The evolution of inclusion/exclusion mechanisms in social dilemma situations [1]

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This paper examines how a selective inclusion mechanism emerges and solves the 'relationship type' social dilemmas. I present a simple computer simulation model supposing that every agent in turn calls for cooperators and try to form a cooperative relationship. The simulation analyses demonstrated the following. (1) The selective inclusion strategy, which includes only cooperative agents into the relationship, emerged through strategic evolution and established highly cooperative relationships in the agents' society. (2) Within a limit, agents' trust tended to increase rather than decrease as temptation to defect increases. High trust can be considered as an adaptive response in an environment with high defection temptation. (3) In order for the selective inclusion strategy to be successful, it must dictate the carrier agent not only to selectively offer an opportunity to be a cooperator, but also to accept an offer selectively. (4) An agent should be provided with high incentive to become an organizer, in order to establish full-fledged cooperation. Finally, this paper argues that the 'societal type' social dilemmas will be also solved by inclusion/exclusion mechanisms under specific conditions.

1. Introduction: Social dilemma in a cooperative relationship

Solving social dilemmas has been a central theme in the social dilemmas literature, and a lot of arguments have been devoted to finding out the solutions to attain cooperation, avoiding the deficient equilibrium where most actors defect (e.g., Foddy, Smithson, Hogg, & Schneider, 1999). Among the possible solutions, this paper focuses attention on a promising one, that is, the inclusion of cooperators and exclusion of defectors.

It seems obvious that a social dilemma will be solved if a society or a relationship can select members on the basis of their cooperativeness, including only cooperative actors and excluding non-cooperative actors. Such a selective inclusion/exclusion is important, at least in the following two ways. First, some individuals will consistently act cooperatively or uncooperatively depending on the motivational orientation (Kramer, McClintock, & Messick, 1986; Liebrand, & van Run, 1985). If we expect that much of prospective members will cooperate or defect constantly, it

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is evidently rational to accept only those who will cooperate as friends, and to reject those who will defect as enemies. Secondly, the working of such mechanisms will convert most of the possible defectors into cooperators, assuming that joining a cooperative relationship will bring them higher payoffs in the long run. The significance of inclusion/exclusion mechanisms rests on their ability to make most actors cooperative, rather than the ability to expel defectors.

Though we can safely suppose that such a selective inclusion/exclusion mechanism will work to enhance cooperation, whether it is possible for such a mechanism to come to exist, or how it comes to exist remains to be settled. From the ‘evolutionary perspective’ adopted here, the emergence of inclusion/exclusion mechanisms should be explained in the bottom-up fashion, that is, explained as an equilibrium point where actors choose the strategies which make selective inclusion/exclusion possible.

In considering inclusion/exclusion, it seems meaningful to consider the two types of social dilemmas, the societal type of dilemmas and the relationship type dilemmas. The effective mechanisms to control the dilemma will vary depending on the type.

By a ‘societal type’ dilemma, I mean a situation where all the members of a society are more or less involved in a social dilemma. The members are already included in the society, and externalities exist among them so that any member’s action influences other members. This is a typical situation which social dilemma researchers have been studying. The difficulty in solving this type of dilemma lies in the fact that defectors as well as cooperators are already in the society, and by some reasons one cannot expel the defectors from the society. Then, in order for cooperators to expel defectors from the society, they must contrive some mechanism to detect and expel the defectors. Such a job is hard to accomplish and it is one reason why solving this type of social dilemmas is difficult.

The ‘relationship type’ of social dilemma is the situation where some members of a society form a cooperative relationship containing an element of social dilemma. Consider the instance where some actors form a social exchange relationship. Such a cooperative relationship constitutes a social dilemma, because each actor can potentially cheat. Yet, a cooperator may be able to select the actors who are unlikely to be defectors as coworkers. Assuming that an actor can tell who would be defectors, realizing a defector-free situation is relatively easy in comparison with the case of societal type dilemma.

In this paper, I restrict my arguments to solving relationship type of social dilemmas. The purpose of this paper is to examine how a selective inclusion mechanism emerges in a society and solves the 'relationship type' social dilemmas there, conducting computer simulation experiments. I will demonstrate that selective inclusion strategies, which discriminate actors on the basis of their cooperativeness, can be predominant, and that these strategies establish a high level of cooperation as well as high trust in the specific conditions. In the final section, I will make an argument about the societal type dilemmas and the possibility of the society-level ostracism.

