

A Simple Method of Inducing Cooperation in a Finitely Repeated Prisoner's Dilemma Game

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1. Introduction

Kumru and Vesterlund (2012) (hereafter, KV (2012)) found that social status mattered for fundraising. Soliciting the high-status donors first was the key to earn more money because it induced followers to donate more. Many fundraisers in the practical world such as New York Public Library adopted this strategy. The role of status was theoretically examined in Frank (1985), Congleton (1989), Hopkins and Kornienko (2004, 2009), and others. Weiss and Fershtman (1998) offered a survey of social status and economic performance. Empirical analysis of the role of status was found in Ball et al. (2001) in a competitive market place with the high-status seller (resp. the buyer) and the low-status (resp. the seller) and the authors found that the high-status side always captured a greater share of the surplus. They gave high-status to those whose scores of five obscure economic questions were the highest. KV (2012) conducted experiments to examine the effect of status on charitable giving by using the random procedure to induce status. They offered a trivia quiz with 10 questions, all of which had numerical answers and half of group members whose answers were the largest numerical numbers were acquired high-status (called “star”) and in half the sessions and those whose answers were the smallest numerical numbers were acquired high-status (called “star”) and in the other half sessions. They compared two sequential moves games: Star-First where the star-player (= high-status) was the

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leader (= the first mover) and the no-star player was the follower (= the second mover) vs. Star-Second where the no-star-player was the leader (= the first mover) and the star player was the follower (= the second mover). They concluded that players contributed more in Star-First game than in Star-Second game.

The effects of leaders were examined theoretically and experimentally in the literature. Sugden (1984), Arce (2001), and Huck and Rey-Biel (2006) theoretically showed that leaders (= the first movers) could influence on followers' (= the second movers') behaviors. Experimental works showed that the leader influenced followers' contributions regardless of the procedures to choose the leader (= the first mover). Moxnes and van der Heijden (2003) and Gächter and Renner (2018) used random procedure to choose the leader (= the first mover). In Gächter and Renner (2003), the leader was designated based on his past contribution behavior. Güth et al. (2007) allowed groups to vote on whether they wanted a leader and the participants were further allowed to vote for their preferred leader in one of the treatments. The authors found that when leaders had no power to exclude certain members, the participants refused to be the leader. In addition to how leaders were selected, participants had information about the past behavior of their team members, which was not the case either in KV (2012), or in our design. In KV (2012) and in the current paper, each follower (= the second mover) observed the leader's (= the first mover's) action and each leader (= the first mover) observed the follower's (= the second mover's) action in each period, but no one knew the past actions of the currently matched player. To examine decision-making under risk, Kocher et al. (2009) allowed the leaders to be elected by their team members and found that collectively chosen leaders were more likely than randomly-chosen leaders to follow the majority decisions, even when majority decisions differed from their self-interests. In Levy et al. (2011), participants elected a leader based on their suggested strategies. They could not vote for themselves, which meant that leadership depended on how enticing a player's proposal appeared to others. The authors found that a suggestion was followed more readily when it came from a human leader than when the leader was generated by a computer. They did not aim, however, at investigating the motives of voluntary leaders. Two recent experiments studied self-selected leaders. Rivas and Sutter (2011) allowed the group members to voluntarily move first and found that voluntary leaders shifted contributions upwards.

In contrast to our experiment, the groups may contain as many leaders as volunteers. The authors also did not focus on the determinants for becoming a leader. Nosanzo and Sefton (2011) extended Varian's (1994) endogenous timing game to allow subjects to move first with a low contribution, effectively committing to free-ride. At the end of each period, the contributions and associated payoffs of all team members are made public. Given the endogenous selection procedures, it is possible that no participant is willing to lead. In that case, the three group members move directly to the second stage and contribute simultaneously to the public good. The game is then similar to a standard voluntary contribution mechanism game—the only difference being the fact that simultaneity. Rivas and Sutter (2011) also considered self-selected leadership. Arbak and Villeval (2013) stated: In Kumru and Versterlund (2010)¹⁾, the assignment was based on a participant's performance in a preliminary trivia quiz. We doubted that the procedure to award social status in KV (2012) based on the numerical answers on the last question of their trivia quiz was interpreted as random by subjects. Therefore, we modified their random status awarding procedure and we checked whether our subjects understood our status awarding procedure was random and they understood that it was equally probability to be awarded status and not to be awarded status. As in KV (2012), the only thing that distinguished a leader (= the first mover) from a follower (= the second mover) in our game was the timing of the contributions in our game: leaders (= the first movers) moved first and, became vulnerable to any free-riding behavior by their followers (= the second movers). Préget, Nguyen Van, and Willinger (2016) carried out a laboratory experiment of two stage game with four members per group. In stage 1, subjects answered unconditional and conditional contribution to elicit each subjects' behavioral types and they classified them to free-riders, conditional cooperators, triangle-contributors, and others, which was the method taken by Fishbacher et al (2001). In stage 2, subjects played repeated contribution game with a clock and an endogenous leader. If the first contribution was made within 60 seconds, s/he became a leader, the leader's contribution was observed by other 3 members, and the 3 members contributed simultaneously. They found that conditional-cooperators are more likely to volunteer to be a leader, leadership appeared 95.5%

1) It is an unpublished version of Kumru and Vesterlund (2012).

of the time, having a leader could not prevent decay, and a leader contributed more than followers even it was costly regardless of the leader's behavioral type identified in stage 1. Arbak and Villeval (2013) introduced endogenous leader selection procedures and examined the role of status and compared three procedures to choose the leader. They conducted two stage public good experiment with three players. The leader was selected in stage 1 and stage 2 was public game where the leader moved first and two non-leaders moved simultaneously after observing their leader's contribution. They considered three procedures to select the leader. The first one was benchmark treatment and every member was asked whether s/he wanted to be the leader. If there were more than one volunteers, one candidate was chosen randomly. The second procedure was attribute treatment and two attributes were considered. The first one was based on each subject's charitable behavior in advance of the actual two stage public good game and the second one was each subject's gender. They concluded that expectation over followers' donations, gender, and charitable behavior were the main determinants of being a leader and expectations over follower' donations and candidacy frequencies were the main determinants of leaders' contributions. The third way to select the leader was imposed treatment and the leader was chosen randomly. They concluded that followers were more responsive to randomly chosen leaders. Ebeling et al. (2017) conducted a field experiment to examine the effect of status. They collected data of about 15,000 passengers in total. They counted the amount of donation by passengers to the newspaper seller in the streetcar in Cologne. They compared three conditions: high status (H) where the first donor looks like a high status 31 years old male, low status (L) where the first donor looks like a low status 31 years old male, and control (C) without any intervention. The average amount of donation was 0.90€ in H, 0.76€ in L, and 0.68€ in C respectively and the concluded that soliciting high status generated higher donations. They concluded that soliciting high status donor was effective as KV (2012) did.

