Does being intergenerationally accountable resolve intergenerational sustainability dilemma?

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Abstract

We address whether being intergenerationally accountable (IA) is effective at maintaining intergenerational sustainability (IS) through conducting lab-in-the-field experiments of IS dilemma games. In baseline, a sequence of six generations, each composed of three members, is organized, and each generation chooses whether to maintain IS (sustainable option) or to maximize their payoff by imposing costs on future generations (unsustainable option) via deliberation. In IA, each generation is additionally asked to provide reasons and advice to subsequent generations along with the decision. Results indicate that IA induces generations to choose the sustainable option with positive reasons and advice, enhancing IS.

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Key Words: Intergenerational sustainability dilemma; intergenerational accountability; lab-in-the-field experiments

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

"Why does not the current generation become accountable for future generations? All actions relating to the right of other men are unjust if their maxim is not consistent with publicity (Kant, 1795)."

"The fundamental purpose of accounting since the ancient period is to keep, accumulate and provide records and the associated information to stakeholders about economic entities. The records and information are intended to be useful for the stakeholders to make decisions (Nissen et al., 1993)."

"Whatever regrets you have over your life, your life shall be considered complete if you successfully transfer your will to future generations (Ozawa, 2016)."

1. Introduction

Maintaining intergenerational sustainability has become one of the greatest challenges due to its unidirectional nature; the current generation affects future generations, but the opposite is not true. In such occasions, the current generation must decide whether or not to behave for future generations. If the current generation chooses an action that is to her own benefit, burdens are left on future generations and intergenerational sustainability is compromised. We call such a situation "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 the sustainability of subsequent generations. Possible solutions to maintain intergenerational sustainability have been discussed in relation to responsibility, justice and equity (Padilla, 2002, Garri, 2010, Kverndokk et al., 2014, Hoberg and Baumgartner, 2017). However, contemporary economic and political institutions are not 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 (Buchanan and Stubblebine, 1962, Krutilla, 1967, Barry, 1997, Wolf, 2008, Milinski et al., 2006, Hauser et al., 2014, Caney, 2014, Streeck et al., 2016, Caney, 2018).

Economic literature defines sustainability as a minimum condition to be satisfied, that is, maintaining the welfare of successive generations, as compared with the current generation (Hartwick, 1977, Becker, 1982, Dasgupta and Mitra, 1983, Howarth, 1991, Weitzman, 1997). However, many important social problems in contemporary societies violate the sustainability condition where the current generation prioritizes her benefit by leaving burdens on future generations. For instance, outstanding debts of some OECD countries, such as Japan, US, France and Italy, amount to 2.36, 1.3, .08 and 0.96 times their GDP, respectively, and Japan will take more than 100 years to pay her debt even by raising consumption tax from 10% (its current level as of 2018) to 40% (Hansen and Imrohoroglu, 2016). Similarly, there is a serious threat of global climate change the current generation imposes on future generations. The coastal communities are predicted to suffer from a sea level rise by 2m up to 2100, and it is reported that the rise is due to high greenhouse gas emission the current generation has cast (Bamber et al., 2019). Fundamental nature of the aforementioned sustainability problems can be considered ISD.

This paper addresses the potential solution for ISD. To this end, we suggest a mechanism with accountability of reasons and advice as a one-way communication device from the current generation to the subsequent generations to possibly improve intergenerational sustainability, which we call intergenerational accountability" (IA).[1] We experimentally implement and evaluate IA in ISD game (ISDG) where a sequence of generations is organized and each generation chooses either maintaining intergenerational sustainability (sustainable option) or maximizing her own generation's payoff by irreversibly costing future generations (unsustainable option) within a 10-minute deliberation. We hypothesize that with IA, generations are likely to choose sustainable option, giving the positive reasons and advice to their subsequent generations.

We have conducted ISDG lab-in-the-field experiments in Nepal with the three treatments: (i) baseline ISDG, (ii) an imaginary future generation (IFG) and (iii) IA. With baseline ISDG treatment, a sequence of six generations is organized, and each generation chooses either sustainable option or unsustainable option within a 10-minute deliberation. Additionally, in IFG treatment, one member in a generation is randomly assigned as a representative of the subsequent generations for deliberation. Instead, with IA treatment, each generation is asked to provide the underlying reasons for her decision as well as advice to future generations during the deliberation, which shall be passed to the subsequent generations. The novelties of our research lie in (i) proposing and instituting a new institution of IA in the context of ISD and (ii) evaluating its effectiveness in ISDG. ISDG experiments specifically evaluate and answer a question, i.e., are generations more likely to choose sustainable option in IA than in baseline ISDG and IFG?

Past studies examine people's decisions for intergenerational sustainability by employing an experimental approach. Fischer et al. (2004) demonstrate that the existence of "intergenerational links" motivates people to exploit fewer resources in an intergenerational common pool experiment and enhances sustainability. Janssen et al. (2011, 2012) conduct laboratory and field experiments of vertical social dilemmas with power asymmetry feature for sequential withdrawals from the commons. The authors claim that the power asymmetry is an important driver for stationary bandit problems and the development of norms to allocate fair shares of the recourses is achieved when there are sufficient levels of trust among community members. Hauser et al. (2014) present that median voting as an institution promotes sustainability in an intergenerational goods game especially when a majority of people are prosocial. Sherstyuk et al. (2016) analyze the level of difficulty 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. Kamijo et al. (2017) design and implement ISD game (ISDG) in a laboratory setting and show that introducing an agent for future generations as IFG in a group decision process improves intergenerational sustainability. Shahrier et al. (2017) conduct ISDG experiments with IFG in rural and urban areas of Bangladesh, demonstrating that rural people choose sustainable options more often than urban people and IFG is not effective at enhancing IS.[2] Overall, intergenerational sustainability is found to be affected by individual social preferences and institutions.

Literature in economics has sought to understand behaviors and performances of a group under various settings, such as communication (McCallum et al., 1985, Kameda and Davis, 1990, Bornstein and Yaniv, 1998, Kugler et al., 2012, Charness and Sutter, 2012, Cooper and Kuhn, 2016, Meub and Proeger, 2017, Crawford and Harris, 2018, Carbone et al., 2019, Vollstadt and Bohm, 2019). In some specific situations, it is reported that communication does not necessarily enhance coordination and performances, influencing the group members and groups in unexpected ways, such as in competitive coordination games (Bornstein et al., 2002, Kugler et al., 2012, Charness and Sutter, 2012, Cason et al., 2012, Keck et al., 2014, Bradfield and Kagel, 2015, Kagel and McGee, 2016, Cason et al., 2017). Schotter and Sopher (2003, 2006, 2007), Chaudhuri et al. (2006) and Chaudhuri et al. (2009) address the roles of advice and communication in ultimatum, coordination, minimum effort games and voluntary contributions to public goods with an intergenerational context. On the other hand, Hackett et al. (1994), Carpenter (2000), Fehr and Gachter (2000), Brosig-Koch et al. (2003) and Lopez and Villamayor-Tomas (2017) have demonstrated that advice and communication are usually effective at enhancing cooperation in an intragenerational or intragroup settings. Schotter and Sopher (2003, 2006, 2007) show that wisdom and knowledge that accumulate over generations through advice and communication promote the creation of social convention and/or norms, leading generations to learn reciprocity and fairness. Overall, these studies suggest that groups' fundamental preferences concerning themselves and/or others as well as the ways of communication are key factors for coordination and performances, yielding a wide array of decisions and outcomes within a group and between groups.