2. Selective inclusion and trust

We can intuitively infer that an actor who try to form a cooperative relationship will follow the strategy which dictates to include only trustworthy others into the relationship. Then one might well argue that, if most actors adopt such a strategy, only cooperative actors would be included in the relationships and a high level of cooperation would be easily established.

A little more elaborated thinking will reveal that the story is not so simple. At the initial stage of interaction, an actor will find a lot of unknown actors. Then, cautious actors will be reluctant to form a cooperative relationship with others. If it is the case, an attempt to form a cooperative relationship might be discouraged at the early stage of interaction, and strategies seeking cooperation might not be selected in the process of strategic evolution, because strategies seeking cooperation with others might disappear at the early stage of interaction process.

The above argument leads us to the idea that 'trust' will play an important role in the emergence of cooperation. In accordance with Yamagishi (1998, 1999), I define trust as a default value of subjective probability of cooperation, which the actor attributes to any other unknown actor. An actor with high trust is the one who believe that any other actor will cooperate with high probability. With this definition of trust, it will be reasonably inferred that actors must be highly trusting in order for cooperation to start in the society, and that the combination of high trust and the selective inclusion strategy will constitutes the social mechanism to assure the emergence of cooperation.

However, this inference does not necessarily mean that the selective inclusion strategy coupled with high trust can evolve and can be dominant among the actors. From the evolutionary perspective, a strategy will be selected by many actors only if this strategy brings its carriers high profits. Highly trusting actors are vulnerable to exploitation by defectors so that high trust might be extinct in the process of strategic evolution.

For the purpose of examining whether the selective inclusion mechanism evolves from the bottom up and produces cooperation as argued above, I conducted the simulation analyses. The simulation model is based on the 'Organizing Cooperation Game.' Using this simulation model, I will demonstrate below that the selective inclusion strategy as well as high trust can evolve and establish cooperation in the simulated society.

3. Simulation model

Organizing Cooperation Game

The simulation model I use is based on the ''Organizing Cooperation Game,' which presumes as follows.

A society is composed by one hundred actors (agents). Each of the agents is running its own business, e.g., managing its own farm. An agent can do its job alone, but if it gets cooperation from others, the outcome will be larger. It is assumed that an agent has in turn a chance to be an 'organizer,' who can make offers to others in order to ask them to be cooperative 'partners.'[2] To whom the organizer make offers depends on the organizer's 'inclusion strategy.' The agent who received the offer from the organizer decides to accept or reject the offer, depending on the agent's 'acceptance strategy.'

The cooperative relationship an organizer can try to form is of N-person type. The profit for a partner increases as the total number of actors involved increases, while there is an optimal relationship size N^* for the organizer, because the revenue function is marginally decreasing and a fix cost per additional partner incurs to the organizer. If the cooperative relationship is successfully organized, its size will be close to the optimal size.

After joining a cooperative relationship, agents including an organizer can choose to cooperate or defect. The probability to defect is also specified in the agent's strategy. Since a 'defecting cooperator' gets additional profit in the expense of other participating agents, the cooperative relationships are considered as social dilemma situations.

An agent acts as its strategy dictates, and the agents' strategies will change according to the same procedure as genetic algorithm (crossover and mutation). Basically, agents' strategies will shift to those proven to produce larger profits.

Payoff structure

Let N_t be a total number of agents involved in a given cooperative relationship, including the organizer. Then the profit for an organizer U_o, and the profit for a partner U_p are expressed as follows.

$$U_o = a \cdot N_t^{1/2} - b \cdot N_t. \qquad [1]$$

$$U_p = a \cdot N_t^{1/2} / 10. \qquad [2]$$

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2 This game postulates that only one agent (organizer), rather than all the concerned agents, takes the initiative in forming a cooperative relationship. I put this postulate, since it nicely simplifies the relationship formation processes. If it is assumed that many agents have equal says regarding relationships formation and who should be included, we would have to postulate complicated multilateral negotiation process, whose validity will be easily challenged.

As is described, the basic revenue from a cooperative relationship ($a \cdot N_t^{1/2}$) is an increasing function of N_t, but marginally decreasing. Since the cost ($- b \cdot N_t$) incurs to the organizer, too large relationship is undesirable for the organizer. I assign 3 to *a*, and 1/2 to *b*. The optimal relationship size for the organizer is 9, assuming that none defects. Therefore, a 'rational' organizer may try to get 8 cooperators.