As Arbak and Villeval (2013) stated, we doubted that the status awarding procedure in KV (2012) was interpreted as a random procedure by subjects. We thought that participants might easily misunderstand that they actually awarded high-status (= star) to those whose scores of the trivia quiz were the highest rather than to those whose numerical answers to the last question were the highest, or

the lowest. Therefore, we tested three different award giving procedures: a random procedure where draw determined high-status players, trivia quiz score where high-status were awarded to those whose trivia quiz scores were in the top half, and calculation quiz score where high-status were awarded to those whose calculation quiz scores were in the top half. Except Status awarding procedures, we mimicked KV (2012) as much as possible. Our experimental outcomes showed us that subjects thought our random status awarding procedure was fair and it caused self-expansion which made them to take the cooperative action more than 90% of the rounds. Another strand of literature explained non negligible cooperation rate in sequential prisoner's dilemma game by introducing the other player's payoff into a player's preference explicitly. Some of them also used the term of fairness, but it was different from ours. Our fairness implied that a subject believed s/he was equally likely to be a high-status player, or a low-status player. Bolton (1991), Bolton and Ockenfels (in press) and Fehr and Schmidt (1999) changed a player's preference so that the other player's payoff was explicitly included in a player's preference.

Rabin (1993), Dufwenberg and Kirchsteiger (1998) and Falk and Fischbacher (2006) incorporated reciprocity in their models. Clark and Sefton (2001) ran experiments of 2-person sequential move prisoner's dilemma game in the USA and in the UK and showed that the most important variable influencing cooperation was the first mover's choice of cooperation and concluded that cooperation happened due to reciprocity rather than pure altruism. Their experiment had 10 rounds. The cooperation rate for the first movers was 0.425 in the first round and it was 0.283 in the last round. The second movers' cooperation rate was 0.101 in the first round and 0.035 in the last round when the first movers did not take the cooperative action. In contrast, it was 0.412 in the first round and 0.235 in the last round when the first movers took the cooperative action.

Section 2 will offer a brief explanation of the theory. Section 3 explains our experiments based on the theory explained in section 2. The results and interpretation of our experiment is provided in section 4. Section 5 concludes the paper.

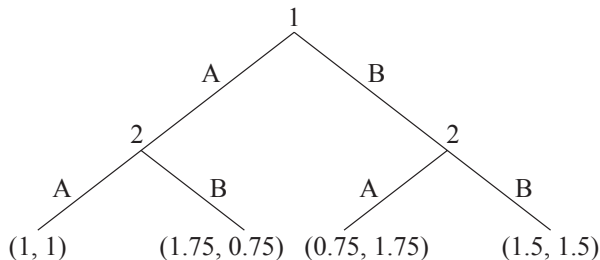
There are many practical problems applicable to prisoner's dilemma such as global CO₂ emission problem, arms races, plastic pollution, overfishing, OPEC's controlling oil price, charity, public goods provision, and so on and cooperative

behavior of players are important. Bergstrom et al. (1986) showed that the fundraiser preferred not to announce past contributions because announcement induced free-ride on subsequent donors, our random status awarding procedure achieved 96.2% of cooperation rate even the follower (= the second mover) observed the leader's (= the first mover's) action before the follower decided his/her own action when a status awarded player was the leader (= the first mover) and 93.8% when status awarded player was the follower (= the second mover). Fairness in our random status awarding procedure yielded self-expansion and subjects took cooperative action. We hope we can contribute to solve practical prisoner's dilemma problems by our procedure.

2. Theory

We use the stage game expressed by Fig. 1 as KV (2012) did. It is a sequential move 2x2 prisoner's dilemma game. We use subgame perfect Nash equilibrium (hereafter, SPNE) as our equilibrium concept. To obtain SPNE, we apply backward induction. There are two subgames; one is starting from player 2's move after player 1 chooses A and the other is starting from player 2's move after player 1 chooses B. In both subgames, player 2's action B is strictly dominated by player 2's pure action A. Therefore, player 2 takes A in both subgames. Given that, we take one step backward and consider player 1's move. Again, player 1's pure action B is strongly dominated by player 1's pure action A. Therefore, (A, A) is the unique SPNE in this game; however, both players' payoffs are higher in (B, B) than in (A, A). So, (B, B) Pareto improves (A, A). Player 1 and player 2 know all of this game structure, but end up choosing A instead of B to maximize his/her own payoff. When players repeat this stage game finitely many times,

Figure 1. Stage game



we can use the backward induction and conclude that taking A in every move is the unique SPNE. Therefore, action A is the only action observed when each player takes the action which maximizes his/her own pay off.

3. Experimental design

KV (2012) is the paper our experimental design is based on. They considered finitely repeated prisoner's dilemma game with sequential move in the context of charity. There were two stages in their game. There were 4 groups and 12 subjects in each group. So, 48 subjects in total. In the first stage, high-status was assigned to half of the subjects in each group. They were called star group (= high-status) and those who were not assigned to star-group were called no-star group (= low-status). More precisely, they offered trivia quiz with 10 questions all of which had numerical answers to each subject and star status was assigned to those who provided largest numerical answers to the last question in half of the sessions and to those who provided smallest numerical answers to the last question in the other half of the sessions. Their last question was: how many millions of dollars did the University of Pittsburgh receive in research money from National Institute of Health between 1995 and 2002? KV (2012) claimed this procedure was random, but it was possible that some subjects did not think so. It is possible that some subjects misunderstood that status was awarded to those whose trivia quiz scores were in the top half. We changed their procedure to a more random one. To examine whether KV's (2012) status awarding procedure was interpreted to be random by subjects, or not, we used three status awarding procedures. The first one was random selection. In our experiment, each of 12 subjects took any of 12 available seats in a room by first-come, first-served basis. The available seats were marked with post-its whose last two digits numbers were 01, 02, . . . , and 12. The seats were available 50 minutes in advance of the experiment started and there was an assistant. The assistant showed 12 cards with the numbers matched to the last two digits numbers assigned to each available seat in the room. Then, the assistant put all 12 cards in a dark green thick opaque plastic bag and shuffled it for 30 times. The bag was thick enough so that no subjects could see any card inside the bag. After 30 times of shuffling, the assistant picked one card without looking inside. If an even number card was picked, those whose seats had even numbers were awarded high-

