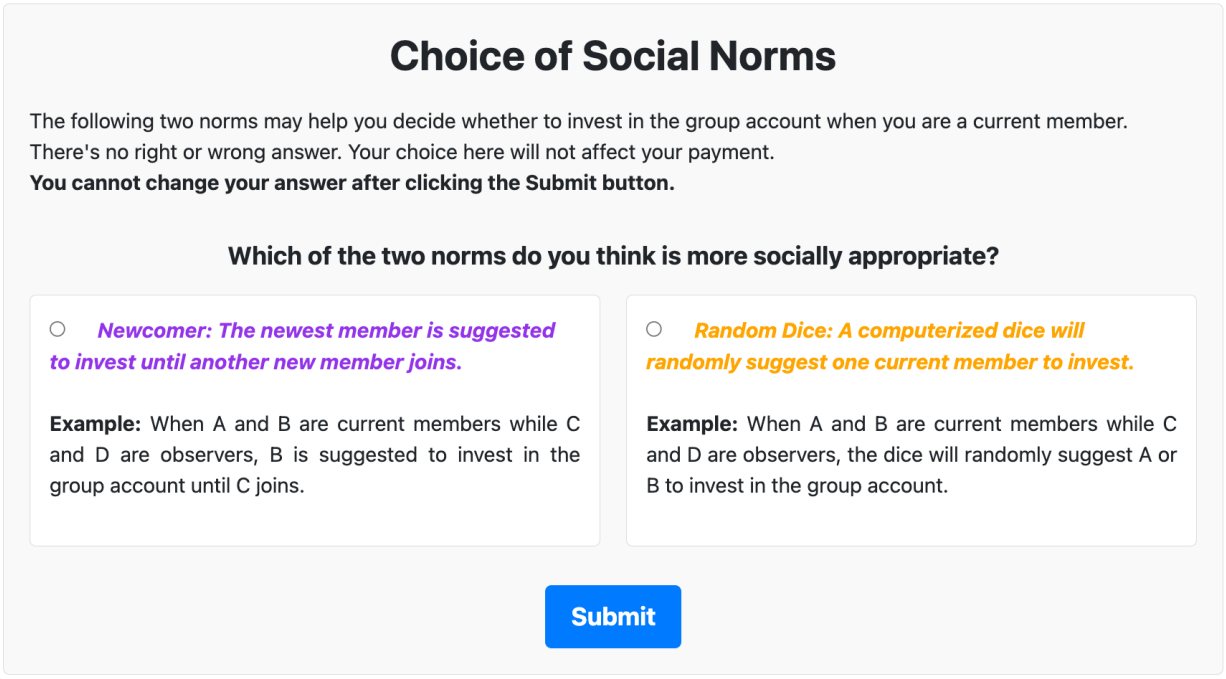


Figure A3.2.15: Second choice of social norm

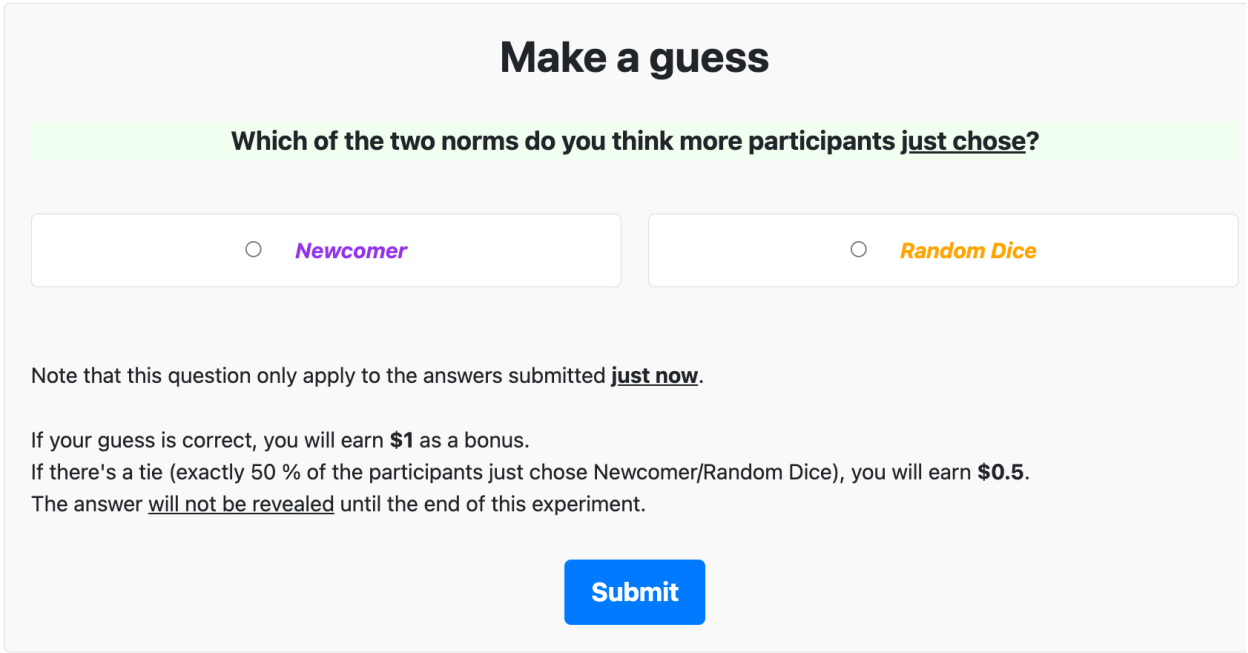


Figure A3.2.16: Second choice of social norm - Make a guess

You are about to begin Block 5.

Reminder: You chose **Newcomer** just now.

There are three Stages in this Block:

[Stage 1: Role Assignment]
The computer will randomly assign you a role from A, B, C, and D with equal probabilities (i.e., 25%).

[Stage 2: Grouping]
After your role is assigned, you will be randomly placed into a group of four. You will then receive information about your group.

[Stage 3: Investment Decisions]
If you are **a current member**, you will make an investment decision. If you are **an observer**, you will wait for current members to make their decisions.

Note: There will be a few questions for you to answer in [Stage 3] before you move on to the results page. Each correct answer will earn you 2 tokens.

Round 1: Only Member A is a current member.
Round 2: Member B becomes a current member.
Since Round 3, the computer will randomly pick one card out of 1 Red Heart and 3 Black Spadesat the beginning of each round.

1. The first time a Red Heart is picked, Member C will become a current member since that round.
2. The second time a Red Heart is picked, Member D will become a current member since that round.
3. The third time a Red Heart is picked, the Block will immediately stop.

Please click Next to continue with **[Stage 1: Role Assignment]**.

