The Emergence of Generalized Exchange[1]

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The existence of generalized exchange characterized by unilateral resource giving has been a puzzle when we assume rational actors, because free riding can occur. This article first identifies pure-generalized exchange in which each actor gives resources to the recipient(s) of his choice. Then, it proposes the fairness-based selective-giving strategy. An actor adopting this strategy selects a recipient whose behaviors satisfy her criterion of fairness, provided perfect information is given. The results of evolutionary simulation show that pure-generalized exchange can emerge among egoists without collective norms, even in societies in which individuals have information only about their immediate neighbors.

INTRODUCTION

Generalized exchange has been one of the central topics in the classical social exchange literature both in sociology and anthropology (e.g., Befu 1977, 1980; Blau 1964; Ekeh 1974; Heath 1976; Lévi-Strauss 1949; Malinowski 1922; Mauss [1925] 1954; Sahlins 1972). Generalized exchange has been conceived as one of the mechanisms that enhances social solidarity. However, little empirical work has been done on generalized exchange (Emerson 1976, 1981; Gillmore 1987; Heath 1976). As a result, a main question remains unanswered: Why does generalized exchange emerge, and how is it maintained? This question addresses the mechanism that can generate and maintain generalized exchange systems. Generalized exchange is typically characterized by unilateral resource giving (Molm and Cook 1995) because one's giving is reciprocated not by the recipient, but by the third party. Thus, from the viewpoint of social exchange, rational choice, or evolutionary theory, the existence of generalized exchange is a puzzle because any member of the exchange system can free ride. There is no guarantee of reciprocity. Therefore, previous researchers have ex-

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plained generalized exchange as the result of altruism (Sahlins 1972; Takagi 1994, 1996) or collective norms (Ekeh 1974; Lévi-Strauss 1949). Recently, however, several new attempts to explain the emergence of generalized exchange have been made (e.g., Bearman 1997; Takagi 1994, 1996; Takahashi and Yamagishi 1996, 1999; Ziegler 1990). However, these solutions are typically limited to forms of generalized exchange that have a fixed network structure. Based on this research, especially Takahashi and Yamagishi (1996), this article develops a more plausible and general solution to the problem of the emergence of generalized exchange that holds even when none of the previous requirements are satisfied.

What Is Generalized Exchange?

Social exchange theory has roots in multiple disciplines. These include sociology (e.g., Homans [1961] 1974; Blau 1964; Emerson 1972*a,* 1972*b;* Heath 1976), psychology (e.g., Thibaut and Kelley 1959), and anthropology (e.g., Lévi-Strauss 1949; Ekeh 1974; Sahlins 1972). Although different versions of social exchange theory use different terminologies, most share a key distinction between restricted (or direct) exchange and generalized (or indirect) exchange (e.g., Bearman 1997; Befu 1980; Blau 1964; Ekeh 1974; Emerson 1976, 1981; Heath 1976; Gillmore 1987; Lévi-Strauss 1949; Molm and Cook 1995; Sahlins 1972; Takagi 1996; Takahashi and Yamagishi 1996, 1999; Yamagishi and Cook 1993).

In restricted exchange, two actors exchange resources with each other. In other words, the resources that one actor gives are directly contingent on the resources that the other gives in return. If *A* gives to *B, B* is the person who would reciprocate to *A*. This type of exchange is very common. Examples include exchanges between teachers and students, economic transactions, employers and employees, and so on. Most of the social exchange network research that has emerged since the 1980s in sociology focuses only on restricted exchange (e.g., Bienenstock and Bonacich 1992; Cook and Emerson 1978; Cook, Emerson, Gillmore, and Yamagishi 1983; Friedkin 1992; Markovsky, Willer, and Patton 1988; Yamagishi, Gillmore, and Cook 1988).

In contrast to restricted exchanges, which occur between two actors, generalized exchange inherently involves more than two people. In generalized exchange, there is no one-to-one correspondence between what two actors directly give to and receive from each other. *A*'s giving to *B* is not reciprocated by *B*'s giving to *A,* but by *C*'s giving to *A,* where *C* is a third party. Thus, reciprocation is indirect, not mutual. *A* gives help to *B* when *B* is in need, and at cost to *A*. If and when *A* needs help, and other actors (*C, D, . . . , N*) are around, one of them may provide it—again, with no assurance of return (Emerson 1981). “If I see burglars in my neighbor’s house, I have the duty of doing something about it (e.g., calling the police), not because I expect any reciprocation—of whatever type from my unfortunate neighbor—but perhaps because I expect any neighbor of mine to do the same thing if he sees burglars in my own house” (Ekeh 1974, p. 206).

At first sight, this does not appear to be an exchange at all. However, each actor provides resources at some time and eventually receives some benefit in return—not from the same actor, but from a different actor. In this sense, exchange theorists have traditionally considered generalized exchange as one type of exchange. The classic examples of generalized exchange are the Kula ring (e.g., Malinowski 1922; Ziegler 1990) and matrilateral cross-cousin marriage (e.g., Lévi-Strauss 1949; Bearman 1997). These forms are special cases of generalized exchange because in each there is a fixed network structure of exchange, that is, a chain. Generalized exchange is present, at least in a rudimentary form, in many aspects of social life (Emerson 1981; Heath 1976; Gillmore 1987). Examples include revolving credit associations, duplicate bridge games in which the players cycle through hosts, reviewers of journal articles, helping a stranded driver on a mountain road, the anonymous donation of blood, giving shower gifts, villagers going from household to household helping in harvesting, and so on (e.g., Bearman 1997; Befu 1977; Emerson 1981; Molm and Cook 1995; Takagi 1996).

One may have noticed that the existence of such a system is problematic. People who engage in unilateral resource giving in generalized exchange systems do not expect nor receive a direct return from the recipient, although they may expect a return from someone else in the future (e.g., Befu 1977; Ekeh 1974; Sahlins 1972; Yamagishi and Cook 1993). Therefore, every member of a generalized exchange system can (but need not) receive resources if everyone gives his or her resources to someone else. Thus, forming a generalized exchange system is very risky because unilateral resource giving is an invitation to exploitation (e.g., Bearman 1997; Gillmore 1987; Yamagishi and Cook 1993). This feature of generalized exchange coincides with the problem that is prevalent in another research area: the free rider problem of social dilemmas (e.g., Takagi 1996; Yamagishi and Cook 1993; Ziegler 1990). In other words, generalized exchange has the characteristic of social dilemmas (e.g., Molm 1994; Takagi 1996; Yamagishi and Cook 1993; Ziegler 1990). Rational self-interested members will be better off if they do not give resources to others. However, members who think that others will not give are unlikely to give away their own resources, and generalized exchange may never be established. Thus, the establishment and maintenance of a generalized exchange system requires the solution of a social dilemma.

PREVIOUS RESEARCH TRADITIONS

Generalized exchange is characterized by unilateral resource giving. But how and why does such an exchange system exist? In this section, I first briefly review what has been argued by the classic researchers. Then, I review several works that are directly related to this article.

The first type of explanation is that people give resources unilaterally because they have an altruistic motivation. Although there are debates about the definition of altruism, here it simply means that an actor's behaviors are based on concern for others' well-being.[2] Sahlins (1972), for example, characterized generalized exchange in terms of pure gifts with no obligation to repay. Thus, the result of unilateral resource giving or altruism is the generalized exchange system (Takagi 1994, 1996). However, the utility of this explanation is limited, because it raises another question: Why do people have such a motivation? Some researchers answered socialization to this question (e.g., Nye 1979), but this raises another question: Why is there such a socialization pressure in a society? These answers may hold one or the other—not both.