status. If an odd number card was picked, those whose seats had odd numbers were awarded high-status. When the experiment was over, each subject was asked how s/he felt about the status awarding procedure. Then, all except one subjects told the assistant that they felt that the status awarding procedure was fair and they were equally likely to be the high-status players, or the low-status players. The one subject said that he should be the one to pick the card instead of the assistant. He told the assistant that he understood he would be a high-status player with probability 0.5, but he wanted to determine states of everyone in his group. Therefore, every subject understood high-status was awarded randomly. In the second procedure, high-status was awarded to half of the group members whose scores of a trivia quiz were the highest. Our trivia quiz had 19 questions while KV (2012) had 10. This was because our preliminary trivia quiz experiment showed that there were too many ties in their scores when there were only 10 questions. Ties didn't matter in KV (2012), but it matters in our case. The actual trivia quiz question is available in Appendix. In the third procedure, high-status was awarded to half of the group members whose scores of a calculation quiz were the highest. We used the same calculus quiz introduced by Niederle and Vesterlund (2007) where subjects calculated summation of five 2-digit numbers for 5 minutes and 2-digit numbers were randomly chosen by a computer. This calculation quiz was very familiar to Japanese students because many of us solved grade level calculation quiz in every morning for 5 minutes in elementary schools. After the status awarding procedure was over, we offered the status awarding ceremony. Although our ceremony style was the same as in KV (2012), we gave slightly different prizes. We gave each high-status player a mechanical pencil with ribbon and a gold star mark. We asked star players to put their prize mechanical pencils and star mark on the desk so that no-star players always could observe them during stage 2 game. Due to this star mark, we sometimes call a high-status subject as a star player and a low-status subject as a no-star player respectively following KV (2012). After the status award ceremony, stage 2 game began. In stage 2, subjects played the sequential move 2×2 prisoner's dilemma game depicted in Figure 1 for 12 rounds. At the beginning of each round, a star player was randomly and anonymously matched to a no-star player and they played a stage game described by Figure 1. After each round t , $1 \leq t \leq 11$, and before round $(t+1)$, each leader (= the first mover) was told round

t action taken in period t by the follower (= the second mover) s/he had matched in period t . A player was not matched to the same player more than twice in a session. To eliminate the order effect, two groups which followed the same status awarding procedure played the stage 2 game in different orders. Group 1 (G1) and group 2 (G2) played random status awarding procedures, group 3 (G3) and group 4 (G4) played trivia quiz score status awarding procedures, and group 5 (G5) and group 6 (G6) played calculus score status awarding procedures. In stage 2, G1, G3, and G5 played Star-First in session 1, then played Star-Second in session 2. G2, G4, and G6 played stage 2 game in the reverse order. They played Star-Second in session 1 and played Star-Second in session 2. Furthermore, we denote G_{ij} ($i = 1, 2, 3, 4, 5, 6$ and $j = 1, 2$) as j -th ($j = 1, 2$) session of G_i ($i = 1, 2, 3, 4, 5, 6$).

Lastly but importantly, the payoffs in KV (2012) were measured in US dollar because they ran their experiment in Pittsburgh in the USA. Since we conducted our experiment in Tokyo, Japan, we had to use Japanese yen for payment. For simplicity, compatibility, and convenience, we used the exchange rate of 100 Japanese yen = \$1. The actual exchange rate between Japanese yen and US dollar was 98.7200 Japanese yen = \$1 by EXCHANGE-RATES.ORG (2013). Therefore, our payments were smaller than that in KV (2012), but the difference was 1.28%. Considering this and making payoff as simple as possible made us to use the exchange rate of 100 Japanese yen = \$1.

4. Results

This section is also closely related to the outcomes obtained in KV (2012). As KV (2012), we start with average group contribution per round for Star-First and Star-Second in our three different status awarding procedures. Recall the notations we introduced in section 3. Star-First was the stage 2 game where star players were the leaders (= the first movers) and no-star players were the followers (= the second movers). Star-Second was the game where no-star players were the leaders (= the first movers) and star players were the followers (= the second movers). In our Figures and tables below, we repeatedly use the notations we introduced in section 3. $G_{11}+G_{22}$ is the set of players who played Star-First in stage 2 after playing random status awarding procedure in stage 1. $G_{12}+G_{21}$ is the set of players who played Star-Second in stage 2 after playing random status

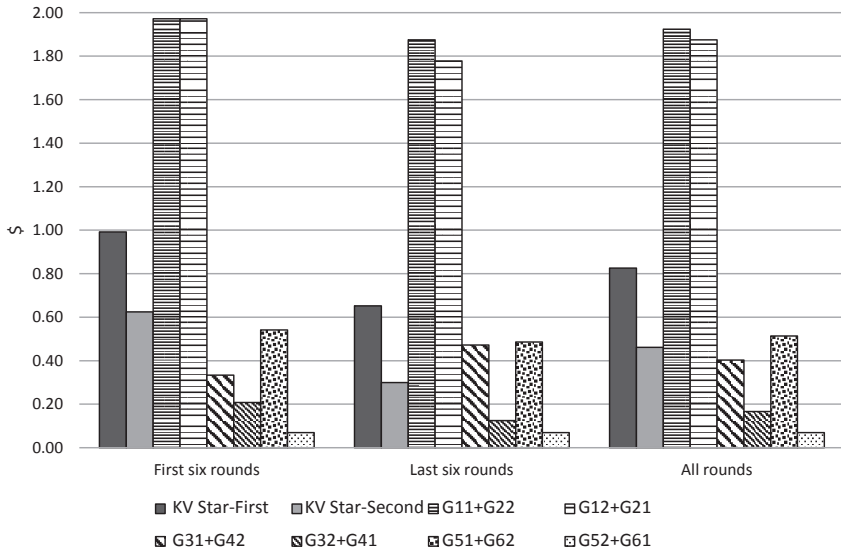
awarding procedure in stage 1. G31+G42 is the set of players who played Star-First in stage 2 after playing trivia quiz score status awarding procedure in stage 1. G32+G41 is the set of players who played Star-Second in stage 2 after playing trivia quiz score status awarding procedure in stage 1. G51+G62 is the set of players who played Star-First in stage 2 after playing calculus quiz score status awarding procedure in stage 1. G52+G61 is the set of players who played Star-First in stage 2 after playing calculus quiz score status awarding procedure in stage 1. Also, g1 is the leader (=the first mover) and g2 is the follower (=the second mover).