Next

Figure A3.2.17: Block 5 - Begin page

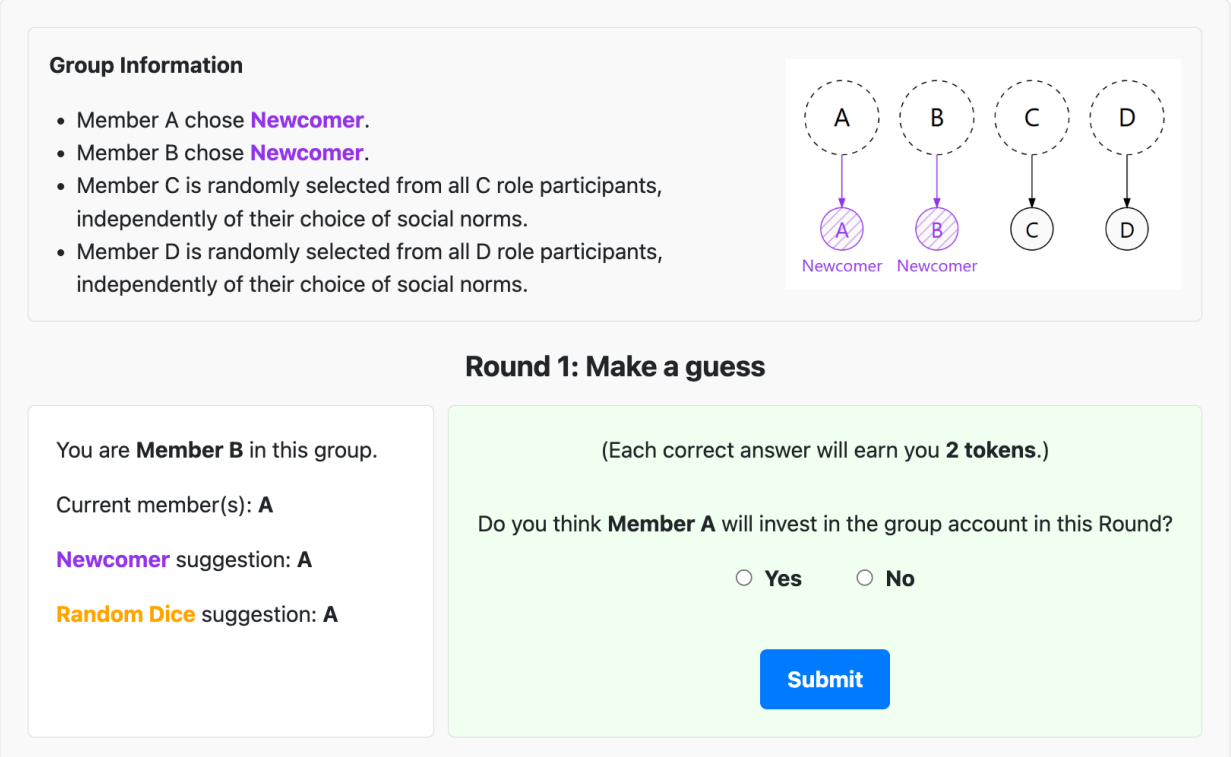


Figure A3.2.18: Block 5 - Guess page

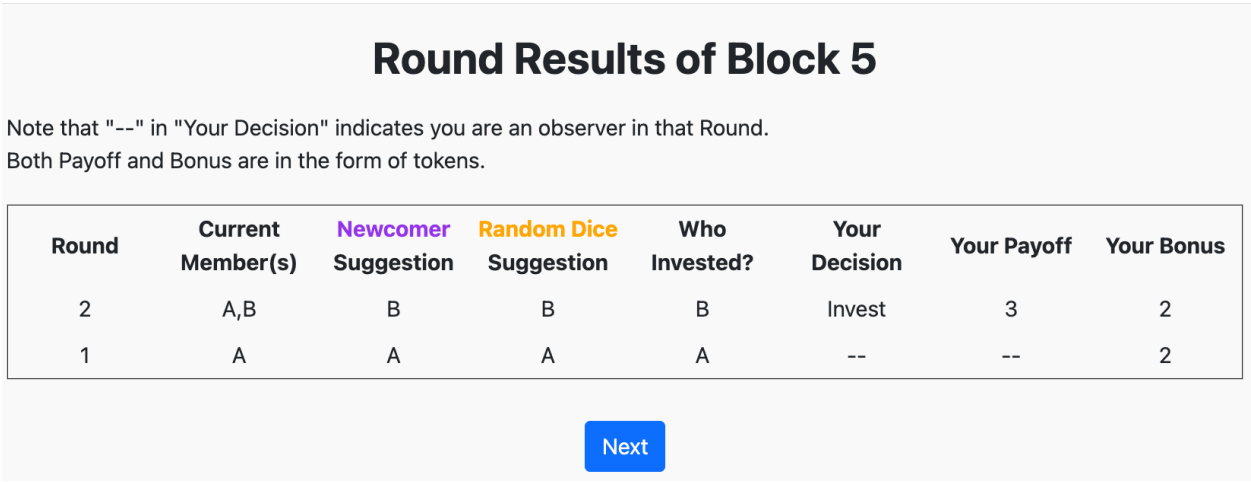


Figure A3.2.19: Block 5 - Result page

A3.3 Part 3: A Gamble Game

Part 3: Instructions

On the following page, you will be required to undertake a Gamble Selection Task:

- You will be shown five gambles, and will be asked to choose the one you prefer.
- Each gamble has 2 possible outcomes, both with equal (50%) chance of occurring.
- Your payment from this task will depend on which gamble you choose, and which outcome occurs.

To proceed, please kindly click the 'Next' button.

Next

Figure A3.3.1: Gamble - Begin page

Gamble Selection Task

The table below presents the associated costs and outcomes for both projects.

Gamble	Random numbers 1-50 (50% chance)	Random numbers 51-100 (50% chance)
1	You earn $2	You earn $2
2	You earn $3	You earn $1.5
3	You earn $4	You earn $1
4	You earn $5	You earn $0.5
5	You earn $6	You earn $0

Please indicate the gamble you want to select:

- ○ Gamble 1
- ○ Gamble 2
- ○ Gamble 3
- ○ Gamble 4
- ○ Gamble 5

Next

Figure A3.3.2: Gamble

A3.4 Part 4: Social Value Orientation

Part 4 : Instructions

In this part of the study, you will be randomly paired with another person, whom we will refer to as the **other**. You will not know who the other person is, nor will the other person be informed about your identity. You will make a series of choices among several alternative allocations of Points. These Points will be converted into Dollars at a rate of **1 Point = 0.05 Dollars**. This rate is only effective for this part.

