AN IDENTITY MODEL FOR NETWORK EXCHANGE*

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Network exchange theory has developed primarily as a static, structural theory of power and dependence in networks. I introduce a dynamic model of the exchange process in which network nodes are based on a model of identity processes as given by identity theory. That is, I use the assumptions of identity theory to model the identity of a "typical" experimental subject whose primary goal is to participate in exchanges in an experimental paradigm. Computer simulations of the exchange process based on this identity model then generate predictions about the power advantage of particular nodes (actor's positions) relative to other nodes in a variety of networks. The resulting predictions correspond closely with results obtained in published experiments that have been interpreted as supporting network exchange theory. In addition, varying the characteristics of the identity model in the simulation reveal the interaction between individual (identity) and structural (network) characteristics in determining power and process in the network. I also show how a process model, like the one simulated, allows us to understand the exchange process over the long run, which can differ considerably from the usual short-term laboratory experiment.

The primary focus of network exchange research is to increase our understanding of the distribution of power in exchange networks—networks of individuals, each of whom can exchange with selected others. The research has emerged from neoclassical economic theory and the structuralist tradition in sociology. Issues of interest concern how different actors, each of whom controls varying amounts of different resources that each needs or desires according to some utility function, can exchange those resources so as to improve upon his or her prior condition.

At issue is how much each actor gives up and how much each actor gains. Economic theory by itself cannot solve the problem in the two-person situation because large numbers of actors are required to model competitive markets (Cook and Emerson 1978); so other approaches must be brought into play. To help resolve this problem, Cook and Emerson (1978) introduced the concept of dependence of one actor on another for resources. Central to the concept of dependence is the idea that actors may have alternative sources for whatever resource they need. Thus, each actor exists within a network of other actors with resources, and the network structure (i.e., who can exchange with whom) determines the existence and number of alternative sources each actor has. By varying the structure of the network connections (type of social structure), one can investigate the impact of this miniature social structure on the dependence of one actor on any other in that network. Inasmuch as power is the inverse of dependence, this paradigm illuminates how social structure determines the distribution of power. The theoretical concepts of power and exchange in sociology have grown from this perspective.

Much work on power in exchange networks, however, has maintained a static conceptualization of power. In their review,

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Skvoretz and Fararo (1992) suggest the need to go beyond the current "comparative statics" analyses to a "formal, dynamic process conceptualization of power development in exchange networks" (p. 325). I focus on this goal in the present paper. Using identity theory, broadened to incorporate the control of resources as well as meanings (Freese and Burke 1994), I present a formal, dynamic, multilevel identity model and apply it in a simulation of the network exchange paradigm. In a series of exchange networks, each actor is represented by a model of the identity process such that each actor/identity interacts with other actors/identities in the networks, negotiating and exchanging according to the rules of the identity model and the structure of the particular network.

With this approach, several things can be demonstrated. First, points earned in an exchange may not be the relevant resource that controls network interaction, nor may points earned be the best indicator of power. Second, power is not associated with position in the network alone, but hinges on the relationship between individual goals and how these goals can be met in the network. Third, understanding that exchange interactions in the network are by nature a *process* leads to new conceptualizations of network structure, and new questions about those structures and the distribution of power in them extend from this understanding.

NETWORK EXCHANGE MODELS

In the network exchange paradigm, a number of individuals is brought together in an experimental setting. Each participant can interact and exchange only with a predetermined subset of the others. It is explained to them that they will engage in a series of rounds of exchange—usually 40 rounds. Typically, an exchange consists of a negotiated agreement on the division of a 24-point award during the round. If a division of points is not achieved in a given amount of time, neither party receives any points in that round. In most network structures, each participant can engage in one exchange per round. Depending on the structure (i.e., who can exchange with whom), some participants occasionally may be left out of an exchange in one round, thus receiving nothing. To secure an exchange in the next round, these participants therefore agree to a "less profitable" exchange in the next round; this leads to inequalities in points earned over the 40 rounds.

Figure 1 shows a number of different networks; each varies in the number and pattern of potential exchange connections between participants. Consider, for example, a line4 network (see Figure 1b). Suppose actors B_1 and A_1 are bargaining over the division of a 24-point award. Suppose that B_2 has already offered B_1 10 points if B_1 and B_2 exchange, thus B_1's alternative is 10 points. A_1 has only B_1 as an exchange partner, so A_1's alternative is 0 points. If A_1 and B_1 agree to divide the award unequally with 13 points for B_1 and 11 points for A_1, then B_1 gets 3 points more than B_2 has offered, while A_1 gets 11 more points than his/her alternative.

Currently, four basic theoretical models are used to predict the distribution of power (i.e., points) in exchange networks: (1) *core theory* (Bienenstock and Bonacich 1992); (2) *equidependence theory* (Cook and Yamagishi 1992); (3) *network exchange theory,* with variations including network exchange-resistance theory (NET-R), network exchange resistance-degree theory (NET-RD), and the iterative graph-theoretic power index (GPI) (Markovsky et al. 1993; Lovaglia, Skvoretz, Willer, and Markovsky 1995); and (4) *expected value theory* (Friedkin 1986). As Skvoretz and Willer (1993) point out, these theories share the fundamental assumption that power differentials between actors are related to differences in the actor's positions in the network of exchange relations. Power is thus a function, not of the actions of the individuals, but of the *positions* they occupy in the network structure. Also, all four models assume that actors are rational—that each actor attempts to maximize his or her payoff in each exchange.

Characteristics of the Models

The four models above are structural theories of power because the power of a particular node (an actor's position) in a network is primarily a function of the characteristics of the network as a whole[1] and of the location

[1] Network exchange theory has shown that under some conditions, only the local structure of