Table 1. The leaders, the followers, and group contribution per round

		g1			g2			G		
		First six rounds	Last six rounds	All rounds	First six rounds	Last six rounds	All rounds	First six rounds	Last six rounds	All rounds
KV (2012)	Star-First	0.6380	0.4580	0.5520	0.3540	0.1940	0.2740	0.9920	0.6520	0.8260
KV (2012)	Star-Second	0.4370	0.2310	0.3330	0.1870	0.0690	0.1280	0.6240	0.3000	0.4610
G11+G22	Star-First	0.9861	0.9722	0.9792	0.9861	0.9653	0.9757	1.9722	1.9375	1.9549
G12+G21	Star-Second	0.9931	0.9444	0.9688	0.9931	0.9375	0.9653	1.9861	1.8819	1.9340
G31+G42	Star-First	0.3681	0.4167	0.3924	0.3681	0.4097	0.3889	0.7361	0.8264	0.7813
G32+G41	Star-Second	0.2708	0.2292	0.2500	0.2708	0.2361	0.2535	0.5417	0.4653	0.5035
G51+G62	Star-First	0.3194	0.2917	0.3056	0.3125	0.2917	0.3021	0.6319	0.5833	0.6076
G52+G61	Star-Second	0.1667	0.1250	0.1458	0.2083	0.1319	0.1701	0.3750	0.2569	0.3160

Figure 2 shows average group contribution per round, which corresponds to Figure 1 in KV (2012). Following KV (2012), we denote $g1=1$ when the leader (=the first mover) took action B in a stage game and $g2=1$ when the follower (=the second mover) took action B. Recall that action B is the cooperative action in a stage game. Similarly, we denote $g1=0$ when the leader (=the first mover)

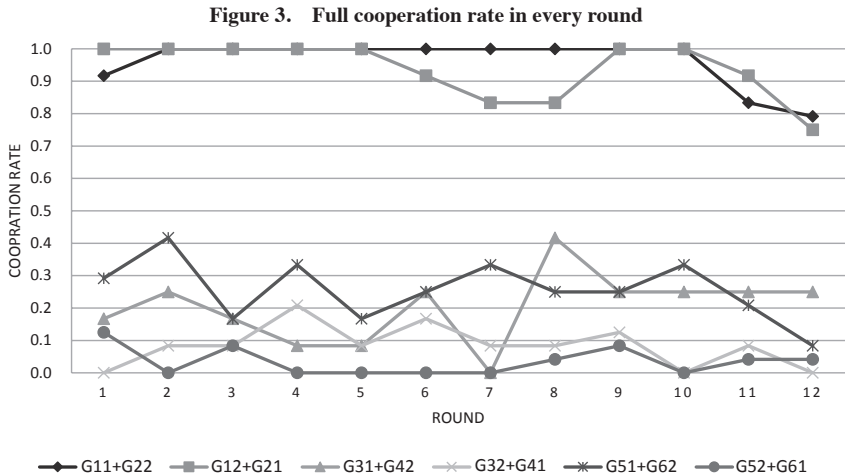
Figure 2. Average group contribution per round



took action A in a stage game and $g_2=0$ when the follower (=the second mover) took action A. So, average group contribution, G , is $0 \leq G \leq 2$ in any round. It is 0 when all the leaders and the followers took A in a relevant round and it is 2 when all the leaders and the followers took B in a relevant round.

We can also draw a graph of the frequency of full cooperation where both the leader (=the first mover) and the follower (=the second mover) took action B, that is $g_1=1$ and $g_2=1$.

KV (2012) claimed that subjects cared about the status and the average group contribution was 80 percent larger in Star-First than in Star-Second in their random status awarding procedure and the difference was statistically significant; however, Figure 2 tells us that there were no differences between Star-First (G11+G22) and Star-Second (G12+G21) in our random status awarding procedure. Table 1 tells us that average total contribution of our random status awarding methods achieved incredible amount of full cooperation, 96.2% in Star-First and 93.8% in Star-Second and solved prisoner's dilemma problem almost perfectly. As in KV (2012), we also observed that average total contributions in the first 6 rounds were higher than those in the last 6 rounds. Ex-post questionnair



for subjects showed that they clearly considered the last period as a special period in the sense that they understood the last period game was the same as one-shot game and A was the action to be taken in the last period to maximize his/her own payoff, but still took action B. Although majority thought that they were expected to take action B and they were obliged to do so, some who took action A told us that motivation to maximize their payoffs won over incentive to take the cooperative action B as the last round approached. The key to interpret this incredibly high overall cooperation rate is expansion-self. 96% of subjects thought our random status awarding procedure was fair and 100% of our subjects thought it was equally likely s/he ended up to be a star-player, or a no-star-player. This fairness induced a subject to consider the problem from “our” payoffs point of view rather than “my” payoff point of view. The previous work which used the concept of expansion-self is Nakagome, et al. (2017). They conducted an experiment to measure perception of affordance by comparison of a task with two subjects and with one subject. Their task was based on the one by Mishima (1994) and used a high jump stand and a bar. They used fNIRS (functional near-infrared spectroscopy) to measure brain activity of subjects during task and concluded that affordance was immediately raised between two players who faced the common task. Three sentences below are from Ayaz et al. (2019) who describes fNIRS: fNIRS a wearable and portable brain-monitoring technology