If an agent defect in a relationship, each of other agents involved, of course including the organizer, gets a damage of $- a \cdot N_t^{1/2} /5$. If an agent has faced N_d defectors, this agent's loss amounts to $N_d \cdot a \cdot N_t^{1/2} /5$. Since $a \cdot N_t^{1/2} /5 > U_c = a \cdot N_t^{1/2} /10$, an agent will lose its asset if only one agent involved defects. A defecting agent gets the profit of $(N_t -1) \cdot w \cdot a \cdot N_t^{1/2} /10$.[3] The coefficient *w* is the defection-incentive coefficient, the larger the coefficient, the larger the incentive to defect for every agent.

As described so far, the payoff structure embedded in such a cooperative relationship conforms to that of social dilemma. A characteristic feature of this game is the asymmetry of payoffs, that is, $U_o > U_p$, assuming that N_t does not exceed the optimal relationship size too much. It should be noted, however, that an agent may get profits as a cooperative partner more than it gets as an organizer. During the trial-period of this game, an agent becomes an organizer only once, while it can usually be a partner many times, maximally 99 times.[4] Of course, such asymmetry of the payoff structure might influence the simulation results. Therefore, as will be described below, I manipulate the degree of asymmetry to examine the effects of asymmetric nature of the payoff structure.

The payoff structure becomes more complicated if 'conspiracy' is introduced. With the current model, a simulation run can be conducted in the conspiracy condition. In this condition, an agent can be either with or without conspiracy, depending on the strategy. It is assumed that randomly selected 20 agents are exposed to the information that a given agent will be an organizer next. An informed agent with conspiracy makes a conspiracy proposal to the prospective organizer, if this agent decides to defect with its defection probability defined in its strategy. If the prospective organizer is without conspiracy, it simply ignores this proposal. If the prospective organizer is also with conspiracy, it decides to conspire with the proposing agent, and the conspiracy results. In case of conspiracy, the organizer includes the proposing agents into the cooperative relationship, knowing that they will definitely defect. In exchange for such inclusion, the

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[3] I assume that, in case that the number of involved agents in the relationship is only one (the organizer), the organizer simply 'cooperate.'

[4] If we can assume that no agent defect and every cooperative relationship is optimal-sized (9), given the parameter values described, then an agent can get the profit of 4.5 as an organizer. On the other hand, an agent can be a partner, on the average, 8 times, and will get the profit of 0.9 on every occasion. Therefore, an agent will obtain the profit of 7.2, more than 4.5, as a partner of the other organizers.

proposing agent must pay $1.5 \cdot w \cdot a \cdot N_t^{1/2} /5$ to the organizer. Conspiracy is the mechanism to include an agent who could not be included if inclusion is selective. Introducing conspiracy is expected to increase tendency to defect among the agents.

Strategy

An agent's strategy is represented by an array of nineteen bits. A strategy is composed by 'inclusion strategy,' 'acceptance strategy,' 'defect strategy,' 'conspiracy strategy,' and 'trust.'

Inclusion strategy (7 bits) applies when the carrier agent is an organizer. It chooses the way of selecting cooperative partners. This strategy works as follows. First, it decides how many agents should be partner candidates. It designates any integer number from 0 to 15. Secondly, it decides whether the agent chooses candidates randomly, or chooses selectively on the basis of their cooperation-defection history. Third, it decides the criterion of the defection rate. When an agent chooses candidates selectively, it will invite the agents whose past defection rates are under this criterion. If the agent finds more agents than it can make offers, it will select candidates randomly.

Acceptance strategy (5 bits) applies when the agent receives an offer from an organizer. First, it specifies whether the agent decides to accept randomly or selectively. Second, it specifies the probability to accept an offer in case of random acceptance. Third, it chooses the criterion of 'relationship risk tolerance.' It is assumed that an agent knows the organizer and the partner-candidates, and that the agent calculates the probability that at least one agent among them defects, based of their past defection rates. If the calculated probability is less than the criterion value chosen, the agent accept the offer from an organizer.

Defect strategy (3 bits) is a simple probability that the carrier agent defects in the proposed cooperative relationship.

