The Origins of Status Hierarchies: A Formal Theory and Empirical Test[1]

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This article offers a formal theoretical model of the emergence of hierarchy that bridges the division between individualistic and structuralist accounts of inequality. In the model, actors reproduce status hierarchies by adjusting their own status-conferring gestures according to collective attributions. These collective attributions are just the aggregate of individual gestures, leading to a self-reinforcing status ranking. Winner-take-all hierarchies are discouraged, however, when people prefer reciprocation of their status-conferring actions. The model therefore depicts a status ranking as an equilibrium resulting from individual responses to the trade-off between social influence and the distaste for making unreciprocated gestures. Analysis of the model generates several precise predictions about the patterns that social networks should exhibit at equilibrium. Data on interaction in task groups, friendship ratings in a fraternity, and play in a set of infant quintuplets is used to show that the formal theory makes unusually accurate predictions about network structure.

Differentiation among individuals and groups with respect to various valued outcomes is a core topic for social science. A major reason, apart from the distrust of inequality that many social scientists share, is the near-universality of the phenomenon: across a wide range of scales and contexts, actors are sorted into social positions that carry unequal rewards, obligations, and expectations. For example, small groups regularly differentiate into a few core members who contribute actively to conversation

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and task performance and receive a great deal of attention, and a larger number of peripheral members who participate rarely and receive little attention. Loosely organized street-corner groups nearly always have a leader, one or two mid-level individuals, and a set of followers (Whyte 1943; Suttles 1967; Sherif and Sherif 1966; Anderson 1990). Complex organizations invariably have an internal structure differentiated with respect to compensation and authority. Large- and small-scale societies, even hunter-gatherer groups, are typically divisible into strata differentiated by authority, prestige, wealth, or political influence (Bendix 1978; Godelier 1982; Milner 1994; Sahlins 1963; Tilly 1998).

Broadly speaking, social science has two frameworks within which to account for the durability and ubiquity of hierarchical differentiation. The first, which may be termed the individualist or market framework, presupposes very simply that outcomes are unequal because individuals vary in qualities that are locally salient. Small groups differentiate because some individuals are more talkative, confident, or competent than the rest, and these assume the role of task leader. Informal youth groups differentiate because one individual is stronger, braver, or more charismatic than others, and this individual in turn cultivates one or two trusting relationships with others slightly less strong, brave, or charismatic. An organization confers more authority (and compensation) upon some members than upon others because the former have devoted more energy to the organization's goals, invested more in developing valuable skills, revealed unusual talents, or have shown a flair for "leading" rather than "following" (Becker 1964; Rosen 1981, 1982). These higher rewards are viewed, moreover, not merely as compensation for such contributions, but symmetrically as incentives designed to elicit them. Even if no one consciously creates such incentive systems, competitive pressures push organizations and groups toward their adoption. In the individualist framework, then, differentiation in rewards occurs because and to the degree that people make contributions of differential value. Although this perspective is dominant within economics, it has also had forceful proponents within sociology (Homans 1961; Blau 1964; Coleman 1990).

The second broad framework, which finds most of its proponents within sociology, ascribes differentiation in valued outcomes not to the attributes of individuals, but rather to the quality of the social positions individuals occupy. What determines rewards in this perspective, which might be termed "structural" in a broad sense, is occupancy of an advantageous social position, regardless of the means by which the incumbent of such a position has come to occupy it. In the literature on stratification, "position" is usually taken to refer to aspects of family background, in the sense that opportunities for offspring vary with the position occupied by parents. The concept also encompasses educational credentials, which are

thought to open or close doors in ways that correlate only imperfectly with talent and potential. More recently, studies of mobility within organizations (White 1970; Bielby and Baron 1986; Stewman and Konda 1983; Strang and Baron 1990) have extended the framework to ranks within bureaucratic job ladders, noting that job differentiation facilitates earnings inequality and that promotion into high-ranking jobs may be as much a function of exogenously produced vacancies as of the qualities of those vying for promotion. Synthesizing the various versions of the position concept, Sørensen (1996) suggested that sociologists represent the differential rewards accruing to social positions as rents. Similarly, Tilly (1998) portrays inequality in general as the outcome of political struggles in which some individuals or groups have managed to secure exclusive access to valued resources, at the expense of other, weaker individuals or groups.

In brief, the alternatives are, on the one hand, a perspective in which hierarchy is a natural or *emergent* phenomenon reflecting underlying variations in individual qualities, and, on the other hand, a perspective in which hierarchy is artificially imposed or *enacted* by interested parties and as a result accords benefits to incumbents of privileged positions in a way that is largely independent of their individual qualities.[2]

A range of considerations suggests that a third theoretical option is desirable—namely, one in which hierarchy is explained as the product of an emergent social process without presupposing that the resulting assignment of actors to positions is a straightforward reflection of underlying qualities. One consideration is purely logical: there is no reason to assume that emergent hierarchies necessarily give back to individuals precisely what they put in, and thus no reason to assume that the only hierarchies that allocate rewards according to some other rule are enacted hierarchies.

There are empirical considerations as well. In the first place, hierarchy is simply more widespread, durable, and free of conflict than one would expect if its achievement and maintenance were primarily the result of "primitive accumulation," collective action, and coercion. In the second place, a good deal of anecdotal and ethnographic evidence indicates that occupants of subordinate social positions actively contribute to the main-

[2] Not surprisingly, the first perspective is usually viewed as a moral defense of social hierarchy and the second as a basis for moral opposition to it. It bears pointing out, however, that the question of the scientific utility of these two frameworks for explaining hierarchy is entirely independent of the moral value of the positions on whose behalf they are typically invoked: one could easily accept as fact that hierarchy emerges naturally from competitive processes while rejecting the outcome on ethical grounds, just as one could defend hierarchy on ethical grounds while admitting that assignment to privileged and subordinate positions is imposed artificially and unrelated to individual qualities.

tenance of hierarchy, and in ways that even the occupants of dominant positions may only partially recognize (see, e.g., Bourdieu 1984; Gaventa 1982; Liebow 1967; Willis 1977). In the third place, there is solid evidence that hierarchy persists even in the face of determined efforts, on the part of elites and nonelites, to eradicate it (see, e.g., Dumont 1970; Milner 1994). Hierarchies seem to be produced and sustained through processes that are more decentralized and less purposeful than the structuralist perspective usually contemplates.