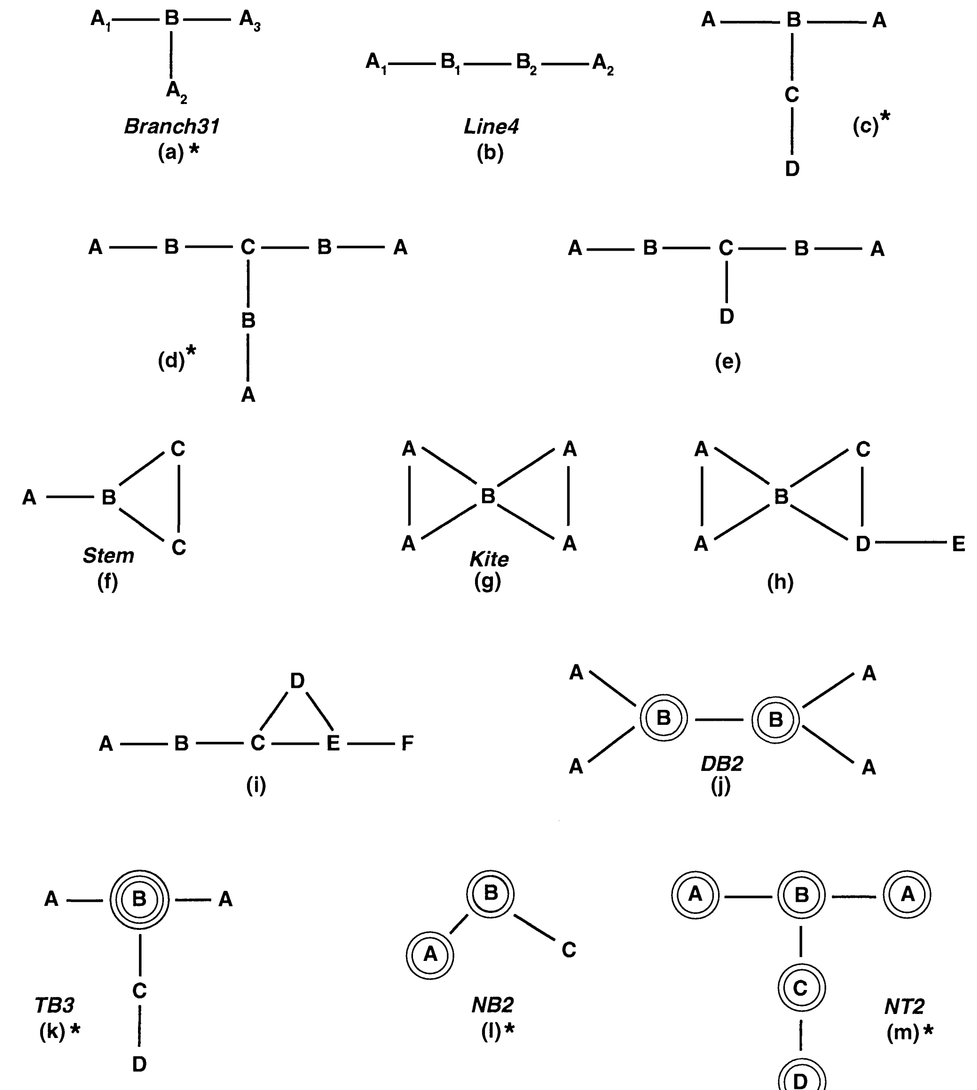

Figure 1. Networks in the Study

Note: Lines indicate possible network connections. Circles indicate the number of exchanges permitted for the node during each period of exchange. Asterisks (*) indicate strong-power networks in which power differences become extreme; the remaining networks are weak-power networks.

of that node in the network. Because power is seen as residing in *position*, these models pay little attention to the *process* by which that power is realized. They do include some auxiliary assumptions, as tests of the models are usually conducted by having actors negotiate network exchanges in laboratory experiments. The usual assumptions are that actors want to earn as much as possible during each exchange and that they are "rational"—they will choose as exchange partners those who offer the "best" deal and then will try to negotiate an even better deal.

Each actor's degree of dependence on the potential exchange partners is the primary factor determining that actor's power in the network. Network exchange-resistance theory (NET-R) measures this dependence by

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the network is relevant (i.e., the structure of the network in the immediate vicinity of the node under consideration) (Markovsky, Willer, and Patton 1988).

a graph-theoretic power index (GPI), modified by the probability of being excluded from exchanges given the network structure. The network exchange resistance-degree model (NET-RD) adds a bias determined by the degree of connectedness of a position. Expected value theory measures dependence in a third way. Equidependence theory focuses more on the point values of the exchanges than on the probability of inclusion; nevertheless, exclusion figures heavily in the model because the alternative exchange always equals 0 for the person who may be excluded.

All these factors, then, are fixed by the network structure. Process enters into the situation only because actors must complete negotiations and exchanges over a period of time so researchers can collect data that reflects the features of the network structure. The models thus are static—they are oriented only to predicting the distribution of points earned, which according to these theories reflects the distribution of power in the network.

Each of these network exchange models predicts power in networks by using specific network properties in a set of simultaneous equations and the "unknown" of the number of points offered by actors in each of the network nodes. The set of equations is solved for the unknown points offered (or earned). For the networks considered in this study (see Figure 1), the theoretical point advantages certain nodes have over others are presented in Table 1 on page 143 (Markovsky 1992; Skvoretz and Fararo 1992; Skvoretz and Willer 1993; Fararo and Hummon 1994; Lovaglia, Skvoretz, Willer, and Markovsky 1995).

Two Process Models

Since power is measured in terms of earnings across a set of negotiated exchanges, power is, in fact, *realized* by the *process* that leads to those earnings. Some theorists have begun to look at this process by building stimulus-response simulation models that attempt to mirror the network exchange *process* (Markovsky 1987, 1992; Fararo and Hummon 1994). In these works, the characteristics of the actor, in addition to his or her network position, play an important role, and these characteristics are, in fact, subject to investigation in terms of their impact on the power process (Markovsky 1987).

Markovsky's (1992) X-NET model, for example, follows a simple set of rules.[2] Simulated actors at each node seek exchanges with actors at each of the other nodes to which he or she is connected. If a node is included in an exchange in one round, its offer is decreased in the next round by one point. If it is excluded from an exchange in one round, its offer is increased in the next round by one point. This is a simple stimulus-response model. The Discrete Event Simulation (DES) model by Fararo and Hummon (1994) follows a similar, though slightly more complicated, set of rules. It was designed more as an illustration of modeling procedures than as an attempt to fully model network exchange theory. In the DES simulation, simulated "agents" bargain, making offers and counter-offers until an exchange occurs. The resulting exchange represents the "most" that each agent could get and still complete the exchange. Each agent starts with an "aspiration level"—the number of points desired from an exchange. Initially, the aspiration level is set high and is lowered one point at a time as necessary until an exchange occurs. Again, this is a stimulus-response model that simply responds in a predetermined way to particular fixed stimuli. While the DES model, compared with X-NET, simulates much more of the activity that human actors actually go through in making exchanges, it depends heavily on initial aspiration levels, and unlike X-NET it has no mechanism for lowering its offers (raising the aspiration levels) once the bargaining starts. The predictions of these models for some of the same networks under consideration, are also presented in Table 1 (see page 143).

THE IDENTITY MODEL

Before presenting the identity model for exchange processes that I test here, let me first

[2] Indeed, the model is not presented as a theory of the exchange process nor is it meant to predict experimental results. It is simply a computer "agent" that can play "intelligently" against human subjects in an experimental situation.