Conspiracy strategy (2 bits) determines if the agent uses the conspiracy opportunity. First, it specifies if the agent makes a conspiracy offer to the organizer when it is not an organizer and it has just been exposed to the information of who would be a prospective organizer. Secondly, it determines whether or not the agent accept the conspiracy offer when the agent is the organizer.

Trust (2 bits) is a default value of subjective probability to cooperate, which the agent attributes to any other agent whose past defection rate is not available. When an agent's trust is high, the agent assumes that a stranger will not defect with a high probability. An agent uses trust not only when it tries to select the cooperators as an organizer, but also when it estimates the relationship risk.

Agent's memory

How an agent estimates the probability that other agents cooperate plays an important role in the simulation model described here. The model assumes that an agent (A) use the observed cooperation rate of another agent (B) as A's subjective probability that B cooperates. It is further assumed that an agent observes only the relationships it has actually participated in+, retains actual instances of cooperation/defection it has observed, and calculate the other agents' cooperation rates on the basis of its memory. The model does not assume the formation and working of reputation.[5]

Simulation steps

A simulation run is composed to be a series of generations, and at the end of each generation strategic change (crossover[6] and mutation[7]) is introduced. As generation proceeds, the poor strategies providing their carriers with low profits tend to be replaced by superior ones. I repeated 200 generations for each run. In the first generation, agents' strategies are completely randomized.

During a generation, I repeated 200 trial-periods. In each trial-period, an agent has in turn one opportunity to be an organizer. The order to be an organizer was randomized in each trial period. Then, maximally 20,000 cooperative relationships can be formed during a generation. An agent's 'trial profit' is the sum of the profits it gained during a trial period. The 'generation profit' of an agent is defined as a sum of trial profits throughout the generation period.

Factorial design

This simulation is conducted under the 2 x 4 factorial design. The first factor (2 levels) is whether or not an agent has a chance to use conspiracy strategy. In the No-conspiracy condition, every agent has no chance of conspiracy. The second factor (4 levels) is the defection incentive size. This factor is manipulated by the defection-incentive coefficient *w*. Defection incentive can be small (*w*=0.1), middle (*w*=2/3), large (*w*=1.0), or very large (*w*=5/3). I repeated 10 simulation runs for each of the eight conditions. Since the cooperation levels in the simulated societies were stabilized at about the 50th generation, a simulation run was terminated when the 200th generation was over.

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5 The establishment of reputation is itself a complex process, and introduction of reputation requires additional assumptions.

6 At the end of a generation, agents are reordered along the size of 'generation profit.' Then, the superior 10 agents group and the inferior 10 agents group were defined. The strategy of an inferior agent was replaced by a new strategy given by a crossover procedure. The new strategy is an offspring whose parents were the strategies of the two agents belonging to the superior group. A superior agent was selected to be a parent in proportion to its 'generation profit' size.

7 At the end of a generation, after the crossover processing was over, every strategy dimension value of an agent was changed to the different value (e.g., from 1 to 0) with probability .015.

4. Simulation Results

Evolution of cooperation

The simulation results demonstrated that the evolution of selective inclusion strategies, cooperation, and trust took place in all the conditions. **Figure 1** and **Figure 2** show an example of the process of a simulation run (The first 100 generations of the first run in the no conspiracy - large

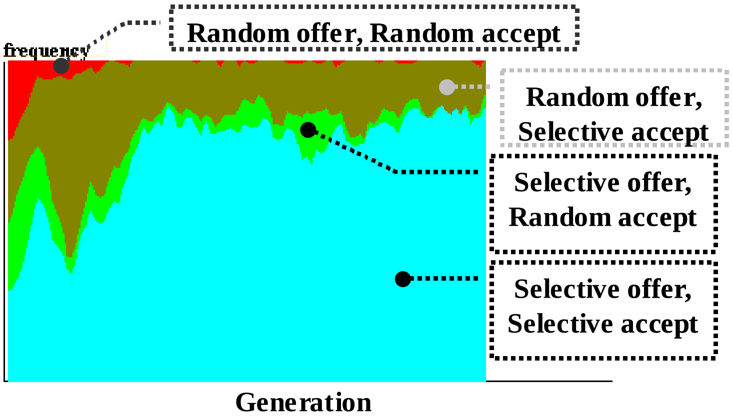

Figure 1: The Strategic evolution in a simulation run

defection incentive condition). Agents tended to adopt the selective offer - selective acceptance strategy, rather than selective offer - random acceptance, random offer - selective acceptance, or random offer - random acceptance strategy (**Figure 1**). Together with this strategic change, we can see the increase of agents' cooperation rate and trust, followed by the increase of the mean cooperation size (the size of cooperative relationships, **Figure 2**). Both the cooperation rate and mean trust approached to the upper limits (1.0), and the mean cooperation size also tended to