Together, these observations suggest the desirability of a theoretical framework in which social hierarchies are understood to emerge and persist spontaneously rather than by conscious creation, but at the same time without ensuring that rewards exactly reflect differences in individual qualities. In such a framework, ranked social positions would constitute a stable and self-reinforcing system even though the incumbents of ranked positions might receive benefits that exceed or fall well short of the "fair" allocation—in which rewards just equal contributions—that the individualist framework envisions. Occupancy of a disadvantaged position, for instance, would imply that an individual receives less credit, and hence lower rewards, than would be his or her due under the individualist model; at the same time, assignment to such a position might depend at least in part on a stable trait that is related to how much credit is due. The key to such a theoretical framework is a mechanism that relates the credit people receive to underlying qualities, but at one remove—a remove mediated by the creation of ranked social positions.

Although the distinction often goes unnoticed, it is one thing to call for a particular kind of theory and quite another to construct one. Having done the former in the foregoing, my aim in the remainder of this article is the latter. According to the theory proposed here, the reason positions with greater and lesser advantage exist is that judgments about relative quality are socially influenced. Socially influenced judgments amplify underlying differences, so that actors who objectively rank above the mean on some abstract quality dimension are overvalued while those ranking below the mean are undervalued—relative to the baseline scenario, in which social influence does not operate. Amplification occurs because observable interactions expressing judgments of quality are also cues to other actors seeking guidance for their own judgments.

As a result, even if judgments are ultimately shaped by the underlying qualities of individuals, the benefits those judgments determine are exaggerated on one end of the scale and diminished on the other. At the same time, the advantageous positions individuals on the high end occupy are not, in this theory, consciously created or defended by anyone: each individual contributes to the creation of structural positions simply by allowing the judgments of others to influence his or her own.

Note that the mechanism just sketched succinctly captures much of what sociologists mean by the term "status," which is to say the prestige accorded to individuals because of the abstract positions they occupy rather than because of immediately observable behavior. The opinions of a respected public figure, for instance, receive more attention and credence than those of ordinary folk even when the opinions themselves are quite mundane. The difference is no doubt due in part to the past achievements that made the public figure's reputation in the first place; but it is also, according to my argument, due to the recognition by observers that all other observers are prepared to give the opinion in question a great deal of attention. The status of public figures, then, is the respect accorded to them by each observer *just because* they are accorded respect by everyone else—even though some of this respect may in some sense, and at some point, have been earned.

In the next section I offer a more elaborate but still informal sketch of this argument, along with a discussion of prior research lending surface plausibility to the account. Following the informal sketch, I formalize the model so as to show that the implications just described do indeed follow rigorously from the assumptions. More significantly, the formal model is shown to imply a series of precise hypotheses; the third section of the article tests these hypotheses on social network data from three empirical studies. The relevance of sociometric data for testing a model of this kind should be evident but is nonetheless worth articulating. Because status positions are modeled as the expression and result of gestures of approval by multiple actors, and because such gestures are precisely the sort of thing sociometric data reflect, the social mechanism captured in the model generates strong predictions about what kinds of sociometric structures should be observed. Significantly, the hypotheses can be tested on social network data *without observing or making assumptions about the distribution of underlying actor qualities*.

AN INFORMAL MODEL OF STATUS HIERARCHIES

A recurrent theme in sociological studies of the emergence of status rankings—in adolescent social groups, in communities that produce knowledge, in organizations and populations of organizations, and in task groups—is the self-fulfilling character of subjective judgments. Whether the issue is the validity or originality of propositions, the efficiency or utility of organizational procedures or products, or the relative talents or qualities of individual actors, there is strong evidence that subjective assessments are profoundly socially influenced. Experiments in social psychology (Asch 1956; Milgram 1974) revealed the powerful effects of au-

thority and majority opinion on the behavior of subjects, even in cases where the subject's own inclinations were clearly right. In sociological studies of science, it is commonly observed that prominent individuals benefit—and marginal individuals suffer—from the "Matthew effect" (Merton 1968; Zuckerman and Merton 1971; Cole and Cole 1973), a pattern in which contributions of apparently similar quality are evaluated differentially depending on the status of the contributor. Studies of organizations frequently posit that status and legitimacy, either along with or instead of efficiency concerns, influence the survival and success of organizational forms, practices, or actors. This claim is central to research in the neoinstitutionalist tradition (Powell and DiMaggio 1991), but appears outside that school of thought as well (see, e.g., White 1981; Davis 1991; Podolny 1993; and Podolny and Stuart 1995).[3] Experimental research on status expectations (Berger et al. 1977; Ridgeway and Berger 1986; Ridgeway et al. 1998) has consistently revealed effects of status characteristics (sex, race, education, and others) on subjective assessments of task performance and on compliance with authoritative instructions.

A central conclusion from all these lines of research is that the uncertainty and subjectivity inherent in quality judgments gives rise to a self-reinforcing process in which collective adherence to socially provided assessments reproduces and thereby validates those very assessments. The status rankings of individuals, groups, or other social entities that result are consequently stable, not because of stable intrinsic differences among actors but because of the self-validating character of social judgments.

The idea of self-fulfilling, socially influenced attributions is logically consistent with, and in this article will be modeled in terms of, the game-theoretic concept of a Nash equilibrium (Fudenberg and Tirole 1991; Gibbons 1992). The concept describes a situation in which everyone's current choice of action is preferable to (or as good as) the alternatives so long as everyone else's choice of action remains constant. So, if attributions of popularity, quality, talent, status, and so forth are responses to observed patterns of attribution which are themselves the product of earlier attributions, then the patterns should tend toward a stable state in which collective attributions confirm themselves in each time period—implying a Nash equilibrium. If they do not, then phenomena such as the Matthew effect require a different explanation from the one available in the literature. If they do, then it should be possible to derive

[3] White argues that production markets generate a ranking of firms in which consumers infer product quality from the price paid, reversing the common-sense notion that firms can charge more for products that are (objectively) superior. Podolny (1993) and Podolny and Stuart (1995), respectively, offer evidence that organizations with core positions in networks of securities offerings and of patent citations reap benefits from their new ventures that exceed what would be expected on the basis of quality alone.

propositions from an equilibrium model that describes, in a falsifiable way, how such attributions should be distributed in real-world settings.

