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Does Voting Solve the Intergenerational Sustainability Dilemma?

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Abstract: Does voting solve the intergenerational sustainability dilemma? Do voting rules matter when trying to induce people to collectively select a sustainable alternative that leaves more resources for future generations? To answer these questions, we conducted a laboratory experiment using an intergenerational sustainability dilemma game in which players are asked to choose between two alternatives. Choosing the alternative that maximizes the players' immediate benefit decreases the resources left for subsequent generations. The choice is made by the votes cast within small groups representing successive generations. We compare three voting rules: ordinary voting, whereby each person in the group has one vote; proxy voting, whereby some but not all of the players are given an extra vote to cast on behalf of subsequent generations; and two-ballot voting, whereby all players are given an extra vote. We observe that both proxy voting and two-ballot voting increase the frequency at which the sustainable alternative is selected; however, the frequency of such a choice remains low. This suggests that voting individually is a relatively ineffective way to elicit sustainable choices from successive generations even if the rules of voting are modified.

Keywords: proxy vote; intergenerational sustainability dilemma; future generation; laboratory experiment

1. Introduction

Voting is a widely used means of determining policies in modern societies. Clearly, however, only members of the current generation can participate in the vote despite the fact that subsequent generations can be greatly affected by the outcome. The absence of future generations in voting makes it difficult for intergenerational opinions, especially those that prioritize the interests of future generations, to be reflected in voting results. From a political perspective, this is a fundamental issue in creating a sustainable society [1].

A somewhat similar intergenerational issue exists between the young and the elderly within the current generation. Children under the legal voting age are excluded from the voting process. Moreover, as the proportion of young people continues to decline in developed countries, their opinions will be even less likely to be reflected in voting outcomes in the future. As one solution to this problem, giving extra votes to parents with children under the voting age has been proposed as a way to promote intergenerational justice. Van Parijs [2] (p. 309) cites as an example the voting system in the French protectorates of Tunisia and Morocco during the Interwar period, where the fathers of four or more children were given a second vote. He points out that, although the introduction of this type of parents' vote is rare, it has been discussed repeatedly in France from a natalist point of view. Recently, a parents' vote was discussed in the German parliament and was envisaged in a draft of the new constitution in Hungary (where it failed to be adopted). Aoki & Vaithianathan [3] conducted an online survey to determine the attitude of Japanese voters toward the idea of a parents' vote, reporting approval ratings of 68.2% among parents with children under the voting age, 31.5% among parents with children over the voting age, and 44.5% among adults without children. Wolf et al. [4] argued that a parents' vote is justifiable, but that its success or failure depends on whether parents use their proxy votes faithfully to reflect their children's preferences, a proposition that needs to be tested empirically. Kamijo et al. [5] conducted an online experiment in which parents voted to choose an amount to be donated from their endowment to non-profit organizations whose activities were beneficial to future generations. The authors observed that females with children under the voting age voted for a larger donation than others when they were each given one vote, but that this difference disappeared when they were given an extra vote to be cast on behalf of their children.

There is, of course, a fundamental difference between the case of children currently living with their families and yet-to-be-born members of future generations: For the children of the current generation, we can readily apply the one-person-one-vote principle to entrust their votes to their parents or legal guardians, while for the unknown and uncountable members of future generations, such a simple prescription is hardly possible. Wolf et al. [4] (p. 364) state that "voting rights for children do not give a voice to the not-yet-born. If a society wants to give the interests of non-yet-existing individuals their weight too, other tools are needed." Kamijo et al. [6], Miyake [7], and Kamijo et al. [8] considered an extension of the idea of proxy voting to future generations by giving extra votes to a subset of members of the current generation, along with the explanation that these extra votes were to serve as proxy votes for future generations unable to participate in the current voting process. To examine the effectiveness of such a system, the authors conducted a laboratory experiment involving a one-shot game in which participants were divided into groups of three, with two of the group members assigned the role of the current generation and the remaining member taking the role of future generations. The two current-generation participants were to vote to determine how to divide a given amount of money among the three participants. The choice was whether to divide the money equally among the three group members or to give more to themselves at the expense of the future generation's share. A proxy vote for the future generations was given to one of the two current-generation participants. The study found that such proxy voting did not promote the choice of a future-friendly alternative, as the proxy votes were not necessarily cast for the future-friendly alternative and the one-ballot voters often switched from the future-friendly alternative to the own-payoff maximizing alternative when another voter is given an extra vote.

We conduct a similar test here, but in this case, the experiment involves an intergenerational situation in which small groups representing six successive generations are asked to make decisions that significantly affect the number of resources left for subsequent generations. This intergenerational situation, presented in the form of a game called the intergenerational sustainability dilemma game (ISDG), was first proposed by Kamijo et al. [9] and has been used to test the effectiveness of various types of face-to-face discussions for solving the dilemma that the game poses [10–13]. In the experiment conducted by Kamijo et al. [9], each three-person group (i.e., generation) chooses either an own-payoff maximizing alternative or a sustainable alternative after engaging in a ten-minute face-to-face discussion. Group members also determine how to divide the revenue that they earn as a group from their choice. Kamijo et al. [9] found that if one of the three members in each group was assigned the role of "imaginary future generation" and was instructed to negotiate with the other two members on behalf of the subsequent generations, the frequency of sustainable choice improved significantly.