that tracks and monitors the cortical hemodynamic response using near-infrared light sources and detectors placed over the scalp. fNIRS measures the changes of cortical deoxygenated and oxygenated hemoglobin concentrations noninvasively and safely in ecologically valid settings. As such, fNIRS is an ideal tool for a diverse range of neuroergonomic applications that involve monitoring human brain activity in relation to behavioral performance in natural environments and everyday conditions. By using fNIRS and measured brain activities of subjects in two subjects and in one subject task with high jump stand and bar, they found that affordance was quickly emerged between two subjects during task. Nakagome et al. (2017) concluded that a subject followed “self-expansion” and judged the task from “our” (s/he and his/her teammate) point of view rather than “my” point of view. The concept of self-expansion was introduced by Aron and Aron (1996, 1997) and Aron et al. (1991, 1998, 2004, 2013). Aaron et al. (2013) stated that one way people seeked such expansion was through close relationships in which the other’s resources, perspectives, and identities were to some extent “included in the self.” Self-expansion lets us to enrich perception of affordance. Gibson (1979) introduced the concept of affordance and he stated that affordance implied the complementarity of the animal and the environment.

Since 96% of subjects who played the game with random status awarding procedure told us that they felt that the procedure was fair and 100% of subjects understood that it was equally likely they would be awarded high-status (= star player), or low-status (= no-star player) and also told us that they thought how

Table 2. Follower’s conditional contribution probabilities.

	$\Pr(g2=1 g1=1)$	$\Pr(g2=1 g1=1)$	$\Pr(g2=1 g1=1)$	$\Pr(g2=1 g1=0)$	$\Pr(g2=1 g1=0)$	$\Pr(g2=1 g1=0)$
	First six rounds	Last six rounds	All rounds	First six rounds	Last six rounds	All rounds
KV Star-First	0.52	0.37	0.45	0.06	0.06	0.06
KVStar-Second	0.34	—	0.30	0.09	0.02	0.05
G11+G22	142/142=1	135/140=6%	277/282=0.98	0/2=0	4/4=1	4/6=0.67
G12+G21	142/143=0.99	128/136=0.94	270/279=0.97	1/1=1	7/8=0.88	8/9=0.89
G31+G42	24/53=0.45	34/60=0.57	58/113=0.51	29/91=0.32	25/84=0.30	54/175=0.31
G32+G41	15/39=0.38	9/33=0.27	24/72=0.33	24/105=0.23	25/111=0.23	49/216=0.23
G51+G62	39/46=0.85	35/42=0.83	74/88=0.84	6/98=0.06	7/102=0.07	13/200=0.07
G52+G61	5/24=0.21	5/18=0.28	10/42=0.24	25/120=0.21	14/126=0.11	39/246=0.16

the followers (= the second movers) would like them to play when they were the leaders and they felt that they should take the cooperative action, B. The followers (= the second movers) interpreted their leaders' (= the first movers') taking B meant that they should also take B. It was matched to self-expansion, both the leaders (= the first movers) and the followers (= the second movers) put themselves in their matched players' shoes, and they acted from the point of maximizing "our" payoffs rather than maximizing one's own payoff.

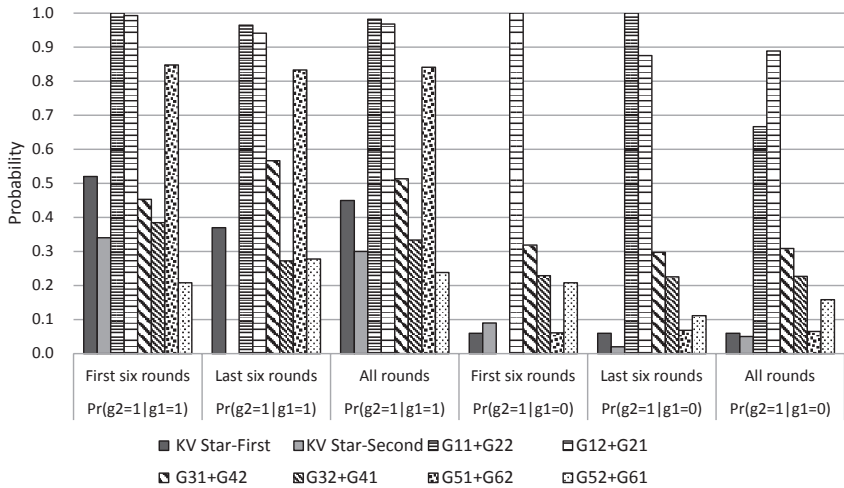
In Table 2, $\Pr(g_2=1|g_1=1)$ is the probability that the follower (g_2) took action B ($g_2=1$) conditional on the leader (g_1) took action B ($g_1=1$). Similarly, $\Pr(g_2=1|g_1=0)$ is the probability that the follower (g_2) took action B ($g_2=1$) conditional on the leader (g_1) took action A ($g_1=0$). Recall that Figure 1 tells us that action B is cooperative action in stage 2 game and both players' taking action B Pareto dominates both players' taking action A, but taking action A is the unique subgame perfect Nash equilibrium in the stage game. Furthermore, taking action A in every round is the unique subgame perfect Nash equilibrium in the stage 2 game because we have finite 12 rounds. In Table 2, "—" in KV Star-Second means that $g_1=1$ did not happen.

Based on Table 2, we obtain Figure 4 which corresponds to Figure 2 in KV (2012).

KV (2012) stated that the p-value of Mann-Whitney test for Star-First and Star-Second was 0.0786 in their case and it was statistically significant at 10% level, which meant that they rejected the null hypothesis that the follower (= the second mover) was less-likely to mimic the leader's (= the first mover's) action in Star-First than in Star-Second. On the other hand, the p-value is 0.27 in our random status awarding procedure, and it is not statistically significant while the p-values are 0 when high status was awarded by trivia quiz scores, or calculus quiz scores. This implies that the status awarding procedure in KV (2012) was not considered as random by subjects and their outcomes were between our

Table 3. Mann-Whitney tests for follower's conditional contribution probabilities for Star-First vs. Star-Second in three different status awarding procedures.

	Random	Trivia quiz score	Calculus quiz score
z	-1.102	-6.696	-7.52
p-value	0.270	0	0

Figure 4. Follower's conditional contribution probabilities.