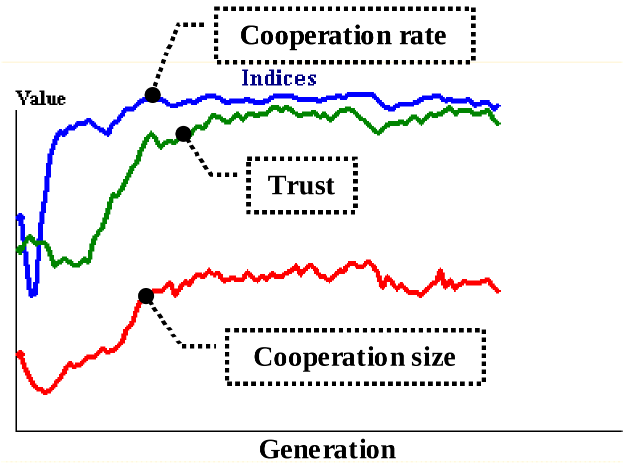

Figure 2: The evolution of cooperation in a simulation run

approach to the optimal size (N_t=9). It should be noticed that Figure 1 and 2 show an example in the condition likely to produce cooperation. In some other conditions, these indices are a little lower.

Cooperation rate, mean trust, and mean cooperation size were analyzed by 2 (conspiracy) x 4 (defection incentive) design. The dependent measures were obtained by averaging cooperation rate, mean trust, and mean cooperative relationship size in each of the last generation block (the last 40 generations).

Regarding the cooperation rate, only the main effect of defection incentive factor was significant (*F(3,72)=12.03, p< .001*). As is seen in **Figure 3**, cooperation rate is lower as the incentive becomes large. However, the significant difference was found only between the Very Large incentive condition and the other three conditions (*SNK test, p<.05*).

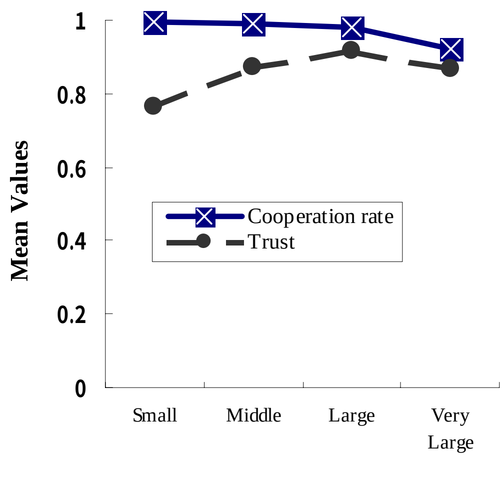

Figure 3: Cooperation rate and Trust

The analysis of mean cooperation size revealed the two main effects. First, it was influenced by the incentive factor (*F(3,72)=5.88, p< .001*, **Figure 4**). In accordance with the result of cooperation rate, cooperation size was significantly smaller in the Very Large defection incentive condition than the other conditions. In the Small, Middle, and Large conditions, mean cooperation size was more than 8, and very close to the optimal size 9. Secondly, mean cooperation size was larger in the No conspiracy condition than in the Conspiracy condition (*F(1,72)=4.89, p< .05)*. Therefore, it can be said that the two factors of temptation to defect, defection incentive and conspiracy, tended to lower the size of cooperative relationships.