In our current experiment, while we observed that the proxy vote improved the frequency of the sustainable choice in comparison with the conventional one-person-one-vote rule, the frequency of such a choice was still low. This suggests that the introduction of proxy votes is not sufficient to achieve sustainability, which is consistent with the result reported for the one-shot game described above. What appears to be needed, then, is another version of proxy voting, other voting rules, or even other political institutions. It should be noted that our result is in contrast to Hauser et al. [14], who reported that in their experiment involving an intergenerational goods game, sustainability was achieved with the introduction of median voting. We will later discuss the factors that may account for these different results.

The remainder of this paper is organized as follows: Section 2 describes the design of the experiment; Section 3 explains the experimental procedure; Section 4 gives the results; Section 5 presents a discussion of results; Section 6 offers conclusions and suggests future directions. Appendix A provides the instructions given to participants in the experiment.

2. Experimental Design

2.1. Intergenerational Sustainability Dilemma Game

In this experiment, the intergenerational sustainability dilemma game (ISDG) proposed by Kamijo et al. [9] was used to introduce voting as a way for group members to choose one of two alternatives. The participants are divided into six groups (i.e., generations) of three members each, and the groups successively choose one of two alternatives: Alternative A, the own-payoff maximizing choice, or Alternative B, the sustainability-oriented choice.

According to the game's rules, if the first group chooses alternative A, the group receives a total of 3600 Japanese yen. If the group chooses alternative B, it receives only 2700 yen. The choice then passes to the second group. If alternative A was chosen by the first group, the payoff from each of the two alternatives for the second group decreases by 900 yen. That is, the second group will receive 2700 yen if it chooses alternative A or 1800 yen if it chooses alternative B. On the other hand, if alternative B was chosen by the first group, the possible payoffs for the second group will be the same as they were for the first group (i.e., 3600 yen and 2700 yen, respectively). The 900-yen reduction applies to each subsequent group whenever the preceding group has chosen alternative A. Thus, if alternative A is chosen each time, the payoff from A decreases from 3600 yen to 2700 yen, to 1800 yen, to 900 yen, and to 0 yen.

2.2. Three Voting Rules

We compare three voting rules. All three rules select the winning alternative according to the majority vote in the group. That is, the alternative that attracts the greater number of votes is considered the group's choice. Ties are broken randomly. For simplicity, the payoff determined by the group's vote will be equally divided among the group's three members. Abstention is not allowed, and the vote(s) of each participant must be cast for either alternative A or alternative B.

The only difference among the three voting rules is the number of votes given to each group member. Under ordinary voting, each group member has only one vote. Under two-ballot voting, each member is given two votes. In this case, the group members are told that the first vote is the member's own vote and that the second vote is a proxy vote for subsequent groups who will be making choices later in the game. Under proxy voting, only one of the three members of the group is given two votes, while the other two members have just one vote each to cast. The same explanation regarding the extra vote as that given in the two-ballot voting case is given here.

The proxy vote is introduced as a way of injecting the interests of future generations into the current voting process. Hence, for the institution designer, the ideal result would be that 100% of the proxy votes are cast for sustainable alternative B. However, there is no guarantee that a proxy vote will actually be cast for B since this would reduce the payoff for each member of the current-generation group.

Proxy voting creates an asymmetry in the number of votes allotted to voters. In the case of the parents' vote, the asymmetry can be justified under the traditional one-person-one-vote principle, which, in this case, would include children. However, if a proxy vote is to be cast on behalf of future generations, applying the same principle is clearly problematic. The two-ballot voting scheme included in our experiment is intended to avoid such asymmetry but still reflect the interests of future generations in the current voting process.

2.3. Group Assignment

As described in Table 1, two types of sessions were conducted in our experiment: ordinary/two-ballot sessions and proxy sessions. In the ordinary/two-ballot sessions, the participants made their voting choices under ordinary voting and two-ballot voting in random order. In the proxy sessions, each participant voted in each of two circumstances in random order: He/she was one of the two members with one vote each while the remaining member had two votes, or he/she had two votes while the other two members had one vote each. In both types of sessions, each participant experienced both decisions with one vote and decisions with two votes.

Table 1. Two types of sessions.

Session Name	Decisions with One Vote	Decisions with Two Votes
Ordinary/two-ballot	Ordinary voting	Two-ballot voting
Proxy	Proxy voting with one vote	Proxy voting with two votes

Note: In the ordinary/two-ballot sessions, participants made decisions under ordinary voting and two-ballot voting in random order. In the proxy sessions, they made decisions in random order in two circumstances, one in which they were given one vote and one in which they were given two votes.

Participants were assigned to either the ordinary/two-ballot sessions or the proxy sessions according to the date of their participation. They were also assigned to a generational group (groups 1 through 6) according to the time of their participation. The experiment began with the first group and continued through the sixth group. As shown in Appendix A, the instructions differed between the two types of sessions in terms of voting rules but were the same among the six groups within each type of session. Participants were informed of their assigned generation (group) on their voting-decision form, which was distributed after the instructions were given.

Although participants in the sixth-generation groups received the same instructions as the previous five generations and were given a monetary incentive in the form of a gratuity determined by their vote, their instructions did not mention the sixth generation and beyond. While they were told that each group belonged to a sequence of groups, no mention was made of how far the sequence extended. In actuality, we did not have sessions for the seventh generation or beyond.

