KOCHI UNIVERSITY OF TECHNOLOGY

Social Design Engineering Series *SDES-2019-2*

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4th April, 2019

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April 3, 2019

Abstract

"Intergenerational sustainability dilemma (ISD)" is a situation where the current generation chooses actions to her benefit without considering future generations under current economic and political systems, compromising intergenerational sustainability (Kamijo et al., 2017, Shahrier et al., 2017). We institute a new mechanism to improve intergenerational sustainability called "intergenerational accountability (IA)" and examine its effectiveness through field experiments consisting of ISD games (ISDGs). In Baseline ISDG, a sequence of six generations, each composed of three members, is organized, and each generation is asked to choose whether to maintain intergenerational sustainability (sustainable option) or maximize their payoff by irreversibly imposing costs on future generations (unsustainable option) within a 10-minute deliberation. With IA, each generation is asked to provide the reasons of her decision as well as her advice to future generations that are passed to subsequent generations. Our results show that generations under IA choose a sustainable option much more often than under Baseline ISDG, giving positive reasons and advice for sustainable options to subsequent generations. Overall, one-way communication of reasons and advice in IA is identified to function as a social device to not only transfer a common image but also decrease social distance over generations for intergenerational sustainability.

Key Words: Intergenerational sustainability dilemma; intergenerational accountability; field experiments

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Nomenclature

IA Intergenerational accountability

IFG Imaginary future generations

ISD Intergenerational sustainability dilemma

ISDG Intergenerational sustainability dilemma game

NPR Nepalese rupees

SVO Social value orientation

USD US dollars

1 Introduction

Maintaining intergenerational sustainability has become one of the greatest challenges due to its unidirectional nature in the sense that the current generation affects the future ones, but the opposite is not true. In particular, the current generation chooses an action that is to her benefit, leaving more burdens on future generations and compromising intergenerational sustainability under current economic and political systems, which we call "intergenerational sustainability dilemma (ISD)" (Kamijo et al., 2017, Shahrier et al., 2017). Many important problems are considered to have occurred due to ISD, such as climate change and government debts, threatening sustainability of subsequent generations (Garri, 2010, Fischer et al., 2004, Hauser et al., 2014, Sherstyuk et al., 2016, Hansen and Imrohoroglu, 2016, Kamijo et al., 2017, Shahrier et al., 2017). Possible solutions to maintain intergenerational sustainability have been discussed in relation to responsibility, justice and equity. However, contemporary institutions such as capitalism and democracy are claimed not to be effective at maintaining intergenerational sustainability, because they fail to ensure an efficient allocation of resources such as natural resources, public and environmental goods as well as their intergenerational provisions (Krutilla, 1967, Barry, 1997, Wolf, 2007, 2008, Milinski et al., 2006, Hauser et al., 2014). This paper addresses ISD and the potential solution of how to maintain intergenerational sustainability.

Past studies examine people's decisions for intergenerational sustainability, employing experimental approach. Sherstyuk et al. (2016) analyze the level of difficulties for maintaining dynamic externalities over multiple generations. They find that controlling dynamic externalities is challenging under intergenerational settings because individuals make selfish decisions, as compared with non-intergenerational settings. Fischer et al. (2004) demonstrate that an existence of "intergenerational links" motivates people to exploit fewer resources in an intergenerational common pool experiment, enhancing sustainability. Hauser et al. (2014) demonstrate that median voting as an institution promotes sustainability in an intergenerational goods game. Kamijo et al. (2017) design and implement ISD game (hereafter, ISDG) and show that introducing an agent for future generations named as an imaginary future generation (IFG) in a group decision process improves

intergenerational sustainability. Shahrier et al. (2017) conduct ISDG field experiments in rural and urban areas of Bangladesh, demonstrating that rural people choose sustainable options more often than do urban people. Overall, resource sustainability in an intergenerational setting is found to be affected by individual social preferences and institutions.

Schotter and Sopher (2003, 2006, 2007), Chaudhuri et al. (2006) and Chaudhuri et al. (2009) address the roles of advice & communication in ultimatum games, coordination in minimum effort games and voluntary contributions to public goods with an intergenerational context.[1] Schotter and Sopher (2003, 2006, 2007) show that wisdom and knowledge accumulate over generations by advice & communications and promote creating social convention and/or norms, leading generations to learn reciprocity and fairness. Chaudhuri et al. (2006) find an importance of social learning processes created by the previous generation's advice to subsequent generations, demonstrating that such intergenerational social learning enhances norms of cooperation to address public goods problems. Overall, the previous literature establishes that advice & communications can be effective to solve some classes of allocation and public goods problems in an intergenerational setting.

Schotter and Sopher (2003, 2006, 2007), Chaudhuri et al. (2006) and Chaudhuri et al. (2009) use the experimental games in which the current generation is incentivized to give advice to subsequent generations for their better plays, and the possibility of Pareto improvement mostly exists. More specifically, the current generation's payoff depends on subsequent generations' actions (or performances). In this type of experimental settings, Schotter and Sopher (2003, 2006, 2007), Chaudhuri et al. (2006) and Chaudhuri et al. (2009) focus on addressing the roles of social learning through advice over generations. On the other hand, in ISD, the current generation affects subsequent generations, but the opposite is not true where there is no possibility of Pareto improvement across generations. In other words, the current generation's payoff does not depend on subsequent generations' ones, but subsequent generations' payoffs depend on the current generation's payoff in a unidirectional manner. This is a unique feature in ISD and different from

[1] Hackett et al. (1994), Carpenter (2000), Fehr and Gachter (2000), Brosig et al. (2003) and Lopez and Villamayor-Tomas (2017) also demonstrate that advice and communications are effective to enhance cooperation in an intra-generational or intra-group setting.

the experimental games in previous literature, reflecting environmental and resource sustainability problems over generations. Our main focus is on addressing intergenerational sustainability and a possible mechanism to resolve ISD.