You will be making a series of decisions about allocating points between you and this other person. For each of the questions, please indicate the distribution you prefer most by selecting the corresponding button in the middle row. You can only make one choice for each question. There are no right or wrong answers, this is all about personal preference.

Diagram: Example of an allocation choice. In the example below, a person chose the allocation giving 50 Points to herself, and 40 Points to the unknown other person. In terms of Dollars, this yields an allocation of 50 × 0.05 = 2.50 Dollars for the person making the choice and 40 × 0.05 = 2.00 Dollars for the unknown other.

You Receive	30	35	40	45	50	55	60	65	70
	○	○	○	○	◉	○	○	○	○
Other Receives	80	70	60	50	40	30	20	10	0

Submit

As you can see, your choices influence both the number of Points you receive, as well as the number of Points the other person receives.

After you have made all your choices, one of the allocation choices will be randomly selected by the software. **For this choice, the software will randomly assign one person from your group (you or the other) the role of "Receiver" and the other the role of the "Sender". The allocation choice made by the Sender will be enforced.** This allocation will be paid in cash to both the Sender and the Receiver.

If you have any questions, please raise your hand.

Next

Figure A3.4.1: Instructions

Part 4 : Decision 1 of 6

Choose a distribution between yourself and the other individual

You Receive	85	85	85	85	85	85	85	85	85
	○	○	○	○	○	○	○	○	○
Other Receives	85	76	68	59	50	41	33	24	15

Submit

Part 4 : Decision 2 of 6

Choose a distribution between yourself and the other individual

You Receive	85	87	89	91	93	94	96	98	100
	○	○	○	○	○	○	○	○	○
Other Receives	15	19	24	28	33	37	41	46	50

Submit

Part 4 : Decision 3 of 6

Choose a distribution between yourself and the other individual

You Receive	50	54	59	63	68	72	76	81	85
	○	○	○	○	○	○	○	○	○
Other Receives	100	98	96	94	93	91	89	87	85

Submit

Figure A3.4.2: Tasks 1-3

Part 4 : Decision 4 of 6

Choose a distribution between yourself and the other individual

You Receive	50	54	59	63	68	72	76	81	85
	○	○	○	○	○	○	○	○	○
Other Receives	100	89	79	68	58	47	36	26	15

Submit

Part 4 : Decision 5 of 6

Choose a distribution between yourself and the other individual

You Receive	100	94	88	81	75	69	63	56	50
	○	○	○	○	○	○	○	○	○
Other Receives	50	56	63	69	75	81	88	94	100

Submit

Part 4 : Decision 6 of 6

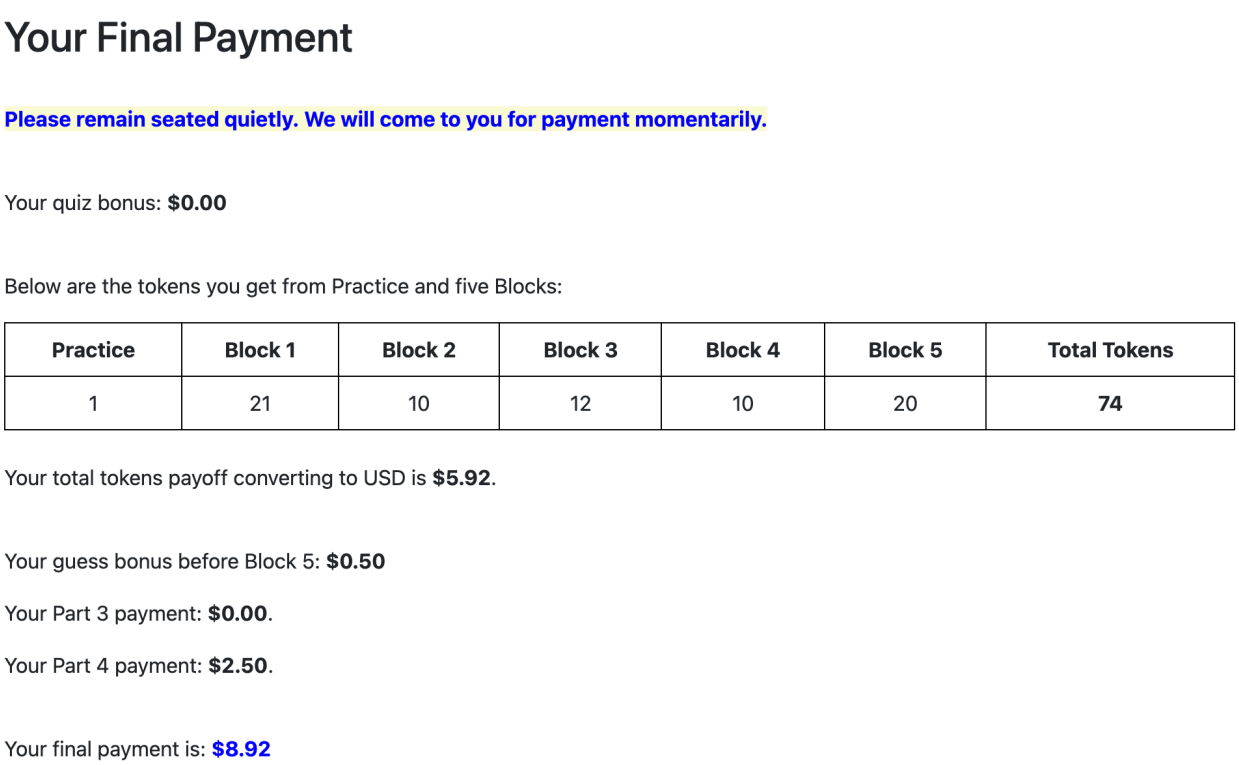
Choose a distribution between yourself and the other individual