Schotter and Sopher (2003, 2006, 2007), Chaudhuri et al. (2006) and Chaudhuri et al. (2009) use experimental games in which the current generation is incentivized to give advice to subsequent generations for their better choices and the possibility of Pareto improvement mostly exists. Specifically, the current generation's payoff depends on subsequent generations' actions (or performances) as if the relationship is overlapping, such as a parent-child one. 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. However, in ISD, our focus is on addressing sustainability for long-run relationship across generations as if they are non-overlapping, and such long-run sustainability problems are exemplified by emergence of global climate change, various environmental problems and government debts as mentioned earlier. In the ISD situations, the current generation is considered to affect subsequent generations, but the opposite is not true where there is no possibility of Pareto improvement across generations (or all possible allocations are Pareto efficient). That is, the current generation's payoff does not depend on subsequent generations' payoffs, but subsequent generations' payoffs depend on the current generation's payoff. This is a unique feature in ISD, as it reflects environmental and resource sustainability problems over generations in the long run and is different from the experimental games in previous literature.

The remainder of this paper is organized as follows. The sampling and the data are described in Section 2, i.e., "the experiments" with a subsection of intergenerational sustainability dilemma game and experimental procedures. Section 3 reports the experimental results along with quantitative and qualitative statistical analyses. Finally, discussions, conclusions and implications are provided in Section 4.

2. The experiments

2.1 Intergenerational sustainability dilemma game (ISDG)

We first explain baseline ISDG, following Kamijo et al. (2017) and Shahrier et al. (2017). In the ISDG, a non-overlapping generational sequence is prepared with three members in a group called a generation and each member participates only once. Each generation is asked to decide between an unsustainable option A and a sustainable option B through deliberation as well as how to split the share from the selected option within the generation. It is claimed that the ultimate goal of sustainability is to fairly ensure wellbeing of people among the current and future generations, i.e., intragenerational and intergenerational equalities at the same time (Dasgupta and Mitra, 1983, Howarth, 1991, Weitzman, 1997, Kverndokk et al., 2014, Fochmann et al., 2018, Martinet et al., 2022). Therefore, the ISDG is designed to mimic the intergenerational and intragenerational decisions each generation must make for the equalities in sustainability. With the design, ISDG enables us to understand how individuals and groups sequentially behave toward sustainability within a single framework, building upon some literature in individual and group decisions (McCallum et al., 1985, Bornstein and Yaniv, 1998, Janssen et al., 2011, 2012).

The 1st generation starts ISDG with $X = 1200$ as a payoff for choosing A and a payoff ($X - 300 = 1200 - 300 = 900$) for choosing B. After choosing 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 share. Each subject's payoff is the sum of the individual generation share plus initial individual endowment of 300. These numbers represent experimental points that a subject earns from ISDG. Throughout the manuscript, we have consistently mentioned only the numbers for simplicity. Consequently, if members in a generation split the payoff equally among them, each member earns 400 by choosing A and 300 by choosing B as the individual generation share. Therefore, the total payoff of each subject within the generation choice of A is 700 (= 400 + 300), whereas the payoff is 600 (= 300 + 300) when choosing B.

The current generation's decision affects subsequent generations such that subsequent generations' payoffs decline uniformly by 300 when the current generation chooses A. Suppose that the 1st generation chooses A. Then, the 2nd generation will face the game in which they can get 900 and 600 for choosing options A and B, respectively. However, if the 1st generation chooses B, the next generation (i.e., the 2nd generation) can have the same decision environment as that of the 1st generation. When the 1st generation chooses *B*, the 2nd generation plays a game in which they can get 1200 and 900 for choosing options *A* and *B*, respectively. Following the same rule, the game continues for the rest of the subsequent two generations (i.e., between i^{th} and $i + 1^{th}$ generations). Therefore, *B* can be considered a "sustainable option," whereas *A* is the choice that compromises intergenerational sustainability and can be considered an "unsustainable option."

In each session, the 1st generation starts and then proceeds to the 2nd, 3rd, . . ., 6th generations in a sequence. Information regarding the previous generations' decisions are provided to each of the 2nd, 3rd, . . ., 6th generations just before they start deliberation. In ISDGs, the 5th and 6th generations may face the game in which options *A* and *B* are associated with the generation share of zero and/or a negative payoff if all previous generations keep choosing *A*. In ISDG, we explain and ensure that an initial endowment is given to all subjects for covering their losses, following Mason et al. (2005). They argue some justification and procedures of preparing an initial endowment for subjects not to incur the losses via participating in experiments. In such a situation, generation members equally split their zero or negative generation share and recover by their initial individual endowments of 300. For instance, if all previous 5 generations in a sequence choose *A*, then the 6th generation faces the game in which options *A* and *B* are associated with generation shares of −300 and −600, respectively. If the members in the 6th generation choose *B*, they receive the generation share of −600. In this case, each member would receive $-200 = -\frac{600}{3}$ from the generation share, ending up with the payoff of $100 = 300 - 200$ by the initial endowment. Therefore, each subject's payoff never becomes negative even in the worst-case scenario.

Each generation deliberates to decide between options *A* and *B* and how to split the generation share within a 10-minutes discussion. When the decisions cannot be made within 10 minutes, the following rules are applied: (1) if the generation share is positive, each member receives an initial endowment of 300, (2) if the generation share is negative, say, −Z, each member equally splits −Z by three and receives the payment of $-\frac{Z}{3}$ plus an initial endowment of 300. In the experiments, all the generations reached the decisions within 10 minutes across all the treatments. The subjects know that they are assigned to one generation within a sequence. However, subjects are not informed of which generation is the last in the sequence. Note that we use more than 6 rooms in a session depending on the days, locations and the number of subjects, and prepare a separate room for each generation to keep anonymity among generations in a sequence (See figure A2 in Appendix). This experimental environment is important to avoid a situation where the subjects detect "we may be the last generation in the sequence." In our way, the end game effect is minimized. For further details of experimental procedures, refer to the experimental instructions provided as a supplementary material.

A dominant strategy and a Nash equilibrium (NE) strategy in ISDG are choosing *A* because it maximizes her payoff, irrespective of how other generations choose in the past and will choose in the future within the same sequence. All allocations in ISDG are Pareto optimal because every allocation cannot be Pareto improved by any other feasible allocation. However, there exists a unique allocation that leads to sustainability and maximizes the sum of payoffs for all the generations (i.e., social welfare). The socially desirable allocation shall be the one achieved when every generation keeps choosing *B*, maintaining sustainability. Thus, in this paper, a new mechanism called "intergenerational accountability" (IA) as well as "imaginary future generations" (IFG) are instituted as treatments to improve intergenerational sustainability in ISDG. The treatments are explained as follows:

• **ISDG with IA:** In IA treatment, generations are asked to choose between options *A* and *B* through a 10-minute deliberation as in baseline ISDG. With IA treatment, during the deliberation, each generation is asked to provide reasons & advice for her decisions by writing in a paper being accountable for subsequent generations. We do not prepare any punishment even if generations do not provide the reasons and advice to subsequent generations. The experimental instructions use a neutral term of "please be accountable by providing the reasons and advice for your decision during the deliberation." We ensure that each generation's reasons and advice are passed to their subsequent generations within a sequence. Each generation writes the reasons and advice on a sheet of papers and hands it over to RAs. After that, they are asked to choose one concept from the list of seven concepts that they consider the closest to their reasons and advice, as suggested by Timilsina et al. (2021b) and Timilsina et al. (2021a). Generations that choose *A* or *B* select one among the concepts 1 - 5 or 6 - 7 as shown in table 6, respectively. In this way, generations cannot revise their decision and messages after seeing the list of concepts. Finally, we observe that generations in IA treatment provide the reasons and advice to subsequent generations except one generation. The one generation provides only the reasons to the decision without mentioning any advice.