None of the past studies have addressed how communication of reasons and advice resolves ISD where the current generation unidirectionally affects future generations, but the opposite is not true. We design and institute a mechanism with accountability of reasons and advice as a one-way communication device from the current generation to the subsequent generations, possibly improving intergenerational sustainability, which we call the "intergenerational accountability" (IA) and examine its effectiveness using ISDG field experiments ISDG in Nepal. In Baseline ISDG, a sequence of six generations is organized and each generation can either maintain intergenerational sustainability (sustainable option) or maximize her own generation's payoff by irreversibly costing future generations (unsustainable option) within a 10-minute deliberation. With IA, each generation is asked to provide the underlying reasons of her decision as well as her advice to future generations that are passed to the subsequent generations. The results reveal that, in IA, generations are more likely to choose sustainable option than under Baseline ISDG and IFG, giving positive reasons and advice for sustainable option to the subsequent generations. Overall, one-way communication of reasons and advice in IA is identified to work as a social device for not only transferring a common image but also decreasing social distance over generations for intergenerational sustainability.

2 Materials and methods

2.1 Study areas

We conduct experiments in the following regions of Nepal: Kathmandu, Lalitpur, Bhaktapur and Pokhara (figure 1). These regions are homogeneous in terms of culture, language, economy and religion. The residents are usually ranked high on the human development index (HDI) on the basis of UNDP (2014), and the population density is also high in the regions. For instance,

Kathmandu has a population density 4416 people per km^2 (Central Bureau of Statistics, 2011) and is the most crowded city, with 24.3 % of the total urban population of Nepal. Large cities such as Kathmandu, Lalitpur, Bhaktapur and Pokhara are the center for businesses and services.

[Figure 1 about here.]

2.2 Experimental setup

We conduct intergenerational sustainability dilemma game (ISDG), individual interviews, social value orientation (SVO) game and questionnaire surveys to collect behavioral and sociodemographic data.

Intergenerational sustainability dilemma game (ISDG)

We first explain Baseline ISDG, following Kamijo et al. (2017) and Shahrier et al. (2017). A group of three subjects are called a generation, and each generation chooses between options A and B. The generation receives a payoff of X for choosing option A and a payoff $X-300$ for choosing option B. After making a choice between options A and B, the generation is asked to split the payoff associated with the option they choose among the generation members, which is considered "their generation's individual share." Each of the subject's payoff is the sum of their generation's individual share plus initial experimental endowment of 300. For example, the generation earns 1200 experimental point ($X = 1200$) by choosing option A, whereas the generation earns 900 points ($= X - 300 = 1200 - 300$) by choosing option B. Consequently, if members in this generation split the payoff equally among them, each member earns 400 by choosing option A and 300 by choosing option B as their generation's individual share. Therefore, the total payoff of each subject with the generation choice of option A is 700 ($= 400 + 300$), whereas the payoff is 600 ($= 300 + 300$) when choosing option B.

Each generation is allowed to deliberate about choosing between options A and B and how to split the generation's payoff within a 10-minute discussion. However, when the decisions cannot be

made within 10 minutes, the following rules are applied: (1) if the generation's payoff is positive, each member receives an initial endowment of 300 points only, (2) if the generation payoff is negative, say, $-Z$, each member equally splits $-Z$ by three and receives the payment of $-\frac{Z}{3}$ plus initial endowment of 300 points. Each session consists of $18 \sim 24$ subjects, organized into $6 \sim 8$ generations. Each generation is randomly assigned to the 1st, 2nd, ... and 6th generations. When the number of subjects participating in a session are 21 or 24, we organize 7th and even 8th generations; however, they are assigned as 1st and 2nd in another sequence of generations as shown in figure 2.

[Figure 2 about here.]

Current generation's decision affects the subsequent generations such that subsequent generations' payoffs decline uniformly by 300 points when the current generation chooses option A. Suppose that $X = 1200$ and the 1st generation chooses option A. Then, the 2nd generation will face the game in which they can get 900 and 600 by choosing options A and B, respectively. However, if the 1st generation chooses option B, the next generation can have the same decision environment as that of the 1st generation. When the 1st generation chooses option B, the 2nd generation plays a game in which they can get 1200 and 900 by choosing options A and B, respectively. Following the same rule, the game continues for the rest of the subsequent two generations (i.e., between ith and $i + 1$th generations). Hence, option B can be considered a "sustainable option," whereas option A is the choice that compromises intergenerational sustainability and can be considered as an "unsustainable option." In each session, the 1st generation starts ISDG with $X = 1200$, implying that the 5th and 6th generations may face the game in which options A and B are associated with payoffs of zero and or a negative payoff of -300, respectively, if all previous generations keep choosing option A. In such a situation, generation members equally split their zero or a negative payoff that will makes the individual payoff to be 300 or at least zero by summing it with an initial endowment of 300 points.

In this paper, a new mechanism called "intergenerational accountability" (IA) is instituted as a treatment to improve intergenerational sustainability in ISDG. The IA mechanism is explained as

follows:

- **ISDG with IA**: In IA treatment, generations are asked to choose between options A and B through deliberation up to 10 minutes as in Baseline ISDG, however, at the same time, they are also asked to be accountable for their decisions by writing the associated reasons and advice to their subsequent generations in a paper.[2] We ensure that each generation's reasons and advice shall be passed to their subsequent generations within a sequence.

We hypothesize that IA treatment shall be effective at maintaining intergenerational sustainability in ISDG through one-way communication from the current to the subsequent generations by being accountable, and our idea is partly inspired by the previous literature, such as Schotter and Sopher (2003, 2006, 2007), Chaudhuri et al. (2006) and Chaudhuri et al. (2009).