The second type of explanation requires a collective norm, the unilateral reciprocity principle. Once an actor receives resources, she is obligated to return to someone else in the future. In other words, free riding is a violation of this norm. Therefore, the social dilemma should not exist in a society characterized by such a collective norm of unilateral reciprocity. And, generalized exchange generates a morality characterized by credit mentality (e.g., Ekeh 1974; Lévi-Strauss 1949). Obviously, such an argument is the functional-collectivist one. There is no explanation of where such a norm comes from. Moreover, generalized exchange should not exist in the absence of such a norm.

The third type of explanation employs a rational choice/game theoretic framework. People give resources unilaterally when this behavior is beneficial to them. This answer assumes rational actors and considers unilateral resource giving as an instrumental behavior in order to gain other benefits. This is one of the most discussed ideas for solving social dilemmas or free rider problems.[3] One of the most well-known answers is the use of selective incentives (e.g., Olson 1965). Olson argued that we have to change the incentive structure in order to solve social dilemmas. For example, a strong organization can sanction members so that it is more beneficial for each member to contribute to the group goal. However, this solution implicitly assumes that actors' behavior can be monitored so that

[2] See Sesardic (1995) for a recent review.

[3] For reviews, see Dawes (1980), Messick and Brewer (1983), Orbell and Dawes (1981), Stroebe and Frey (1982), Yamagishi (1989*a,* 1995).

selective incentives can be efficiently applied, and assumes that the group has the necessary means to provide the incentives in the first place (Gillmore 1987).

In order to overcome these limitations, several new solutions to social dilemmas have been proposed since the 1980s. These solutions suggest that people sometimes change the incentive structure voluntarily so that free riding is impossible. In this article, I adopt this approach and apply it to the generalized exchange problem. In the next section, I selectively review these recent works to develop the logic of the new model that I propose in this article.

SOLUTIONS OF THE FREE RIDER PROBLEM

These solutions have several common features. First, they assume rational actors and no central authority. Second, the solutions employ strategies in which actors' behaviors are contingent on others' behaviors. Third, they consider the free rider problem to be solved when certain strategies that involve giving resources to others can obtain higher profit than other strategies. If such a strategy is possible in a situation, rational actors should adopt this strategy, and eventually there should be no free riders.

There are three distinct solutions to social dilemmas that are directly relevant to this article. They are (1) tit-for-tat (TFT) in iterated prisoner's dilemmas, (2) out-for-tat (OFT) in prisoner's dilemma networks, and (3) downward tit-for-tat in network-generalized exchange. I will use the underlying logic and principles in these three solutions in order to develop the solution to the problem of the emergence of generalized exchange. For other solutions in sociology, not directly relevant to this article, see Macy's (1990, 1991*a,* 1991*b,* 1993*a,* 1993*b*) and Heckathorn's (1990, 1993, 1996) series of work.

The Tit-for-Tat Strategy in Iterated Prisoner's Dilemmas

Tit-for-tat (TFT) in the social dilemmas literature, balanced reciprocity in social exchange theory (Sahlins 1972), and reciprocal altruism in biology are based on similar ideas. Given that people are embedded in long-lasting relationships, resource-giving behavior can be profitable. Suppose A can give some valuable resources to B. If A gives to B, B will give something to A in the future. However, if A does not give to B, B will not give either. In research on the prisoner's dilemma (PD), such a behavior is called a tit-for-tat strategy. It is defined as follows. In an iterated PD, an actor adopting TFT starts with cooperation. In subsequent rounds, an actor adopting TFT cooperates if and only if the partner cooperated in the previous round. Otherwise, he defects. The effectiveness of the TFT strategy has been widely shown both theoretically and empirically (see Axelrod 1980*a,* 1980*b,* 1984; Oskamp 1971; Wilson 1971). In the game theoretic literature, TFT has been one of the best strategies in iterated PDs. Many experiments have shown that TFT produces mutual cooperation. However, it works only in an iterated PD that corresponds to restricted—not generalized—exchange. An actor adopting the TFT strategy does not necessarily give resources to others when there are no long-lasting dyads. Therefore, we need another mechanism.

Out-for-Tat Strategy in Prisoner's Dilemma Networks

The second solution to the free rider problem is to use the out-for-tat (OFT) strategy in prisoner's dilemma networks (Hayashi, Jin, and Yamagishi 1993; Yamagishi, Hayashi, and Jin 1994).[4] A prisoner's dilemma network is a situation where (1) every member of a group chooses a partner, and (2) a PD game is played by members who have chosen each other. In this situation, computer simulation tournaments showed that the OFT strategy is overall the most effective strategy among the known strategies and brings mutual cooperation.[5] The definition of OFT is this. (1) An actor adopting the OFT strategy always cooperates, (2) she sticks with the current partner insofar as the partner cooperates, and (3) she deserts and seeks out a new partner as soon as the partner defects. Because actors adopting the OFT strategy do not choose defectors, eventually they commit to each other. These pairs of actors adopting the OFT strategy can attain mutual cooperation.[6] Contrary to this, the possible partners for defectors are other defectors. Thus, the OFT strategy can produce higher profit than defectors receive. Therefore, in prisoner's dilemma networks, a PD is voluntarily solved by the OFT strategy. Now, we can explain resource-giving behavior in any dyad by either TFT or OFT. However, PD networks still correspond to restricted exchange because the PD involves bilateral resource giving (Yamagishi and Cook 1993). We need a strategy that can solve the free rider problem when there is only unilateral resource giving.

[4] For the review of the recent development of the "selective play" paradigm, see Yamagishi and Hayashi (1996).

[5] For the results of the computer tournament and the detailed discussion of the effectiveness of the OFT strategy, see Yamagishi, Hayashi, and Jin (1994), Hayashi (1995), Yamagishi and Hayashi (1996), Hayashi and Yamagishi (1998).

[6] The OFT strategy is the best only under certain conditions: small number of actors adopting the random strategy and no opportunity costs (e.g., Yamagishi, Hayashi, and Jin 1994; Yamagishi and Hayashi 1996; Hayashi and Yamagishi 1998).

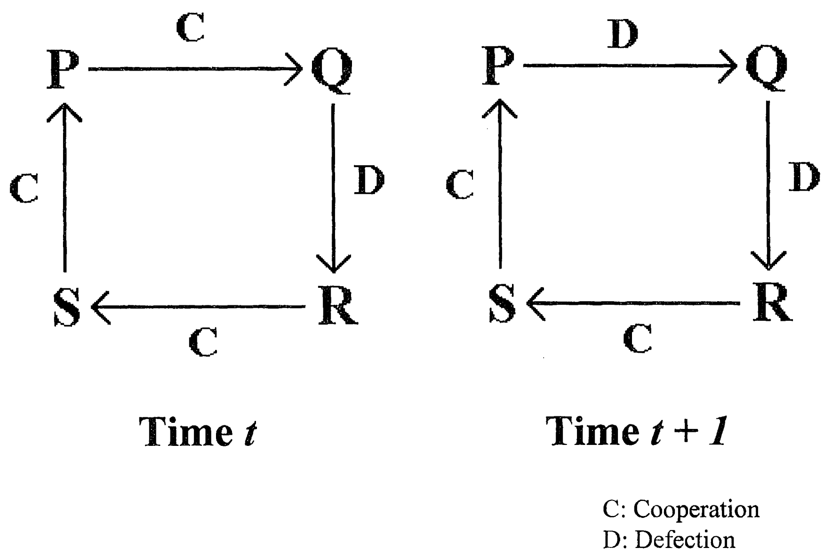

FIG. 1.—Downward TFT in network-generalized exchange

Downward Tit-for-Tat in Network-Generalized Exchange

Only a few empirical studies of generalized exchange have been conducted since the classical studies on the Kula rings and matrilateral cross-cousin marriage in anthropology (e.g., Bearman 1997; Gillmore 1987; Takahashi and Yamagishi 1999; Uehara 1990; Yamagishi and Cook 1993). Among them, Yamagishi and Cook (1993) is the most relevant here. They distinguished two forms of generalized exchange: "group-generalized" exchange and "network-generalized" exchange.[7] In the first type, group members pool their resources and then receive the benefits that are generated by pooling. In the second structure, which is the focus here, (1) each actor gives resources to an actor in the network who does not return resources directly to that actor, and (2) instead, the giver receives resources from some other actor in the network. An example of network-generalized exchange is shown in figure 1. The structure of exchange can be much more complex.