We hypothesize that the IA treatment is effective at maintaining intergenerational sustainability in ISDG through a one-way communication from the current generation to subsequent generations by being accountable; our idea is partly inspired by the previous literature, such as Konow (2000), Schotter and Sopher (2003, 2006, 2007), Chaudhuri et al. (2006) and Chaudhuri et al. (2009).[3] 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 a 10-minute deliberation as in baseline ISDG; additionally, one-member in a generation is randomly picked through a lottery and assigned to be a representative for future generations, called imaginary future generation (IFG), throughout deliberation and decision. In this process, the role of IFG is automatically revealed to the entire group. The IFG person is asked to consider not only the current generation but also the subsequent generations for deliberating and deciding between options *A* and *B* without any coercive obligation. The remaining two members know that one member is asked to play the IFG role, and there are no extra-economic benefits for the IFG person to represent future generations.

2.2 Experimental procedures

We conducted (i) intergenerational sustainability dilemma game (ISDG), (ii) social value orientation (SVO) game and (iii) individual interviews and questionnaire surveys for sociodemographic information, and subjects per session participated in the experiments following this order.

Study areas, recruitment and sample

We conducted the experiments in the following regions of Nepal: Kathmandu, Lalitpur, Bhaktapur and Pokhara (See figure A1 in the Appendix). A series of past studies have identified that urban people are not concerned about maintaining sustainability as compared with rural ones (See, e.g., Timilsina et al., 2017, Shahrier et al., 2017). As claimed in Henrich et al. (2001), Fehr and Leibbrandt (2011) and Edwards (2011), the observations of any decision in economic experiments tend to reflect naturally occurring situations or vice versa. Thus, the results in this paper are considered good approximations for urban people's behaviors in ISD. The selected regions are homogeneous in terms of culture, language, economy and religion. The residents are usually ranked high in the human development index (HDI) on the basis of UNDP (2014) and the population density is also high in these regions. For instance, Kathmandu has a population density of 4416 people per km^2 (Central Bureau of Statistics, 2011b) and is the most crowded city, with 24.3% of the total urban population of Nepal. Urban cities, such as Kathmandu, Lalitpur, Bhaktapur and Pokhara, are the center for businesses and services. We choose the urban cities in Nepal as the fields of our experiments, because it is claimed that urban cities and people in developing countries of Asia, such as Bangladesh, India and Nepal, play a significant role in determining future sustainability of the planet (Henderson et al., 2016, Wigginton et al., 2016).

The first author is a chief administrator for the experiments, hiring local staff and research assistants (RAs) that support some experimental procedures per session, such as subject recruitment, room assignments, recording deliberations, conducting questionnaires and so on. To collect the sample of the urban population in these experiments, we select the desired number of subjects from the different occupational groups, such as banking, government, health, education, business, transportation, entertainment and students (Central Bureau of Statistics, 2011b). We distribute invitation letters in government offices and some organizations of local banks, colleges and business entities, requesting people to participate in the experiments and putting the pamphlets in some open public spaces. We had usually conducted experiments every weekend, considering their time schedules. Because there are sufficient incentives, the participation rate is 80%.

[Table 1 about here.]

Table 1 presents the summary statistics of the subjects' sociodemographic information, such as income, age and education. All income earners in the urban areas are 25-44 years old and mostly engaged in service and non-agriculture sectors. According to Central Bureau of Statistics (2011a), 80% of urban population are high income holders where average yearly income is 40000 NPR. Table 1 summarizes subjects' sociodemographic variables in baseline ISDG, IFG and IA, demonstrating the basic characteristics, such as years of schooling, age, income, number of male members in a generation and number of prosocial members in a generation. We run the Mann-Whitney test to check if there are any statistically significant differences in the sociodemographic variables across treatments. The null hypothesis is that the distributions of the sociodemographic variables between the following pairs of treatments (baseline ISDG vs. IFG, baseline ISDG vs. IA and IFG vs. IA) are the same. We do not find a significant difference in the distributions of years of schooling, income and number of prosocial members in a generation across treatments. However, we find that the distributions of the number of male members in a generation are different and significant at 1% for baseline ISDG vs. IFG ($Z = -2.94$, $p < 0.01$) and baseline ISDG vs. IA ($Z = -2.70$, $p < 0.01$). Similarly, the distributions of age in a generation are different and significant at 1% for baseline ISDG vs. IFG ($Z = -3.20$, $p < 0.01$) and baseline ISDG vs. IA ($Z =$

−3.21, $p < 0.01$). Overall, these summary statistics of sociodemographic information, except for gender and age for some pairs of treatments, are not so different, and we believe that the samples in our experiments reflect the Nepalese urban population.

Implementation of ISDG

The experiments are conducted at training halls of district health organizations and public seminar halls located in the center of the cities and consist of many rooms. Upon arrival at the locations, subjects are gathered in one hall, given experimental instructions and asked to sign the written consent to participate in the study with their native language (Nepali). Once everyone is present, experimental instruction is distributed and an experimenter (the first author) provides the subjects with a verbal explanation of the experimental rules. Each subject plays only once as a member of a single generation that is randomly formed. To maintain anonymity across generations, we confirm that the subjects fully understand the rules. Several quizzes are administered to check subjects' understanding of the game. We proceed with the experiments after confirming that all subjects answer the quizzes correctly. Then, subjects are asked to move toward a door for randomly picking a chip containing their generation ID and individual ID from a bag.[4] Each subject goes to a specific room according to their IDs. The generations are separated into rooms based on their generation IDs and RAs help us in these procedures. In this way, the subjects do not know who belongs to each generation (each subject only knows the members in his or her generation). One session is administered to have 18 ∼ 24 subjects with 6 ∼ 8 generations in a day and in total, there are 19 sessions and 462 subjects (or 154 generations). Each generation is randomly assigned to the 1st, 2nd, . . ., 6th generations as one sequence. When the number of subjects participating in a session is 21 or 24, we organize the 7th and even the 8th generations that are assigned as the 1st and the 2nd in another sequence of generations (See figure A2 in Appendix).

The RAs distribute questionnaires, explain the experimental procedures to the subjects and keep them engaged. In ISDG, the 1st generation makes deliberation up to 10 minutes for deciding between options A and B and how to split the generation share. RAs record what subjects in each generation discuss about during the deliberation via voice recorders. Once the generation makes the decisions, RAs confirm the generation decisions and ask subjects to move to a different room by ensuring anonymity. After the 1st generation's decision, we proceed to the 2nd generation and continue the experiments with the same procedures. The same routine is applied to the remaining generations, i.e., from the 2nd to the 3rd, . . ., from the 5th to the 6th. The decisions of the previous generations are passed in a sheet of papers and each subject in a generation is asked to confirm which generation they belong to in the 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* were chosen by the previous generations. Overall, we prepare baseline ISDG, IFG and IA treatments and conduct lab-in-the-field experiments with between-subject designs. With this information, each generation deliberates and decides between options *A* and *B*. Next, the generation discusses how to split the payoff among the members. There are 26 sequences in total with 10 sequences in baseline ISDG and 8 sequences in both IFG and IA treatments. In this process, we observe that generations in all treatments split their payoff equally among the members after making the decision. In ISDG experiments, subjects are paid a maximum of 550 NPR (≈ 5.50 USD) and 330 NPR (≈ 3.30 USD) on the average.[5]

Individual interviews

The individual interview is administered at the end of the experiments after subjects finish playing the ISDG and SVO game. The subjects do not know that they are going to be interviewed afterwards when participating in the games. We choose to do so for avoiding "subjects behave nicely" when they know that there is an interview. For example, past studies identify that subjects tend to become less selfish when anonymity toward the experimenter decreases (Cherry et al., 2002). The individual interviews identify whether and why each subject changed his or her individual opinion to support *A*, *B* or *N* (where

N denotes that the subject is ambivalent or has no ideas about the opinion to support) before and after deliberation, respectively, in each treatment. By the interviews, we can understand the cognitive processes for subjects to change or to keep opinions in deliberation.