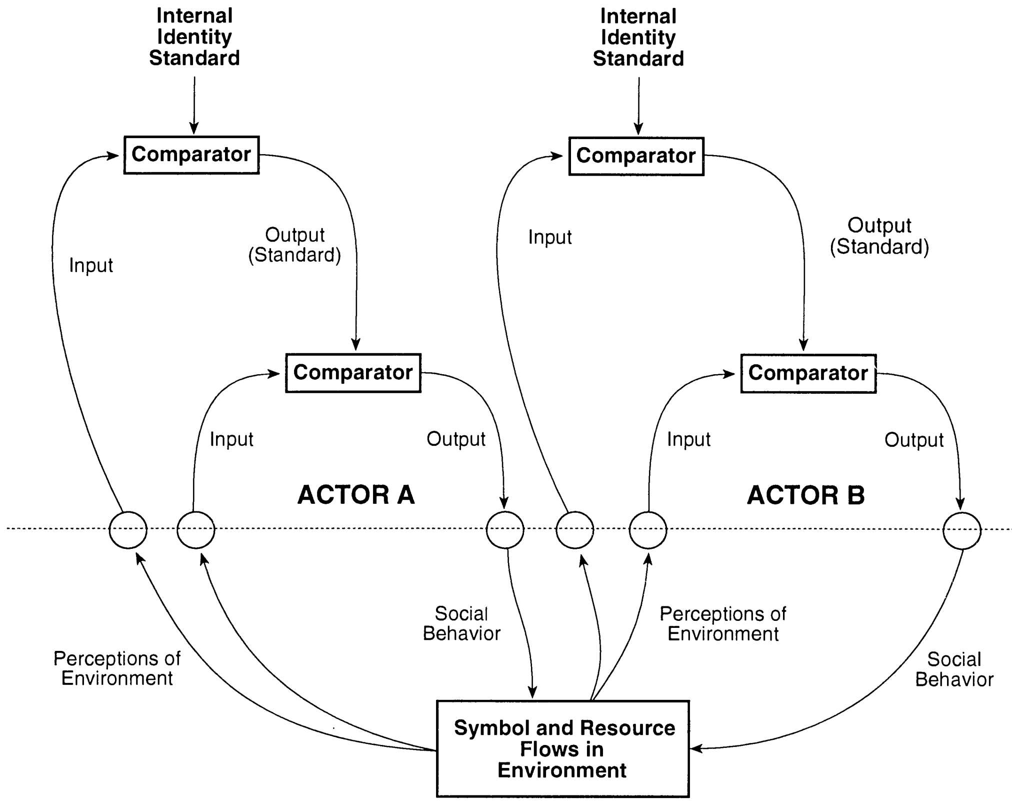

Figure 2. Identity Models for Two Interacting Actors

Note: The space below the dotted line represents the social enviornment in which behavior occurs. The space above the dotted line represents the internal identity systems of the two individuals. The circles on the dotted line represent input/output functions mediating between the individual and the environment.

discuss the general character of the identity models. According to identity theory, an *identity process* is a control system—specifically a perception control system (Powers 1973; Burke 1991). An identity is a set of "meanings" applied to the self in a social role or situation that defines what it means to be who one is (Burke and Tully 1977). This set of meanings is the standard or reference for who one is. When an identity is activated, one or more "feedback loops" are established. Four such loops are shown in Figure 2, which represents a two-level control system for each of two actors (the actors are separated from the social environment by a dotted line in the figure). Each loop has four components: an internal *identity standard* or reference setting (the set of self-meanings); an *input* from the situation (perceptions of self-relevant meanings); a process that compares the input with the standard (a *comparator*); and an *output*. For the lower level control system, output is in the form of meaningful behavior that results from the comparison of perceptions of the environment with an internal standard. This standard for the lower level control system is the output from the higher level control system and indicates how the standard at the lower level changes. Similarly, the standard for the higher level control system is not necessarily taken as fixed, but can be the output of an even higher level control system (not shown in Figure 2).

The lower level control system works to modify the output (social behavior) to the environmental situation in attempts to change the input (perceptions) to match the identity standard. Thus, an actor's behavior controls his or her perceptions of self-relevant meanings when they are disturbed by events in the situation, so that perceptions match meanings contained in the internal identity standard defining who the actor is. Now, this control is not direct; it is mediated by the social situation. The behavior modifies the situation and those aspects of the situation (self-relevant meanings) that are being perceived by the identities of all actors in the situation. Thus, perceptions are altered. The altered perceptions are compared with the identity standard, and the cycling process continues uninterrupted, adjusting perceptions to be in line with the identity standard. When two or more actors are involved, the behavior of each actor serves to disturb or change the perceptions of the others, thus calling for compensating behavior on the part of those others.

The lower level control system is much like a thermostat that has a setting (say, of 70 degrees), an input (a thermometer perceiving the current temperature), an output (signals to the furnace/air conditioner). If the current temperature (perception of, say, 75 degrees) is higher than the setting, the thermostat sends a signal to the furnace/air conditioner (output) to turn on the air conditioner. This lowers the temperature, which lowers the perceptions of the temperature (input) and brings the perceived temperature in line with the setting. When the perceived temperature equals the setting, the air conditioner is turned off. The higher level control system operates like a program in an automatic thermostat, which adjusts the standard (temperature setting) according to the time of day or the outside temperature.

In an internal identity, the standard is scaled not in terms of degrees but in "meanings"—meanings that actors hold for themselves in a role. For example, a college student's identity might be set at certain "degrees" of academic responsibility, intellectualism, sociability, and assertiveness (Reitzes and Burke 1980). A person's gender identity might be set at certain degrees of masculinity or femininity (Burke and Tully 1977). As each person fills many roles, each holds many identities, and whatever the settings the identity standard establishes the meaning of the person's identity for each role. Using Osgood, Succi, and Tannenbaum's (1957) view of meanings as mediational responses, an identity standard for a role may be viewed as a set (or vector) of such meanings.

Recent extensions of identity theory (Freese and Burke 1994) have suggested that in addition to controlling symbolic meanings through symbolic interaction, identities also control sign meanings (direct signals from the environment, not necessarily mediated by social convention) through the manipulation of resources; it is this aspect of the model that I use in the present simulation. Symbols are a specific class of this general class of signs in that symbols stimulate a *shared response* or meaning among the actors; signs may be more individual (Lindesmith and Strauss 1956). For the direct manipulation of objects in the environment, including resources, people generally use sign meanings. For example, physically picking up a pencil with which to write does not require one to "understand" the symbolic value of the pencil but only to know it is a useful object with which to write. Similarly, adjusting the thermostat to a comfortable setting, putting on clothes, eating with a fork, are acts that manipulate objects and resources and do not require attending to the symbolic value that the objects also may have (Lindesmith and Strauss 1956).

By extending the identity model to include sign meanings and the manipulation of resources, Freese and Burke (1994) have attempted to extend identity theory beyond the symbolic framework of traditional symbolic interaction theory. This makes the identity model applicable to a general theory of interaction because it can deal with the exchanges and resources necessary for social structure. This theoretical extension adds sign meanings to both the meanings contained in an identity standard and the meanings perceived in a situation. Action is designed to bring both the perceived sign meanings and symbol meanings into alignment with the meanings of the identity standard. By extending identity theory to include the control of resources in the environment, the theory can be brought to bear on issues relevant to exchange models. The present simulation focuses primarily on the goal-oriented manipulation of signs and resources, using points (one type of resource) to manipulate participation in exchanges (another resource), which is indicated by the signs of a completed exchange with another participant.