Yamagishi and Cook's experiment showed that people give more resources in network-generalized exchange than in group-generalized exchange. They explained this difference by the difference of the effectiveness of strategies. In group-generalized exchange, reciprocal strategies

[7] In Ekeh's (1974) words, this is "chain-generalized exchange."

(e.g., TFT) are not usually effective because one actor's behavior affects all the others (for more complete discussions of the effectiveness of reciprocal strategies in N-person situations, see Dawes [1980] and Yamagishi [1989*b*]). In network-generalized exchange, however, the actor who unilaterally gives resources has total control over the recipient's outcomes. Therefore, if the giver notices that the recipient is not giving to the recipient's recipient, he can punish the recipient by withholding resources until the recipient gives her resources to the recipient's recipient.

In another important study in a different field, biologists Boyd and Richerson (1989) tried to explain prosocial behavior by indirect reciprocity. Although most of the research in biology has focused on cooperation in dyads, they focused on the n-person relationship within a group. Particularly, they focused on the chain of helping, which corresponds to network-generalized exchange in Yamagishi and Cook (1993). According to Boyd and Richerson (1989), in network-generalized exchange, each actor can potentially use two types of unilateral-TFT strategies. These strategies in generalized exchange settings are unilateral because the giver can control the recipient's outcome but not vice versa: there is no way for the recipient to reward or punish the giver. What Boyd and Richerson (1989) proposed are upward-TFT and downward-TFT strategies. An actor adopting upward TFT gives resources to a designated recipient if and only if she received resources from a designated giver. In figure 1, Q gives resources to R at time $t + 1$ if and only if Q received resources from P at time t. Contrary to this rule, an actor using downward-TFT gives resources to a designated recipient if and only if the recipient gave to his own designated recipient in the previous trial. In figure 1, actor P gives her resources to Q at time $t + 1$ if and only if Q gives her resources to R at time t. Based on evolutionary biology and mathematical analysis, Boyd and Richerson (1989) argued that a network-generalized exchange system might be sustained if actors adopted the downward-TFT strategy.[8]

These two studies agree with each other in the conclusion that when network-generalized exchange emerges, it *may* be the result of a downward-TFT strategy. When people adopt this strategy, unilateral resource giving can be profitable. Free riding is not possible. There is at least one serious limitation in this solution, however. For generalized exchange to emerge, a particular fixed network structure must last for a long time.[9]

[8] Strictly speaking, Boyd and Richerson (1989) only argued that generalized exchange is more likely when each actor adopts downward TFT than when each actor adopts upward TFT. They admitted that even if actors adopt downward TFT, generalized exchange may be very unrobust.

[9] Another limitation is that these solutions might work only in extremely small groups. One reason is that network-generalized exchange is vulnerable to only one "hardcore" defector. Boyd and Richerson (1989) admit this possibility. Yamagishi and Cook

The network must be fixed and cannot be flexible. Otherwise, downward TFT is useless. However, many of the generalized exchange systems in the real world are not a simple closed chain of resource giving as in figure 1. For example, we do not always help the same stranded driver. Kula rings are more complex than a simple chain (Ziegler 1990). Empirically, there are certain deviations from the pattern of the chain of marriage (Bearman 1997). Thus, we need a more general solution to the free rider problem when there is no fixed network structure of generalized exchange. I present such a solution in the next section.

NEW MODEL: FAIRNESS-BASED SELECTIVE GIVING IN PURE-GENERALIZED EXCHANGE

In network-generalized exchange, there is a fixed network structure. Contrary to this, we can consider generalized exchange where there is no fixed structure. In Ekeh's (1974) example of the witness of a burglary, there is no fixed network of give and receive in the community. In this article, I call this situation *pure-generalized exchange* (Takahashi and Yamagishi 1995, 1996). Pure generalized is the most general, flexible, and least restricted type of exchange. In pure-generalized exchange, each actor gives resources to a recipient(s) that he chooses unilaterally. An example is shown in figure 2. Pure-generalized exchange is network-generalized exchange with a choice of recipients.

As Takahashi and Yamagishi (1995, 1996) have shown, the downward-OFT strategy can solve the free rider problem in a pure-generalized exchange system. This strategy is a synthesis of the OFT strategy and the downward-TFT strategy. We can consider this strategy as a variation of the OFT strategy where there is no direct reciprocity. Alternatively, we can consider this as a variation of the downward-TFT strategy where there is no fixed "chain" of exchange. However, there is an additional feature in this strategy. An actor using the downward-OFT strategy has to decide her behavior based on the recipient's behavior not to herself but to the third party. Takahashi and Yamagishi (1995, 1996) assumed that an actor compares her own behavior to the recipient's behavior and decides what to do to the recipient based on certain criterion. They called this decision-making mechanism "a sense of fairness." Thus, more precisely, an actor using the downward-OFT strategy (1) keeps giving resources to his recipients insofar as the recipient's behavior pattern of giv-

(1993) also admit this possibility, but they did not find a negative effect of group size on cooperation rate when they compared four-actor and eight-actor networks. The other reason is that it is necessary for each actor to know his designated recipient's behavior in order to use the downward-TFT strategy.

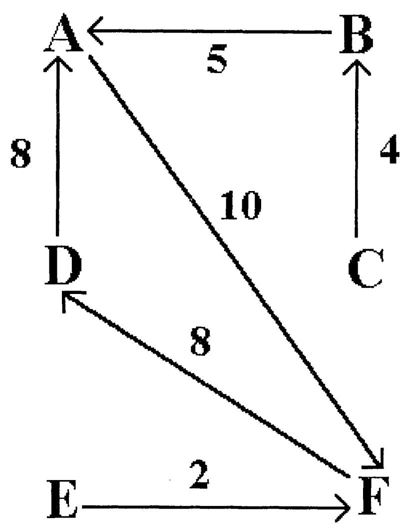

FIG. 2.—Selective giving in pure-generalized exchange. The number of each arrow represents how much each actor gives to a recipient. This giving amount is completely determined by each actor's giving gene. Each actor's tolerance gene is assumed to be 0 in figure 2.

ing meets the actor's criterion of fairness, and (2) deserts the recipient if the recipient does not meet his criterion and selects a new recipient randomly. An advantage of this solution is that an actor adopting the downward-OFT strategy requires information only about his recipient's behavior; therefore, the solution applies to a group of any size. However, it has one serious limitation. For pure-generalized exchange to emerge, the fairness criterion must be the same among all members of a group. In other words, a collective sense of fairness is necessary.

In this article, I propose a new model that eases this limitation, based on the fairness-based selective-giving strategy. I define it as follows: (1) An actor adopting the fairness-based selective-giving strategy gives her resources to a recipient whom she selects. (2) The actor selects a recipient whose giving behavior satisfies her criterion based on information from the previous behaviors. (3) The criterion is determined by the sense of fairness of this actor comparing the giving amount of this actor and that of the potential recipients.

This strategy has several features. First, it has the features of the unilateral conditional strategies. Because there is no direct exchange of resources in generalized exchange, any strategy must work unilaterally. There is no way for potential recipients to affect the giver's outcome.