For the purpose of comparison with previous literature such as Kamijo et al. (2017) and Shahrier et al. (2017), we include the imaginary future generations (IFG) as another treatment and evaluate which works better, IFG or IA.

- **ISDG with IFG**: In IFG treatment, generations are asked to choose between options A and B through deliberation up to 10 minutes as in Baseline ISDG, however, one member in a generation is randomly assigned to be a representative for future generations called an "imaginary future generation (IFG)." The IFG person is asked to discuss by considering not only the current generation but also the subsequent generations for deciding between options A and B without any coercive obligation. The rest of two members know that one member is asked to play such an IFG role.

Overall, we prepare three treatments of Baseline ISDG, IFG and IA, conducting field experiments with between-subject designs. A novelty in this research lies in instituting and implementing IA in the context of ISD and evaluating its effectiveness for intergenerational sustainability. In the ISDG experiment, subjects are paid 550 NPR ($\approx$ 5.00 USD) at maximum and 350 NPR ($\approx$ 3.00 USD) on the average.[3]

[2] Mulgan (2000) defines accountability as a sense of being accountable for one's own actions.

[3] The NPR stands for Nepalese rupees.

2.3 Experimental procedures

We hire local supporting staffs and research assistants (the first author is a chief administrator for our experiments). We conduct occupation-based randomization by selecting the desired number of subjects from each occupation, such as banking, government, health, education, business, transportation, entertainment and students. The experiments are implemented at district health organization training halls and public seminar halls that are located in the center of the cities and consist of many rooms. We send invitation letters to different offices requesting people to participate in our experiments. The letters are dispatched to the selected organizations one week prior to the experiment. We conduct experiments on the weekend and, due to the enough incentives, the participation rate is 80 %.

Upon arriving at the locations, subjects are gathered in one hall and they are given experimental instructions in their native language (Nepali). Once everybody is present in a room, an experimenter (the first author) provides the subjects a verbal explanation of the experimental rules. To maintain anonymity across generations, we first confirm that subjects fully understand the rules, and second, they are asked to proceed toward a door and pick a chip containing their generation ID and individual ID from a bag. Each subject goes to a specific room according to their IDs. The generations are separated into rooms based on their generation IDs. In this way, subjects do not know who belong to each generation (each subject only knows the members in her generation). The subjects know that they are assigned to one generation within a sequence; however, they are not informed of which generation is the last in the sequence.

The research assistants distribute questionnaires and again explain the experimental procedures to subjects. In the ISDG, the 1st generation deliberates to choose between options A and B up to 10 minutes. The deliberation is recorded, and their generation decision is confirmed. Once a generation makes the decision, the members are asked to move to a different room to ensure anonymity. After the 1st generation's decision, we proceed to the 2nd generation and continue the experiment with the same procedures. The same routine is applied to the remaining generations, i.e., from the 3rd to the 6th. The decisions of the previous generations are written on a white-board,

and each subject in a generation is asked to confirm which generation they belong to in a sequence and the payoffs associated with options A and B before deliberation. Therefore, each generation can see the payoff structure as well as how many times options A and B have been chosen by the previous generations. With this information, each generation deliberates and decide between options A and B. After the ISDG is complete, we conduct individual interviews, the SVO game and questionnaire surveys for their sociodemographic and psychological information.

Individual interviews

An individual interview has been conducted for each subject after her generation chooses between options A and B. In this interview, we investigate the patterns of the shift in individual opinions to support A, B or to be ambivalent (to have no ideas) coded as N as "individual initial opinion" and "individual final opinion" before and after the deliberation, respectively. Each subject is asked to recall and answer whether she has supported A, B or N and the associated reasons "before and after" deliberation. The interviewers ask questions such as (1) "your personal opinion might have been different from the generation decision. At the moment of the generation decision, what did you really want to support as your personal opinion?" for her "individual final opinion" and the corresponding reasons and (2) "Before the deliberation started, what did you really support as your personal opinion?" for her "individual initial opinion" and the corresponding reasons.

The individual interviews identify whether or not each subject changes her individual opinion to support A, B or N through deliberation. For instance, some subject is recognized to have supported A as her "individual initial opinion" before deliberation but to have ended up supporting B as her "individual final opinion" after deliberation. In this case, her opinion change is coded as AB, where the first letter represents her initial support for A before deliberation and the second letter does her final support for B after deliberation. In the same manner, we identify and code subjects' opinion changes through individual interviews, and the possible combinations of opinion changes are $AA, AB, AN, BA, BB, BN, NA, NB$ and NN. With this information about individual opinion changes before and after deliberation, we can also identify whether each generation has

a unanimous opinion agreement to choose between options A and B before and after deliberation.[4]

Social value orientation (SVO) games

The SVO game with the "slider method" has been utilized to identify subjects as either prosocial or proself (Murphy et al., 2011). Figure 3 shows six items of the slider measure that gives numbers to represent outcomes for oneself and the other in a pair of persons where the other is unknown to the subject. Subjects are asked to make a choice among the nine options for each item. Each subject chooses her allocation by marking a line at the point that defines her most preferred distribution between oneself and the other. The mean allocation for oneself $\overline{A}_s$ and the mean allocation for the other $\overline{A}_o$ are computed from all six items (see Figure 3). Then, 50 is subtracted from $\overline{A}_s$, and $\overline{A}_o$ to shift the base of the resulting angle to the center of the circle $(50, 50)$. The index of a subject's SVO is given by SVO $= \arctan \frac{(\overline{A}_o)-50}{(\overline{A}_s)-50}$. Depending on the values generated from the test, social preferences are categorized as follows: 1. altruist: SVO $> 57.15°$, 2. prosocial: $22.45° <$ SVO $< 57.15°$, 3. individualist: $-12.04° <$ SVO $< 22.45°$ and 4. competitive types: SVO $< -12.04°$.

[Figure 3 about here.]