The identity model in identity theory is a *process* model. It is a dynamic and continuously operating system that responds to changes in the environment (perhaps produced by others acting in the situation) that disturb an actor's current perceptions. The behavior that results as the output of the model is not only a function of the identity standard (as an automaton) or of a stimulus from the situation (as in a stimulus-response model). What makes the identity model different from most behavioral models is that behavior is viewed as resulting from the *relationship between perceptions of the environment and the internal identity standard.* Even if my identity standard as a professor is set to a high level of "intellectualness," my behavior will not always reflect this level of intellectualness. It may be higher or lower, depending on what my current perceptions of myself are in a specific situation. If I see myself as behaving at a higher level of intellectualness than is set by my identity standard, I will act less intellectual to compensate. If I see myself as acting less intellectual than my identity standard, I will act in a more intellectual manner. The operative here is *compensation* (Stets and Burke 1994). My behavior is a function of the relationship between my identity standard and my *perceptions* of self-relevant meanings. My actions always counteract the disturbances that offset my perceived meanings (symbols or signs) from those embedded in the standard. Indeed, introducing disturbances can test whether the disturbed input is, in fact, what is being controlled.

COMPONENTS OF THE IDENTITY CONTROL MODEL FOR EXCHANGE NETWORKS

The identity I model is that of an experimental subject in a network exchange experiment—or at least I model some aspects of that identity. The model is used to represent each of the nodes (positions) in the exchange network. That is, each node is occupied by a separate identity model. The model is implemented as a two-level hierarchical control process with four control systems; it is presented pictorially in Figure 3. Three of the control systems (1, 2, and 3) are at the higher level and control the standard of one system at the lower level (4). Each of the control systems has its own inputs from the environment, reference levels (standards), comparators, and outputs.

The four control systems perceive the three resource quantities the experimental subject must control: the amount of participation, the amount of the offer from the potential exchange partner, and elapsed time.[3] The rationale for choosing these resources is as follows. Structural theories of exchange are concerned with the power of exclusion (nonparticipation), and normal experimental procedure urges each subject to participate in exchanges as often as possible. A "good subject" thus desires to participate in every possible exchange. Participation is modeled as a higher level goal.[4] As time elapses, if a subject has not become involved in an exchange during a given round, he or she would feel some pressure to act because not acting may lead to being excluded. Elapsed time (too much is to be avoided) is thus the second higher level goal. The third higher level goal is to avoid getting offers of 0 points, and it was added as a mechanism for allowing identities (nodes) the ability to move away from initially unequal splits of points toward more equal splits when participation was at or near the desired level.[5]

For control system 1 (CS1, one of the three control systems at the higher level in Figure 3), the input perception is of the percent of exchanges in which one participates. The standard is set at 100 percent, and the system attempts to bring the perceived percent to 100. In later simulations, this standard is set at lower levels, and future research may explore how this standard may be adjusted by an even higher level control

[3] The model thus treats the experimental subject identity *as if* perceptions of these resource quantities were all that needed to be controlled.

[4] In modeling other identities, other goals (standards) would be appropriate. Money or points may be goals in other situations, as might efficiency or getting money without wasting time participating directly in the exchanges.

[5] Using an inverse-square rule makes the goal of avoiding 0 stronger for those closer to receiving 0 points, and thus moves the system over time toward equal splits. Copies of the algorithm are available from the author (<http://burkep.libarts.wsu.edu/ExchPas.htm>).

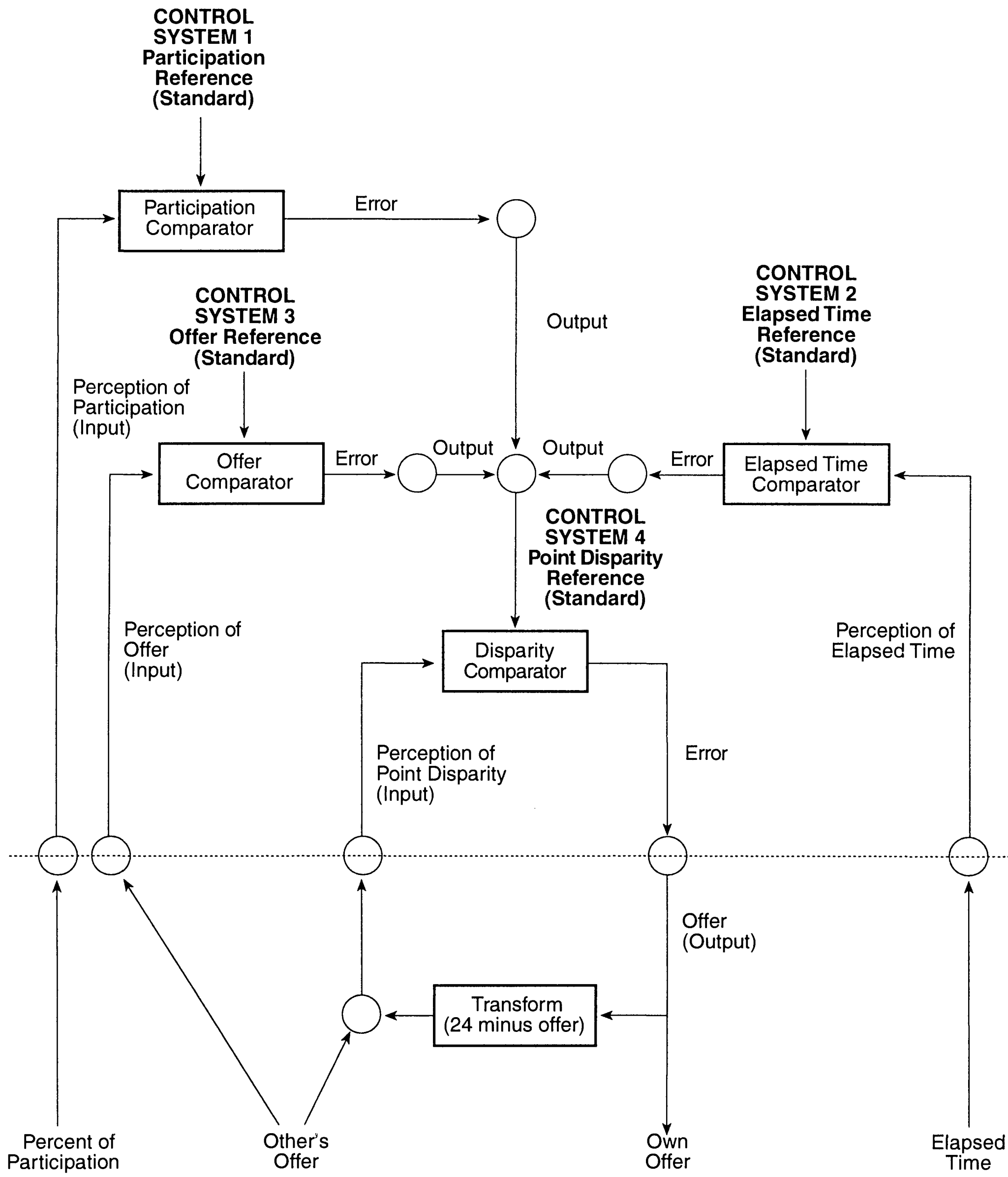

Figure 3. Identity Model of Exchange in the Study

Note: The space below the dotted line represents the social enviornment in which behavior occurs. The space above the dotted line represents the internal identity systems of the simulated actor. The circles on the dotted line represent input/output functions mediating between the actor and the environment.