Qualitative behavioral research establishes that individual opinions and ideas are truthfully elicited by interviews after the incidences of interest (Brinkmann, 2014). For instance, some subjects supported *A* as his or her "individual initial opinion" before deliberation but ended up supporting *B* as his or her "individual final opinion" after deliberation. In this case, the opinion change is coded as *AB*, where the first letter represents the initial support for *A* before deliberation and the second letter represents the final support for *B* after deliberation. In the same manner, we identify and code the subjects' opinion changes through individual interviews; 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 to support options *A* or *B* before and after deliberation. 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 real-world deliberative group decisions; 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).

Social value orientation (SVO) game and questionnaire

A social value orientation (SVO) is considered a good approximation of individual social preferences in relation to other people. The SVO framework assumes that people have different motivations and goals for evaluating resource allocations between oneself and others. Additionally, SVOs are established to be stable for a long time (See, e.g., Van Lange et al., 2007, Brosig-Koch et al., 2011, Carlsson et al., 2014, Sutter et al., 2018). Thus, SVO helps understand what types of people consider about future generations, while deciding in ISDG. SVO game with the "slider method" elicits the decisions to six primary items from each subject and identifies the subject as either prosocial or proself (See, e.g., Murphy et al., 2011, for the details).[6] We use the slider method because it is easy and intuitive for Nepalese subjects to understand even with a limited level of education. As is done in psychological research, we 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 (Murphy et al., 2011).[7] Respondents are informed that the units in this game are points, meaning that the more points they accumulate, the more real money they will earn.[8] After SVO game finishes, subjects proceed with answering the questionnaire surveys for their sociodemographic information. An exchange rate is applied to the points in SVO game to determine the monetary reward and subjects have received a maximum of 150 NPR (≈ 1.50 USD) and 100 NPR (≈ 1.00 USD) on an average. Finally, total payment from the experiments session for each subject is calculated as a summation of the participation fee and his/her earnings from ISDG and SVO game where each subject receives on average 100 NPR, 330 NPR and 100 NPR, respectively.

3. Results

A total of 154 generations participated in our experiments with complete 59 generations in baseline ISDG, 47 generations in imaginary future generation (IFG) treatment and 48 generations in intergenerational accountability (IA) treatment. First, we present the summary statistics of the 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 2 shows the frequencies (percentages) of generation choices for sustainable option *B* and unsustainable option *A* in baseline ISDG, IFG and IA. Approximately 64.41%, 70.22% and 85.42% of generations choose *B* 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 overall 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 vs. IFG, baseline ISDG vs. IA and IFG vs. 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 vs. IA ($\chi2 = 6.05$, $p = 0.014$) and IFG vs. IA ($\chi2 = 3.19$, $p = 0.07$) at the significance level of 5% and 10%. However, the test fails to reject the hypothesis for baseline ISDG vs. IFG. These results confirm that in IA more generations choose sustainable option *B* than any other treatment.

In baseline ISDG, IFG and IA treatments, 9, 7 and 8 sequences have a complete set of 6 generations, respectively. However, there are the 10th and 8th sequences in baseline ISDG and IFG that only have 5 generations, respectively.[9] The percentages of generation choice *B* are calculated by the generational order in sequences and are plotted in figure 1. The percentages vary from 50% to 100%, corroborating that the 1st and 2nd generations have chosen 100% *B* in IA, but have 70% and 75% in baseline ISDG and IFG, respectively. Pooling only the one-generation data makes a sample size very small and it is not appropriate to conduct statistical analyses with the very low frequency (Agresti, 2003, Campbell, 2007). Therefore, some additional statistical analyses, such as pair-wise chi-squared tests, cannot be conducted to establish this result statistically. Instead, figure 1 presents sufficient evidence that the percentages of *B* at the 6th generation in IA are consistently high, i.e., around 75% than those in basic ISDG and IFG with close to 50% and 60%, respectively. Overall, figure 1 suggests that IA induces generations to consistently choose *B* and prevents them from choosing *A* even in the later generations within sequences.

Some behaviors are observed to change from the 3rd and later generations under IA in figure 1. The percentage (percentages) of the 3rd generations' (later generations') choice *B* drop (fluctuate), while those of the 1st and 2nd ones are 100%. We consider that the 3rd and/or later generations may feel less pressures to be sustainable or relax the guilt, implicitly realizing that sustainability will not be crucially damaged by choice *A*. This shall be evident when all of the previous generations (in particular, the 1st and 2nd ones) chose *B*. It should be noted that each generation does not know the end of ISDG in a sequence, while the members may be guessing about it. This type of behavioral changes can be explained by "moral licensing" or "rebound effects," that is, good deeds by one person in a group (at one point in time) give liberation of behaving badly or unethically to other people in the same group (the same person at another later point in time) (Bénabou and Tirole, 2006, Gneezy et al., 2014, Dutschke et al., 2018, List and Momeni, 2021). It is also argued in relation to commitment and progress toward the goal. Suppose that my goal is to reduce the body weight by 5kg within a few months. At initial stages, a "commitment" motive drives me to make efforts a lot for the reduction goal. However, the efforts at the later stages are expected to increase or decrease depending upon the "progress" toward the goal (Dutschke et al., 2018). For example, I am likely to relax myself eating sweet foods along with some justifiable reason, such as "I should reward myself," when the "progress" has been wonderfully made, such as −4kg. Therefore, we conjecture that later generations would be likely to fall into an unethical behavior toward sustainability in ISDG due to the moral licensing or rebound effects, when they observe the "wonderful progress" by the early generations in the same sequence.

To check the robustness of our findings, we apply nonparametric statistical tests accommodating possible serial correlations among generation decisions within a sequence. To this end, we cluster generation decisions at sequence level. There is a total of 26 sequences, 10 in baseline ISDG, 8 in IFG and 8 in IA. We calculate the percentage for generations in a sequence to choose option *B* as one observation, running the Mann-Whitney test to examine the null hypothesis that the distributions of the percentages between the two treatments are the same. In this way, the observations are taken to be independent and the tests should be able to clarify some distributional differences of percentages for generations per sequence to choose *B* between the two treatments. We find the results for baseline ISDG vs. IFG ($Z = 0.51$, $p = 0.61$), baseline ISDG vs. IA ($Z = 2.31$, $p < 0.05$) and IFG vs. IA ($Z = 1.46$, $p = 0.14$), demonstrating that the distributions of the percentages for generations per sequence to choose *B* are different and significant at 5% only for the pair of baseline ISDG vs. IA. However, the test result for the pair of IFG vs. IA suggests that the p-value 14% is close to 10% significance, implying that IA considerably induces generations to choose option *B* even in comparison to IFG. Overall, the results suggest that generations in IA appear to choose sustainable option *B* more often than in baseline ISDG and IFG treatment.

[Table 2 about here.]

[Figure 1 about here.]