According to the argument as stated thus far, then, it is possible for a stable system of ranked social positions to emerge endogenously in the absence of underlying variation in individual attributes. Although it may not be obvious, it turns out (and I will demonstrate this formally in the next section) that the only equilibria possible when there are absolutely no underlying differences across individuals are one in which everyone is ranked equally and one in which one actor receives attention while all others receive none. In other words, if self-reinforcing attributions are the only mechanism operating, the only stable outcomes are radical equality or radical inequality. In the presence of even modest differences in individual quality, only the second of these two outcomes is an equilibrium. Intuition tells us why: if one individual attracts slightly more positive judgments than others because of some intrinsic quality, then the social influence process will set off a cascade in which this small difference is inflated as people react to one another's reactions to its existence.

It is evident that most social hierarchies lie between the two extremes of complete equality and winner-take-all inequality. Consequently, if a social influence process underlies status positions, another mechanism must also be operating alongside it. I propose the following mechanism, motivated by the notion that quality judgments are informative to observers in part because they are costly to make. Positive comments, demonstrations of attention, or expressions of interest reflect approval, thereby influencing opinion, if everyone knows that they are not made lightly; and they will not be made lightly if those making them understand them as forms of deference. It is painful to pay attention to another person if the favor is not repaid. By the same token, it is particularly pleasant to receive attention when it is not solicited: most people would prefer, for instance, to be told, "I thought your presentation was excellent" than to be told, "Yes, I did think your presentation was excellent," or "Thank you; I thought your presentation was excellent as well." If it is unpleasant to offer more approval to someone than he or she gives back, it is reasonable to suppose that it is also enjoyable to receive more approval from a given person than one has offered.

Intuition suggests (although, again, formalization is required to verify intuition) that the link between approval and deference prevents the winner-take-all cascade that social influence operating alone would generate. The displeasure of offering unreciprocated gestures of approval keeps such gestures within limits, in turn limiting their impact on other people's attributions, and so forth. Runaway status hierarchies are thus unlikely to the degree that people are reluctant to make gestures of approval

without having the favor returned, at least in part. (Hence the pressure on media celebrities to feign affection for their fans.)

In sum, individuals face a trade-off between attaching themselves to *desirable* alters and attaching themselves to *available* alters. If asymmetry in attachments were overwhelmingly painful, people would remain unattached, sort themselves into cliques in which everyone was tied equally to everyone else, or forge collections of symmetric dyads. If, on the contrary, there were no discomfort in asymmetric attributions, every individual would give all of his or her attention to the most desirable alter. But in the intermediate case, when people care sufficiently about symmetry (relative to quality), those who receive few or no attributions from the most desirable person will prefer to direct their own attributions toward less attractive alters who at least return the favor. Each person's optimal allocation is therefore a function of the distribution of quality, the relative weight of quality and symmetry in determining well-being, and the attributions made by everyone else. A set of attributions, or attachments, is an equilibrium—more precisely, a Nash equilibrium—if no one has an incentive to change his or her current allocation, given everyone else's current allocation (Fudenberg and Tirole 1993).

The link between the notion of a decentralized production of hierarchy and the reflection of hierarchy in social networks follows from the fact that, at least in some contexts, the set of actors producing attributions is coextensive with the set of actors to whom the attributions refer. Peer evaluation and citation in scientific research (Cole and Cole 1973; Crane 1972; Breiger 1976), interpersonal networks of deference, admiration, trust, and esteem (Coleman 1961; Burt 1987; Krackhardt 1987; White et al. 1976), and interorganizational exchange, imitation, and collaboration (Burt 1992; Podolny 1993; Galaskiewicz 1985; Laumann and Knoke 1987) all share the property that each actor making judgments about others is also judged by those others. In some studies, this duality is in part a product of research design, as when actors are asked to provide information about one another, yielding a network of attributions. In other instances, this duality is an inherent aspect of the social context, for instance when people build bodies of knowledge by citing each other's past contributions to knowledge (Crane 1972; Podolny and Stuart 1995) or choose friends on the basis of who is most liked by others. This holds for judicial knowledge production as well as for academic and scientific research, though the former has not been extensively studied by network analysts.

This duality of assessors and assessed provides the theoretical basis for supposing that symmetry considerations might influence the pattern of attributions in groups: net of socially available assessments of quality or status, individuals should be less willing to demonstrate esteem toward

those who do not return the favor and conversely may prefer to receive such demonstrations without reciprocating. Just as actors calibrate their judgments with reference to the status of those whom they are judging, they also recognize that asymmetry in judgments represents inequality in status. Someone who pays less attention to you than you pay to her implicitly asserts that she is superior to you in status. If you do not respond by withdrawing your attention, you have implicitly agreed. Consequently, if individuals like having high status, they ought to be happier when their own attributions are reciprocated and when they receive attributions that they do not fully repay. There is thus a tension between the self-reproducing character of status attributions and people's desire to have their attributions reciprocated: the more faithfully you follow the existing status ranking in distributing your attributions, the greater the likelihood that your expressions of esteem for high-status alters will be asymmetric. The model sketched here precisely captures the tension between this hypothesized concern for symmetry and the self-reinforcing process by which status is distributed.

Naturally, the scenario I have described is theoretical. Even if it has surface plausibility, it remains to be seen whether it is consistent with human behavior. To answer this question, it is first necessary to derive specific predictions about behavior from the model, which in turn requires that the model be restated in formal terms. In the next section, the formal version of the model is shown to imply a series of specific hypotheses regarding the interaction between status-conferring attributions, reciprocity considerations, and individual positions in observed status hierarchies. In particular, the model predicts that, at equilibrium:

1. Asymmetry in social relationships will be proportional to the difference in choice status between pairs of actors. That is, a high-status (frequently chosen) actor will be more weakly connected to any low-status actor than the latter is to her or him. (For this prediction to be validated, the pattern must obtain over and above the "tautological" level of asymmetry, that is the aggregate level of asymmetry that must be present by the definition of "high-status actor.")
2. All else equal, pairs of actors who are similar in choice status (i.e., in shares of attributions received) will also be similar in the patterns of attachments they make toward others.
3. Across all actors, the sum of attachments directed to others will be proportional to, but more evenly distributed than, the sum of attachments received.