Second, I assume that each actor has his own criterion of fairness and determines to whom he gives based on this sense of fairness. What is called "fairness" here has several characteristics. First, it refers to the comparison between how much the potential recipients give and how much the giver gives. In other words, it is the giver's evaluation of the ratio between how much the potential recipients receive from the giver (i.e., output) and how much the potential recipients give to others (i.e., input). In this sense, this is the same as what has been proposed in various fairness/equity/distributive justice theories in social psychology (e.g., Adams 1965; Homans 1974; Walster, Walster, and Berscheid 1978). All of them are concerned with the ratio of input and output. However, there is a big difference as well. While fairness involves the concern for ego's outcome in the fairness/equity/distributive justice research and mathematical models of justice in sociology (e.g., Jasso 1980; Markovsky 1985), in this pure-generalized exchange setting, "fairness" has nothing to do with ego's outcome. Each actor chooses a recipient based on his sense of fairness. Each actor can either give to a very generous actor or a very stingy actor. However, this choice of recipient makes no difference to the amount the giver receives, because there is no way for the recipient to affect the giver's outcome. Although a sense of "fairness" that is unrelated to one's own outcome seems strange at first sight, we certainly have this sense of "fairness." We like to help those who help others more than those who do not help others. If you encounter a car accident involving two injured people trapped in the cars, one who has worked hard to make the community better and the other who has not participated in any community activities, which person would you try to help first? Probably most people would help the first person first. The literature on helping/prosocial behavior has shown that whether the recipient deserves the help or not has an impact on helping (see, e.g., Batson [1987] and Piliavin and Charng [1990] for the review).

Third, because I assume that there can be a variety of standards of fairness in one society, this assumption is different from assuming that fairness is a collective norm (e.g., "univocal norm" in Ekeh [1974]). The criterion is not determined collectively by the society as a whole but by each individual. A recipient who is considered to be fair by one actor may be considered unfair by another actor.[10]

Fourth, an actor adopting this strategy punishes stingy actors (e.g., nongivers), not by imposing negative sanctions, but by not giving. Each actor's criterion of fairness determines who is stingy and who is not. This

[10] As one of the reviewers pointed out, this formulation still imposes a uniform norm of fairness because everyone has some criteria and everyone has the idea that giving more is better. The point I am making here is that everyone does not have the same criterion of fairness, although everyone does have, more or less, a sense of fairness.

characteristic has an important theoretical implication. As I discussed above, one of the main solutions to the free rider problem is to impose a penalty on defectors or to give a reward to cooperators. These are called selective incentives (Olson 1965). However, this solution implies that there is an agency to administer selective incentives. Thus, this solution introduces another problem: Who pays the cost of creating such an agency, and who pays the cost of sanctioning? Whether either a positive sanction (reward) or negative sanction (penalty) is administered by a central authority or by individuals, it produces another dilemma, called a "second order dilemma" (e.g., Heckathorn 1988, 1989; Oliver 1980; Yamagishi 1986*a,* 1986*b*). However, an actor adopting the fairness-based selective-giving strategy does not have to pay any cost to desert stingy others. She can simply choose another actor who gives much more. Thus, it does not produce a second-order dilemma.[11] This is the most important feature of the "selective play paradigm" where players are endowed with options for leaving the current relation and forming a new relation (e.g., Orbell and Dawes 1991; Hayashi and Yamagishi 1998; Yamagishi and Hayashi 1996). Recent studies have shown the effectiveness of this new paradigm (e.g., Orbell and Dawes 1991, 1993; Schuessler 1989; Yamagishi, Hayashi, and Jin 1994; Vanberg and Congleton 1992; see also Yamagishi and Hayashi [1996] and Hayashi and Yamagishi [1998] for more elaborated discussions on selective play). Moreover, because this sanctioning reduces the target's profit only, it does not produce a domino effect, or a "conflict spiral" (Lawler 1986). Therefore, not giving is the ideal sanction. Based on this theoretical argument, I assume that sanctioning by not giving would also be effective in this new model.

Finally, in applying this model, I assume that each actor knows all of the others' behaviors. This assumption means that this new model can explain generalized exchange only in a group in which everybody knows everybody else. It cannot really explain other types of generalized exchange, such as helping a stranded driver on a mountain road when the driver is a stranger. I will return to this point in the second simulation and try to loosen this restriction as much as possible.

COMPUTER SIMULATIONS

Evolutionary Simulation

In this study, several computer simulations were conducted. These are "evolutionary" simulations, and the basic structure of these simulations is

[11] When there is certain cost to withdrawing resources from the current recipient and seeking a new recipient, sanctioning by not giving produces a second-order dilemma.

based on Axelrod (1986). An evolutionary approach is based on the principle that what works well for an actor is more likely to be used again, while what turns out poorly is more likely to be discarded. Axelrod (1986) argued that there could be several different interpretations of this principle. One is a purely biological mechanism that the more effective individuals are more likely to survive and reproduce. The second is the principle of reinforcement in learning theory that the actors learn by trial and error, keeping effective strategies and altering ones that turn out poorly.[12] In this article, I adopt technical terms of the first interpretation (i.e., gene, natural selection, generation, and mutation) because it is the easiest way to illustrate the content of the simulations based on this evolutionary approach. However, these terms do not have substantive theoretical meaning in this article; I use them only as tools to explain evolutionary simulation.

In this study, I created an imaginary society in a computer that consists of members who have "gene(s)" whose values determine certain behaviors of their bearers. I then examine how this society evolves (e.g., how the values of giving genes in a society change) over generations. The result of evolution is represented by the distribution of the value of gene(s) in a society. The actors who are the members of a society in the final generation are the actors who have gene(s) that have received relatively higher profit. The actors who received lower profit cannot survive, and their gene(s) disappear. The purpose of this simulation is to make clear logically which value of gene(s) brings the maximum profit to each actor in a certain situation.[13]

Basic Flowchart

One simulation consists of many replications, one replication consists of many generations, and one generation consists of several trials. In each trial, the computer gives each actor 10 points. Each actor has two genes, and each decides how much and to whom to give her resources.

In the first generation of each replication, each actor's two genes, a giving gene and a tolerance gene, are determined randomly. The giving gene determines how much an actor gives to his recipient. The tolerance gene determines his potential recipients. In this simulation, each actor gives to only one recipient. The giving gene varies from 0 to 10 points. It determines how much an actor gives to a recipient. The actor whose giving

[12] A third one is purposive learning in that the actors observe each other, and those with poor performance tend to imitate the strategies of those they see doing better.

[13] This simulation is not a substitute for an experiment; instead, it is a substitute for a mathematical analysis.

gene is 0 gives nothing to his recipient in each trial. The actor whose giving gene is 10 gives all of the resources from the computer. The amount of the resources that each actor saves in each trial is added to his total profit in the generation. Thus, the higher the giving gene is, the more an actor loses. However, the amount of the resources that each actor receives from someone else is doubled and added to his total profit.[14] Because resource giving is unilateral, for each actor there is no guarantee of receiving resources from someone else.

Each actor adopts the fairness-based selective-giving strategy and selects a recipient based on her own criterion. This criterion, *M,* is based on the sense of fairness of each actor and is determined by the giving gene and the tolerance gene:

$$M = \text{an actor's giving gene} \times \text{the actor's tolerance gene.}$$

This tolerance gene is introduced here to make the criterion of fairness variable across actors. If two people who have the same value of the giving gene choose the recipient based on the same criterion of fairness, it means that we have a uniform norm of fairness. However, because of the tolerance gene, these two people may still behave differently. For example, let us suppose that a person has a high giving gene. In the extreme case such as a saint, she would also have a high tolerance gene. She would give a lot and would not discriminate between generous people and stingy people as recipients. However, most people who are generous would prefer to give to other generous people. And, who is generous and who is not from the viewpoint of the giver is determined by the combination of these genes. For example, a very discriminating giver might feel that only those who give more than twice of this giver's giving amount are generous and deserved to receive resources from him. An undiscriminating giver (i.e., closer to a saint) might feel that all the people who give more than half of her giving amount are generous and deserve to be given to by her.