The analysis of mean trust revealed the main effect of the incentive (*F(3,72)=25.50, p< .001*), the main effect of conspiracy (*F(1,72)=68.23, p< .001*), and the interaction effect of the two factors (*F(3,72)=10.22, p< .001*). As Figure 3 shows, the effect of incentive

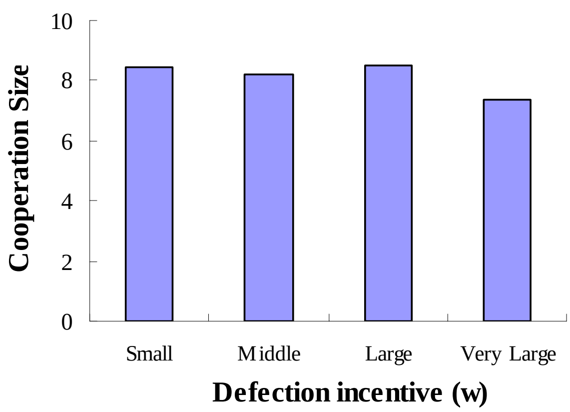

Figure 4: Size of Cooperative relarionships

size is curvilinear. Interestingly, in the Small, Middle, and Large incentive conditions, which do not differ from each other in cooperation rate and cooperation size, trust *increases* as the defection incentive increases. Similarly, mean trust is *higher* when conspiracy is available. The significant interaction effect means that the difference between the Conspiracy condition and the No conspiracy condition disappears as the defection incentive increases. These results imply that, except in the Very Large incentive condition, where establishing cooperation was much difficult, *higher temptation to defect increased rather than decreased trust*.

The results on mean trust is in accordance with those on the distribution of strategies. The proportion of the selective inclusion strategy (selective offer-selective acceptance) showed the same pattern as mean trust. Also found were the main effect of defection incentive ($F(3,72)=13.26$, $p< .001$), the main effect of Conspiracy ($F(1,72)=21.18$, $p< .001$), and the interaction effect ($F(3,72)=6.25$, $p< .001$). Again, the dependent measure increases as the incentive increases except in the Very Large condition, is higher in the Conspiracy condition, and the difference between the Conspiracy and No Conspiracy condition disappears in the Very Large condition. Then, It can be inferred that trust went hand in hand with the selective inclusion strategy.

5. Discussion

Evolution of selective inclusion mechanism and trust

The simulation results showed the following two points.

First, under the assumptions posited here, the selective inclusion mechanism can emerges from the agents' strategic interaction processes. That is, the agents will choose the selective inclusion strategy, which works as the selective inclusion mechanism in a society, and tend to hold high trust. Such a strategy and high trust will establish the high level of cooperation as long as the agents can select strategies freely. I infer that such strategic evolution took place in the past human societies so that human beings can form cooperative relationships despite that these relationships have contained the element of social dilemma.

Secondly, it can also be inferred that high trust is an adaptive response to the possibility of defection. Rather paradoxically, the simulation results showed that temptation of defection increased rather than decreased trust, as long as the defection incentive is not very high. In the High incentive condition, for example, agents trusted others on the average more than in the Low incentive condition, though the actual cooperation rates were almost the same. The most plausible reason of this is that, agents in the non-cooperative environment responded by choosing the selective inclusion mechanism coupled with high trust. Therefore, it can be predicted that in the society where there is almost no temptation to defect because the authoritative agents or the other social devices there maintain peace and order, people's trust will be lowered (Yamagishi, 1998, 1999).

Two components of selective inclusion

In the simulation described above, since the selective inclusion strategy which has the two component, 'selective offer' and 'selective acceptance,' became dominant, this strategy must have a survival value higher than other three strategies. Nevertheless, some might argue that the strategies other than this would do the same job, though less effectively. For example, suppose that agents have the strategy of 'selective offer' and 'random acceptance.' In such an instance, organizers will discriminate against less cooperative agents, and these agents with uncooperative strategies might die out. Then, one might insist that under the 'selective offer' and 'random acceptance' environment, a high degree of cooperation would result. In order to clarify this, I conducted the next simulation.

This simulation was conducted under 2 (offer factor) x 2 (acceptance factor) design. In the Selective Offer condition, agent's strategy can be selectively offering as well as randomly offering, as in the simulation described above. In the Random Offer condition, strategy can only be randomly offering. In the Selective Acceptance condition, agent's strategy can be selectively offering or randomly offering. In the Random Acceptance condition, strategy always specify random acceptance. I assumed that defection incentive was High and there is no conspiracy. In each condition, I repeated 10 runs.

The results clearly demonstrated that both of 'selective offer' component and 'selective acceptance' component were needed in order for cooperation to evolve. It was only in the Selective Offer – Selective Acceptance condition that high levels of cooperation rate, cooperative size, and trust were observed (**Figure 5**).