The SVO framework assumes that people have different motivations and goals for evaluating resource allocations between oneself and others. Also, the SVOs are established to be stable for a long time (see, e.g., Van Lange et al., 2007, Brosig-Koch et al., 2011). Responses that are yielded from six primary items give complete categories of social preferences. A major reason for using six primary slider measures by Murphy et al. (2011) is due to its simplicity and easy to implement in the fields of Nepal. It is very intuitive for subjects to understand even with a limited level of

[4] An alternative way to collect the same data of individual opinions is to incentivize or to ask each subject to reveal their opinions to support A, B or N in a timely manner, i.e., each subject is asked to reveal an "individual initial opinion" before deliberation and again asked to reveal an "individual final opinion" after deliberation. However, this timely-manner procedure does not reflect the process of deliberative group decisions, and it is also reported to induce subjects to have strong priming and anchoring effects that unnecessarily influence group deliberation and decisions (Kahneman, 2011, Kotani et al., 2014). Qualitative behavioral research establishes that individual opinions and ideas are truthfully elicited by interviews after the incidences of interest (Brinkmann, 2014).

education. As it is done in psychology research, we further simplify the four categories of social preferences into two categories of prosocial and proself types; "altruist" and "prosocial" types are categorized as prosocial subjects, while "individualistic" and "competitive" types are categorized as "proself" subjects (see Murphy et al., 2011). Respondents are informed that the units in this game are points, meaning that the more points they get, the more real money they will earn.[5]

An exchange rate is applied to the points in the SVO game to determine the monetary reward, and subjects receives 150 NPR ($\approx$ 1.5 USD) at maximum and 100 NPR ($\approx$ 1.0 USD) on an average. The decisions for this SVO game are made with complete privacy as subjects are instructed not to communicate each other. To compute the payoffs of the subjects, we collect the answer sheets from all subjects in a session, and we randomly match one subject with another as a pair. The payoff for each subject in the SVO game is the summation of points from 6 selections by herself as "You" and 6 selection by the partner as "Other." We explain the methods of random matching and payoff calculation with information of the exchange rate for the real money incentive to subjects before starting the SVO game. We then proceed to the questionnaire surveys after the SVO game, and subjects who finish the questionnaire receive all the payments from ISDG and SVO games, leaving the experimental rooms.

3 Results

A total of 154 generations participated in our experiments where 59 generations did Baseline ISDG, 47 generations did ISDG with imaginary future generation (IFG) treatment and 48 generations did ISDG with intergenerational accountability (IA) treatment. First, we present summary statistics of generation decisions over Baseline ISD, IFG and IA treatments, respectively. Second, we analyze the effects of IFG and IA on generation choices in ISDG. Table 1 shows the frequencies and percentages of generation choices for sustainable option B and unsustainable option A in Baseline ISDG, IFG and IA. About 64.41 %, 70.22 % and 85.42 % of generations chose option B

[5]For details, see the instructions in figure 3.

in Baseline ISDG, IFG and IA, respectively, suggesting that generations are more likely to choose sustainable option B in IA than in Baseline ISDG and IFG. To confirm whether the distributions of generation choices A and B are independent of the treatments, pair-wise chi-squared tests have been performed by taking the following pairs: Baseline ISDG versus IFG, Baseline ISDG versus IA and IFG versus IA. A null hypothesis is that the distributions of generation choices A and B are the same for a pair of treatments. Our results reject the null hypothesis for Baseline ISDG versus IA ($\chi^2 = 6.05, p = 0.014$) and IFG versus IA ($\chi^2 = 3.19, p = 0.07$) significantly at 5 % and 10 % level, however, fails to reject it for Baseline ISDG versus IFG. These results confirm that IA affects more generations to choose sustainable option B than any other treatment.

[Table 1 about here.]

Table 2 summarizes subjects' sociodemographic variables in Baseline ISDG, IFG and IA, demonstrating that the basic characteristics, such as years of schooling, age and gender do not differ among treatments as shown by means and standard deviations. In table 2, it is confirmed that the number of prosocial members per generation across the treatments is not so different one another. Table 3 demonstrates the proportions of generation choice B with respect to the number of prosocial members per generation in each treatment, presenting that the percentages of generation choice B tend to increase in the number of prosocial members per generations in each treatment. This result is consistent with literature in that prosocial people play an important role in cooperation to sustain common pool resources and/or public goods (Shahrier et al., 2016, 2017, Timilsina et al., 2017).

[Table 2 about here.]

[Table 3 about here.]

Table 3 shows that 37.50 %, 66.66 % and 60.00 % of generations choose option B in Baseline ISDG, IFG and IA, respectively, when three members in a generation consist of only proself subjects (or zero prosocials). When there are one prosocial and two proself members in a generation,

50.00 %, 72.00 % and 88.88 % of generations choose option B in Baseline ISDG, IFG and IA, respectively. These findings imply that a generation usually chooses option A in Basic ISDG, when a majority of members are proself. However, in IFG and IA, a generation is likely to choose option B even in the same situation, suggesting that IFG and IA may be effective to induce generations to choose option B. When a generation contains two or three prosocial members, most generations choose option B, irrespective of treatments.

Tables 1 to 3 suggest that the number of prosocial members per generation and IFG & IA might be strong determinants for generation choices between options A and B. Hence, to statistically characterize this, we run three models of logistic regression by taking a dummy variable of generation choice B as a dependent variable and other variables as independent ones. Model 1 uses the data in Baseline ISDG taking that the number of prosocial members per generation is an independent variable. Model 2 uses the data in Baseline ISDG and IFG taking the number of prosocial members and IFG treatment dummy as independent variables. Finally, model 3 uses the data in Baseline ISDG, IFG and IA taking that the number of prosocial members per generation, IFG and IA treatment dummies as independent variables.[6] The detailed definition of each variable used in the logistic regression is explained in table 4.