The participants who gathered at each of the various times in the laboratory were divided into three-member groups and assigned to the same generation. Each group was to be connected with five other groups chosen randomly from the other five generations to form a sequence. At the end of theordinary/two-ballot sessions, one of the two voting rules was randomly selected, and participants' earnings were calculated based on the decisions made under that rule. Similarly, in the proxy sessions, one of the two circumstances was randomly selected for each participant under the condition that only one of the three members would be given two votes in each group.

We employed a strategy method to collect data from the subsequent groups for each voting rule or circumstance. For example, the second group made their voting decisions for two cases—(1) after the first group had chosen A and (2) after the first group had chosen B—in random order. The payoff for each second-generation group was determined by the actual choice made by a randomly selected group of the first generation and the second group's choice for that case. Similarly, subsequent groups made voting decisions for all possible combinations of choices made by the groups that preceded them. Thus, under each voting rule or circumstance, there were four cases to be considered by the third group, eight cases by the fourth group, sixteen cases by the fifth group, and thirty-two cases by the sixth group.

3. Experimental Procedures

Participants were recruited from the subject pool of Kochi University of Technology and consisted of undergraduate students from various academic disciplines. A total of 156 participants assembled at the social science laboratories in December 2018 and January 2019. Twelve of the 156 participants were used to ensure that there were no significant differences between the university's two campuses. The data for 144 participants were used in the final analysis. Four groups of three participants in each of the six generations were formed for each of the two types of sessions. The experimenters were also undergraduate students.

In each session, 12 participants took seats separated from each other by partitions so that they could not see the faces of the others but could see the tops of their heads. The participants drew lots and were divided into three-person groups. Irrespective of the group, all participants remained in their original seats and could not identify who belonged to their group.

The participants read the instructions silently while an experimenter read them aloud. As in the experiment reported by Kamijo et al. [9], we avoided using words such as generation, sustainability, or any others that could hint at the purpose of the experiment. In order to check the participants' comprehension of the instructions, each participant was asked to answer several quiz questions on a written form distributed after the instructions were given. They were then given a voting-decision form on which the participant's generation was written. At this point, the participants proceeded to make their voting decisions as explained in Section 2.3. When the voting finished, a questionnaire was distributed and the participants answered questions about their voting decisions as well as questions focused on participant attributes and questions measuring their social value orientation (SVO) [15]. The SVO questions were used to classify participants as either "prosocial" or "other." Prosocial people were defined as those willing to divide an amount of a hypothetical resource equally with an anonymous person; in general, prosociality refers to behavior that is intended to benefit others. (This differs from altruism which refers to one of the possible motivations for such behavior.) After completing the questionnaire, the participants received the gratuity determined in the voting experiment as well as 900 yen as an honorarium for their participation.

The experiment was conducted as part of a voting-experiment project approved by the research ethics committee of Kochi University of Technology (code: 35-C1). Participants who took part in the experiment did so anonymously, using their IDs. In choosing alternatives, each participant simply placed a mark on the voting form to indicate their choice of either A or B. There was no physical or psychological influence. The standard procedures of experimental economics were followed.

4. Experimental Results

4.1. Voting Outcomes

We compared the three voting rules with respect to the frequency of sustainable choice B. Since the participants in the experiment were randomly divided into three-person groups without identifying their other group members, the actual voting result for each group (i.e., A or B) was merely one of the various possibilities. To illustrate, suppose six participants from a particular generation voted A, A, A, A, B, and B, respectively, under ordinary voting when faced with a particular choice history of previous generations. If one group was formed with three participants who chose A, A, and A while another group was formed with the three remaining participants, who chose A, B, and B, then the decisions made by the two groups would be A and B, respectively. On the other hand, if the six participants were divided into groups consisting of a group of three participants who chose A, A, and B and a second group of three participants who chose A, A, and B, then the group decisions would be A and A. To take such randomness of group-level observations into account, we conducted, after the experiment, the following four-step computer simulation regarding group formation by using the data on each participant's choice for each possible choice history of the previous generations under each voting rule.

Step 1: From the first generation of 12 participants, the computer selects 3 participants randomly to form a group. Under proxy voting, the computer also determines randomly who is given two votes. The computer determines the group's decision (i.e., A or B) using the data on the three participants' actual decisions collected in the experiment. If alternatives A and B are in a tie, the computer selects one of them randomly.

Step 2: For the second generation of 12 participants, the computer performs the same group formation as in step 1. The computer determines the group's decision (i.e., A or B) using the data on the three participants' actual decisions made after the group decision of the first generation determined in step 1.

Step 3: The computer repeats the same procedure as in step 2 until the sixth generation. Then the computer obtains the number of times alternative B is selected in the sequence of six generations.

Step 4: The computer repeats the above three steps 50,000,000 times for each voting rule. In this way, the computer obtains 50,000,000 sequences of group decisions made by six generations for each voting rule.

Table 2 shows the results of the computer simulation based on the actual decisions made by the participants in the experiment. The rows represent the number of times alternative B is selected as a group decision in a sequence of six generations, whereas the columns represent the voting rules. For example, the cell entry of "0" in row "6" and column "Ordinary" indicates that, according to our data, there were no cases in which all six generations choose alternative B under ordinary voting even when 50,000,000 sequences of six generations were randomly created. The distribution of the number of times alternative B is selected among six generations differs between any two of the three voting rules at the 1% level of statistical significance using the Kolmogorov-Smirnov test.

Table 2. Simulation results for the number of times alternative B is selected among six generations.