Table 1 reports summary statistics for the number of prosocial members per generation across the treatments. The prosociality is elicited from each subject's responses to six primary items in the "slider method" SVO game. The Mann-Whitney test is used to examine the null hypothesis that the distributions of the number of prosocial members in a generation between the following pairs of treatments (baseline ISDG vs. IFG, baseline ISDG vs. IA and IFG vs. IA) are the same. The results are insignificant for all the pairs, such as baseline ISDG vs. IFG ($Z = -0.16$, $p = 0.87$), baseline ISDG vs. IA ($Z = 0.67$, $p = 0.50$) and IFG vs. IA ($Z = 0.70$, $p = 0.48$). Thus, the number of prosocial members in a generation across the treatments is not different from 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 the 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). Here, we must admit some possibility that the deliberation process for generation decisions in ISDG influences individual prosociality elicited through the SVO game at the end of each session, and it would undermine some interpretations for the results in table 3. However, the SVOs are reported to be stable characteristics in the long run without having the change by some incidents, and such natures are consistent with the above results in the Mann-Whitney tests (Van Lange, 1999, Perugini and Gallucci, 2001, Van Lange et al., 2007, Brosig-Koch et al., 2011, Cavazza et al., 2014, Carlsson et al., 2014, Sutter et al., 2018). Therefore, it is our belief that the main results will not change much even with the caveat.

[Table 3 about here.]

Table 3 shows that 37.50%, 66.66% and 60.00% of generations choose *B* in baseline ISDG, IFG and IA, respectively, when three members in a generation consist of only proself subjects (or zero prosocials). There might be several explanations for this result. Nepalese urban culture can be considered less competitive than other countries, and urban Nepalese people choose sustainable option *B* much more often than do urban Bangladesh people, controlling for SVO (Shahrier et al., 2017). Shahrier et al. (2017) claim that in "competitive" countries, such as Bangladesh, urban people have experienced harsh competition for daily-life activities, such as businesses, traffic, study and so on, due to very high population density and improper management of public infrastructure. They also argue that such urban Bangladesh people may neither consider subsequent generations nor choose sustainable option *B* in ISDG. On the contrary, the urban areas, i.e., Kathmandu, in Nepal do not impose competitive environment on people, and family and neighbors remain fundamental and close units of daily-life activities, such as businesses, transactions and other practices. A succession to the subsequent generations within families and neighbors, i.e., in-group succession as well as reciprocity culture, still play the most important roles in sustaining businesses and activities for urban Nepalese life.[10] When there are one prosocial and two proself members in a generation, 50.00%, 72.00% and 88.88% of the generation choose *B* in baseline ISDG, IFG and IA, respectively. These findings imply that a generation usually chooses *A* in baseline

ISDG when a majority of the members are proself. However, in IFG and IA, a generation is likely to choose *B*, even in the same situation, suggesting that IFG and IA may be effective at inducing generations to choose *B*. When a generation contains two or three prosocial members, most generations choose *B*, irrespective of IFG and IA treatments.

Regression analysis

To statistically characterize the effects of treatments, we run several models of Probit regression by taking generation choice *B* as a dependent dummy variable that takes unity when the generation chooses it, otherwise zero, along with some independent variables. Recall that the information of earlier generation decisions is passed over to subsequent generations in a sequence. Therefore, there may be serial correlations across generations per sequence. To consider the concern, we estimate the models by clustering the standard errors at sequence level (Angrist and Pischke, 2008). The independent variables are the treatment dummies (IFG and IA), a number of prosocial members in a generation (i.e., characterized by SVO), the percentage of choosing *B* in history, gender (a number of males in a generation), average age and average education. Since the decisions are taken at generational level, we take an average or a summation of independent variables by generations for the analyses (see the definitions of independent variables in table 4's notes). We focus on reporting the marginal effects of the treatment dummies and other independent variables from models 1 to 4 (see table 4). The marginal effects of the treatment dummies can be considered causal due to their random assignments (Angrist and Pischke, 2008). In model 1, we present the marginal effects of the treatment dummies. In model 3, we add a number of prosocial individuals in a generation. Finally, in models 4, we further add other sociodemographic variables for a robustness check.[11]

[Table 4 about here.]

Table 4 presents the marginal effects of independent variables on generation choice *B* in Probit regressions. Models 1,2, 3 and 4 consistently show that the IA dummy is economically and statistically significant, affecting the likelihood for generations to choose *B*. However, IFG dummy in all models are identified as insignificant.[12] Model 4 in table 4 shows that if the number of prosocial members per generation increases by one, a generation is likely to choose *B* by 8.2% points holding all other factors fixed. Model 4 in table 4 reveals a significant IA treatment effect on the probability for generations to choose *B*, suggesting that generations in IA are likely to choose *B* by 23.4% points as compared with those in baseline ISDG holding all other factors fixed. Overall, the results indicate that the IA dummy is a key determinant for maintaining intergenerational sustainability. In particular, IA is identified to be effective for inducing subjects to choose *B* much more frequently than any IFG treatment.

Some readers may wonder that subjects are primed to think about the subsequent generations and there is an observer effect or an experimenter demand effect especially in IFG and IA. The fundamental experimental design is the same in baseline ISDG, IFG and IA in that each generation is neither observed nor required to reveal individual identities to other generations for the deliberation and decision. In other words, nobody is an observer for anybody in every treatment, and thus, there should not be an observer effect in our experiments. Next, IA asks each generation to write reasons and advice using a neutral terminology without implying which decision is good and bad, while IFG directly asks one member in a generation to be a representative of future generations, which is known by other members in the same generation. In that sense, IFG is more explicit about an experimenter's demand and should be more likely to suffer from the effect than IA. Put differently, if IA suffers from an experimenter-demand effect, so does IFG. However, IFG (IA) is identified to be ineffective (effective), implying that an experimenter-demand effect is not a concern.

[Table 5 about here.]

Interview analysis

To identify the mechanism behind the average treatment effects described in the previous section, we utilize the data from the individual interviews conducted after generation decisions are made. Following some past literature, this interview procedure is structured as a within-subject design to investigate the patterns of the shift in individual opinions to have supported options *A*, *B* or to have been ambivalent (no ideas) coded as *N* as his or her “individual initial opinion” and “individual final opinion” before and after the deliberation, respectively (Opdenakker, 2006, Cardenas and Carpenter, 2008, Charness et al., 2012, Falk et al., 2018). As mentioned earlier, the interviews enable us to trace the changes in each subject’s individual initial opinion and individual final opinion to have supported *A*, *B* and/or to be *N* (being ambivalent or no ideas about the opinion to support) before and after deliberation, respectively. When there are no changes between the individual initial opinion and the individual final opinion, such situations are coded as *AA*, *BB or NN*, where the first (second) letter represents the 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 the individual opinion over the course of the deliberation. For instance, *AB* describes a situation where the subject initially supported *A* before deliberation, but changed his or her final opinion to support *B* after deliberation.

Table 5 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. The results suggest that the individual opinions *BB* (*AA*) are more (less) dominant in IA than with other treatments. Furthermore, there is a higher (lower) proportion of subjects with *AB (BA)* in IA than with other treatments. The deliberation alone does not favorably affect individual opinions to change for supporting *B* in baseline ISDG and IFG, as compared with IA. These results confirm that a majority of subjects in IA consistently have individual initial and final opinions of *BB*. In contrast, approximately half of the subjects in baseline

ISDG and IFG exhibit a wide variation in their opinions other than *BB*. Therefore, IA can be interpreted to be a social device that induces self-consistency between individual initial and final opinions for sustainability in ISDG, as compared to baseline ISDG and IFG.