[Table 4 about here.]

[Table 5 about here.]

Table 5 reports the marginal effects of independent variables on generation choice B in logistic regressions. Models 1, 2 and 3 consistently show that the number of prosocial members per generation and IA dummy are economically and statistically significant, affecting the likelihood for generations to choose option B. On the other hand, IFG dummy in models 2 and 3 are identified to be insignificant. Models 1, 2 and 3 in table 5 show that if the number of prosocial members per

[6]Models 1, 2 and 3 have been estimated including other sociodemographic variables at group level, such as gender, years of schooling and so on, showing that they are neither statistically nor economically significant. In other words, the results remain the same as the main ones that will be presented in this paper. Therefore, we have excluded such insignificant sociodemographic variables in regression.

generation increases by one, a generation is more likely to choose option B by 8.70 %. Model 3 in table 5 reveals a significant IA treatment effect on the probability for generations to choose option B, suggesting that generations in IA are 22.30 % more likely to choose option B as compared with those in Baseline ISDG. Overall, the results in logistic regression show that the number of prosocial members per generation and IA dummy are key determinants at maintaining intergenerational sustainability. In particular, IA is identified to be effective for inducing people to choose option B much more frequently than any other treatment.

[Table 6 about here.]

To qualitatively identify the further treatment effects of Baseline ISDG, IFG and IA, we utilize the data of individual interviews that were conducted after generation choices are made. As mentioned earlier, the interviews enable to trace a change in each subject's "individual initial opinion" and "individual final opinion" to have supported A, B and/or to be N ambivalent (to have no ideas) before and after deliberation, respectively. When there are no changes between " individual initial opinion" and "individual final opinion," such situations are coded as AA, BB or NN where the first (second) letter represents her initial (final) opinion to have supported A, B or N before (after) deliberation. The other combinations of the two letters represent situations where a subject changes individual opinions over a course of deliberation. For instance, AB describes a situation where a subject initially had her initial opinion to support A before deliberation, but changed her final opinion to support B after deliberation.

Table 6 shows that the proportions of subjects with BB (AA) are 55.93 % (16.95 %), 56.02 % (21.28 %) and 72.22 % (11.11 %) in Baseline ISDG, IFG and IA, respectively, suggesting that individual opinion BB (AA) is more (less) dominant in IA than in any other treatment. Furthermore, there is a higher (lower) proportion of subjects with AB (BA) in IA than in any other treatment, implying that only deliberation does not favorably affect individual opinion changes to support option B in Basic ISDG and IFG, as compared with IA. The results confirm that a majority of subjects in IA tend to have consistent individual initial and final opinions with BB, while approximately half of the subjects in Baseline ISDG and IFG exhibit a wide variation in their opinions

other than BB. To statistically confirm the variation in individual initial and final opinions, we apply the coefficient of "unalikeability" as a concept of variability for an unordered categorical variable (Gordon, 1986, Kader and Perry, 2007, Frankfort-Nachmias and Leon-Guerrero, 2017).[7] We have identified that the coefficients of "unalikeability" in individual initial (final) opinions are 0.46 (0.52), 0.43 (0.51) and 0.32 (0.32) for Baseline ISDG, IFG and IA, respectively, confirming that subjects with IA have less variation in individual initial and final opinions, leading subjects to support option B at individual level. The analysis suggests that IA appear to trigger members in a generation to think about their subsequent generations before and after deliberation by noting an existence of providing reasons and advice, inducing themselves to consistently support sustainable option B as an individual opinion. It is in line with past literature claiming that asking people reasoning in their action makes themselves more logically consistent (Elster and Rendall, 2008).

[Table 7 about here.]

Figure 4 summarizes occurrence frequencies of reasons and advice provided by each generation to subsequent generations in IA based on the seven concepts suggested by Nakagawa et al. (2016) and Timilsina et al. (2018) (See table 7 for the details of the concepts and categorization of reasons and advice).[8] First, "maximization of the sum of all generations' benefits" has been identified as the most frequent concept that appears as reasons and advice in IA, which could be considered more relevant to justifying or advising option B. Likewise, the 2nd, 3rd and 4th frequent concepts that appear as reasons and advice in IA are "hope to avoid future generations' disadvantages," "expectation that goodwill will succeed with choosing option B" and "willingness to terminate the chain of badwill," respectively, which could also be considered more relevant to advising option B to subsequent generations. On the other hand, we observe the only two concepts relevant to justifying and advising option A in IA, which are "maximization of the current generation's benefits

[7]The coefficient of "unalikeability" measures how often observations differ from one another within the same treatment group, and it is measured on a scale from 0 to 1. The higher the value is, the less alike the observations in a variable are.

[8]Each generation is provided with a sheet of paper to write reasons and advice. After providing reasons and advice, generations are asked to choose one concept from the list of seven concepts that can be considered the closest to their reasons and advice. The frequency histogram is shown in table 7.

by choosing option A" and "non-negligible costs of considering future generations by choosing option A," and the total occurrence frequency of these two concepts in IA is just six. Therefore, figure 4 demonstrates that IA induces the current generations to argue reasons and advice in their decisions that support choosing option B to subsequent generations within the same sequence.

Overall, the results in tables 1 to 3, 5 and 7 and figure 4 show that IA is the most effective and can be considered a social environment or an institution to enhance or maintain sustainability in an intergenerational setting. Literature in brain science, social psychology and anthropology has established that communications can enhance sympathy and/or decrease social distance for out-group members (Epley and Caruso, 2004, Laland, 2004, Gilbert and Wilson, 2007, Behrens et al., 2008, Heyes, 2012, Hein et al., 2016). In this sense, IA is considered to function as a social device to raise sympathy and solidarity beyond self-interest motives across generations through a one-way communication channel from the current generation to subsequent ones in ISD, leading generations' decisions towards a social norm or common image for intergenerational sustainability (Bohnet and Frey, 1999, Haidt, 2004, Elster and Rendall, 2008). This result is in line with past studies of "conditional cooperators" in public goods games (Fischbacher et al., 2001, Schotter and Sopher, 2003, 2006, 2007, Chaudhuri et al., 2006, Hauser et al., 2014), because IA is reinterpreted as a one-way channel through which each generation is induced to be a conditional cooperator through observing not only previous generations' choices but also their associated reasons & advice, or to be a "cooperation" initiator that affects subsequent generations to be conditional cooperators.