system.[6] Control system 2 (CS2) perceives elapsed time. Each round of bargaining begins with the clock set to 0, and as the clock ticks away, the system works to achieve a match with the offer from a potential exchange partner by shifting its own offers closer to a match. Control system 3 (CS3) perceives the level of the offer from the potential exchange partner. The standard for this system is set to 0, and the system works to *avoid* this standard (no points), operating not to earn more points but, like the assump-

[6] This even higher level system would allow identities to "adjust" standards over time, lowering or raising them on the basis of experience.

tion of the core theory, to *avoid earning 0 points*.[7] The gradient for this avoidance is set by an inverse square rule, thus the avoidance becomes stronger as the perceived offers from others move closer to 0.

The outputs of these first three control systems are combined (added together) to represent the standard or goal for the lower level control system (CS4). This system perceives the disparity between the best offer[8] by another participant and one's desired offer as determined by the three higher systems.[9] CS4 attempts to decrease this perceived disparity to the level set by the standard. At equilibrium the standard for the disparity would be 0, representing a situation where the terms of exchange are agreed upon. At this point, one's own offer equals 24 minus the other's offer, and vice versa.

Briefly, then, the program does the following: As a simulated actor's participation falls away from the desired 100 percent, the error/output of CS1 adjusts the standard of CS4 toward a negative disparity (lower than the original standard), which in turn causes the CS4 output (offer) to increase in compensation. As the offers from other exchange partners (the input to CS3) are lowered and approach 0, the error/output of CS3 stimulates the standard of CS4 to shift toward a positive disparity, which causes the CS4 offer to decrease in compensation. Finally, as bargaining time increases and agreement is not reached, the error/output of CS2 pushes the standard of CS4 in the direction (determined by the sign of the error) that leads CS4 to make an offer closer to that desired by the potential exchange partner. All these actions are undertaken simultaneously (sometimes in opposition to each other[10]) by all of the identities for all of the actors in the exchange network, and the behavioral outputs of each actor disturb the input perceptions of the others. From the point of view of identity theory, the importance of the behaviors lies solely in their ability to restore perceptions to the levels set by the internal identity standards of the actors involved.

RESULTS OF THE SIMULATION

The program using this identity model is able to accommodate any one of a number of network structures. The network structures used in this analysis are presented in Figure 1. Each node in a network is occupied by one simulated actor—an instance of the two-level identity model. Thus for network (a) in Figure 1, there are four simulated actors that can exchange with each other according to the structure of the network. The outputs (offers) of one actor are used as part of the inputs for other actors (all represented by the identity model in Figure 3). All actors are programmed to be identical and have the same settings on all parameters.

Each network in Figure 1 was simulated over a "session" of 40 rounds of exchange, that is, periods during which exchanges may be made. Earnings and frequencies of exchanges were calculated for the entire session for each network. For each network, 500 session replications were run. The mean earnings of each node from each of the other nodes for the session were calculated over the 500 replications. These earnings are presented in Table 1 as the predictions of the identity model, and predictions from the other theories for many of these networks are also presented. Table 1 also presents results from experimental studies, which can be compared with the predictions of each of the theories.

Each of the 13 networks is given in the stub of the table. The stub also lists each relevant set of exchange partners in the network (e.g., B/A represents exchanges between any of the B nodes with any of the A nodes). For each theory, the predicted points in the remaining columns represent the point advan-

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[7] This avoids the ambiguous goal of earning "more" points and is consistent with research that shows the power of avoiding costs relative to seeking rewards.

[8] If several offers are tied for "best" then the system randomly selects from among the tied offers.

[9] The desired offer is defined as 24 minus one's own offer. Since the objective is to divide the pool of 24 points, the actor keeps 24 less what the actor offers the other.

[10] For example, exclusion from an exchange may move the point disparity standard toward higher offers, while elapsed time may move it toward lower offers. The relative strength of each effect determines the combined result.

Table 1. Model Predictions and Results from Some Experimental Studies

		Power Advantage Predictions								Experimental Data		
Network	Network Relation	Identity Theory	Core	Equi-dependence	Expected Value	NET-R	NET-RD	DES	X-NET	SW Data	SF Data	LS Data
a (B31)	B/A	21.9	24.0	24.0	22.0	21.2	23.0	15.1	23.0	21.6	19.8	—
b (Line4)	B/A	13.8	16.0	16.0	21.1	16.0	14.5	13.2	13.0	14.1	12.5	14.5
	B/B	12.0	—	12.0	12.0	12.0	12.0	12.0	—	12.0	12.0	—
c	B/A	21.1	24.0	24.0	22.0	20.5	23.0	15.1	23.0	—	19.1	—
	B/C	12.0	—	16.0	12.0	12.0	12.0	—	—	—	12.3	—
	C/D	12.6	12.0	12.0	19.0	14.6	12.0	13.2	12.1	—	12.2	—
d	B/A	17.3	24.0	24.0	18.0	15.7	23.0	13.1	22.6	—	18.1	—
	B/C	17.1	24.0	24.0	18.0	16.7	23.0	13.6	22.7	—	19.1	—
e	B/A	13.2	14.9	16.0	19.0	15.0	12.5	13.1	12.5	—	—	—
	C/B	12.0	—	12.0	12.0	12.0	12.0	13.0	—	—	—	—
	C/D	14.4	18.1	16.0	22.0	17.9	13.0	15.0	13.0	—	—	—
f (Stem)	B/A	15.6	20.1	18.0	22.0	18.3	15.6	14.9	14.0	15.3	14.4	15.9
	B/C	12.9	—	14.4	19.5	15.2	13.7	14.0	—	16.5	15.3	—
g (Kite)	B/A	12.1	—	12.0	12.0	12.5	13.7	13.4	12.1	14.1	12.8	12.8
	A/A	12.0	—	12.0	12.0	12.0	12.0	12.0	12.0	—	12.0	—
h	A/A	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	—	—	—
	B/A	12.7	—	13.7	15.0	13.9	14.0	15.5	—	—	—	—
	B/C	14.8	18.2	16.0	15.0	16.3	14.3	14.6	13.4	—	—	—
	D/B	12.3	—	13.3	16.0	13.5	11.5	—	—	—	—	—
	D/C	14.1	—	17.1	20.0	17.4	14.0	13.8	—	—	—	—
	D/E	16.4	21.1	20.0	22.0	18.2	15.6	14.9	14.0	—	—	—
i	B/A	13.9	16.1	18.0	20.0	15.6	14.5	13.2	12.7	—	—	—
	B/C	12.6	—	14.4	17.0	14.3	11.3	11.0	—	—	—	—
	C/D	12.8	14.2	12.0	12.0	14.3	13.3	13.8	12.1	—	—	—
	E/C	12.4	—	14.4	17.0	14.3	12.4	—	—	—	—	—
	E/D	13.1	—	14.4	20.0	16.4	13.9	14.1	—	—	—	—
	E/F	15.7	20.2	18.0	22.0	18.2	15.6	15.0	13.4	—	—	—

(*Table 1 continued on next page*)

tage of the first mentioned node (e.g., B in B/A) over the second mentioned node (e.g., A in B/A). Thus, the 22.0 for the expected value theory for network (a), relation B/A (row 1) tells us that, according to this theory, the person in position B will get 22.0 points and the person in position A will get 2.0 points (of the total 24 points) in any exchange. *The point advantage reflects the power advantage.* Nodes that have a strong power advantage are those for which this difference in points earned is large (23 versus 1), while nodes that have a weak power advantage have small point differences (approaching 12 versus 12).