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).[13] 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 *B* at individual level. The analysis suggests that IA appears to trigger members in a generation to think about their subsequent generations before and after deliberation by providing reasons and advice, inducing themselves to consistently support *B* as an individual opinion. It is in line with past literature, which claims that asking people the reasoning behind their action makes them logically consistent (Elster and Rendall, 2008).

[Table 6 about here.]

Recall that each generation writes their reasons and advice to the subsequent generations in IA, and then, they are asked to choose one concept from the list of seven concepts that they consider the closest to their reasons and advice. Table 6 summarizes the occurrence frequencies of the reasons and advice provided by each generation to subsequent generations in IA based on the seven concepts suggested by Timilsina et al. (2021b) and Timilsina et al. (2021a) (See table 6 for the concepts of the reasons and advice). First, "maximization of the sum of all generations' benefits" has been identified as the most frequent concept that has appeared as reasons and advice in IA, which could be considered more relevant to justifying or advising *B*. Likewise, the 2nd, the 3rd and the 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 *B*” and “willingness to terminate the chain of bad will,” respectively, which could also be considered more relevant to advising *B* to subsequent generations. However, we observe only two concepts relevant to justifying and advising *A* in IA, which are “maximization of the current generation’s benefits by choosing *A*” and “non-negligible costs of considering future generations by choosing *A*”; the total occurrence frequency of these two concepts in IA is just six. IA induces the current generations to give positive reasons and advice for a sustainable option to the subsequent generations within the same sequence. In summary, IA is considered to function as a successful social device as if it is a sequential writing for one book by different generations to maintain intergenerational sustainability.

4. **Discussion & conclusion**

This research has addressed ISD and examined the potential solution of how to maintain intergenerational sustainability by conducting lab-in-the-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 the generations in IA choose a sustainable option much more often than generations in baseline ISDG and IFG, giving positive reasons and advice for sustainable options to subsequent generations.

Brain scientists, social psychologists and anthropologists have established that social learning through observations and communication enhances sympathy and/or decreases social distance for out-group members (Epley and Caruso, 2004, Laland, 2004, Gilbert and Wilson, 2007, Behrens et al., 2008, Smith, 2010, Heyes, 2012, Hein et al., 2016). Consistent with the literature, a one-way communication of reasons and advice to subsequent generations (out-group members) in IA is identified to function as a social device that decreases social distance over generations and transfer a common image, such as a process of sequentially writing each chapter for one book by different generations to maintain intergenerational sustainability (Sacco et al., 2006). In this sense, IA in ISD is considered to raise sympathy and solidarity beyond self-interest motives across generations through the one-way communication channel from the current generation to subsequent ones, leading generations' decisions toward common image for intergenerational sustainability (Bohnet and Frey, 1999, Haidt, 2004, Elster and Rendall, 2008, Chen et al., 2019).

Past studies find that advice and communication are effective at solving some classes of allocation and public goods problems of overlapping generations, such as in a parent-child relationship or in intragenerational resource sharing (See, e.g., Ostrom, 1990, Ostrom et al., 1994, Schotter and Sopher, 2003, Chaudhuri et al., 2006, Schotter and Sopher, 2006, 2007, Mantilla, 2015a, b). To the best of our knowledge, this is the first study to establish that a one-way communication, such as IA, is effective at solving non-overlapping generational problems of sustainability in a long-run perspective. The possible reasons and mechanisms for the IA result may be relevant to some economic literature. For example, generations have opted for fair allocation by underlying the accountability principle as theorized by Konow (2000). IA can also be considered one possible device that triggers the current generation to feel "warm-glow," to avoid "guilt aversion" or to have an "image motivation" of wanting to be seen as good humans from future generations by the act of doing good or sending signals to subsequent ones (Andreoni, 1993, Sacco et al., 2006, Bardsley and Sugden, 2006, Crumpler and Grossman, 2008, Ariely et al., 2009, Andreoni and Rao, 2011, Koukoumelis et al., 2012, Andreoni et al., 2017, Shahen et al., 2021). The IA result is also in line with past studies of "conditional cooperators" in public goods games (Fischbacher et al., 2001, Hauser et al., 2014). IA is interpreted as a one-way channel through which each generation is induced to be a cooperator by observing previous generations' choices, reasons and advice, and leaving their own reasons and advice for the future as a "cooperation" initiator that induces subsequent generations to be conditional cooperators.[14]

Underrepresentation of future generations is considered a fundamental problem for intergenerational sustainability where future generations cannot participate in the current decision-making process as they are yet to be born (Kamijo et al., 2017, Shahrier et al., 2017, Timilsina et al., 2021a, Shahen et al., 2021). Thus, to guarantee the "early representation," we also introduce IFG where one person per generation is assigned as an agent for future generations to negotiate and decide with the other members. However, we do not find the effectiveness of IFG in the fields with a subject pool of general people and these results are consistent with Shahrier et al. (2017). The underlying reasons behind these results might be that in IFG, only one person is asked to take the perspective of future generations and it is not concrete enough to let the person imagine and incorporate future preferences for sustainability. Therefore, we introduce a new treatment with an "intergenerational" linkage and "accountability," i.e., IA. The rationale of IA is to explicitly introduce an opportunity for the current generation to make a (one-way) communication of reasons and advice for future generations. Accountability can be applied to any real-life decisions in daily practices, e.g., buying biodegradable or plastic products, using environmentally-friendly or fossil-fuel transportation, adopting renewable energies and so on. These choices shall unidirectionally affect future generations, including those not born yet. The prosocial tasks have clear implications that allow to signal own personal traits even when the decisions are made in private (Ariely et al., 2009). In this regard, IA strengthens the intergenerational linkage by making a one-way communication with future generations in comparison to IFG. Thus, the proper working mechanism of IA may be connected to people's self-image concerns for sustainability, triggering people to have some moral commitment for future generations. That is, being accountable is known to signify fairness and/or justice concerns in people's judgments and decisions (Ariely et al., 2009, Khalil and Feltovich, 2018). Thus, our research is considered to experimentally demonstrate that accountability leads people to have such fairness and justice concerns, resolving the underrepresentation problem of future generations for sustainability.

A simple possible application of IA to the real world is introducing and institutionalizing a public responsibility of writing, recording and leaving reasons and advice. The current generation can provide reasons and advice through IA in deciding important policies to the subsequent generations over the problems whose nature is intergenerational at community, city and nation levels. Such intergenerational problems span cultural, environmental, financial and resource sustainability problems. We believe that institutionalizing IA in public policies for intergenerational problems is not too difficult (Ortmann and Gigerenzer, 1997, Rawls, 1999, Schedler, 1999, Chen et al., 2019). Thus far, few countries and organizations have introduced an IA institution, such as mini-publics and local assemblies. For instance, Wales practices public accountability for future generations' wellbeing. To fully resolve ISD in the real world, it shall be necessary to institutionalize IA in practice and further study how a cooperation initiator as well as a conditional cooperator think and behave along with reasons and advice for the decision in ISD. By doing so, we untangle the detailed mechanism and hands-on experiences of how and why IA can be effective in relation to socioeconomic and psychological factors. Such a combination of practices and research will be necessary to lead to a better procedure of IA mechanisms for people to behave toward intergenerational sustainability.