You Receive	100	98	96	94	93	91	89	87	85
	○	○	○	○	○	○	○	○	○
Other Receives	50	54	59	63	68	72	76	81	85

Submit

Figure A3.4.3: Tasks 4-6

A3.5 Final Payment Page



Your Final Payment

Please remain seated quietly. We will come to you for payment momentarily.

Your quiz bonus: **$0.00**

Below are the tokens you get from Practice and five Blocks:

Practice	Block 1	Block 2	Block 3	Block 4	Block 5	Total Tokens
1	21	10	12	10	20	**74**

Your total tokens payoff converting to USD is **$5.92**.

Your guess bonus before Block 5: **$0.50**

Your Part 3 payment: **$0.00**.

Your Part 4 payment: **$2.50**.

Your final payment is: **$8.92**

Figure A3.5.1: Final Payment Page

Note that the numbers shown in this figure come from a test by the experimenter. The real payments to participants are higher than the numbers shown.

Appendix A3: Post-Experiment Survey

Please complete this short survey while we prepare your payment information.

1. What's your gender?

- Female
- Male
- Others
- Prefer not to day

2. What's your ethnicity?

- Asian
- Black
- Hispanic
- White
- Others
- Prefer not to say

3. Is your current major related to Economics or Business?

- Yes
- No
- Prefer not to say

4. Do you have a preferred role, and which one?

- Member A
- Member B
- Member C
- Member D
- Indifferent

5. This experiment consists of 5 blocks. If the number of blocks was not fixed, how many blocks could you play with before feeling bored?

- 1 - 5
- 6 - 10
- 10 +

6. How different did you feel when making decisions in **the first four Blocks** vs. **the 5th Block**?

- Roughly the same
- Somewhat different
- Very different

7. How stressed did you feel during the decision tasks?

- 1 - Not at all stressed
- 2 - Slightly stressed
- 3 - Moderately stressed
- 4 - Very stressed
- 5 - Extremely stressed

8. How excited did you feel during the decision tasks?

- 1 - Not at all excited
- 2 - Slightly excited
- 3 - Moderately excited
- 4 - Very excited
- 5 - Extremely excited

9. How calm did you feel during the decision tasks?

- 1 - Not at all calm
- 2 - Slightly calm
- 3 - Moderately calm
- 4 - Very calm
- 5 - Extremely calm

10. How anxious did you feel during the decision tasks?

- 1 - Not at all anxious
- 2 - Slightly anxious
- 3 - Moderately anxious
- 4 - Very anxious
- 5 - Extremely anxious

11. Did you find any part of the experiment confusing or unclear? If so, which parts and why?

12. What aspects of the experiment did you find most engaging or interesting?

13. What aspects of the experiment did you find frustrating or tedious?

14. Did you choose a different social norm the second time (before the fifth Block)? If so, why did you choose a different one?

15. Aside from the two social norms you saw in this experiment, do you have other ideas/norms to help members coordinate?