Overall, the results generated by the identity model agree quite favorably with the experimental data; generally the model does as well or better than the predictions made either from existing network theories, which deal only with static structural configurations, or the other process simulation models. Table 1 presents the average absolute deviation of the prediction from the average of the experimental data sets in the row labeled "Deviation 1." Also presented in the table is the number of data points available for the comparison.

For only one network, the TB3 network (k) in Figure 1, the identity model does considerably worse than the others in predicting experimental results. In the identity model, each identity has only *one* offer out. This offer holds for *all* potential exchange partners. Thus, in the TB3 network, B cannot make one offer to the A nodes and a different offer

(*Table 1 continued from previous page*)

		Power Advantage Predictions								Experimental Data		
Network	Network Relation	Identity Theory	Core	Equi-dependence	Expected Value	NET-R	NET-RD	DES	X-NET	SW Data	SF Data	LS Data
j (DB2)	B/A	14.2	16.8	16.0	20.2	14.6	15.3	—	—	15.5	—	16.4
	B/B	12.0	—	12.0	12.0	12.0	12.0	—	—	—	—	—
k (TB3)	B/A	7.5	12.0	12.0	12.0	12.0	15.0	—	12.0	13.5	—	—
	C/B	16.9	24.0	24.0	21.1	21.8	15.0	—	23.0	17.9	—	—
	C/D	16.8	24.0	24.0	21.1	16.0	12.9	—	23.0	17.7	—	—
l (NB2)	B/A	19.0	18.0	24.0	18.3	17.9	14.0	—	—	16.1	—	—
	B/C	19.6	24.0	24.0	21.1	16.0	14.0	—	—	17.8	—	—
m (NT2)	B/A	21.1	24.0	24.0	21.8	19.6	14.1	—	22.8	20.7	—	—
	B/C	12.0	24.0	16.0	12.0	12.0	12.7	—	22.8	16.5	—	—
	C/D	12.8	12.0	12.0	17.4	12.0	13.1	—	12.0	12.9	—	—
Deviation 1[a]		1.8	3.3	3.1	3.2	1.6	2.1	2.1	1.9			
Deviation 2[b]		1.2	3.5	3.3	3.4	1.7	2.2	2.1	2.2			
Number of comparisons		21	16	21	21	21	21	11	15			

Note: Power advantage is the number of points (out of 24) that one node gets in an exchange with another; 12 represents equality, with no power advantage. Empty cells (—) indicate either that the theory makes no prediction or that there is no experimental data available.

Source: Equidependence, expected value, and core predictions are taken from Skvoretz and Fararo (1992), with corrections to the core predictions supplied by Bonacich (personal communication, March 1996). NET-RD (network exchange theory resistance degree) predictions are from formulae in Lovaglia, Skvoretz, Willer, and Markovsky (1995). Markovsky X-NET predictions were supplied by Markovsky (Personal communication March 1995). NET-R (network exchange theory resistance) predictions are from Skvoretz and Willer (1993). DES (discrete event simulation) predictions are from Fararo and Hummon (1994). The SW data is from Skvoretz and Willer (1993), the SF data is from Skvoretz and Fararo (1992), and the LS data is from Lovaglia, Skvoretz, Willer, and Markovsky (1995).

[a] Deviation 1 is the average absolute deviation between the prediction and the available data, weighted by the expected number of exchanges between the indicated positions.

[b] Deviation 2 is the same as deviation 1, but excludes the B/A relation of network (k).

to C, as is possible in laboratory experiments. In the laboratory situation, B can divide its market and make a more preferred deal with C than with the A nodes. And because B is sometimes excluded by C, B can make a better offer to counter the exclusion. However, in the identity model as simulated here, rather than being able to direct the better offer only to C, this exclusion affects B's offer to everyone, and the A nodes take advantage of that.[11] Omitting this one comparison (B versus A) results in the identity model performing as well as any of the other models or theories, as is shown in Table 1 in the row labeled "Deviation 2."

[11] To change the model so that B could make separate offers to the A nodes and to C would involve making a separate control system for each potential exchange partner and adding rules about how these different control systems interact with each other within an identity. Such is beyond the scope of this study.

ADDITIONAL QUESTIONS

Equilibrium

Once theories become dynamic and process-oriented, a large number of questions emerge that were not apparent from a static, structural point of view. For example, a primary question concerns the relative power of the different positions in the network. Previously, power has been a static, structural concept. Using a more process-oriented perspective, the results of the experiments can be seen to be a cross-section, at one point in time, of what is occurring,[12] not an indication of what is happening in the long run. For example, if we look at the results for a strong-power network, the branch31 network, network (a) in Figure 1, we see that in the present simulation, on average B earns 21.9 points on each exchange with A. However, that computation is the average over the first 40 bargaining periods, the arbitrary limit of the experiment. Well before the 40th period, B is earning the maximum limit of 23 points from each exchange with one of the As. In the long run, then, B earns not 21.9 points per round, but 23 points per round. An important question, then, is what are the long-run earnings of each node in the network, as this should relate more to the power of a position than would the earnings over an arbitrary and shorter number of rounds. And, related to this, do the long-run earnings reach a stable equilibrium or do they reflect the limit imposed by the constraints of the experiment (such as a 23/1 split of the 24 points available)?

I investigated these questions with the present identity model by letting the number of rounds continue until a stable equilibrium point was reached or until a stable end point occurred (such as a 23/1 split) and held for at least 100 rounds. The results of this analysis are presented in Table 2, in the column labeled "Equilibrium Offer." In this test, the strong-power nodes continue to earn close to 23 points on each exchange. The offers from the weak nodes generally average a little less than 23 as they attempt on occasion to try to avoid earning only 1 point by offering less than 23. However, their reduced offers are not always accepted when the strong-power position has an alternative. In these cases, the weaker nodes are excluded, and then they raise their offers again.