Table 4. Mann-Whitney tests of leaders' contributions in Star-First and Star-Second for three status award procedures

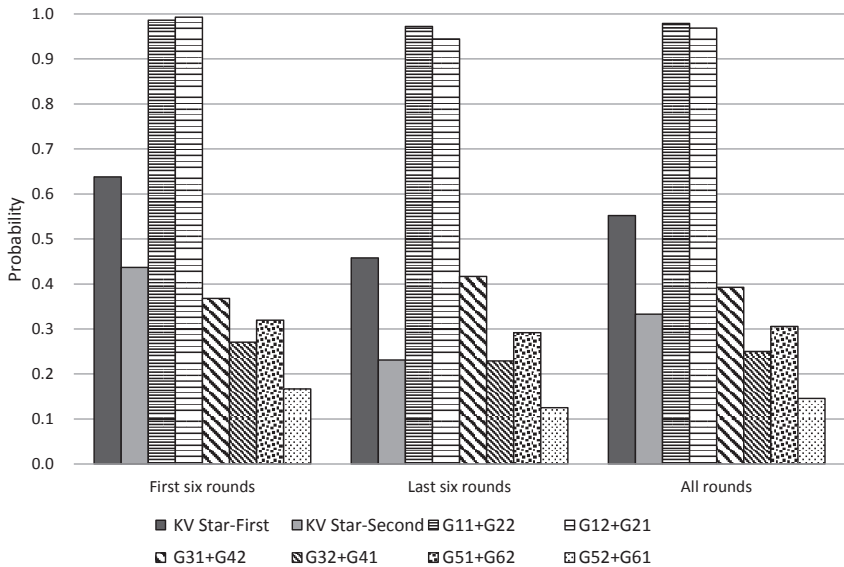
	Random	Trivia quiz score	Calculus quiz score
z	-0.784	-3.655	-4.581
p-value	0.433	0	0

random and our trivia quiz score status-awarding procedures.

Figure 5 shows the frequency of contributions by the leader and it corresponds to Figure 3 in KV (2012).

KV (2012) demonstrated that high-status leaders (= the first movers) were more likely to contribute (55%) than low-status leaders (= the first movers) (33%) and p-value was 0.0429 in the last 6 rounds and it was statistically significant. In our case, p-value was 0.433 and it was not statistically significant. while the p-value of trivia quiz score status awarding procedure was 0 and the p-value of calculus quiz score was also 0. Again, KV's (2012) result lied between our random and trivia quiz score cases.

KV (2012) stated that this was rather unexpected because Hoffman and Spitzer (1985) found that individuals who earned role in a simple bargaining model felt entitled to that role and tended to make less generous offers. In line with them,

Figure 5. Frequency of contributions by the leader


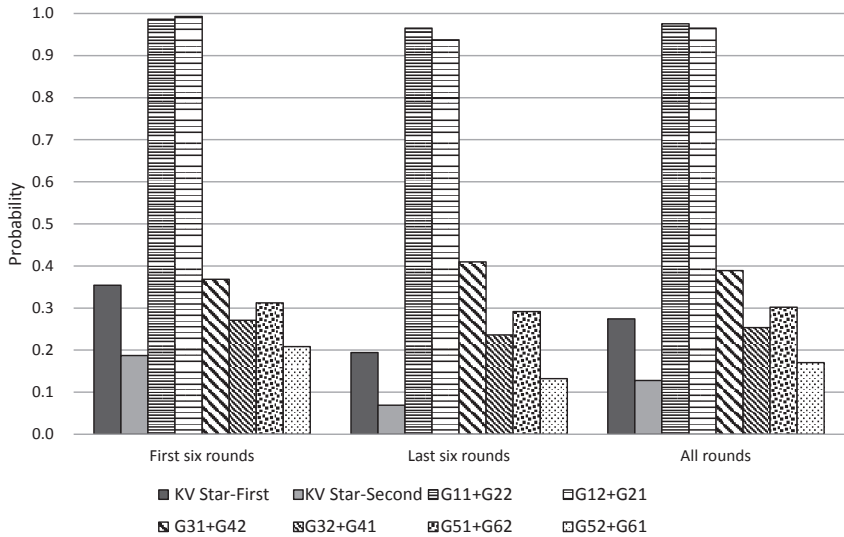
KV (2012) anticipated that high-status leaders (=the first movers) contributed less than low-status leaders, (=the first movers) but they contributed more than low-status leaders.

Figure 6 corresponds to Figure 4 in KV (2012) and it shows the frequency contribution by the follower (=the second mover).

Table 5. Mann-Whitney tests of followers' contributions in Star-First and Star-Second among three status award procedures

	Random	Trivia quiz score	Calculus quiz score
<i>z</i>	-0.738	-3.447	-3.725
<i>p</i> -value	0.461	0.0001	0

Although KV (2012) stated that the contribution frequency was 27% for low-status (=no-star) followers (=the second movers) and only 13% for high-status (=star) followers (=the second movers) and the *p*-value was 0.0571, our *p*-value for random status awarding procedure was 0.461. *P*-values for trivia

Figure 6. Frequency of contribution by the follower


quiz score status awarding procedure was 0.0001 and that for calculus quiz score was 0. So, KV's (2012) outcome again lied between our random and trivia quiz score cases.

Lastly, Table 6 corresponds to Table 1 in KV (2012) and shows average earnings of leaders and followers per session.