		Voting Rule		
		Ordinary	**Two-Ballot**	**Proxy**
Number of times alternative B is selected among six generations	6	0 (0.000%)	22,969 (0.046%)	15,920 (0.032%)
	5	5974 (0.012%)	289,459 (0.579%)	166,605 (0.333%)
	4	90,390 (0.181%)	1,822,002 (3.644%)	640,143 (1.280%)
	3	474,954 (0.950%)	3,312,781 (6.626%)	2,892,368 (5.785%)
	2	4,329,254 (8.659%)	10,234,731 (20.470%)	8,468,484 (16.937%)
	1	17,267,664 (34.535%)	12,062,625 (24.125%)	14,866,201 (29.732%)
	0	27,831,764 (55.664%)	22,255,433 (44.511%)	22,950,279 (45.901%)
Sum		50,000,000 (100.000%)	50,000,000 (100.000%)	50,000,000 (100.000%)

Note: For example, the "0" in the "6" row and "Ordinary" column indicates that, according to the data from our experiment, there were no cases in which alternative B is selected six times among the six generations under ordinary voting, even when 50,000,000 sequences of six generations are randomly created.

Under ordinary voting, more than half of the sequences of six generations end up choosing alternative A every time. Indeed, choosing alternative B one or fewer times occurs more than 90% of the time. Two-ballot voting and proxy voting improve the frequency of choice B to a statistically significant degree, but the successive selection of B is still far from being achieved. Kamijo et al. [9] employed face-to-face discussion as a way to influence group decisions and observed that the frequency of choice B improved from 28% to 60% if one of the three group members played the role of representative of the subsequent generations. The percentages were calculated as the percentage of groups that chose B among all groups in their five generations. If we calculate the same measure from Table 2, the percentages are, respectively, 9.25%, 17.11%, and 14.66% under ordinary, two-ballot, and proxy voting. Based on these results, even if proxy votes are introduced, voting does not appear to achieve sustainability in the ISDG.

4.2. How to Use Each Vote

Next, we investigated each type of vote under each voting rule. Table 3 shows the percentage of choice B made with each type of vote by all participants of each generation for all possible cases of choice histories of previous generations under each voting rule. For example, the value "33.33" in the upper-left cell indicates that 33.33% of the individual decisions made by the 12 participants of the first generation under ordinary voting were a vote for alternative B, while the remaining 66.67% were for alternative A. At the aggregate level, we can see over the six generations, under proxy voting, the use of the participants' own vote when they are given two votes is more or less similar to their use of their vote when they are given one vote. This tendency is also found between the use of their own vote under two-ballot voting and their use of the vote under ordinary voting. On the other hand, although the frequency of proxy votes being cast for alternative B is far from 100%, which is the ideal level intended by the institution designer, and remains around 50%, it is higher than that of the own votes in every generation under both two-ballot voting and proxy voting. These observations suggest that the presence of a proxy vote is the main factor accounting for the difference in the frequency of choice B as a group decision among the three voting rules (Table 2). In fact, proxy votes constitute, respectively, 0%, 50%, and 25% of all votes given to participants under ordinary voting, two-ballot voting, and proxy voting.

Table 3. Percentage of choice B by vote type and by generation (%).

Session Name	Voting Rule	Number of Votes	Vote Type	Generation					
				1st	2nd	3rd	4th	5th	6th
Ordinary/two-ballot	Ordinary	One	Unspecified	33.33	20.83	4.17	30.21	12.50	29.43
	Two -ballot	Two	Own	25.00	16.67	10.42	37.50	17.19	33.07
			Proxy	58.33	45.83	20.83	53.12	63.02	48.96
Proxy	Proxy	One	Unspecified	16.67	16.67	43.75	17.71	30.73	7.81
		Two	Own	16.67	16.67	35.42	16.67	37.50	6.77
			Proxy	25.00	62.50	50.00	54.17	40.10	50.00

Note: The percentage in each cell is calculated from the decision-making data for the 12 participants assigned to that cell for all the possible cases of choice histories of the previous generations.

4.3. Logistic Regression Analysis with Individual Data

Finally, we conducted a logistic regression analysis to identify the factors that appear to induce choice B at the individual level. We divided our data by vote type and performed a regression for each data set. There were three types of votes, as indicated in Table 3: (1) unspecified votes given to each participant under ordinary voting and two of the three group members under proxy voting, (2) own votes, and (3) proxy votes, both of which are given to each participant under two-ballot voting, and to only one of the three group members under proxy voting. We do not include the first generation because, in contrast to the other generations, it has no previous generations. The number of observations for each generation is the number of cases in the choice history of the previous generations (i.e., 2, 4, 8, 16, and 32 cases for the second to the sixth generations, respectively) times the number of participants for each type of vote (i.e., 24 participants for every generation). In all, 1488 observations were available for the regression involving each type of vote.

The binary dependent variable indicated a vote for either alternative B (1) or A (0). The set of explanatory variables represented the following factors: whether the vote was made under proxy voting (1) or the other two voting rules (0) (i.e., proxy dummy), the proportion (between 0 and 1) of times that alternative B was selected in previous generations (i.e., proportion of choice B), whether the participant is prosocial (1) or not (0) according to the SVO measure (i.e., prosocial dummy), whether the participant is female (1) or not (0) (i.e., female dummy), and dummy variables for each generation, with the second generation as the baseline. In order to confirm whether the effects of the proportion of choice B and each participant's prosociality differed depending on generation, terms for their interaction with the generation dummies were also included. The random effect for each participant was introduced in the regressions to take into account the fact that a set of data was generated from each participant.