In the weak-power networks, networks (b), (e), (f), (g), (h), (i), and (j) in Figure 1, weaker nodes initially make bigger offers to become included in the exchanges. However, as the exchanges proceed, the networks become segmented into smaller exchange networks, involving only two nodes each, with each node exchanging with its opposite 100 percent of the time. In the line4 network, network (b) in Figure 1, for example, the A node initially offers 12 points and then moves to offering 14, 15, or 16 points in order to become included. The B nodes respond by reducing their offers to match A's at 10, 9, or 8 points. When this happens, for each B, the other B is no longer an attractive exchange partner because they are offering less than can be gotten from the A node. This makes the B node dependent upon the A node and segments the four-actor network into two two-actor networks. Once the segmentation of the network occurs, each node exchanges 100 percent of the time with its established partner, thus matching their standard for engaging in exchanges.

In the identity model, since this perception matches the standard, there is no longer any pressure to offer more points. The only pressure that remains is to move away from earning amounts closer to 0. The A-node actors feel this pressure more because they are closer to earning 0 points. Over time, therefore, the A-node actors begin to offer less and move toward an equal 12/12 split. However, the 12/12 split itself is unstable, since at that point the network is no longer segmented and the B-node actors can exchange with each other just as easily as with the A nodes. Once again the A nodes are excluded, and they begin to offer more. Over time, the As generally offer 13 points, but occasionally dip to 12, only to revert to offers of 13 points again to avoid being excluded. The result is that a 13 to 11 point split is fairly stable.

This process view of network exchange shows that the other weak-power networks evolve in slightly different ways. In network (e) in Figure 1, A–B exchanges can migrate over time back to 12/12 and still be segregated from C–D exchanges of 11 to 13, while in network (h), A–A exchanges at 12/12 are segregated from B–C exchanges (11/13), but D–E exchanges must stay at 10/14 to remain segregated from B–C exchanges. When the primary motive is inclusion in the exchanges, the segregation of the network becomes an important principle for maintaining stability. In networks where each node is limited to one exchange per round, only networks with an even number of nodes can segregate into exchanging pairs, and the magnitude of the offers that maintain this segregation is crucial.

[12] More correctly, the experimental results are an average of what is going on over a limited series of cross-sections.

Table 2. Long-Run, Equilibrium Outcomes of Identity Exchange Model

Network	Node	Equilibrium Offer	Participation Proportion	Reduced Participation Equilibrium Offer	Further Reduced Participation Equilibrium Offer
a (Branch31)	A	23.00	.33	20.93	12.93
	B	1.00	1.00	3.00	11.00
b (Line4)	A	13.00	1.00	—	—
	B	11.00	1.00	—	—
c	A	23.00	.50	19.93	12.89
	B	1.00	1.00	4.00	11.00
	C	12.00	1.00	12.00	12.00
	D	12.00	1.00	12.00	12.00
d	A	22.58	.75	19.90	5.92
	B	1.37	1.00	4.05	18.04
	C	22.57	.75	19.97	5.94
e	A	12.00	1.00	—	—
	B	12.00	1.00	—	—
	C	11.00	1.00	—	—
	D	13.00	1.00	—	—
f (Stem)	A	13.00	1.00	—	—
	B	11.00	1.00	—	—
	C	12.00	1.00	—	—
g (Kite)	A	12.00	.80	—	—
	B	12.00	.80	—	—
h	A	12.00	1.00	—	—
	B	11.00	1.00	—	—
	C	13.00	1.00	—	—
	D	10.00	1.00	—	—
	E	14.00	1.00	—	—
i	A	13.00	1.00	—	—
	B	11.00	1.00	—	—
	C	12.00	1.00	—	—
	D	12.00	1.00	—	—
	E	11.00	1.00	—	—
	F	13.00	1.00	—	—
j (DB2)	A	13.00	1.00	—	—
	B	11.00	1.00	—	—
k (TB3)	A	1.65	1.00	6.61	19.91
	B	22.35	.75	17.41	4.08
	C	1.36	1.00	6.03	19.43
	D	22.64	.75	17.90	4.55
l (NB2)	A	22.75	.75	17.71	4.70
	B	1.22	1.00	6.29	19.30
	C	22.85	.50	17.58	4.70
m (NT2)	A	20.92	.50	20.17	11.94
	B	3.00	1.00	3.77	12.00
	C	12.00	1.00	12.00	11.00
	D	12.00	1.00	12.00	13.00

Note: Results are based on 100 rounds of exchange after equilibrium has been achieved.

Taking a Process View of Power

The identity model, which employs a process view of the exchange paradigm, provides a somewhat different perspective on power. The power of a position is not seen as being able to demand extra resources in an exchange. Rather, it appears, as Markovsky (1992) has pointed out, that the person in a "less powerful" position (i.e., one that becomes excluded) offers *more* resources to others *in an attempt to be included.* It is, thus, in part, larger offers from others that make a position more powerful, and it is *the desire to be included* that motivates others to offer more resources. This becomes clear when we alter in the models the reference level for inclusion. Since identities (actors) only need to bring their participation level to the level set in their identity standard, when the reference level for inclusion is less than 100 percent they are under less pressure to make better offers to become included more often.

To see how this works, I reran the simulations for each model, but this time I set the reference level for inclusion for a node to the level achieved for that particular node in the prior run for that model.[13] For example, in the branch31 network, network (a) in Figure 1, each of the A nodes can expect to participate only one-third of the time, since they must exchange with B; and B can only exchange with one of the three A nodes each time. To make these results comparable with the results in Table 1, the same 40-round bargaining session was used and was replicated 500 times.

In analyses not reported here, it is clear that as the identities in the "weaker" nodes are able to achieve[14] their reference levels of participation without giving up resources, they do exactly that. The result is greater earnings for the identities in these "weaker" nodes than they would get otherwise. With a change in the reference levels for participation, the average earnings of each position over the first 40 rounds of bargaining changes, reflecting a shift in power as the level-of-participation goal is changed. The "powerful" position no longer controls access to the same extent once the reference levels change.

Beyond the first 40 rounds of the normal experiment, however, even with the reference levels for participation lowered, the initial gains in the first 40 rounds are mostly lost over the long run. Table 2 presents the *long run* offers for each node in the strong-power networks, after allowing the network to move toward stability in the column labeled "Reduced Participation Equilibrium Offer."[15] These results suggest that power differences in the strong-power networks remain, although at a somewhat reduced level. This is because the reference levels for participation were set at a *barely* achievable level. If random exclusions temporarily lower the participation level below the desired level (as sometimes happens), the response of the identity is to raise its offer further. This produces a slow creep toward the stronger inequalities shown in Table 1.

To overcome this, the participation standards must be set slightly *below* the level that *can* be achieved. When the standards are lowered by only 3 percentage points (for example, at .30 rather than .33 for the A node in the branch31 network), the identities are allowed to get above the standard, and control can proceed by raising or lowering participation as necessary. That is, if the perceived participation is too high, the identity can act to reduce it, and if the perceived level is too low, the identity can act to increase it. Now, when random exclusions temporarily lower the participation level, the identity can compensate by getting above the desired level for a short time.