[Figure 4 about here.]

4 Conclusion

This research has addressed ISD and examined the potential solution of how to maintain intergenerational sustainability by conducting field experiments of ISD games (ISDG) in Nepal. The three treatments of Baseline ISDG, imaginary future generation (IFG) and intergenerational

accountability (IA) are prepared and implemented to see whether IFG and IA work for intergenerational sustainability. Our results demonstrate that generations under IA choose a sustainable option much more often than under Baseline ISDG and IFG, giving positive reasons and advice for sustainable options to subsequent generations. Brain scientists, social psychologists and anthropologists establish that communications enhance sympathy and/or decrease social distance for out-group members (Epley and Caruso, 2004, Laland, 2004, Gilbert and Wilson, 2007, Behrens et al., 2008, Heyes, 2012, Hein et al., 2016). Being consistent with the literature, a one-way communication of reasons and advice with subsequent generations (out-group members) in IA is identified to function as a social device to not only transfer a common image but also decrease social distance over generations for intergenerational sustainability.

Our results are relevant to past experimental studies of "conditional cooperators" in public goods games (Fischbacher et al., 2001, Schotter and Sopher, 2003, 2006, 2007, Chaudhuri et al., 2006, Hauser et al., 2014). That is, people are more likely to be cooperators once they observe that others cooperate. IA can be interpreted as a social device of creating a one-way channel through which each generation is induced to be a conditional cooperator through observing not only previous generations' choices but also their associated reasons & advice, or to be a "cooperation" initiator that affects subsequent generations to be conditional cooperators through sending her reasons and advice. Finally, we note some limitations and future avenues of research. The results in this research are established mainly from observed behavioral data. However, the qualitative data of transcribed documents from interviews and generation discussions can be further utilized to confirm our results, following qualitative deliberative analysis (see, e.g., Krippendorff, 2003, Vaismoradi et al., 2013, Brinkmann, 2014, Corbin and Strauss, 2014, Cason and Mui, 2015, for qualitative deliberative analysis). Therefore, future studies should be able to analyze not only behavioral data but also qualitative data for purpose of detailing how and why IA is effective. These caveats notwithstanding, it is our belief that this study is an important first step for the resolution of ISD problems, hoping that further studies will ensue to suggest something new to enhance intergenerational sustainability.

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Figure 1: Study regions: Cities of Nepal

Figure 2: Structure of experiment and data collection procedures

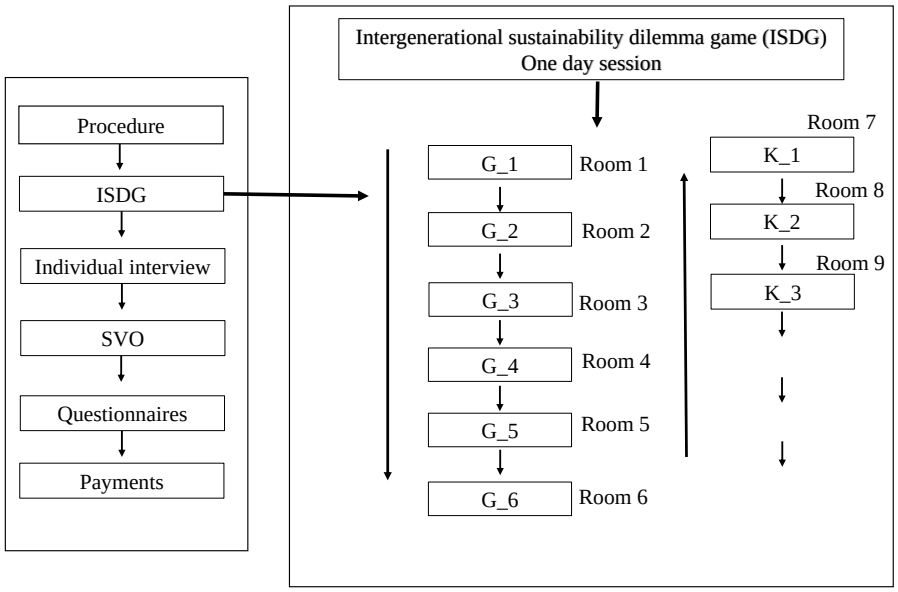


Figure 3: Instructions of the "slider method" for measuring social value orientation (Murphy et al., 2011)