Table 6. Average earnings (\$)

	KV (2012)		Random		Trivia quiz score		Calculus quiz score	
	Leaders	Followers	Leaders	Followers	Leaders	Followers	Leaders	Followers
Star-First	12.8	16.1	17.84	17.88	14.33	14.36	13.80	13.89
Star-Second	12.2	14.6	17.78	17.82	13.54	13.49	13.09	12.80

Although KV (2012) claimed that followers' (= second movers') average payoffs were statistically significantly larger than leaders' (=first movers') pay-offs both in Star-First and in Star-Second, leaders' and followers' average payoffs were not significantly different in all the three status awarding procedures in our

experiment. This was mainly because our data showed that when a leader took action A for the first time in some round, say, t , $1 \leq t < 12$, but the follower still took action B in round t , then, the leader took action B in the next round ($t+1$) and the follower took action A in round ($t+1$) although the leader matched with a different subject in round ($t+1$). Ex-post questionnaire revealed that they felt guilty when they took action A for the first time as the leader in some round, say, t , $1 \leq t < 12$, but the follower still took B. They took action B in the next period even they knew that they matched to different subjects in round ($t+1$). We made sure that every subject understood that s/he did not match with the same subject in two successive rounds and s/he randomly matched to some other subject with different status and no one was matched to more than twice with the same subject, but still it happened. The fact of high-status (= star) leaders (= the first movers) earned less than low-status (= no-star) followers (= the second movers) in KV (2012) is striking because many people seek high-status in the real world. High-status should lead to a higher payoff under game theoretical assumptions where rational players interact with each other and each one takes a strategy which maximizes his/her own payoff. Ball and Eckel (1998), Ball et al. (2001), and Glaeser et al. (2000) experimentally showed it in bargaining games, in competitive markets, and in a trust game respectively. In our experiment, self-expansion occurred quickly among subjects and self-expansion made each subject to consider “our” payoffs rather than “my” payoff. Accordingly, both the leader (= the first mover) and the follower (= the second mover) took action B which maximized “their” payoffs more than 90% of the time while taking action A was the unique SPNE. Therefore, it is very natural that there was no statistically significant difference between the average payoff of the leader (= the first mover) and that of the follower (= the second mover) both in Star-First and Star-Second in our experiment.

Since our experiment had three different status awarding procedures, we can run several additional Mann-Whitney tests to compare different status awarding procedures and different order of moves by two players, that is, Star-First and Star-Second.

For Tables 7, 8, 9, 10, and 11, and 12, we need to introduce more notations to simplify our tables. For example, “1s” in the first column in Table 7 correspond to leaders (= the first movers) in the set of players in the next column. If they

are “2s,” they correspond to followers (=the second movers) in the set of players in the next column. Similarly, “1s” in the first row correspond to leaders (=the first movers) of the set of players in the next row. If they are “2s,” they correspond to followers (=the second movers) of the set of players in the next row. For example, 1 in the third row and first column means the leaders (=the first movers) in G11+G22 and 1 in the first row and the fourth column in Table 7 means that the leaders (=the first movers) in G31+G42. Each column's two numbers are Mann-Whitney's z and p-value where p-value is in parentheses. For example, Table 7 shows that Mann-Whitney's z is -15.516 and p-value is 0.0000 when we tested the null hypothesis that leaders' contributions were the same in G11+G22 (where high-status was awarded by random procedure) and G31+G42 (where high-status was awarded by trivia quiz scores).

Table 7. Mann-Whitney tests for leaders' contributions for Star-First in different status awarding procedures

		1	1	1
		G11+G22	G31+G42	G51+G62
1	G11+G22	————	-15.156 (0.0000)	-16.850 (0.0000)
1	G31+G42	-15.156 (0.0000)	————	-2.184 (0.0290)
1	G51+G62	-16.850 (0.0000)	-2.184 (0.0290)	————

Table 7 tells us that status awarding procedures influenced leaders' (=the first movers') contributions statistically significantly in Star-First game.

Leaders (=the first movers) in G11+G22 (where high-status was awarded by random procedure) contributed more than leaders in G31+G42 (where high-status was awarded by trivia quiz scores) and leaders (=the first movers) in G31+G42 (where high-status was awarded by trivia quiz scores) contributed more than leaders (=the first movers) in G51+G62 (where high-status was awarded by calculus quiz scores).

Similar to Star-First game, Table 8 tells us that status awarding procedures influenced leaders' contributions statistically significantly in Star-Second game. As in Star-First game, leaders G12+G21 (where high-status was awarded by a

Table 8. Mann-Whitney tests for leaders' contributions for Star-Second in three different status awarding procedures

		1	1	1
		G12+G21	G32+G41	G52+G61
1	G12+G21	————	-17.663 (0.0000)	-19.864 (0.0000)
1	G32+G41	-17.663 (0.0000)	————	-3.135 (0.0017)
1	G52+G61	-19.864 (0.0000)	-3.135 (0.0017)	————

random procedure) contributed more than leaders in G32+G41 (where high-status was awarded by trivia quiz scores) and leaders in G32+G41 (where high-status was awarded by trivia quiz scores) contributed more than leaders in G52+G61 (where high-status was awarded by calculus quiz scores).

Table 9. Mann-Whitney tests for the follower's contributions for Star-First in three different status awarding procedures

		2	2	2
		G11+G22	G31+G42	G51+G62
2	G11+G22	————	-15.110 (0.0000)	-16.814 (0.0000)
2	G31+G42	-15.110 (0.0000)	————	-2.189 (0.29)
2	G51+G62	-16.814 (0.0000)	-2.189 (0.29)	————

Table 9 and Table 10 tell us that status awarding procedures influenced followers' contributions significantly in both in Star-First and Star-Second games except G32+G41 (where high-status was awarded by trivia quiz scores) and G52+G61 (where high-status was awarded by calculus quiz scores). This was partly what we predicted. Although Table 7 and 8 show that leaders' contributions were statistically significantly different between G32+G41 (where high-status was awarded by trivia quiz scores) and G52+G61 (where high-status was awarded by calculus quiz scores) against our prediction, Table 9 and Table 10

Table 10. Mann-Whitney tests for the follower's contributions for Star-Second in different status awarding procedures

		2	2	2
		G12+G21	G32+G41	G52+G61
2	G12+G21	————	-17.492 (0.0000)	-19.244 (0.0000)
2	G32+G41	-17.492 (0.0000)	————	-2.445 (0.14)
2	G52+G61	-19.244 (0.0000)	-2.445 (0.14)	————

tell us that followers' contributions were not statistically significantly different between G32+G41 (where high-status was awarded by trivia quiz scores) and G52+G61 (where high-status was awarded by calculus quiz scores). Since followers' (=the second movers') contributions were influenced by not only leaders' contributions, but how leaders were chosen. We predicted that when high status was awarded by some quiz scores, followers' contributions were not significantly different while the behaviors of the subjects with randomly chosen leaders were significantly different from those of the subjects with leaders chosen by high quiz scores and subjects took the cooperative action B significantly more frequently when high-status (=star) was awarded by a random procedure due to a random status awarding procedure yielding expansion-self as we explained before. Our data showed that our prediction was partly correct. As we mentioned, many Japanese students experienced 5 minutes grade level calculation quiz in every morning before class in elementary schools and it linked to our academic grade. This might cause differences of the leaders' behaviors between G32+G41 (where high-status was awarded by trivia quiz scores) and G52+G61 (where high status was awarded by calculus quiz scores). because some linked calculus quiz scores to academic success.