The long-term results of this very slight change in participation standards are shown in the last column of Table 2, labeled "Further Reduced Participation Equilibrium Offer." Here the standard of .33 is reduced to .30, the .75 to .72, and the .50 to .47. In networks (a), (c), and (m) we see a real shift to-

[13] This might be thought of as an adjustment to the identity standard that occurs over time just as people adjust their expectations and goals toward achievable levels.

[14] Achieve may be too strong a word. They approach this level from below, but can never get above it. These results are available from the author.

[15] The weak-power networks achieved stability without this reduction in the desired level of participation.

ward equality, although segmentation of the networks that can be segmented still prevents complete equality. In networks (d), (k), and (l), however, something very different happens—there is a power reversal. The standard for level of participation for the "weaker" positions is less than they can achieve. So to achieve these lower levels, the "weaker" identities must participate *less* than their exchange partner desires. Now the identity in the "stronger" position must raise its offer to the identity in the "weaker" position in an attempt to increase its participation to its still desired 100 percent.

So, where is the power? These results clearly show that power rests not just in the structural position occupied within a network, although structural position is important. As long understood, power lies in the ability of one party to control the resources that another "desires." However, if the other has no desire, there is no power. Consistent with Waller's (1938) principle of least interest, my results show that lowering the desire of the "weaker" party results in a turn-about in power and the distribution of resources.

DISCUSSION

In proposing an identity model of the exchange process, I have focused on a number of important questions. First, I have extended identity theory to include the control of both resources *and* symbols, thus allowing it a much wider scope. Second, I embedded an identity theory perspective in the network exchange paradigm to force an investigation of the *processes* involved in that paradigm. Rather than asking what implications a particular network has for the distribution of power, I have asked what actors are trying to accomplish from the positions they occupy in the network. And, what actors try to accomplish is given, in part, by their identity standards. I have shown that the impact of a network structure strongly depends on what the actors in the network are *trying to do;* and what they *can do* in the network strongly depends on the structure of the network.

In the present identity model, the identities (actors) are trying to participate in exchanges at a level dictated by their participation reference standard. Participation is a resource just as is access to a job or membership on a committee. In the model, the identities are trying to control their perceptions of level of participation by observing the signs indicating the percentage of trials in which they accomplished an exchange. The goal for participation is 100 percent, and that is the *primary* goal of the identities simulated here. There are other goals as well, which have to do with controlling other resources. These simulated identities are not programmed to seek points, but to avoid getting 0 or just a few points. Also, they are seeking to match offers with potential exchange partners and to avoid taking a long time to do so. In the cross-section, the result of having these goals (reference standards for perceptions) is a point distribution across network positions (nodes) in a variety of exchange network configurations that closely matches observed experimental results. In process terms, there is a rate of earning points that moves toward and around an equilibrium value, but this is coincidental to each node maintaining a certain rate of participation.

Other important lessons emerged from this process perspective. Rather than viewing the 40 rounds of exchange as 40 replications of a single process, the 40 rounds are seen as the beginning of a long-term process that has not yet had a chance to stabilize. By allowing the process to continue until it does stabilize, a different picture emerges about the nature of power in these networks. This is especially true for the weak-power networks. In the long term, stability is achieved by segmenting the overall network into smaller subnetworks. In these subnetworks, usually pairs of actors, exchanges are exclusive and participation rates achieve 100 percent.[16] The division of points approaches an equal 12/12 within each subnetwork, but must remain differentiated from the point divisions achieved in adjacent subnetworks to maintain the stability. Thus, each simulated actor must offer sufficient points to its subnetwork exchange partner to keep that partner committed to continuing exclusive exchanges and not seeking ex-

[16] This is for networks with an even number of participants. In networks like the kite, g network, an actor is always excluded, but exclusion occurs randomly among all the actors.

changes from an actor in a different subnetwork, breaking down the "partnership." This raises the question of commitment.

In the present simulation, it is observed that as the process continues over the long run, the subnetworks occasionally do break down for a round or two of exchanges, when adjacent subnetworks all make offers of 12/12. When this happens, exchanges between the subnetworks result in exclusions. The excluded partners then offer 13 points to reestablish their participation, and the subnetwork structure is reestablished. Nothing in the current model allows the identities to learn from this. However, it may be possible to build into the model some notion of commitment or trust that would allow movement to the 12/12 without breaking up the subnetwork structure and disrupting the 100 percent participation levels of all parties.

Finally, I return to the question, "Where is power?" The simulation results presented here clearly indicate the nature of the interaction between position (node) and actor (identity) in understanding power.[17] Power is not inherent in any particular position in a network. Power is defined as the ability of one actor to control the resources that another desires, and there are two parts to the equation. First, we must understand how a position in a network controls resources, and second we must know what resources are desired by other actors in the network. Without desire, there is no power. In the identity model simulated here, the "big" desire is to participate in exchanges, not to earn points in an exchange. In the initial runs, it was assumed that the reference standard, or desire for participation, for each of the simulated identities was 100 percent. This yielded results very close to experimental data where subjects were told to try to engage in as many exchanges as often as they could. Lowering this reference standard in the simulation changed the "desires" of the identities, and thus changed the ability of other identities to control the resource of participation. This "small" change in the identity model resulted in a very large change in the distribution of power, as measured by the accumulation of points, and illustrated that power is dependent on both the network structure and the nature of the identities positioned in that structure.

One final point. Measuring power by the distribution of points earned, either total points or on a per exchange basis, perpetuates the myth that individuals desire only to accumulate points. In the present simulation, points are used by the actors as a currency to "buy" the thing that is desired—participation in exchanges at the rate set by the identity standard.[18] The points have little intrinsic value, although the simulated actors do try to avoid getting 0 points. Their primary value and "meaning" comes from the ability of actors to exchange them. In the current simulation, once all actors are participating at their desired levels (attainable only in the weak-power networks), little in the way of further dynamics occurs, except for actions which maintain that participation level. Measuring power by points diverts our attention away from what is happening—actors are behaving to counteract disturbances to perceptions that they are trying to keep in line with their identity standards. And once we understand that actors are primarily concerned with countering disturbances to identity-relevant perceptions, new measures of power may be developed. Such new measures may concern the things actually being controlled (in this case participation rates), or may concern the mechanisms of control (in this case, points used to "buy" participation). In either case, attention must focus on the way some actors disturb the controlled perceptions of other actors, thus altering the way those other actors are able to achieve their own goals. While the structure of exchange networks clearly does influence how actors can achieve their goals, the actual goals that actors have and how those goals may change and vary across actors must also be considered.

[17] A third factor, the "rules of the game," is also important (Markovsky et al. 1993). For example, the c and k networks are structurally the same, as in this simulation, the individual identities at each node are the same, yet, because B can make three exchanges in k and only one in c, the results are very different.

[18] Earning a certain number of points or earning points at a certain *rate* could be a standard in an identity control system, but it is not a standard used in the present identity system.

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