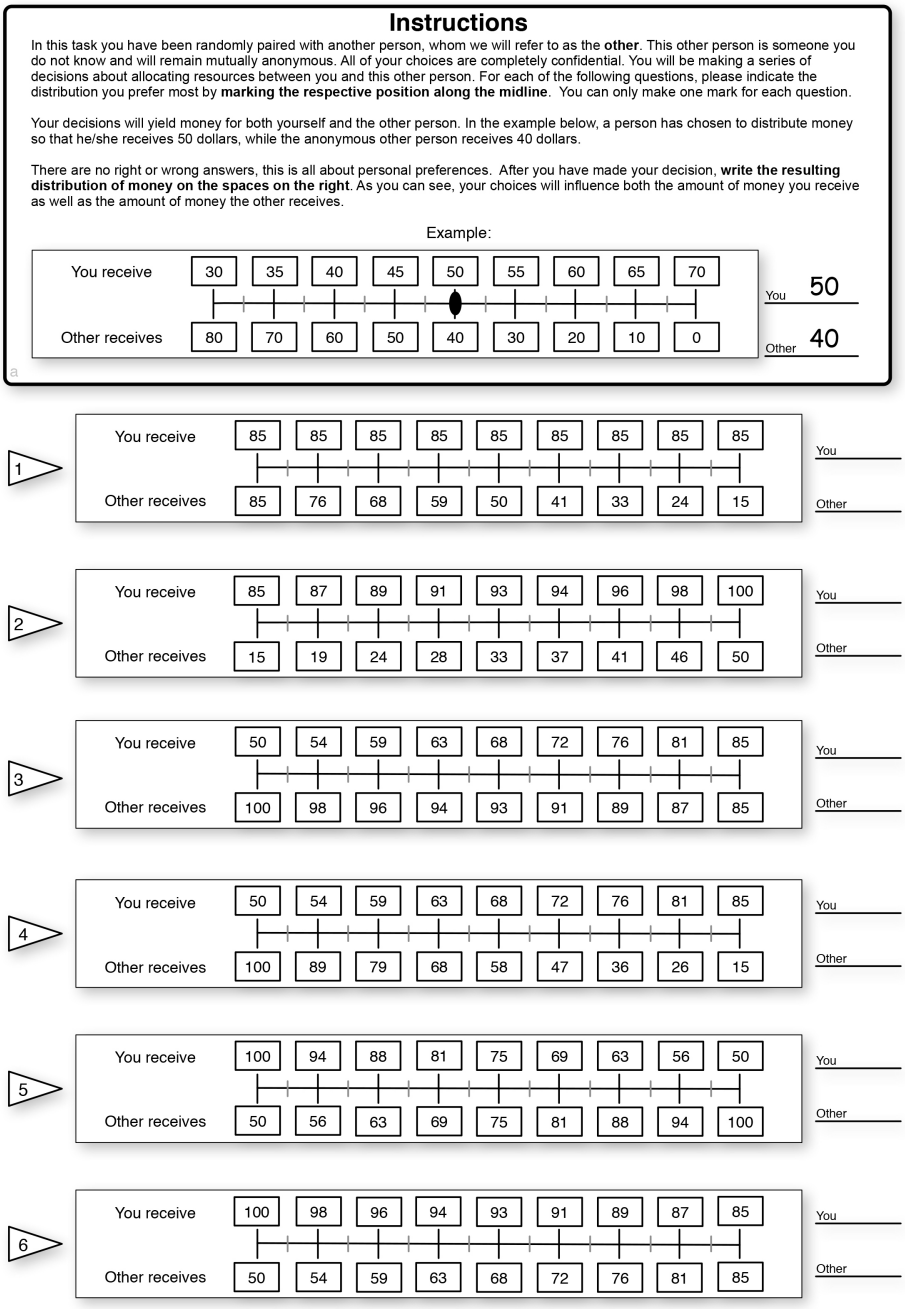
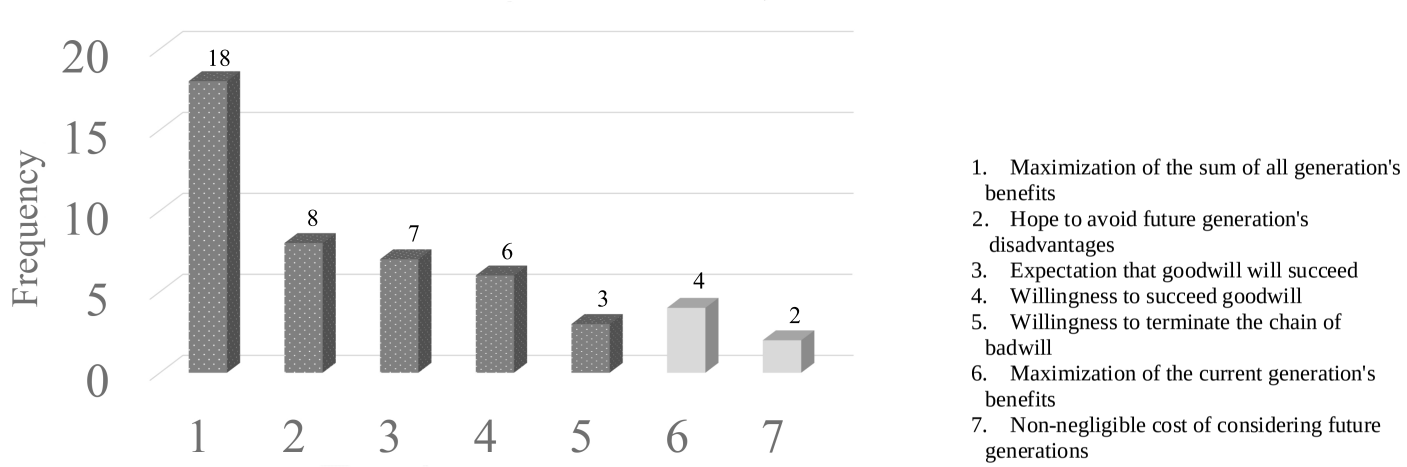


Figure 4: Frequency distribution of reasons and advice given by each generation for choosing sustainable option B and unsustainable option A in IA treatments



List of Tables

Table 1: Frequencies and percentages of generation choices of option A and B in Baseline ISDG, IFG and IA

	A	B	Overall
Baseline ISDG	21 (35.59 %)	38 (64.41 %)	59 (100 %)
IFG	14 (29.78 %)	33 (70.22 %)	47 (100 %)
IA	7 (14.58 %)	41 (85.42 %)	48 (100 %)

Table 2: Summary statistics of socioeconomic characteristics: 154 generations with 462 observations