The proxy dummy was used to examine the effect of asymmetry in the number of votes among group members. The proportion of choice B was used to determine the effect of the decisions made by previous generations on the decision of the current generation. The prosocial dummy and the female dummy were used to reveal the effect of each participant's characteristics on his or her decision. Although the effects of the proxy dummy and the female dummy were difficult to predict, the proportion of choice B and the prosocial dummy were expected to have positive effects on the probability of alternative B being chosen by each participant in the voting.

Table 4 shows the estimation results of the random effect logistic regressions. As predicted, the prosocial dummy had a positive and statistically significant effect on the probability of voting for B for every type of vote. The SVO here measures the individual's prosociality towards an anonymous person who exists currently. This estimation result suggests that such prosociality can be activated in a situation involving successive group decisions.

Table 4. Estimation results for the random-effect logistic regressions.

	Unspecified Vote		**Own Vote**		**Proxy Vote**	
Explanatory Variables	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**
Proxy dummy	0.423	0.845	−0.197	0.892	−0.321	0.957
Proportion of choice B	0.772	1.263	4.729 **	2.267	−0.000	1.013
% of choice B × 3rd gener. dum.	2.584	1.835	−2.195	2.553	0.601	1.498
% of choice B × 4th gener. dum.	2.419	1.698	−1.052	2.523	3.042 **	1.452
% of choice B × 5th gener. dum.	1.564	1.524	−2.115	2.416	3.233 **	1.267
% of choice B × 6th gener. dum.	3.110 **	1.424	−1.514	2.346	2.428 **	1.143
Prosocial dummy	5.725 **	2.495	7.875 ***	2.868	7.246 **	2.974
Prosocial dum. × 3rd gener. dum.	−0.280	3.222	−3.958	3.485	−1.510	3.549
Prosocial dum. × 4th gener. dum.	−3.649	2.991	−5.081	3.370	−4.949	3.562
Prosocial dum. × 5th gener. dum.	−2.196	2.940	−4.246	3.290	−6.178 *	3.520
Prosocial dum. × 6th gener. dum.	−2.011	2.946	−4.176	3.325	−8.097 **	3.590
Female dummy	0.994	0.862	0.984	0.906	−0.854	0.991
3rd generation dummy	−1.671	2.506	3.580	3.139	−3.880 *	2.035
4th generation dummy	0.433	2.184	4.099	3.066	−1.575	2.074
5th generation dummy	−0.538	2.144	3.689	3.010	−1.130	2.032
6th generation dummy	−1.268	2.000	2.858	2.932	0.149	1.883
Constant	−6.763 ***	1.880	−10.600 ***	2.862	−0.563	1.562
Number of observations	1488		1488		1488	
Wald χ^2	71.72 ***		67.39 ***		63.21 ***	

Note: The dependent variable indicates whether the vote of an individual is for B (1) or A (0). Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

On the other hand, the coefficients for the interaction terms between the prosocial dummy and the generation dummies were negative for every type of vote. In particular, for the proxy vote, they were statistically significant for the fifth and sixth generations, with negative effects that offset the positive effect of the prosocial dummy. However, for the proxy vote, the proportion of choice B had significantly positive effects for the fourth generation and later. These observations imply that, for decision making on the proxy vote, as the generations go forward, the influence of prosociality diminishes, while how often sustainable choices have been made in the previous generations becomes important. The importance of the frequency of sustainable choice in the previous generations is also found for the sixth generation in the regression of the unspecified vote. For own vote, the proportion of choice B had a positive and statistically significant effect, while its interaction terms with the generation dummies were not statistically significant.

The larger proportion of choice B by previous generations could affect the decision of the current generation in one or more of the following three ways: First, it might induce indirect reciprocity—that is, the participants might believe that they should leave a larger pie for subsequent generations because previous generations had done so for them. Second, it might have an income effect—meaning that since the larger proportion of choice B by previous generations left a larger pie for the current generation, the current generation is able to earn a sufficiently large reward even if it chooses alternative B. Finally, it might create a custom—that is, the larger proportion of choice B by previous generations could be perceived by the current generation as an established custom to be followed. All three effects would work to encourage the selection of choice B. On the other hand, our society could be regarded as one that has successively and consistently chosen the own-payoff maximizing alternative A. Our experimental result suggests that such successive own-payoff maximization leads to a higher frequency of own-payoff maximization by subsequent generations.

Our study's results regarding the positive effects of the proportion of sustainable choices by previous generations and each individual's prosociality on the probability of voting for the sustainable alternative are consistent with those of Shahen et al. [16], who conducted an ISDG experiment wherein each generation was represented by one person. They observed that a larger proportion of unsustainable choices made by previous generations led to a higher frequency of the unsustainable choice by the current generation, and that prosocial participants were more likely to choose the sustainable alternative.

5. Discussion

Our results are in contrast to those of Hauser et al. [14], who observed in their intergenerational goods game (IGG) that the introduction of voting increases the frequency of sustainable choice dramatically. By way of explanation, we believe that the ISDG represents a more difficult situation for sustainability than is the case in the IGG.