Finally, we note some limitations and future avenues of research. The results of this research are established mainly from observed behavioral data. The qualitative data from the transcribed interviews and details of deliberative processes by asking subjects about the corresponding reasons for their opinions, such as how they change their minds and whether there is an influence from other members during deliberation are not fully examined. As one possible future research, we should examine whether or not generation members look for unanimity and/or to identify an existence of a leader per generation following qualitative deliberative analysis (See, e.g., Krippendorff, 2003, Vaismoradi et al., 2013, Brinkmann, 2014, Corbin and Strauss, 2014, Cason and Mui, 2015a, for qualitative deliberative analysis). Next, the current study neither compares individuals and groups (generations) regarding how they are similar and different in making decisions under ISD nor fully untangle the learning effect of IA with the number of messages an agent receives from past generations. By doing such future research for individuals versus groups or the learning effect, we will be able to further identify the precise mechanism of IA effectiveness at individual and group levels. These caveats notwithstanding, we believe that this study is an important first step in resolving ISD problems, hoping that further studies will suggest something new to enhance intergenerational sustainability.

Institutional review

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of Kochi University of Technology (protocol code: 38-C2 and date of approval: 01.04.2016).

Informed consent

Informed consents were obtained in written forms from all subjects for participating in the experiment.

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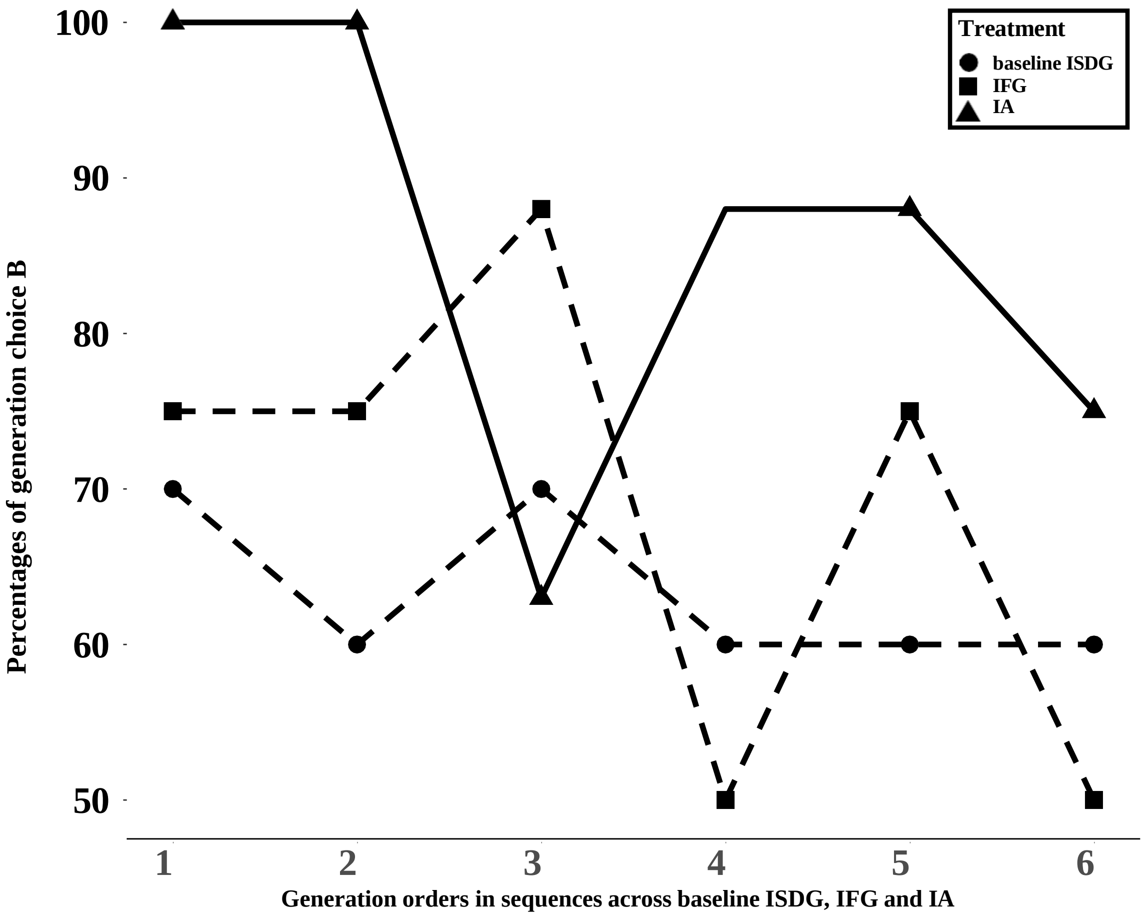
Figure 1: Trends for percentages of generation choice B over the orders in sequences across baseline ISDG, IFG and IA treatments



Tables:1-6

Table 1: Summary statistics of socioeconomic characteristics: 154 generations

	Baseline ISDG 59 generations	IFG 47 generations	IA 48 generations	Overall 154 generations
Age[1]				
Mean (Median)[2]	33.75 (34.67)	28.66 (28.00)	28.66 (27.00)	30.58 (30.00)
SD3	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[4]				
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
Income (in NPR 1000)[5]				
Mean (Median)	50.00 (40.00)	59.00 (40.00)	55.00 (41.00)	54.00 (40.00)
SD	47.00	73.00	53.00	58.00
Min	10.00	10.00	10.00	10.00
Max	332.00	480.00	318.00	480.00
Number of male members[6]				
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[7]				
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 The median age in Nepal is 25 years (Central Bureau of Statistics, 2011b).
2 Median in parentheses.
3 SD stands for standard deviation.
4 Literacy rates in urban areas of Nepal stand at 82.3%, with a secondary level of schooling of 12 years (Central Bureau of Statistics, 2011b).
5 The average monthly household income in urban areas of Nepal is 40 (000) Nepalese rupees (NPR), rounded to the nearest thousand (Central Bureau of Statistics, 2011b).
6 The sex ratio is low in Nepal mainly due to the huge outflow of youths from rural Nepal to the Middle East, East Asian countries and urban areas. Therefore, more males are found than females in urban areas (Central Bureau of Statistics, 2011b).
7 Social value orientations (SVOs) categorize social preferences of subjects into two types, prosocial and proself. The SVO game with the "slider method" elicits the decisions to six primary items from each subject and identifies the subject as either prosocial or proself (See, e.g., Murphy et al., 2011, for the details).

Table 2: Frequencies and percentages of generation choices between options *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 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*			
	Baseline ISDG	IFG	IA	Overall
0	37.50% $\left(\frac{3}{8}\right)$	66.66% $\left(\frac{2}{3}\right)$	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% $\left(\frac{16}{18}\right)$	69.84% $\left(\frac{44}{63}\right)$
2	79.31% $\left(\frac{23}{29}\right)$	61.54% $\left(\frac{8}{13}\right)$	88.88% $\left(\frac{16}{18}\right)$	78.33% $\left(\frac{47}{60}\right)$
3	100.00% $\left(\frac{2}{2}\right)$	83.33% $\left(\frac{5}{6}\right)$	85.71% $\left(\frac{6}{7}\right)$	86.66% $\left(\frac{13}{15}\right)$
Total	64.4% $\left(\frac{38}{59}\right)$	70.22% $\left(\frac{33}{47}\right)$	85.42% $\left(\frac{41}{48}\right)$	72.72% $\left(\frac{112}{154}\right)$

Table 4: Marginal effects of the independent variables in probit regressions for generation choice *B*

	Marginal effects			
Generation choice *B*[1]	Model 1	Model 2	Model 3	Model 4
IFG dummy[2]	0.066	0.061	0.060	0.084
	(0.093)	(0.096)	(0.098)	(0.100)
IA dummy[3]	0.240***	0.223**	0.222**	0.234**
	(0.087)	(0.090)	(0.104)	(0.109)
# of prosocial members[4]		0.087*	0.087*	0.082*
		(0.048)	(0.047)	(0.049)
The percentage of *B* in history[5]			0.003	0.018
			(0.092)	(0.089)
Average age[6]				−0.001
				(0.004)
Average education[7]				0.015
				(0.010)
Gender[8]				0.048
				(0.050)
Observations	154	154	154	154

The Wald $\chi 2$ statistics are 7.11, 8.94, 9.35 and 18.94 in models 1, 2, 3 and 4 respectively.
Standard errors are clustered by sequence level and reported in parentheses.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.
[1]A dummy variable that takes 1 if the generation chooses *B*, otherwise 0.
[2]A dummy variable that takes 1 when the IFG treatment is given to one sequence consisting of 6 generations, otherwise 0.
[3]A dummy variable that takes 1 when the IA treatment is given to one sequence consisting of 6 generations, otherwise 0.
[4]The number of prosocial members in each generation.
[5]A variable that represents the percentage of previous generations with choice *B* in a sequence.
[6]A variable that represents the average age of three subjects in a generation.
[7]A variable that represents the average year of schooling over three subjects in a generation.
[8]A variable that represents the number of males in a generation.