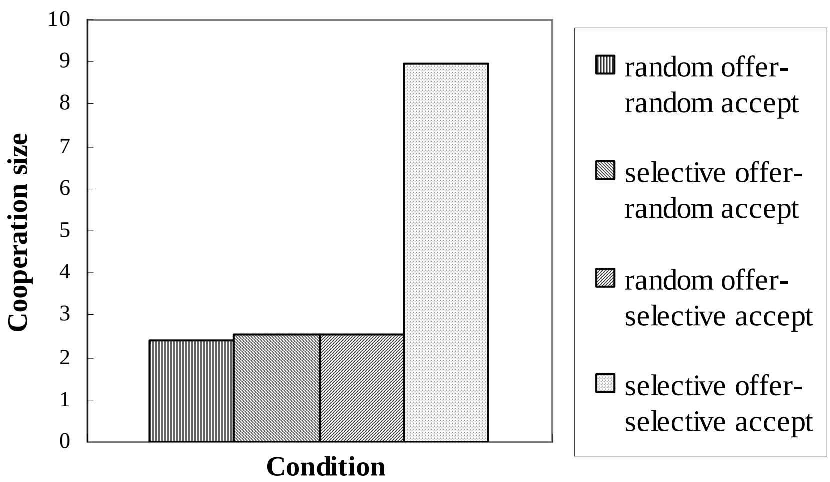

Figure 5: Mean cooperative relaruinship size in the four strategy conditions (without Conspiracy)

Asymmetric payoff structure

So far, I described the simulations whose payoff structures were asymmetric. The profit for an organizer was higher than that for a cooperative partner. One might argue that this asymmetric nature was responsible for some simulation results. As I wrote before, an agent will earn as a partner more than as an organizer, because it will have more opportunities to be a partner than opportunities to be an organizer. However, this asymmetry might cause some effects, so I conducted the next simulation by varying the profit size of an organizer, in order to examine the effects of asymmetry.

I defined an organizer's profit as $U_o/10*w$, where U_o is given in [1].[8] An integer value in [1, 10] was assigned to *w*. The simulation was run in the No Conspiracy – High defection incentive condition. I conducted 10 simulation runs for each of the 10 conditions.

The analysis of this simulation revealed that the cooperation indices increased and reached an asymptotic value as the value of *w* increased. Mean cooperation size increased as *w* increased, but it remained the same if *w* is more than 6 (*SNK, P<05*, **Figure 6**). When *w* is 1, mean size of cooperative relationships less than optimal, but it can be said that a certain level of cooperation is still maintained. The cooperation rate reached the asymptotic value when *w* is 4. Mean trust and frequency of the selective inclusion strategy became unchanged when *w* is 3.

The results imply the following. First, asymmetric nature of payoff structures is not necessary for a certain level of cooperation to emerge. Secondly, however, providing an organizer with sufficient incentive will be a necessary condition for full-fledged cooperation to be established in a society.

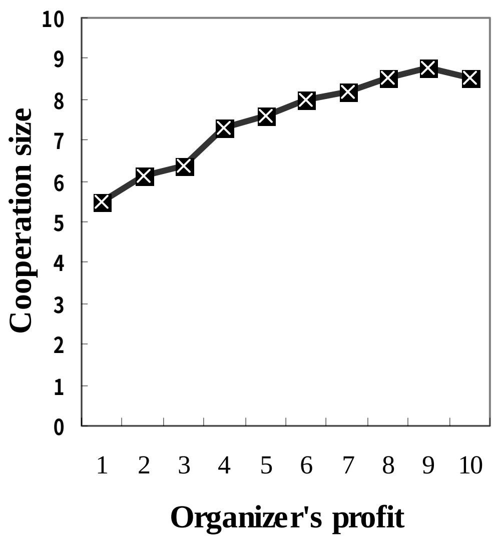

Figure 6: Mean cooperative relationship size as a function of organizer's profit (without Conspiracy)

Implications

The implications of the simulation results described above can be summarized as follows.

(1) In a situation where people want cooperative relationships but the temptation to defect exists, the selective inclusion strategy will emerge to resolve the social dilemma embedded in such relationships.

(2) High trust coupled with the selective inclusion

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[8] I defined an organizer' profit in this way because, this definition make the optimal cooperation size unchanged regardless of the value of *w*.

strategy will also evolve in a society, in response to the temptation to defect.

(3) In order for the selective inclusion strategy to be successful, it must have both of ‘selective offer’ component and ‘selective acceptance’ component.