Because this simulation assumes perfect information, each actor knows how many points all of the other actors gave to someone else in the previous trial. Each actor makes a list of actors who gave an amount equal to or more than his criterion. Then, each actor randomly chooses only one recipient from the list. If there is no one who gave more than M in the previous trial, the actor seeks "the second best," choosing the actor who gave the maximum (but still below M) points in the group in the last trial

[14] Following the standard practice in social dilemmas research, I assume that the value of resources received is twice as high as that of one's own resources. However, how many times the value of the given resources to the recipient would not have a big impact on the result, as long as the multiplying factor is larger than 1, which is the necessary condition for social exchange (Takagi 1996).

as a recipient. If the maximum actors are more than 1 in this case, this giver chooses a recipient randomly.

Let me demonstrate how this works in figure 2. In order to simplify this demonstration, assume that the tolerance genes of all of the actors in figure 2 are 1.0 (but in the actual simulations, it varies). First, let us consider *A*. The value of *A*'s giving gene is 10, and the value of *A*'s tolerance gene is 1.0. Therefore, *M* is 10 for *A*. Because none of the others satisfies *M* in figure 2, *A* must choose the second best. *F* and *D,* who give 8 points each, are the second best. Of the two, *A* randomly chooses *F* as his recipient. Next, consider *D*. The actors who satisfy *D*'s criterion are *A* and *F,* and *D* selects *A* as a recipient in this trial. Similarly, the actors who satisfy *C*'s criterion are *A, B, D,* and *F,* and *C* selects *B* in this figure. However, unfortunately, *C* receives points from no one in this trial. The only potential giver to *C* is *E,* because *E* is the only actor who gives less than *C*. However, *E* gives to *F* in this trial.

One generation consists of 10 trials. After the tenth trial, "natural selection" and "mutation" determine the members of a society in the next generation. In natural selection, each actor's cumulative profit in the generation is compared to others' total profit. An actor whose performance was poor is replaced by an actor whose performance was successful.[15] After that, mutation changes the value of each actor's genes by a small probability.

Simulation 1

To see whether generalized exchange can emerge in a society that consists of various members is the purpose of this first simulation. Table 1 shows the parameters. In this simulation, there is no independent variable. The dependent variable is the mean of the giving gene of each group in the final 10 generations. I conducted two sets of simulations. In simulation 1–1, the initial value of the giving gene was determined randomly. However, even if pure-generalized exchange could emerge in this simulation, this might not be enough to conclude that it can emerge in various societies. In the first generation, there are some members whose giving genes are high. Therefore, the emergence of generalized exchange (if possible) might be the effect of preexisting altruistic actors (i.e., the actors whose giving genes are high). To eliminate this possibility, I conducted the second set of simulations. In simulation 1–2, all giving genes are initially set

[15] The actors whose cumulative profits were less than the criterion (i.e., average profit in the group-standard deviation) leave no offspring. The actors whose cumulative profits were more than the criterion leave two offspring. The actors whose cumulative profits were close to the average leave one offspring. For simplicity, I adjusted the group size to be constant.

TABLE 1

Parameters of Simulation 1

Parameter Names	Values
Group size	20
Number of replications	50
Number of generations	1,000
Number of trials per generation	10
Number of resources that each actor is given in each trial	10
Value of resources that each actor receives from others	2
Giving gene	from 0 to 10
Tolerance gene	from .1 to 2.0
Mutation rate	.05 (5%)

to 0. This means that no actor gives to anybody in the first generation. The initial value of the tolerance gene was determined randomly in both simulations.

To obtain my measure of the dependent variable, generalized exchange, I first calculated the mean of the giving gene among the group in the last 10 trials, and I then calculated the mean of 50 replications as the mean of each condition. The results are very clear. The level of generalized exchange during the last 10 trials was 9.30 in simulation 1–1, and 9.47 in simulation 1–2. Standard deviations were 1.25 and 0.65, respectively. Thus, there is no substantial difference between the results of these two sets of simulations. Pure-generalized exchange emerged from a society with no altruists, that is, a society in which no one gave to anyone initially. The mean of the tolerance gene during the last 10 trials was 1.00 in both simulations. Standard deviations were 0.22 and 0.27, respectively. Although the value of the tolerance gene varied across members, generalized exchange nonetheless emerged.

Figure 3 shows one example of the history of evolution. This graph shows that generalized exchange is robust. Although the average giving gene declined several times, it soon recovered. This means that a mutant whose giving gene is more than 1 can get more profit than others whose giving genes are 0.[16] Therefore, generalized exchange can emerge even among egoists. In contrast, the mean of the tolerance gene fluctuated. Under the parameters of this simulation, the value of the tolerance gene does

[16] If only one mutant, whose giving gene is more than 0, emerges in a society where no one gives to anyone, he cannot profit. This mutant simply loses his resources. However, when more than one mutant is born in the same generation, these mutants might survive and eventually dominate others whose giving genes are 0.