In the IGG, each generation consists of five members, and each member extracts any number of units between 0 and 20 from a common pool of 100 units endowed to his or her generation. If the total number of units extracted by the five members does not exceed a predetermined threshold (50, 40, or 30 units), the size of the common pool reverts to 100 units for the next generation. However, if the number of extracted units exceeds the threshold, the common pool is destroyed so that nothing is left for the next generation, which means the end of the game. In this setting, participants having any social preference would want to avoid a catastrophic outcome. It would be reasonable to expect that such players would be most satisfied by extracting from the common pool an amount up to the threshold, thus ensuring the full recovery of the common pool for the next generation. In fact, Hauser et al. [14] observed that, in most of the five-person groups, a majority of members extracted 10 units or less, but that a minority extracted a larger number of units, and hence the total number of units exceeded the threshold.

In the IGG with median voting, the number of units that each member extracts are common to all five members of each generation and is determined by voting among the five members. Each member votes for a number of units and the median of the five proposals is used as the number of units that each member extracts. Hauser et al. [14] observed that under such median voting the total number of units extracted by each generation was below the threshold with an extremely high frequency. Since in the IGG a majority extracted 10 units or less, it follows that the median member would also vote for 10 units or less in the IGG with median voting. As voting is a device to reflect the preference of the majority, it works well to prevent a minority from acting against the majority. Therefore, if the sustainable sequence of generations is preferred by the majority, it will be accomplished through voting.

In the ISDG, on the other hand, only two alternatives are available—the own-payoff maximizing alternative and the sustainable alternative. If participants want to increase their payoff by even a small amount, there is no intermediate alternative available to them; they would need to choose the own-payoff maximizing alternative. Furthermore, choosing the own-payoff maximizing alternative does not end the game; it merely decreases the common pool left for the next generation by 900 yen. Hence, participants in the ISDG seem to be given a stronger incentive to choose the own-payoff maximizing alternative than is the case in the IGG. In fact, a majority of our participants preferred the own-payoff maximizing alternative under ordinary voting. While two-ballot voting and proxy voting increased the selection of sustainable choice, the increase was quite small.

6. Conclusions

In this paper, we conducted a laboratory experiment with human subjects to examine the potential of introducing a proxy vote on behalf of future generations in order to increase the frequency with which participants choose the sustainable alternative in the intergenerational sustainability dilemma game (ISDG). We observed that under the traditional one-person-one-vote rule, the frequency of choosing the sustainable choice was extremely low and that the introduction of proxy votes increased this frequency only slightly. This negative result is in contrast to the positive result reported in Hauser et al. [14]. We attribute this difference to differences in the basic structure of the games used in the two studies, suggesting that the ISDG in our study represents a more difficult situation for sustainability than the IGG used in Hauser et al. [14]. In the ISDG, the majority of participants preferred the own-payoff maximizing alternative, whereas a majority in the IGG preferred a sustainable choice.

In principle, voting is a means for collective decision-making that reflects the preference of the majority. The key to sustainability issues from the perspective of majoritarianism is that, while a majority of a constituency that includes both the current generation and future generations may prefer sustainable options even if they are costly to the current generation, a majority of the current generation does not. Therefore, for sustainable options to be chosen in today's society, it is necessary to either somehow include future generations in the current decision-making process or change the preferences of the majority of the current generation in a direction that is compatible with future generations. The proxy vote examined in this paper was introduced as a way of including future generations in the voting process. However, since it is ultimately members of the current generation who cast such proxy votes, their preferences need to be compatible with future generations in order for the proxy vote approach to succeed in selecting sustainable options. It has been thought that the introduction of proxy votes would direct voters' attention to the interests of future generations and result in the selection of sustainable options. However, our experiment suggests that the provision of a proxy vote does not have a sufficiently large effect on voter choices. As a future task, we need to develop a political institution that does not overly rely on, or rather brings out, the prosociality of the current generation regarding future generations.

One of the changes that might activate such prosociality in the ISDG is to set voting more firmly in the context of sustainability. In our experiment, we used terms such as "subsequent groups" rather than "future generations." However, if a proxy vote is introduced into an actual voting system, it must be made clear that the proxy vote is for future generations rather than for "subsequent groups." Examining the effect of providing the context of sustainability and highlighting intergenerational issues will be an important next step.

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Appendix A

This appendix provides an English translation of the Japanese instructions used in our experiment. The "attached table" in the instructions is Figure 1 of Kamijo et al. [9] with grid lines added.

Instructions

(1) Outline of the experiment

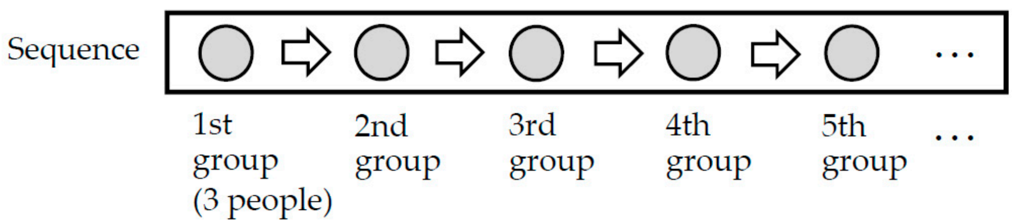
As an honorarium for participation in this experiment, 900 yen will be paid to each participant. We will pay this after the experiment is over. Additional gratuities will be determined by the choice explained below.

In this experiment, participants in the laboratory will be randomly divided into groups of three. You will not be told who the other members of your group are.