After setting out the model and deriving these predictions, I test the predictions using data from existing studies of small-group interaction. In addition to analyses of static relationships under the assumption of

equilibrium, I test the equilibrium assumption itself using some of the few existing longitudinal network studies. The data are drawn from R. F. Bales's small-group studies, William Blatz's study of the Dionne quintuplets, and Theodore Newcomb's study of a University of Michigan fraternity. In the discussion, I show how the current model builds on and departs from existing sociological accounts of hierarchy, with particular reference to the small-group tradition and its descendant, the status expectations research program.

AN EQUILIBRIUM MODEL OF NETWORK STRUCTURE

To formalize the foregoing theoretical model, assume a closed and finite population of individuals, each of whom can direct attachments in any way he or she chooses across others in the population.[4] Assume further that the quantity of attachments can vary across individuals. Finally, assume that each individual (call him or her i) cares about only two things when choosing objects j from the general population: (1) the (abstract) quality of each potential alter, and (2) the gap between i's attachment to j and j's attachment to i. Each person's welfare is positively related to (1), but negatively related to (2). In other words, individuals like to be tied to attractive others, but they do not like to be tied to people who do not reciprocate the attachment. Initially, to give a straightforward sense of how the model works, quality will be treated as an exogenously determined and publicly observed scalar attribute of individuals. I will then generalize the model to the case in which attractiveness is assumed to be at least partly endogenous—specifically, when each individual's perceived quality is jointly determined by some exogenous trait and by the sum of attachments he or she receives from others.

Conversely, individuals like to receive attachments that they do not repay, inasmuch as such attachments signify (and contribute to) their status. The impact on i's welfare of either type of asymmetry, however, is proportional to the strength of i's attachment to j. In other words, a given excess (shortfall) in attachment to j is worse (better) for i when his or her attachment to j is itself large. If this idea seems implausible, consider what it feels like to have someone you care about not return a telephone call, as compared with someone whose friendship matters to you only

[4] In the theoretical argument sketched in the previous section, "attributions" were discussed as if they were intrinsically positive. But it is unnecessarily restrictive to make this assumption: surely people express scorn through interaction as effectively as they do deference, with symmetrical effects on the reputation of the target. Accordingly, in the formalization laid out below, attachments are not constrained to be positive.

slightly. Reversing roles, consider how much more pleasant it is to be sought after by people you like than by people you do not.

More formally, we can describe individual i's allocation in a group of size n as a vector of attachments $a_{ij}(i \neq j)$, across all $n - 1$ alters in the group. Assume that actor i derives some benefit from directing an attachment to an actor of nonnegative quality; for example, it is more beneficial to listen to what someone is saying the more interesting what she or he has to say is. In this model, "listening" for a certain amount of time represents an attachment and the "interest" of what the person is saying represents quality. Quality could also be interpreted as the value of an individual's contribution to a group effort, in which case attachments would represent expressions of praise or gratitude. Or it could represent how enjoyable someone's company is, while attachments reflect efforts to spend time together. Each of these interpretations should be seen as a possible realization of whatever attribute a social context makes salient as a determinant of social desirability.

Let q_j describe individual j's quality, with $q = 0$ interpreted (without loss of generality) as the mean. Assume, further, that i's welfare increases linearly in $a_{ij}q_j$, implying that i's welfare increases by q_j for a unit attachment to j. (For a more explicitly general model, one could substitute $f(q_j)$ for q_j, reflecting the potentially nonlinear impact of a given actor's quality on i's welfare. Implicitly, however, the model as stated is equally general, since we may posit that $q_j = f(x_j)$, where f is an appropriate transformation of an underlying quality score x.)

Assume, finally, that the negative contribution of the quantity $a_{ij} - a_{ji}$ to i's welfare is increasing in a_{ij}. Conversely, the extent to which the same quantity contributes positively to j's welfare is increasing in a_{ji}. Informally, this means that i is more bothered by unrequited attachment to j the stronger this attachment, and that j only benefits from being the object of unrequited attachment to the extent that he or she allocates some attachment to i. This double dependence on a_{ij} can be represented by describing i's welfare as linear and decreasing in the quantity $a_{ij}(a_{ij} - a_{ji})$, and conversely for j.

Beginning (for ease of exposition) with a population of three persons (i, j, k), the welfare of individual i can therefore be expressed as

$$u_i = a_{ij}q_j + a_{ik}q_k - s[a_{ij}(a_{ij} - a_{ji}) + a_{ik}(a_{ik} - a_{ki})] \quad (s \geq 0), \tag{1}$$

where s is a parameter representing the weight of symmetry considerations relative to the quality of i's alters in determining i's welfare. The same equation with subscripts rearranged expresses the welfare functions for j and k. Observe that, since a_{ij} is unconstrained, negative attachments are also possible, interpreted here as expressions of disapproval. Negative attachments to individuals with negative quality increase welfare, as do

positive attachments to individuals with positive quality. More subtly, equation (1) also implies that (for nonzero s) actors are hurt not only by directing positive attachments to others that exceed those they receive from the latter, but also by directing negative attachments to others whose attachments to them are either less negative or strictly positive. In other words, ego can feel bad either about expressing excess approval *or* excess disapproval. This coincides with intuition to the extent that expressing intense dislike for someone who is only mildly disdainful toward oneself is just as much a sign of vulnerability as liking someone too much.

The social network resulting from a combination of attachments is a Nash equilibrium if and only if each individual's allocation maximizes his or her welfare, contingent on the allocations of the other two. Differentiating (1) for i, j, and k, setting to zero and solving the resulting system of three equations yields the following expression for i's optimal allocation of attachment to j:

$$a_{ij}^{*} = \frac{q_i + 2q_j}{3s}. \tag{2}$$

This result (which applies to all three nodes, with substitution of subscripts) shows that, in equilibrium, each individual directs attachments to others as a function of the other's quality *and*, at a lower rate, of his or her own quality. However, the amount of the attachment is limited by the importance of reciprocity. In the limit, as s increases, all attachments approach zero, and alter's quality therefore makes little difference. On the other hand, for sufficiently large gaps in attractiveness or sufficiently low values of s, large differences in attachments across actors appear in the equilibrium condition; consequently, status positions are highly differentiated to the degree that quality varies and to the degree that reciprocity has little importance. Note, finally, that the reason attachments depend on ego's quality as well as alter's is that actors benefit from *partially* reciprocating attachments they receive: when a_{ji} exceeds a_{ij}, which it will do when i's quality exceeds j's, the contribution of the asymmetry to i's welfare, following equation (1), is increasing in a_{ij} .