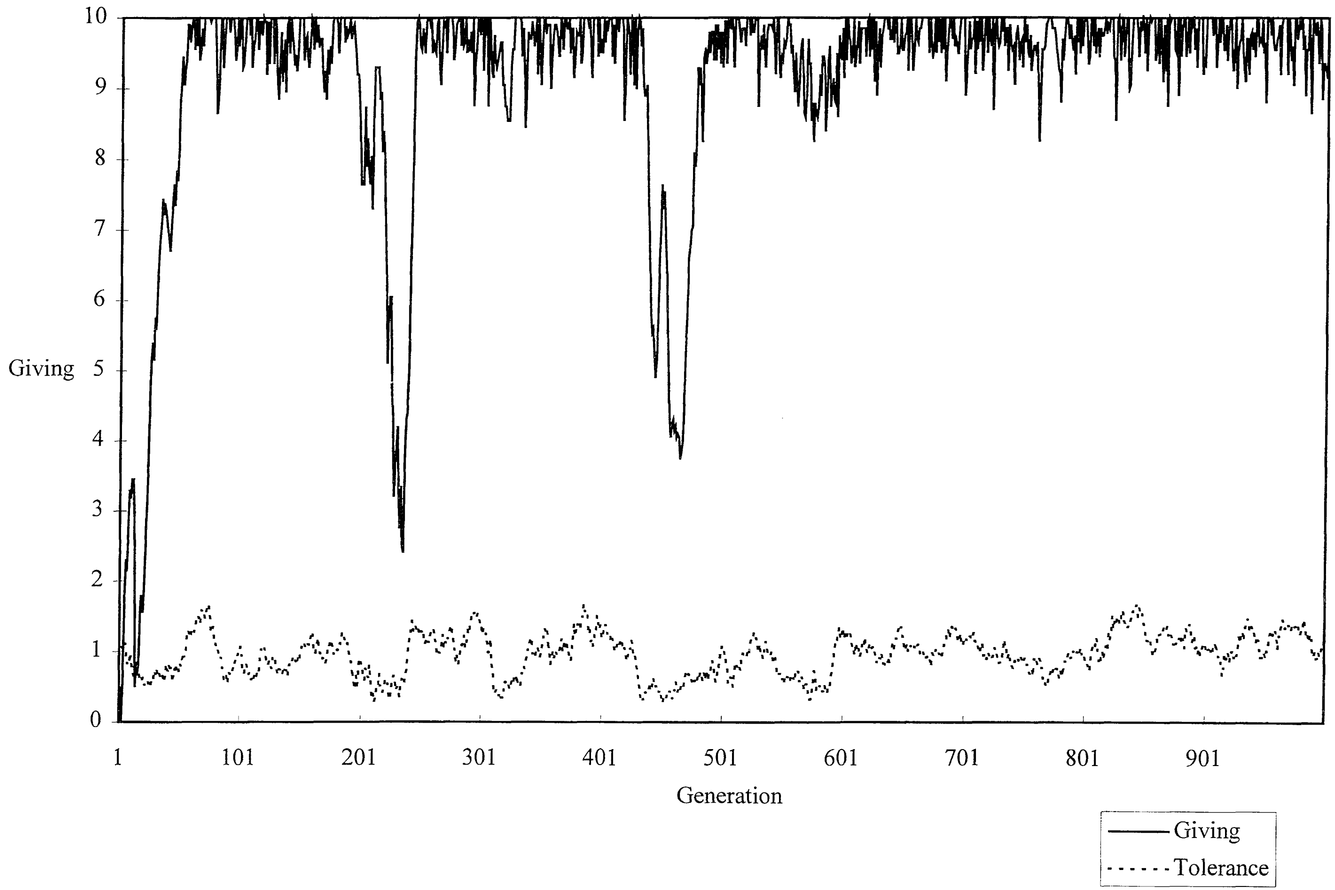

FIG. 3.—One example of simulation 1

not affect an actor's own total profit. Only the giving gene affects her profit. Therefore, this fluctuation should be random, and it was produced by mutation. Even with this fluctuation, pure-generalized exchange emerged. Therefore, the emergence of generalized exchange does not require a sense of fairness as a collective norm.

Simulation 2

The results of simulation 1 show that the emergence of generalized exchange is easier than had been expected. It does not require central authority, altruism, nor collective norms. However, the new model in this article requires another major assumption: perfect information. The new model can apply only in situations in which everybody knows everybody else. As long as this assumption exists, the emergence of generalized exchange remains possible only in limited situations. Therefore, in this second simulation, I loosen this assumption.

In natural settings, people are embedded in social networks, such as family, school, company, organization, and so forth. People interact with the other members of these networks more frequently than with those who are outside the networks (e.g., Grannis 1998; Marsden and Laumann 1984; Wellman and Berkowitz 1988). Therefore, a reasonable assumption is that each member of a society does not know all of the other members of a society but knows only other members of the networks that are significant to himself. In other words, perfect information may not hold true in an entire society but may hold true in these significant networks. However, even in this situation, it is anticipated that pure-generalized exchange can emerge. Based on simulation 1, I anticipated that generalized exchange can emerge first in a local small group. Because it is plausible that a large society consists of many small groups or networks, and they overlap to some extent, it is possible that generalized exchange then spreads beyond the specific group or network.

To test this prediction, I conducted a second series of simulations. The purpose of this simulation is to see whether generalized exchange can emerge even in a society in which each member knows only a part of the society. This simulation is also based on the evolutionary approach. To operationalize a large society that consists of many small local groups, I used the territorial system (Axelrod 1984). In this situation, each actor is embedded in a two-dimensional space and interacts only with his spatial neighbors. Although there are several other ways to represent a society in which each member knows only a part of it, I used the territorial system because it is the simplest way. According to Axelrod (1984), territories can be thought of in two ways. One way is in terms of geography and physical space. Each house or each country is located on the surface of the earth.

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

FIG. 4.—Territorial system. The number of each cell represents the number of each actor.

The other is in terms of an abstract space of characteristics. For example, people interact with relatively similar others more frequently than with relatively dissimilar others. The mechanism of spreading of successful strategies can occur in two ways, too. One is imitation, and the other is colonization. If the neighbor is doing well, the behavior of the neighbor can be imitated. Or, the location of a less successful actor can be taken over by an offspring of a more successful neighbor. But whether spreading occurs by imitation or colonization, the idea of a territorial system is the same: neighbors interact with each other, and the most successful actors spread to bordering locations.

In this simulation, a society consists of 100 actors. Each actor is embedded in a two-dimensional space. Figure 4 shows an example. Each actor knows only eight adjoining actors around herself.[17] For example, actor 55

[17] Figure 4 is considered to be a square. In other words, the number of actors that peripheral actors know is less than the number that central actors know. For example, actor 1 knows only actors 2, 11, and 12. Although the territorial system in Axelrod (1984) is a surface of a sphere, in order to guarantee that everyone has exactly the same number of neighbors, I decided to use a square for simplicity. Replicating this 50 times should be sufficient to cancel out the effect of peripheral actors.

TABLE 2

Parameters of Simulation 2

Parameter Names	Values
Group size	100
Number of replications	50
Number of generations	200
Number of trials per generation	10
Number of resources that each actor is given in each trial	10
Value of resources that each actor receives from others	2
Giving gene	from 0 to 10
Tolerance gene	from .1 to 2.0
Mutation rate	.01 (1%)

knows only actors 44, 45, 46, 54, 56, 64, 65, and 66. She does not know the other actors, such as actor 43. It means that each actor belongs to a small group of nine members from each actor's point of view. In this small local group, each actor does the same thing as in simulation 1. Table 2 shows the parameters. However, there is one difference between the algorithm of simulation 1 and that of simulation 2. In simulation 1, the criterion of "natural selection" is the mean and SD of total profit for the entire group. An actor whose total profit is large can have more "children" than low performers in each generation. However, in simulation 2, if one actor has any neighbor whose total profit was higher than his own profit, this actor learns the strategy of the most successful of them regardless of the mean or SD of the entire society. Figure 5 shows an illustrative example based on colonization. For simplicity, I assume no mutation occurred from generation t to generation $t + 1$ (but in the actual simulations, it occurs). For example, actor (9, 9), whose giving gene is 5 and whose total profit is 146 points, was taken over by actor (8, 9), whose giving gene is 7 and whose total profit is 334 points. This actor (8, 9) in generation t also colonized actor (9, 8) and actor (9, 10). However, this actor was taken over by actor (7, 9) whose total profit was 368 points.

In simulation 2, there is no independent variable. The initial value of the giving gene was set to 0. The initial value of the tolerance gene was determined randomly. The result is striking: The mean of the giving gene during the last 10 trials was 9.47, and SD was 1.77. Since the maximum potential value is 10.0, a mean of 9.47 implies that almost perfect generalized exchange emerged. There were only two replications in which the mean of the giving gene was under 9.5. Figure 6 shows an example of the history of the society in one replication. This figure shows that generalized

0	0	0	0	0	0	0	0	0	0
(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)
0	0	0	0	0	0	0	0	0	0
(100)	(116)	(108)	(100)	(100)	(100)	(100)	(100)	(100)	(100)
0	4	0	0	0	0	0	0	0	0
(100)	(60)	(108)	(100)	(100)	(100)	(100)	(100)	(100)	(100)
0	0	0	0	0	0	0	0	0	0
(100)	(132)	(116)	(100)	(100)	(100)	(100)	(100)	(100)	(100)
0	0	0	0	0	0	1	7	0	0
(100)	(100)	(100)	(100)	(100)	(100)	(90)	(68)	(100)	(100)
0	0	0	0	0	0	0	1	7	7
(100)	(100)	(100)	(100)	(100)	(100)	(100)	(102)	(258)	(100)
0	0	0	0	0	0	4	7	7	7
(100)	(100)	(100)	(100)	(100)	(100)	(100)	(236)	(368)	(240)
0	0	0	0	0	4	4	7	7	7
(100)	(100)	(100)	(100)	(100)	(68)	(116)	(320)	(334)	(146)
0	0	0	0	0	4	4	4	5	5
(100)	(112)	(118)	(106)	(100)	(148)	(108)	(68)	(146)	(130)
0	0	3	0	0	4	4	4	5	5
(100)	(118)	(70)	(106)	(100)	(76)	(116)	(68)	(124)	(80)