Each group chooses between alternatives A and B. Depending on that choice, the gain will be determined. Please see the attached table. The numbers in this table are in hundreds. For example, 27 is 2700 yen. If the first group chooses A, it gains 3600 yen. If it chooses B, it gains 2700 yen. Each group's choice will be decided by voting. The additional gratuity you receive will be the amount of the gain chosen by your group divided equally by all the three members.

The figure below shows an overview of the experiment. Your group will be connected to other groups that are formed at other times. For example, suppose that your group is the third group in a sequence of groups. Then, the gains from A and B for your group will change in response to the choices made at the previous times by the first and second groups of the sequence to which your group belongs. Note that for the first group there will be no effect from any previous groups because it is the first group in its sequence. Depending on the choice of your group, the gains from A and B for the subsequent groups of your sequence will change.

Groups assembled at the same time in the laboratory will be given the same order in different sequences. Hence, the choices of other groups gathering in this laboratory now do not affect the choice of your group. It is the choices of the previous groups in the same sequence that will influence your group's choice. The choice of your group will also affect the choices of the subsequent groups in the same sequence.



(2) How gains are determined

The gain for each group is determined as follows. If the first group chooses A, the gain for the second group will be reduced by 900 yen for both A and B. In other words, like the shaded part of the following table, the second group gains 2700 yen from A and 1800 yen from B. On the other hand, if the first group chooses B, the second group faces the same choice as the first group. In other words, the second group gains 3600 yen from A and 2700 yen from B.

1st Group	2nd Group
A 3600 yen	A 2700 yen B 1800 yen
B 2700 yen	A 3600 yen B 2700 yen

Next, let us consider the third group. Now, suppose that the first group has chosen A. Then, the second group faces the choice in the shaded part of the table above. The table below shows the gains for the third group that follow the shaded part of the table above. Here, if the second group chooses A, the gain from A for the third group decreases by 900 yen and becomes 1800 yen, and the gain from B also decreases by 900 yen and becomes 900 yen. On the other hand, if the second group chooses B, the third group gains 2700 yen from A and 1800 yen from B.

2nd Group	3rd Group
A 2700 yen	A 1800 yen B 900 yen
B 1800 yen	A 2700 yen B 1800 yen

As explained so far, if one group chooses A, the gain for the next group will be reduced by 900 yen for both A and B. On the other hand, if one group chooses B, the gains for the next group will be the same as the previous ones for both A and B.

Please refer carefully to the attached table. Raise your hand if you have any doubts. Then an experimenter will come to your assistance. During the experiment, conversations with others except the experimenters are strictly prohibited.

(3) Decision-making by each group

After the instructions, you will be given a sheet of paper on which the gains from A and B for your group are written. These gains are determined by the choices of the previous groups, although those for the first group are known to be 3600 yen from A and 2700 yen from B. If the gain will be negative as a result of your group's choice, you must pay it from your 900-yen honorarium for participation in this experiment.

You will make voting decisions for two different experiments.

- Experiment X

[The following paragraph is presented in ordinary/two-ballot sessions.]

In Experiment X, all members of your group have one vote each. Group members are respectively asked to cast their votes for A or B. The alternative that receives a majority of the votes will be the decision of your group.

[The following two paragraphs are presented in proxy sessions.]

In Experiment X, one of the three members of your group, not you, has two votes, while you and the remaining member have one vote each.

You and the remaining member are respectively asked to cast your votes for A or B. The member who has two votes is asked to cast one vote as "his or her vote" and another vote as a "proxy vote on behalf of the subsequent groups" who cannot participate in your group's vote. He or she is free to decide whether to cast each of the two votes for A or B. The alternative that receives a majority of the votes will be the decision of your group. If a tie happens, a lottery will determine which of the two alternatives is chosen.

As explained so far, the gains from A and B for your group will change depending on the choices by the groups who participated in this experiment before you. There are multiple possible combinations for the choices of the previous groups. You will make voting decisions on all the cases that can arise.

For example, suppose that your group is the third group. Then, there are four possible cases for the choices of the previous groups, "the first group chose A and the second group chose A," "the first group chose A and the second group chose B," "the first group chose B and the second group chose A," and "the first group chose B and the second group chose B." Hence, the third group will make voting decisions on a total of four cases. Similarly, the number of cases in which voting decisions are made is one for the first group, two for the second group, eight for the fourth group, sixteen for the fifth group, and so on.

- Experiment Y

[The following two paragraphs are presented in ordinary/two-ballot sessions.]

In Experiment Y, all members of your group have two votes each. The other rules are the same as Experiment X.

You are asked to cast one vote as "your vote" and another vote as a "proxy vote on behalf of the subsequent groups" who cannot participate in your group's vote. You are free to decide whether to cast each of the two votes for A or B. The alternative that receives a majority of the votes will be the decision of your group. If a tie happens, a lottery will determine which of the two alternatives is chosen.

[The following two paragraphs are presented in proxy sessions.]

In Experiment Y, out of the three members of your group, you have two votes while the other two members have one vote each.

You are asked to cast one vote as "your vote" and another vote as a "proxy vote on behalf of the subsequent groups" who cannot participate in your group's vote. You are free to decide whether to cast each of the two votes for A or B. The other two members are respectively asked to cast their votes for A or B. The alternative that receives a majority of the votes will be the decision of your group. If a tie happens, a lottery will determine which of the two alternatives is chosen.

As in Experiment X, you will be asked to make voting decisions on all the cases that can arise.

When you make voting decisions, the two experiments are listed in random order. In other words, some participants make voting decisions in the order of "Experiment X → Experiment Y," while the other participants make voting decisions in the order of "Experiment Y → Experiment X."