Generalizing to a population of size n yields the following expression for the welfare of person i:

$$u_i = \sum_j a_{ij} q_j - s \sum_j a_{ij}(a_{ij} - a_{ji}). \tag{3}$$

For any individual i, the equilibrium allocation of attachments is the set of attachments across all alters j that maximizes u_i, conditional on the attachments directed by everyone else. The optimal attachment from each actor i to every other actor j can therefore be found by taking the partial derivative of u_i with respect to a_{ij} for each j, setting the derivatives to

zero across all j, and solving the resulting system of $n-1$ simultaneous equations of the following form:

$$\frac{\partial u_i}{\partial a_{ij}} = q_j - 2sa_{ij} + sa_{ji} = 0.$$

It is easy to show that for the case in which q_j is exogenous, i's optimal attachment to j is given by equation (2) regardless of the quantity n. This is not the case, as I will show presently, when q is also a function of the pattern of attachments.

Calculating across all i and j gives an exact prediction for the structure of the network, given the distribution of q and the values of s and n. Naturally, the model makes no predictions about what particular structures will be observed unless these values are specified. Given these values, however, the model describes a variety of structural properties of networks of status-conferring social interactions. The choice status of any actor j, for example, is given by

$$\sum_{i \neq j} a_{ij} = \frac{(2n-3)q_j + \sum_i q_i}{3s}, \tag{4}$$

indicating that the quantity of attachments directed toward j is proportional to q_j, to the number of actors, and to the overall quality of actors in the group. (The latter echoes the result from [2] that each actor's own quality affects the level of attachments he or she directs to others.)

Normally, of course, "quality" cannot be observed directly—hence the durability of debates about the origins of inequality. What makes the model particularly useful, however, is that it can be shown to imply statements (such as eq. [4]) about general conditions that any equilibrium structure satisfies, which is to say properties that *all* equilibrium structures (other than corner equilibria) possess, independent of the distribution of q and the value of s. These statements represent strong, falsifiable predictions about network structure across a wide range of situations. After generalizing the model to allow for social influence, I derive and test several such predictions.

SOCIAL INFLUENCE ON QUALITY JUDGMENTS

To this point I have treated each individual's "quality" q as exogenously determined and directly observable by others. But the goal is to model contexts in which quality is socially determined, either intrinsically (e.g., people prefer to have popular friends) or because people depend on the judgments of others when making their own judgments. Take an example

familiar to scholars: identification of the most important contributions to a field of research. In deciding which authors are central, researchers invariably consider names their peers have cited in print or mentioned in conversation; but these peers have done the same thing in deciding whom to mention. Identification of a particular author's influence, as measured by frequency of printed or oral citation, is therefore partly endogenous: each person's evaluation of an author's importance is in part a subjective judgment of the quality of her or his writings, and in part a function of other people's assessments. The resulting evaluation is, at the same time, an assessment that informs other individuals' evaluations. To the degree that an individual's status in an academic discipline is reflected in the frequency with which others mention his or her work, we observe a self-reinforcing status mechanism.

To capture the idea of self-reproducing status hierarchies, then, it is necessary to extend the model to include situations in which q_j is jointly a function of exogenously produced factors *and* choice status within the network of attributions. In this section I generalize the formal model so that the scenario in which quality is exogenously determined is a special case.[5] The most important analytical result is that, as quality becomes increasingly endogenous, status differences are amplified. The resulting distribution of status departs from the baseline distribution as reflected in (4), and is thus interpretable as a system containing both privileged and disadvantaged structural positions.

Consider, then, the scenario in which q_{ij}, the index of j's attractiveness to i as an object of social attachment, is a function of result of j's intrinsic quality *and* the set of attachments directed toward j by everyone else. Assume in particular that

$$q_{ij} = (1 - \omega)Q_j + \omega \sum_{k \neq i,j} a_{kj},$$

where q_{ij} represents j's quality as i perceives it, Q_j expresses the exogenously determined portion of j's perceived quality, and ω represents the weight of social influence on i's judgment of j's quality. Note that the

[5] In the following analysis, I implicitly treat the equilibrium as the outcome of a one-shot game. This assumption implies that actors have no incentive to deviate from a given equilibrium by redirecting attachment to an otherwise unpopular alter. In a repeated-game situation, actors might be tempted to deviate in the hope that the redirected attachment will attract other attachments, with the potential result that the one-shot equilibrium is unstable. Note, however, that for sufficiently large n the equilibrium is unchanged by the one-shot assumption because no actor can unilaterally change the distribution of q enough to influence other actors' allocations. Further exploration may reveal the conditions under which iterated choices in small groups lead to a different equilibrium; in this article, I restrict my analysis to the one-shot situation.

latter component of j's attractiveness is independent of a_{ij}—that is, actor i cannot increase his or her own perception of j's attractiveness by directing an attachment to j. Observe in addition that the model in the previous section corresponds to the case in which ω equals zero. What follows is thus a formal generalization of the model.