↓

0	0	0	0	0	0	0	0	0	0
(116)	(116)	(116)	(108)	(100)	(100)	(100)	(100)	(100)	(100)
0	0	0	0	0	0	0	0	0	0
(116)	(116)	(116)	(108)	(100)	(100)	(100)	(100)	(100)	(100)
0	0	0	0	0	0	0	0	0	0
(132)	(132)	(132)	(116)	(100)	(100)	(100)	(100)	(100)	(100)
0	0	0	0	0	0	0	0	0	0
(132)	(132)	(132)	(116)	(100)	(100)	(100)	(100)	(100)	(100)
0	0	0	0	0	0	1	7	7	7
(132)	(132)	(132)	(116)	(100)	(100)	(102)	(258)	(258)	(258)
0	0	0	0	0	0	7	7	7	7
(100)	(100)	(100)	(100)	(100)	(100)	(236)	(368)	(368)	(368)
0	0	0	0	0	4	7	7	7	7
(100)	(100)	(100)	(100)	(100)	(116)	(320)	(368)	(368)	(368)
0	0	0	0	4	4	7	7	7	7
(112)	(118)	(118)	(118)	(148)	(148)	(320)	(368)	(368)	(368)
0	0	0	0	4	4	7	7	7	7
(118)	(118)	(118)	(118)	(148)	(148)	(320)	(334)	(334)	(334)
0	0	0	0	4	4	4	5	5	5
(118)	(118)	(118)	(118)	(148)	(148)	(148)	(146)	(146)	(146)

FIG. 5.—An example of colonization. The top table shows the situation at generation t, and the bottom table shows the situation at generation $t + 1$. The numbers outside the parentheses represent the value of the giving gene. The number inside the parentheses represent the total profit.

exchange is very stable and never declines. This implies that the situation in which everyone has a high level of the giving gene is an equilibrium. Again, the mean of the tolerance gene fluctuates as expected. There seems to be no equilibrium point. From these results, we can conclude that pure-generalized exchange can emerge even in a society in which each member has information only about her neighbors. Therefore, the assumption of perfect information in the new model is successfully loosened.

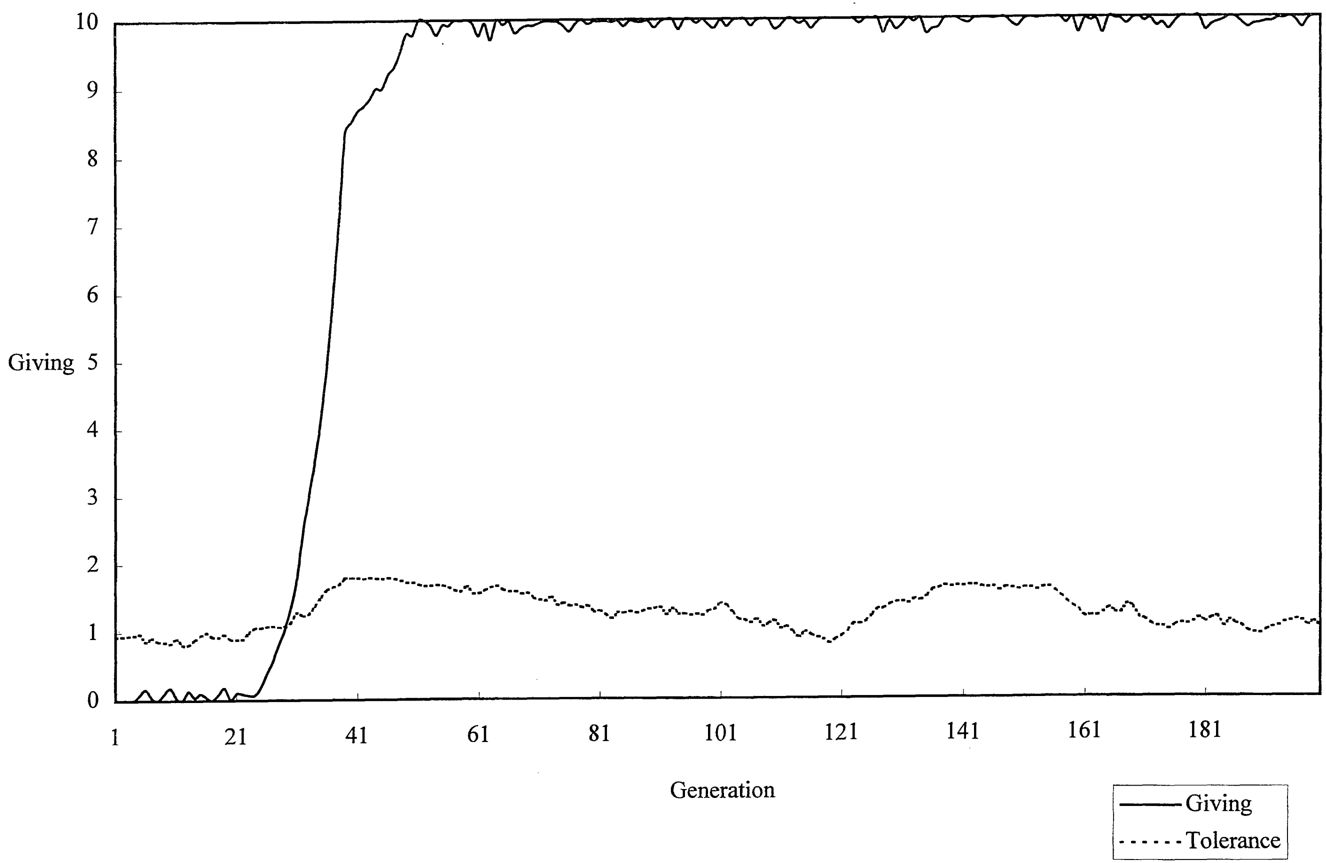

Fig. 6.—One example of simulation 2

DISCUSSION

Generalized exchange has been explained by altruism (e.g., Sahlins 1972; Nye 1979) or collective norms (e.g., Ekeh 1974; Lévi-Strauss 1949). However, if we assume that actors are self-interested, the emergence of generalized exchange, characterized by unilateral resource giving, has posed a puzzle because of the possibility of free riding. Thus, we need to solve the social dilemma problem that is involved in a generalized exchange situation. One of the main solutions for the free rider problem is selective incentives (Olson 1965), but that introduces another issue: the second-order free rider problem (Oliver 1980; Yamagishi 1986*a,* 1986*b*). Previous studies that adopt the social exchange/rational choice perspective have solved these problems by imposing a particular social structure (i.e., network-generalized exchange; e.g., Boyd and Richerson 1989; Yamagishi and Cook 1993). However, this solution has its own weakness and limitation. This study also adopted the social exchange/rational choice approach and tried to impose particular social structures as little as possible.

In order to pursue this goal, this study proposed a new model that can solve the free rider problem that exists in generalized exchange. I first identified a new situation, pure-generalized exchange, in which each actor gives resources to the recipient(s) of her choice. Second, I proposed a new strategy, the fairness-based selective-giving strategy, in which actors select recipients whose behaviors satisfy their own criteria of fairness. The main argument was that this fairness-based selective-giving strategy would make pure-generalized exchange possible.