(4) High incentive for an organizer of cooperation must be provided in order for a cooperative relationship to be fully established.

6. The evolution of societal level ostracism

The most important implication of the simulation results above is that the selective inclusion mechanism can emerge in response to the social dilemmas embedded in the cooperative relationships. The effectiveness of this mechanism comes from the simple fact that in forming a cooperative relationship, actors can select partners on the basis of their cooperativeness. Then, such mechanism cannot be applied to the societal type of social dilemmas, since defecting actors are already in a society. Other inclusion/exclusion mechanism must be installed in order to resolve societal social dilemmas.

My idea on this issue is that generalized exchange will emerge in a society and the resultant ‘generalized exchange club’ will work as an effective inclusion/exclusion mechanism to resolve a societal type dilemma. Just look at what generalized exchange is, and how it works as a social control mechanism.

I once proposed the generalized exchange perspective (Takagi, 1996, 1999). From this perspective, altruism, which can be observed in a human society, can be seen as generalized exchange. Generalized exchange is defined as a social situation where any party gives his/her own resource to other parties without expecting direct return. An actor who is involved in generalized exchange does favors for others, and receives help from someone later. There is no definite connection between giving and receiving.

I conducted computer simulation analyses to see if generalized exchange as altruism can evolve among artificial agents most of whom were holding the egoist strategy (Takagi, 1996). The results showed that an altruistic strategy can evolves in an egoist-dominant environment. Moreover, it was found that the strategy which evolved and robustly established altruism was highly exclusive in nature. This strategy dictates its carrier to give its resource only to those who are nice only to altruists. It views not only non-altruists but also altruists who do favors for non-altruists as 'enemies,' and discriminates against them. Since this strategy is highly in-group oriented, I call this strategy as 'in-group altruist strategy.' I can say that this strategy make generalized exchange a club good. The rule of this generalized exchange club prescribes that every member must be nice to other members, and that violators or those who support a violator will also lose membership. The more tolerant strategies, including the 'conditional altruist strategy,' which stipulates to give resource only to altruists, were found not strong enough to beat egoism.

Though the generalized exchange perspective explains altruism as generalized exchange, the scope of this perspective is not restricted to the emergence of altruism. Since 'communal societies' are characterized by altruism within them, and since stable altruism or generalized exchange will be supported by the highly in-group oriented strategy, this perspective predicts that a communal society as a generalized exchange club will come to have characteristic emergent properties. One of these emergent properties is the ability to solve social dilemmas (Takagi, 1999).

I predicted that a communal society would come to be able to solve social dilemmas in the following way. Consider a small-scale society where members interact more or less directly with each other and assume that this society is confronted with a social dilemma, e.g., a public good problem. Members will be better off if the public good is amply provided. Then, it is no surprise that some members would come to think that cooperation in this situation should be treated as a requirement to be a member of this communal society and to get a fruit of generalized exchange. These members will advocate a strategy linking cooperation with generalized exchange. As the number of members holding such a 'linkage strategy' increases, members in general will cease to be defectors as regards the social dilemma, since they must forgo the temptation to defect in order to have the fruit of generalized exchange. In this way, generalized exchange will 'pull up' the cooperation level in a dilemma situation.

A computer simulation analysis revealed that such line of reasoning is logically consistent. In the simulation model, each of agents plays two games, Generalized Exchange Game and Public Goods Game. An agent's payoff is the sum of the payoffs in both games. In the condition where an agent can select the strategy linking the two games, a linkage strategy tended to be selected, and both of generalized exchange and the public good were amply provided. What was selected was the strategy which dictates a carrier agent to support only the supporters of the 'public good supporting altruists.'

These simulation results have much relevance on the current topic. In a small-scale society, generalized exchange will spontaneously emerge from strategic interaction, and a generalized exchange club will be formed. Such a club will provide its members with benefits but will reject outsiders. Then, as long as generalized exchange provides ample benefits, the societal members will tend to be cooperators of the dilemma game, in order to be included in the club or to avoid exclusion from the club. It can be said that generalized exchange works as a system of social ostracism to maintain the cooperation level in the society on behalf of the society itself.

It should be noted that generalized exchange will be dominant only in a small-scale society. Other social mechanism such as a law system will have to do the job of selective inclusion or exclusion. How such a system emerges is the topic outside of the scope of this paper.

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