When perceived quality q depends on intrinsic quality Q and on observed attributions, the equilibrium attachment of actor i to actor j is given by

$$a_{ij}^{*} = \frac{(1-\omega)[(2s+\omega)Q_j + sQ_i + \frac{s\omega(3s+2\omega)\sum_k Q_k}{(s+\omega)[3s-(3n-5)\omega]}]}{3s^2-(2n-7)s\omega-(n-2)\omega^2}. \quad (5)$$

Summing across all actors i, and with some algebra, an actor j's choice status (the sum of attachments directed toward j) is the following:

$$\sum_{i\neq j} a_{ij} = \frac{(1-\omega)[(2n-3)s+(n-1)\omega]}{3s^2-(2n-7)s\omega-(n-2)\omega^2}Q_j + \frac{s(1-\omega)(3s+2\omega)}{[3s-(3n-5)\omega](3s^2-(2n-7)s\omega-(n-2)\omega^2}\sum_i Q_i. \quad (6)$$

It is clear by inspection that j's choice status is increasing in Q_j for sufficiently small n and ω; the singularity as these parameters increase relative to s (causing the denominator to approach zero) suggests an unrealistically large amplification of status differences when social influence dominates exogenous quality in determining attachments. Although the quantity of attachments increases without bound in this expression, it is reasonable to assume some absolute limit on the positive and negative attachments actors can direct; given such a limit, the singularity implies that there is a corner optimum in which even a small advantage in quality Q for one actor leads to a cascade of positive attachments toward that actor (and a concentration of negative attachments on the lowest-ranking actor). The appendix provides a proof of the existence of this corner equilibrium. In the analysis to follow, I assume sufficiently small values of ω and sufficiently large values of s to sustain an interior equilibrium—justified, again, with reference to the general impression that the majority of status hierarchies do not look like winner-take-all cascades.

Because the expression in (5) is cumbersome to interpret, figure 1 presents a graphical representation of the impact of actor quality (ranging from –5 to 5) on choice status across a range of values for ω, given moderate values of the other parameters ($s = 2.5$; $n = 10$). Exogenous quality Q is assumed to be centered on its mean, so the second term in (6) equals zero. Choosing a lower value for s or a higher value for n

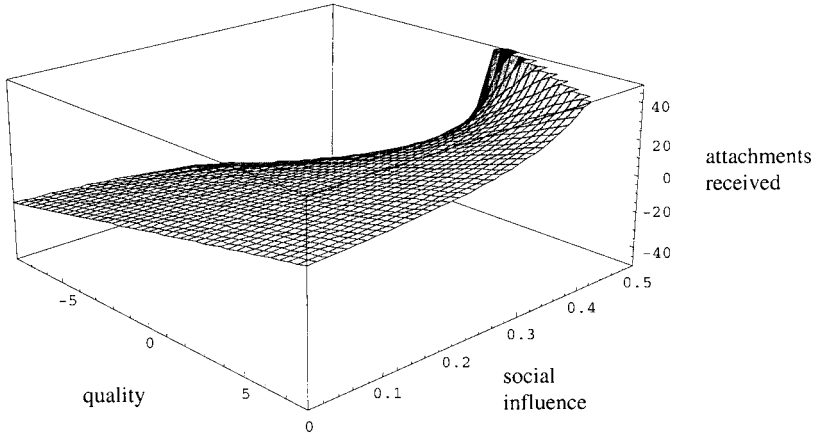

FIG. 1.—Attachments received (choice status) as a function of actor quality and level of social influence ($n = 10$, $s = 2.5$).

produces the same surface except that acceleration toward the corner equilibrium is more rapid. The figure reveals a substantial intensification of status inequality as the importance of social influence relative to exogenous quality increases—confirming the intuition that subjectivity in quality judgments contributes to the creation of advantaged and disadvantaged status positions. Note, however, that no differences in choice status would obtain if underlying differences in "quality" were completely absent, other than in the extreme case of a cascade of attachments to a single actor. Although the model shows that social influence on judgments can exaggerate the impact of quality differences, it does not sustain an interior equilibrium in which status differences appear without some quality differences. Ironically, in other words, the only status hierarchy that is stable when quality differences do not exist is the most extreme version of hierarchy—that of hereditary monarchs, for instance, or film celebrities.[6]

The most significant implication of this set of results is that it offers a formal basis for the sociological intuition that socially influenced attributions enhance status differences. In other words, it provides a rigorous theoretical account for the idea that gaps in status might overstate differences in merit. At the same time, the model implies that this effect

[6] Naturally, cascades are also possible in the model when exogenous differences in quality do exist. Invariant quality implies that hierarchy, when it obtains, will be extreme; but the inverse, that extreme hierarchy implies invariant quality, does not hold.

should only obtain in certain situations—namely, those in which third-party attributions to alter are not outweighed by the concern for reciprocity. If deference is sufficiently painful (and receiving deference sufficiently enjoyable), then differences in choice status will in fact understate differences in quality.

A further point worth noting is the implication that status hierarchies in the model are the result of a social dilemma: that is, an unequal distribution of choice status can be an equilibrium even though it does not maximize total welfare. It is simple to show that total welfare is maximized, given some upper bound on attachments a_{max}, if everyone sets all attachments to a_{max}. But for sufficiently large s, individuals have an incentive to reduce their attachments to alters with low q, giving them the benefit of the deference the resulting asymmetric attachment implies.[7] Because the reduction of an attachment from i to j reduces j's welfare more than it enhances i's welfare, aggregate well-being is always reduced by the extraction of deference. Only if actors can discipline each other, say through the threat of withdrawing future attachments from anyone who reduces attachments in the present, can groups climb out of the social trap status hierarchies represent. This solution, however, depends on foresight and on group size. Myopic actors will not be deterred because they assign greater weight to the benefit of deference in the present than to the threatened loss of attachments in the future. More important, in large groups the substantial loss of well-being low-status actors would incur in retaliating against high-status actors—that is, actors whose receipt of many attachments enhances their value as targets of attachment—undermines the credibility of the threat of retaliation. Note that this inference accords with the intuition that small groups find it easier to sustain an egalitarian social structure than do large groups.

ANALYSIS OF THE MODEL

The following propositions can be derived formally from the equilibrium condition expressed in equation (5). I assume interior solutions throughout; in other words, I assume that s is sufficiently large (or, equivalently, dispersion in Q sufficiently low) to preclude corner optima for all actors. This assumption is plausible inasmuch as very few actually observed network structures resemble "stars," as they would if corner solutions were common. Proofs of the propositions appear in the appendix.

Proposition 1 states that asymmetry in attachments between any two actors is proportional to their difference in choice status.

[7] I am indebted to Jim Fearon for clarifying this point.

PROPOSITION 1.—Let $g = \sum_k a_{kj} - \sum_k a_{ki}$. Then

$$\frac{\partial(a_{ij} - a_{ji})}{\partial g} = \frac{s + \omega}{(2n - 3)s + (n - 1)\omega}. \tag{7}$$

Stated informally, the proposition shows that the difference in attachments between any two actors is greater, the greater their difference in choice status. In particular, in any interior equilibrium, the more popular actor receives a larger attachment from the less popular actor than he or she offers in return, with the asymmetry proportional to their difference in choice status.