You will find out where in a sequence of groups your group has been placed (i.e., first, second, and so on) on the form handed out after the instructions.

(4) How to determine additional gratuities

Your additional gratuities will be determined in accordance with the following procedures.

[The following two steps are presented in ordinary/two-ballot sessions.]

[1] *Either Experiment X or Experiment Y is randomly selected.*

[2] *The case that your group has faced is determined based on "the actual choices of the previous groups" in the selected experiment.*

[The following two steps are presented in proxy sessions.]

[1] *Out of the three members of your group, two members are assigned to Experiment X while one member is assigned to Experiment Y randomly.*

[2] *The case that your group has faced is determined based on "the actual choices of the previous groups."*

[3] The votes of all the group members in that case will be counted, and the choice of your group is determined.

[4] The resulting gain is divided into three equal parts, and each part is given to each of your group members.

(5) Questionnaire

Once you have completed your voting decisions on all cases, you will receive a questionnaire from an experimenter which you will be asked to complete.

References

1. Saijo, T. Future Design. In *the Future of Economic Design: The Continuing Development of a Field as Envisioned by Its Researchers*; Laslier, J.-F., Moulin, H., Sanver, M.R., Zwicker, W.S., Eds.; Springer: Berlin/Heidelberg, Germany, 2019; pp. 253–260.
2. Van Parijs, P. The Disfranchisement of the Elderly, and Other Attempts to Secure Intergenerational Justice. *Philos. Public Aff.* **1998**, *27*, 292–333. [CrossRef]
3. Aoki, R.; Vaithianathan, R. *Sedaikan no Seiji Keizai: Senkyo ni kansuru Ankēto Chōsa kara (Intergenerational Political Economy: From a Questionnaire Survey on Elections)*; Discussion Paper No. 540; Center for Intergenerational Studies, Hitotsubashi University: Tokyo, Japan, 2009. (In Japanese)
4. Wolf, S.; Goldschmidt, N.; Petersen, T. Votes on Behalf of Children: A Legitimate Way of Giving Them a Voice in Politics? *Const. Political Econ.* **2015**, *26*, 356–374. [CrossRef]
5. Kamijo, Y.; Tamura, T.; Hizen, Y. Effect of Proxy Voting for Children under the Voting Age on Parental Altruism towards Future Generations. *Futures* **2020**, *122*, 102569. [CrossRef]
6. Kamijo, Y.; Hizen, Y.; Saijo, T. *Hearing the Voice of Future Generations: A Laboratory Experiment of "Demeny Voting"*; Discussion Paper SDES-2015-8; Kochi University of Technology: Kochi, Japan, 2015.
7. Miyake, K. Jikken kara Saguru Domein Tōhyō Hōshiki no Yūkōsei to sono Kadai (The Effectiveness and Challenges of the Demeny Voting System Explored Through an Experiment). Bachelor's Thesis, Kochi University of Technology, Kochi, Japan, 2015. (In Japanese).
8. Kamijo, Y.; Hizen, Y.; Saijo, T.; Tamura, T. Voting on Behalf of a Future Generation: A Laboratory Experiment. *Sustainability* **2019**, *11*, 4271. [CrossRef]
9. Kamijo, Y.; Komiya, A.; Mifune, N.; Saijo, T. Negotiating with the Future: Incorporating Imaginary Future Generations into Negotiations. *Sustain. Sci.* **2017**, *12*, 409–420. [CrossRef] [PubMed]
10. Nakagawa, Y.; Kotani, K.; Kamijo, Y.; Saijo, T. *Solving Intergenerational Sustainability Dilemma through Imaginary Future Generations: A Qualitative-Deliberative Approach*; Discussion Paper SDES-2016-14; Kochi University of Technology: Kochi, Japan, 2016.
11. Shahrier, S.; Kotani, K.; Saijo, T. Intergenerational Sustainability Dilemma and the Degree of Capitalism in Societies: A Field Experiment. *Sustain. Sci.* **2017**, *12*, 957–967. [CrossRef]
12. Shahrier, S.; Kotani, K.; Saijo, T. *Intergenerational Sustainability Dilemma and a Potential Solution: Future Ahead and Back Mechanism*; Discussion Paper SDES-2017-9; Kochi University of Technology: Kochi, Japan, 2017.
13. Timilsina, R.R.; Kotani, K.; Nakagawa, Y.; Saijo, T. *Concerns for Future Generations in Societies: A Deliberative Analysis on Intergenerational Sustainability Dilemma*; Discussion Paper SDES-2018-16; Kochi University of Technology: Kochi, Japan, 2018.
14. Hauser, O.P.; Rand, D.G.; Peysakhovich, A.; Nowak, M.A. Cooperating with the Future. *Nature* **2014**, *511*, 220–223. [CrossRef] [PubMed]
15. Van Lange, P.A.M.; De Bruin, E.M.N.; Otten, W.; Joireman, J.A. Development of Prosocial, Individualistic, and Competitive Orientations: Theory and Preliminary Evidence. *J. Personal. Soc. Psychol.* **1997**, *73*, 733–746. [CrossRef]
16. Shahen, M.E.; Kotani, K.; Saijo, T. *How Do Individuals Behave in the Intergenerational Sustainability Dilemma? A Strategy Method Experiment*; Discussion Paper SDES-2020-1; Kochi University of Technology: Kochi, Japan, 2020.