	Baseline ISDG	ISDG with IFG	ISDG with IA	Overall
Age				
Mean (Median)[1]	33.75 (34.67)	28.66 (28.00)	28.66 (27.00)	30.58 (30.00)
SD[2]	8.60	6.34	10.44	8.94
Min	21.00	18.00	17.67	17.67
Max	52.00	42.67	56.33	56.33
Education				
Mean (Median)	15.20 (16.00)	14.63 (16.00)	14.92 (15.33)	14.94 (16.00)
SD	2.54	2.85	2.32	2.57
Min	8.67	7.00	8.00	7.00
Max	18.00	18.00	20.00	20.00
Number of male members				
Mean (Median)	2.00 (2.00)	1.55 (2.00)	1.58 (2.00)	1.74(2.00)
SD	0.87	0.65	0.74	0.79
Min	0.00	0.00	0.00	0.00
Max	3.00	3.00	3.00	3.00
Number of prosocial members				
Mean (Median)	1.42 (2.00)	1.47 (1.00)	1.56 (2.00)	1.48 (1.00)
SD	0.77	0.80	0.87	0.81
Min	0.00	0.00	0.00	0.00
Max	3.00	3.00	3.00	3.00

[1] Median in parentheses.
[2] SD stands for standard deviation.

Table 3: Distributions of generation choice B with respect to the number of prosocial members per generation in each treatment

# of prosocial members in one generation	Percentage of choice B			Overall
	Baseline	IFG	IA	
0	37.50 % $\left(\approx \frac{3}{8}\right)$	66.66 % $\left(\approx \frac{2}{3}\right)$	60.00 % $\left(= \frac{3}{5}\right)$	50.00 % $\left(= \frac{8}{16}\right)$
1	50.00 % $\left(= \frac{10}{20}\right)$	72.00 % $\left(= \frac{18}{25}\right)$	88.88 % $\left(\approx \frac{16}{18}\right)$	69.84 % $\left(\approx \frac{44}{63}\right)$
2	79.31 % $\left(\approx \frac{23}{29}\right)$	61.54 % $\left(\approx \frac{8}{13}\right)$	88.88 % $\left(\approx \frac{16}{18}\right)$	78.33 % $\left(\approx \frac{47}{60}\right)$
3	50.00 % $\left(= \frac{1}{2}\right)$	83.33 % $\left(\approx \frac{5}{6}\right)$	85.71 % $\left(\approx \frac{6}{7}\right)$	80.00 % $\left(= \frac{12}{15}\right)$
Subtotal	30.95 % $\left(\approx \frac{37}{59}\right)$	29.57 % $\left(\approx \frac{34}{47}\right)$	85.42 % $\left(\approx \frac{41}{48}\right)$	72.72 % $\left(\approx \frac{112}{154}\right)$

Table 4: Descriptions of variables included in regressions

Variables	Descriptions
Generation choice B	A dummy variable that takes 1 if the generation chooses option B, otherwise 0.
# of prosocials	The number of prosocial members in each generation.
IFG	A dummy variable that takes 1 when IFG treatment is given to one session consisting of 6 generations, otherwise 0.
IA	A dummy variable that takes 1 when IA treatment is given to one session consisting of 6 generations, otherwise 0.

Table 5: Marginal effects of Logistic regressions for generation choice B

Variable	Marginal effect		
	Model 1	Model 2	Model 3
# of prosocial members	0.087**	0.087**	0.087**
	(0.044)	(0.044)	(0.044)
IFG dummy		0.061	0.061
		(0.807)	(0.080)
IA dummy			0.223***
			(0.083)

***significant at the 1 percent level, **significant at the 5 percent level

Table 6: Frequencies and percentages of change in individual opinions for supporting option "A" "B," or "N" ambivalent/no ideas before and after the deliberation (percentage in parenthesis)

Individual opinion change	Treatments		
	Baseline	IFG	IA
AA	30 (16.95 %)	30 (21.28 %)	16 (11.11 %)
AB	12 (6.78 %)	5 (3.54 %)	12 (8.33 %)
AN	9 (5.08 %)	3 (2.13 %)	0 (0.00 %)
BB	99 (55.93 %)	79 (56.02 %)	104 (72.22 %)
BA	11 (6.21 %)	16 (11.35 %)	6 (4.17 %)
BN	9 (5.08 %)	4 (2.84 %)	5 (3.47 %)
NN	2 (1.13 %)	0 (0.00 %)	0 (0.00 %)
NA	3 (1.69 %)	1 (0.71 %)	0 (0.00 %)
NB	2 (1.13 %)	3 (2.13 %)	1 (0.70 %)
Total	177 (100.00 %)	141 (100.00 %)	144 (100.00 %)

Table 7: List of reasons and advice provided by each generation to subsequent generations in IA

Category	No.	Reasons	Example
Reasons for choosing B (Sustainable option)	1	Maximization of the sum of all generations' benefits	It is social justice and the sum of benefits will be larger if every groups choose B.
	2	Hope to avoid future generations' disadvantages	Nobody is happy when there is injustice and justice gives happiness to everybody, we feel that we should avoid any disadvantage to the next groups.
	3	Expectation that goodwill will succeed	We are social beings and we should think about next group and we choose option B because, we expect that future groups will do the same.
	4	Willingness to succeed goodwill	We should not become selfish and short sighted, if we do future group might copy us, therefore, we choose option B.
	5	Willingness to terminate the chain of badwill	We decided to choose B because it is fair for another group as it will not make any reduction on their initial choices and we would like to change a bad chain of choosing option A.
Reasons for choosing A (Unsustainable option)	6	Maximization of the current generations' benefits	All other earlier groups have kindly considered about next groups and if we choose A it will not make situation very bad.
	7	Non-negligible cost of considering future generations	We have chosen A because if we consider about next groups, we will lose benefit and they will lose incentive to work hard and to find alternative solution for their survival