PROPOSITION 2.—*The relationship between choice status and asymmetry declines with group size.*

Proposition 2 follows straightforwardly from the presence of n in the denominator in (7). Casual observation of social behavior indicates that there is more asymmetry in relationships between popular and unpopular individuals than between individuals of comparable popularity. At the same time, it is by no means obvious that the relationship should be linear, that people should conform strictly to it, or that the relationship should decline with group size. The mathematical basis for the proposition derives from the fact that, in the model, an actor receiving many attachments contributes more, all else equal, to the welfare of each alter attached to him or her than does an actor receiving few attachments. At the same time, ego also contributes to the welfare of alter by directing an attachment to him or her exceeding that received from alter. At equilibrium, an unpopular actor must therefore offer a stronger attachment than a popular actor to induce any arbitrary alter to reciprocate. Thus if an actor j receives more attachments overall than an actor i, then i's attachment to j will exceed j's attachment to i by an amount proportional to their difference in popularity. However, (7) implies that this relationship declines as group size increases.

PROPOSITION 3.—*Any pair of actors* i, j *will be similar in the attachments they direct toward others in proportion as they are similar in choice status. Formally, as before, let* $g = \sum_k a_{kj} - \sum_k a_{ki}$, *representing the difference in choice status between* j *and* i. *Then*

$$\frac{\partial(a_{ik} - a_{jk})}{\partial g} = \frac{s}{(1 - \omega)[(2n - 3)s + (n - 1)\omega]}. \tag{8}$$

PROPOSITION 4.—*Moreover, if* $g = 0$, *then* $a_{ik} - a_{jk} = 0$.

It is obvious, therefore, that the difference in the attachments i and j direct to any third party k is greater as i and j are increasingly different

in choice status. Note also that, as with proposition 1, the slope of the function is decreasing in n. Again, the proof appears in the appendix.

Informally, propositions 3 and 4 imply four things. First, two actors with the same choice status have identical attachments to others. Second, because the quantity in (8) is positive for nonzero s and any value of ω on the interval (0, 1), the more distant two actors are from one another in choice status, the greater the differences in their attachments to others. Third, the slope of this functional relationship declines asymptotically toward zero as group size increases. In other words, the impact of status proximity on the similarity of the attachments of any pair of actors declines as group size increases. Fourth, and most surprisingly, given any two actors, the one who is higher in choice status directs a *greater* attachment than the one who is lower in choice status to any third actor—even if the third party is very low in choice status. The reason is given below, in proposition 5.

Together, these implications of proposition 3 and 4 reveal that structural equivalence between actors is a function of their proximity in choice status, which is indirectly a function of their underlying quality difference. This principle follows from the model's stipulation that actors distribute their attachments not only according to the desirability of alters but also according to the attachments they receive from alters. Actors who are similar with respect to desirability attract similar quantities of attachment from similar others, and consequently direct similar attachments to those others.

PROPOSITION 5.—*Actors direct attachments to others in proportion to the quantity of attachments received. Formally, for any actor* j,

$$\sum_{j \neq i} a_{ji} = \frac{s(n-3) - \omega}{s(2n-3) + (n-1)\omega} \sum_{i \neq j} a_{ij}.$$

Similar reasoning gives an intuitive account for this result. Inasmuch as ego benefits from receiving attachments, but only to the degree that these attachments are partially returned, actors receiving many attachments are led, at equilibrium, to direct more attachments toward others. On average, then, actors with high choice status are also those with the greatest "outdegree," which is to say attachments directed outward. Note, however,

PROPOSITION 6.—*The slope of the function that transforms choice status into attachments directed outward is always less than unity. Consequently, the distribution of choice status* (*popularity*) *is more unequal than the distribution of outdegree* (*gregariousness*).

These propositions (and accompanying proofs) show that the theoretical model generates nontrivial predictions that, as I shall presently show, can be subjected to empirical test. Most notably, as proposition 3 shows, the

model predicts the emergence of roles, which is to say structurally equivalent positions occupied by actors who receive similar quantities of attachment from others. Unlike many formulations in the rational-choice tradition—for example, the exchange network paradigm explored by Markovsky and colleagues (Markovsky, Willer, and Patton 1988; Skvoretz and Willer 1993), Cook and colleagues (Cook et al. 1983; Yamagishi, Gilmore, and Cook 1988), and others (Bienenstock and Bonacich 1997)—the structures that emerge from this model are endogenous. That is, they do not follow from a prior assignment of actors to positions, as in the experimental exchange network paradigm. Rather, they follow purely from the individual welfare function, from the parameters n and s, and from the distribution of Q. In this respect, the model outlined here is closer to the Coleman action framework, in which exchange relationships are deduced from an exogenous distribution across actors of "control over events" (Coleman 1973, 1990). Yet there is an important distinction from Coleman's approach as well: in the scenario in which quality judgments are socially influenced, even very small exogenous differences among individuals can lead to significant differentiation in structural position. The main difference between the proposed model and those extant in the network literature, therefore, is that it offers an explanatory account of observed structure (a distribution of status positions) with minimal assumptions about the existence of a prior, underlying structure.

EMPIRICAL EVIDENCE

For an empirical investigation, I rely on existing data that, while not gathered with a view to validating a model of this sort, correspond closely enough in form to be suitable for testing the propositions derived above. The most appropriate network data are those in which actors' choices are unconstrained in number, variable in value, and nonsymmetric. In other words, to conform to the model's assumptions, nodes should be permitted to vary in the number of attachments they direct toward others, attachments should be permitted to vary in weight (as opposed to being dichotomous), and i's tie to j must not be assumed to be equal to j's tie to i.

Two studies for which data are available meet all three criteria. One is Robert F. Bales's (1956) study of verbal communication in task groups of various sizes; the second is William Blatz's (1937) intensive study of the Dionne quintuplets between the ages of two and three. Bales and his colleagues counted the number of times each member of each group verbally addressed each other member. They then combined the results from multiple groups into a single, archetypal network (one for each group size)

by imposing an equivalence across groups between the most talkative members, the second-most talkative, and so on. The result is one network where there were originally a dozen or more, which suppresses variation across groups. At the same time, this procedure has the virtue of washing out idiosyncratic differences among individuals, leaving a record of interaction patterns that is in some sense a purer representation of social structure than any of the original interaction matrices.