Table 11 tells us that star (=high-status) players contributions were not significantly different when they acted as the leaders (=the first movers) and when they acted as followers (=the second movers) when their status were awarded randomly, but they acted significantly different when their status were awarded by trivia quiz cores, or by calculus quiz scores. Star (=high-status) players

Table 11. Mann-Whitney tests for star players' contributions as the leader and as the follower in three different status awarding procedures

		1	1	1
		G11+G22	G31+G42	G51+G62
2	G12+G21	-1.013 (0.311)	-17.892 (0.000)	-19.620 (0.000)
2	G32+G41	-17.892 (0.000)	-3.561 (0.000)	-5.926 (0.000)
2	G52+G61	-19.620 (0.000)	-5.926 (0.000)	-3.813 (0.000)

contributed more as the leader (=the first mover) when high-status was awarded by trivia quiz scores, or by calculus quiz scores.

Similar to Table 11, Table 12 tells us that no-star players contributions were not significantly different when they acted as the leaders (=the first movers) and when they acted as followers (=the second movers) when their status were awarded randomly, but they acted significantly different when their status were awarded by trivia quiz cores and by calculus quiz scores.

Table 12. Mann-Whitney tests for no-star players' contributions as leaders and as followers in three different status awarding procedures

		1	1	1
		G12+G21	G32+G41	G52+G61
2	G11+G22	-0.507 (0.612)	-16.607 (0.000)	-14.889 (0.000)
2	G31+G42	-16.607 (0.000)	-3.571 (0.000)	-1.397 (0.000)
2	G51+G62	-14.889 (0.000)	-1.397 (0.162)	-4.494 (0.000)

We concluded that a truly random status awarding procedure induced subjects to feel the status awarding procedure was fair and they could equally likely to be a high-status (=star) player, or a low-status (=no-star) player. When a subject felt the status awarding procedure was fair, the leader (=the first mover) and the follower (=the second mover) put their feet in the other player's shoes when s/he decided which action to take by self-expansion. Therefore, we achieved

very high cooperation rate; 96.2% for Star-First and 93.8% for Star-Second games.

5. Conclusion

We modified status awarding procedure in KV (2012), introduced a different random status awarding procedure, and achieved 96.2% of overall cooperation rate in Star-First and 93.8% in Star-second by expansion-self. It shows that the status awarding procedure in KV (2012) was not considered as random as they claimed. Our experiment shows that the outcomes in KV (2012) lied between our random status awarding procedure and our trivia quiz score status awarding procedure. We found there was no statistically significant difference between the leader (= the first mover) being a high-status (= star) player and the leader (= the first mover) being a low-status (= no-star) player while KV (2012) claimed higher contributions were achieved when the leader (= the first mover) being a high-status (= star) player. Theoretically, a prisoner's dilemma game with sequential moves has a unique subgame perfect equilibrium of non-cooperation where every player takes action A whenever her/his move comes, but it is not socially efficient because both players' taking action B Pareto dominates both players' taking action A; however, past experimental works showed that cooperation happened. Actual cooperation rates varied from several percent to more than 80% depending on experimental procedures. Our experiment achieved the highest cooperation rate, that was, 96.2% of overall cooperation rate when a status awarded player was the leader (= the first mover) and it was 93.8% when a status awarded (= star) player was the follower (= second mover). As we mentioned in section 4, we interpret our high cooperation rate by the concept of expansion-self. It induced a player to think the problem from "our" point of view rather than "my" point of view and put one's feet in the other player's shoes to whom s/he was matched in that round when s/he decided which action to take in that round regardless of s/he was awarded high-status (= star), or not.

We conducted related experiments to examine whether altruistic personality caused cooperative behavior. Our data showed that those who were categorized as altruistic in a preliminary quiz were only 10% or so. Most of these altruistic players changed their action from the cooperative action B to the non-cooperative action A after they observed the other players took action A in several con-

secutive rounds regardless of their taking action B. This fact tells us that altruistic behavior was conditional on the other players behavior and altruism could not be the reason for our high cooperation rate.

As an extension, we are interested in sequential prisoner's dilemma with n ($n > 2$) players. For example, suppose $n = 6$. Then, we can make three sequential prisoner's dilemma game structures even we restricted to equal numbers of players in each period: 3 periods where 2 players move simultaneously in each period, 2 periods where 3 players move simultaneously in each period, and 6 periods where 1 player moves in each period. We would like to examine which of the above three games yields the highest cooperation rate. Although literature tells us that a sequential move prisoner's dilemma game achieved higher cooperation rate than a simultaneous move prisoner's dilemma game, what kind of sequential move structure achieves the highest cooperation rate is an open question as long as we know. Characterizing the sequential move structure to achieve the highest cooperation rate is very important in the real world because prisoner's dilemma depicts many important international problems such as arms races, fund raising for developed countries, global CO₂ emissions, OPEC, arms races, Ocean plastic pollution and so on.

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Appendix.

Trivia quiz questios.

1. The hight of Mt. Fuji is () meters.

2. There are () states in Japan.
3. There are () colleges in Aoyamagakuin University.
4. There were () years in Edo era.
5. There are () states in the USA.
6. There are () days in 2020.
7. Haiku has () syllables.
8. The World War II started in ().
9. () km are the distance set for a full marathon.
10. There are () stations on Yamanote Line.
11. Karl snack produced by Meiji Seika went on sale from the year, ().
12. The annual fee of Amazon Prime membership is () yen.
13. A postcard costs () yen in a post office.
14. The Kamakura Bakufu was overthrown in the year, ().
15. Aoyamagakuin University was founded in the year, ().
16. There are () countries in the world today.
17. There are () squares on a Shogi board.
18. Humans have normally () baby teeth per person.
19. The numbers of the members of the House of Representative are ().