Table 5: Frequencies and percentages of a change in individual opinions for supporting option "*A*," "*B*," or "*N*" ambivalent/no ideas before and after the deliberation (percentage in parenthesis)

Individual opinions	Treatments		
	Baseline ISDG	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%)

The unit of observations is a count of subjects who stated their individual opinions in the interviews before and after deliberation corresponding to the one among *AA, AB, AN, BB, BA, BN, NN, NA and NB.*

Table 6: List of reasons and advice provided to each generation after the decision between options *A* and *B* in IA

Category	No.	Reasons	Examples	Frequencies
Reasons for choosing *B* (Sustainable option)	1	Maximization of the sum of all generations' benefits	It is social justice and a larger sum of benefits if every group chooses B.	17
	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	8
	3	Expectation that goodwill will succeed	We are social beings and we should think about the next group and we choose B because we expect that future groups will do the same.	7
	4	Willingness to succeed goodwill	We should not become selfish and short-sighted, if we do future groups might copy us, therefore, we choose B.	6
	5	Willingness to terminate the chain of bad will	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 the bad chain of choosing A.	3
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.	4
	7	Non-negligible cost of considering future generations	We have chosen A because if we consider the next groups, we will lose benefits and they will lose incentive to work hard and to find an alternative solution for their survival	2

One generation that chose option *A* did not put any tick mark in the list we provided. Therefore, one observation of the frequencies in the reasons for choosing *A* is missing.

Endnotes

1. The unincentivized communication, such as chat messages, cheap talks and signaling, are studied intensively through laboratory experiments (Cason et al., 2012, Cason and Mui, 2015b, Cason et al., 2017, Crawford and Harris, 2018). Following this line of research, we utilize unincentivized communication of reasons and advice as well as individual interviews to elicit subjects' motives and belief behind the decision in a similar fashion with Blanco et al. (2010) and Armantier and Treich (2013). These features of our experiments shall be described in the details later. Additionally, in this research, we consistently mention the term "IA" to refer to "a (one-way) communication of reasons and advice," and the terms are interchangeably used throughout the manuscript.
2. See Saijo (2019) for an extensive review of IFG treatment.
3. Accountability principle states that the scope of fair allocations varies in proportion to the relevant variables that people can influence (e.g., action-work effort), and the variables that cannot be influenced tend to be out of the scope (e.g., physical handicap by birth) (Konow, 2000). "Reasons" and "advice" are two important elements of accountability as part of public and social communication for self-governance (Mulgan, 2000, Wagner, 2005). In this research, ISD represents sustainability problems, such as global climate change, with a long-run perspective of non- overlapping generations. No previous literature has systematically examined how "reasons" and "advice" are effective at resolving sustainability problems under non-overlapping generations, while some studies mention that offering "reasons" and "advice" to the public and responding to them may induce citizens to manifest their commitment to justice (Ortmann and Gigerenzer, 1997, Rawls, 1999, Schedler, 1999, Hadfield and Macedo, 2012, Kogelmann and Stich, 2016, Caney, 2018). Therefore, we hypothesize that reasons and advice in ISD function as part of institutions to enhance intergenerational sustainability.
4. The chip each subject picks indicates the following type of information: "2017-11-*G*3-2," where "2017-11" is the date of an experiment, "*G*3" is the 3rd generation within *G* sequence, and "2" indicates individual ID within the 3rd generation. However, these explanations are not given to the subjects. The information is only used by the research assistants to manage the generations in a sequence during experiments.
5. Nepal's GDP per capita is approximately 866 USD according to the economic survey report (Government of Nepal, 2018).
6. The decisions for this SVO game are made with complete privacy as subjects are instructed not to communicate with each other. Each decision maker (subject) and the other person in a pair will remain mutually anonymous, while and after the decisions are made. Such anonymity removes the potential influence of fear of reprisal, reciprocity and reputation concern.
7. Figure A3 shows the six items on the slider measure that uses numbers to represent the 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 an allocation by marking a line at the point that defines his or 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 A3 in Appendix). 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 $\text{SVO} = \arctan\frac{(\overline{A}o)-50}{(\overline{A}s)-50}$. 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: SVO < −12.04°.
8. To compute the payoffs, we collect the answer sheets from all subjects in a session and randomly make a pair. The payoff for each subject in SVO game is the summation of points from 6 selections by him- or herself as "You" and 6 selections by the partner as "Other" in the pair. We explain the payoff calculation with the exchange rate for the real money to subjects before starting SVO game.
9. We cannot complete these sequences with 6 generations due to time and budget limitations. This is not problematic, because subjects in such sequences do not know that there does not exist the 6th generation, as we have explained in the earlier subsection of "Intergenerational sustainability dilemma game (ISDG)."
10. We argue that such cultures may even shape urban people's preferences (other than their social preferences) and behaviors, inducing the subjects to choose sustainable option *B* in ISDG. This argument is in line with literature that claim "daily-life practices and culture shape people's preferences (Tomasello et al., 2005, Leibbrandt et al., 2013, Shahrier et al., 2016, Timilsina et al., 2017, Hernuryadin et al., 2020)."
11. The additional models are also estimated by controlling for sociodemographic variables at generational level, such as gender, age and years of schooling, the percentages of generation choice *B* in sequence history (or the value of *X* each generation faced), previous generations decision, the number of subjects in a generation with an initial opinion *A* and the interaction with IFG and IA treatment dummies (See different models in Appendix). We confirm that the results qualitatively remain the same as those in base models 1, 2, 3 and 4, irrespective of the various model specifications we have tried for robustness check.

12. IFG dummy is not significant, and it implies that IFG effectiveness is not established in the fields with a subject pool of general people in Nepal. This result is consistent with the findings of Shahrier et al. (2017). Refer to Tsuji and Shen (2021) for an extensive review of methodological decision-making processes in intergenerational social dilemma mediation regarding IFG and other treatment.
13. The coefficient of "unalikeability" measures how much the observations of a categorical variable differ from one another within the same treatment group. It is a scale from 0 to 1, and higher the value means, the less alike the observations are in the group. For example, the "unalikeability," u, for the observations of the three categories, such as *A*, *B* and N, is computed by the equation of $u = 1 - p_A^2 - p_B^2 - p_N^2$ where P_A, P_B and P_N are the proportions of *A*, *B*, and *N* the observations in the categories of *A*, *B* and *N*, respectively.
14. See table A5 for extensive examples of messages given by the current generation to the subsequent ones in I A treatment.