To show that this normative and theoretical argument can hold, I conducted two evolutionary simulations. The results of simulation 1 showed that pure-generalized exchange can emerge very easily, even in a society in which no one gives to anyone else initially (i.e., a society of egoists). They also showed that pure-generalized exchange can emerge even in a society in which members have different standards of fairness. Therefore, altruism and a collective sense of fairness are no longer required. However, in simulation 1, this solution required another strong assumption, the assumption of perfect information. In order to select the recipients, each actor must know every other actor's behavior.

To loosen this assumption as much as possible, I conducted simulation 2. Using the territorial system, simulation 2 created societies where members had information only about their immediate neighbors. The results again supported the theoretical argument. Even in this situation, pure-generalized exchange could emerge by virtue of the fairness-based selective-giving strategy.

In sum, the results of these simulations show that we can explain the emergence of pure-generalized exchange even if we do not assume preexisting altruistic motivation or norm of reciprocity, provided that each individual has a sense of fairness.[18]

Because I assume self-interested actors, it might be possible to interpret the results of the simulations as showing that actors intentionally give their resources unilaterally in order to increase their own profits. This interpretation corresponds to the forward-looking rationality that typical rational choice theory adopts. However, there is another reasonable interpretation. Based on the logic of learning theory and evolutionary biology, it is possible that actors come to give their resources unilaterally because unilateral resource giving brings profit (but not necessarily from the recipient)—regardless of the actors' intentions. This corresponds to backward-looking rationality. Because pure-generalized exchange is complex, and because there is no guarantee of quid pro quo, actors may not know the consequences of their behavior in advance. Thus, in a society in which pure-generalized exchange holds, actors who give their resources altruistically (i.e., not expecting future return) to others receive benefits. Therefore, the new model in this article may suggest a foundation for "altruism" (i.e., certain behavioral patterns that encourage people to believe that an actor might be an altruistic person, but not altruistic motivation per se).[19] In English, there are several interesting proverbs, such as "Charity is a good investment," or "He who gives to another bestows on himself." Similar proverbs exist across the world. They might represent the truth. The computer simulation, of course, is silent on the question of which motivation (i.e., maximizing one's outcome or altruism) is empirically true. What I have shown is that behaviors that look like altruism can emerge even if we do not assume altruism in the first place.

However, this "altruism" is not altruism in a broad sense. Indeed, if this study could show a foundation for altruism, it would not be a foundation for "universal altruism," but a foundation for "selective altruism" or "discriminating altruism" (Hardin 1982; Takagi 1994, 1996). Universal altruism means no discrimination. A person adopting universal altruism gives resources to anybody, whether the recipient is a good person or a

[18] We can consider an alternative model that uses the principle of homophily; people give to those who are similar to themselves in level of giving, not to those who give less or to those who give more. This may work as well as fairness-based selective-giving strategy. This is certainly an interesting approach for the future research. One could also specify the conditions under which generalized exchange emerges. This is beyond the scope of this article; however, I can speculate several effects of the conditions on generalized exchange. I believe that the density of the network in simulation 2 should have a positive effect on cooperation. The more eyes there are, the more likely cooperation is to be achieved. And, I believe that the size of groups does not matter in simulation 1.

[19] Takagi (1994, 1996) also suggested this implication.

killer. In contrast, selective altruism means that a person behaves altruistically to one kind of person but not to another kind. A person who adopts discriminating altruism selects a recipient based on certain criterion. The extreme case is kin selection in evolutionary biology. In this case, the selection criterion is the number of common genes between the person and the target. What Hardin (1982) originally had in mind is altruism only to in-group members (e.g., cronyism, tribalism, and patriotism). In this case, the criterion might be race, ethnicity, or country. Although the context is different, the concept of the fairness-based selective-giving strategy fits that of discriminating altruism. In this case, the criterion is how a target behaves to others compared to how oneself behaves to others. I called this fairness in this article. Therefore, what this study may show is a foundation of selective altruism based on a type of fairness. This is parallel to what Axelrod (1984) showed. He showed that reciprocal altruism between dyads can emerge even if we assume self-interested actors. This article showed that selective altruism based on fairness among multiple actors can emerge even if we assume self-interested actors.

Limits and Future Directions

The new model that I proposed in this article can explain generalized exchange under much less restrictive conditions than those used in previous research. However, it cannot explain all patterns of generalized exchange. First, the fairness-based selective-giving strategy requires a certain amount of information about potential recipients. Based on this information, an actor using fairness-based selective giving decides whether or not to give. Although this condition was loosened in simulation 2, at the same time, the potential recipients of each actor were only his neighbors. Therefore, this model cannot explain unilateral resource giving to a complete stranger (e.g., helping a stranded driver), although this model is appropriate for Ekeh's (1974) example of witnessing a burglar.

From this restriction, two future directions can be considered. First, it might be possible that generalized exchange emerges originally in a relatively small subgroup (i.e., neighbors, friends, work-related acquaintances, etc.) and then spreads throughout an entire society. The fact that cultural anthropologists have observed generalized exchange in primitive societies might suggest this possibility. In order to examine this possibility, either social network research (e.g., Granovetter 1973; Blau 1977; Marsden 1987), which examines the internal structure of a society, or evolutionary biology (e.g., Hamilton 1964), which examines altruism in kinship groups, would be useful.

The second direction involves studies about behavior under uncertainty. Following the new model in this article, if an actor gives her resources to a stranger, she should estimate whether this stranger typically gives much or little. Very recently, research studying the relationship between social uncertainty and cognitive traits has begun. For example, Frank (1988) and Frank, Gilovich, and Regan (1993) argue that people can detect their partners' intentions to some extent in a PD game. Also, this line of research has begun to use the approach of the signaling game from evolutionary biology (e.g., Macy and Skvoretz 1998). Orbell and Dawes (1991, 1993) argue for a "false consensus" effect, that is, a person who is cooperative estimates that others also would be cooperative. Recent development of the theories of trust by Yamagishi and his associates (e.g., Yamagishi and Yamagishi 1994; Yamagishi, Cook and Watabe 1998) argue that people use their own general trust as a default to estimate others' benevolence. Linking generalized exchange to these findings would be very fruitful.

The other restriction of this study is the assumption of an individual sense of fairness. As I discussed above, the conception of fairness in this article is somewhat different from that used by previous fairness/justice researchers. Previous researchers have typically assumed a situation where fairness-based action directly affects one's own outcome. Certainly, people have an egocentric bias of the fairness judgment (e.g., Messe, Hymes, and MacCoun 1986; Messick and Sentis 1979). However, the sense of fairness in this article *does not* affect one's outcome. Having this sense of fairness does not fit either the perspective of forward-looking rationality that is typically assumed in rational choice and game theory or perspective of the backward-looking rationality that is typically assumed in social exchange theory, learning theory, and evolutionary theory (Heath 1976; Macy 1993*a*). Having a sense of fairness is not beneficial to the actor. As I argued above, it is true that the fairness-based selective-giving strategy can fit both perspectives, but the sense of fairness itself does not. However, having this sense of fairness does not contradict the rationality principles, either, because having it does not give any disadvantage to the actors. More technically, each person's profit is determined by the giving gene, not by the tolerance gene. As long as persons give to someone else, they are likely to be targets of giving by others, whether they are selective or not. That is why the mean of the tolerance gene fluctuated around 1.00. Therefore, this study does not show a foundation for fairness, although it would have been better if it could. Thus, I leave this as an assumption: a certain level of fairness within a society is a necessary condition for the emergence of generalized exchange, although the fairness criterion of each individual can be different. At this point, I can only suggest that there might be an interdependency between a tendency to give and fairness. One preliminary experimental study of generalized exchange showed that there is a positive correlation between the amount of giving and the concern with fairness (Takahashi and Yamagishi 1999). In other words, empirically, generous givers are more selective (choosy) than stingy givers. Clearly future research on the origin of the sense of fairness is needed.

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