Blatz and his colleagues observed physical interactions among the Dionne quintuplets at regular intervals over a period of nearly two years, recording the number of times each of the children approached each of the others in a way that suggested an invitation to play. One of the most appealing features of this data source is the fact that the individuals involved were genetically identical. The fact that the quintuplets nonetheless sorted themselves, at an early age, into clearly differentiated status positions, as reflected in sharply varying frequencies of play overtures, offers prima facie evidence that the model I am proposing captures an important property of status hierarchies: that they can emerge even in the presence of minimal exogenous differences among actors.

A third data source, Theodore Newcomb's (1961) longitudinal study of a residential fraternity, meets two of the three criteria: each of 17 members ranked the others in terms of how friendly they were, once per week for 15 weeks. All three sets of network data satisfy the requirements of nonsymmetry (it is possible for A to express an attachment to B that B does not reciprocate) and non-dichotomous relationships (A can be more or less tied to B, not simply tied or untied). The fraternity study, by requesting rankings, constrained outdegree to be equal across all actors. It cannot therefore be used to test proposition 5. This disadvantage is offset, however, by a distinct advantage: because Newcomb administered his sociometric survey repeatedly over the course of a semester, allowing for changes over time in network structure, the data make it possible to ask whether social structures evolve toward the model's predicted equilibrium.

All six propositions can be tested with exclusive reference to the network data, which is to say without measuring Q or assuming values for the parameters s and ω (n is observed, of course). The reason is that the relationships implied by the propositions are completely independent of the distribution of Q (which is reflected in choice status), and partly independent of s and ω in the sense that the signs of the implied relationships are invariant over the theoretically permitted range for these parameters. Note, in addition, that the observed attachments are interpreted as positive, even though the model does not require this interpretation: the propositions hold regardless of whether all attachments are positive or whether they are centered on zero.

The first column in table 1 gives the correlations between status distance ($\sum a_{kj} - \sum a_{ki}$) and dyad asymmetry ($a_{ij} - a_{ji}$) for the Bales task groups ranging in size from five to eight, for physical interaction among the Dionne quintuplets, and for the Newcomb fraternity at the beginning and end of the fifteen-week study. From proposition 1, the prediction is that the asymmetry will be greater between nodes that differ more in choice status; in particular, the higher-status actor will direct a weaker attachment to the lower-status actor than the latter directs to him or her. For all the tests reported here, statistical significance is assessed nonparametrically, by calculating the relevant correlation coefficient for 500 random permutations of the observed networks and comparing the resulting distribution to the observed coefficient.

For all of the Bales networks and the quintuplet network, the correspondence is consistently in the direction predicted, and statistically significant except in the smallest Bales group and the quintuplets "play" network. In general, asymmetry in interaction is closely related to status distance across the $[n(n-1)]/2$ dyads in the two settings (from 10 to 28 dyads in the Bales study; 10 dyads in the Blatz study). In the five-person Bales group and the quintuplet play data, the correlation is in the expected direction but is not significant at the .05 level. The coefficients in these cases are inconclusive in part because substantial positive correlations are easy to achieve in random networks of this size.

At the end of the first week of the Newcomb study, the correlation between asymmetry and status distance was already substantial at .52, but reached .80 by the end of the semester. Here, the number of dyads across which the pattern holds is 122. Figure 2 shows the evolution of this pattern over the study period: the correspondence between status distance and asymmetry rose steadily for six or seven weeks, then leveled off and remained more or less stable for the remainder of the study.[8]

The second column of table 1 tests proposition 2 with regression coefficients for the relationship of asymmetry to status distance, for the Bales task groups. Recall from (7) that the slope of the relationship between status distance and asymmetry declines with n. The slope also depends on s and ω, which are not observed, so that point predictions are not

[8] It is important to interpret these correlations correctly. Aside from the issue of small-sample variability in correlation coefficients, there is at least a component of the observed relationship that is tautological: because i's attachment to j contributes directly to j's choice status, then it must be true on average that there will be a greater gap in status between j and i if i's tie to j exceeds j's to i. This reasoning is especially relevant for small groups. The tautology does not account for the observed correlations, however, because the same consideration applies to the random networks used in the statistical tests. (Data on the sampling distributions are available upon reques; see n. 1 above.)

TABLE 1
CORRELATION OF STATUS DISTANCE WITH (1) DYAD ASYMMETRY AND (2) STRUCTURAL DISSIMILARITY

	ASYMMETRY		DISSIMILARITY	
CONTEXT (n)	Correlation (1)	Slope (2)	Correlation (3)	Slope (3)
Bales:				
(5)	.76	.140	.47	.175
(6)	.82**	.072	.84*	.173
(7)	.85**	.071	.79**	.124
(8)	.68*	.067	.56*	.095
Quintuplets (5) ...	.33		.91**	
Fraternity:				
$t = 1$ (17)	.52*		.27	
$t = 15$ (17)	.08*		.44**	

NOTE.—P-values are based on nonparametric estimates of the likelihood of observing a correlation of a given size or greater across random permutations of the observed network of interactions. To estimate this likelihood, the observed graphs for each study were permuted 500 times, randomly reassigning the set of observed attachments to the $n(n-1)$ nodes. An observed coefficient is statistically significant at the .05 level if coefficients of equal or greater magnitude are observed fewer than 25 times across 500 permutations.

* $P < .05$, one-tailed.

** $P < .01$.

possible; nevertheless, the model predicts steady but decelerating decline in the regression coefficient as n increases. This is exactly what column 2 reports.

Proposition 3, which states that the attachments of any two actors differ in proportion to their dissimilarity in choice status, is tested in column 3 of table 1. I use a conventional network analytic measure of role dissimilarity, Euclidean distance, which is a function of the expression $a_{ik} - a_{jk}$ used in the proposition. (Euclidean distance between any two actors i and j is the square root of the sum across all other actors k of the quantity $(a_{ik} - a_{jk})^2$. Here "status distance" is the absolute magnitude of difference in choice status, since the proposition does not depend on whether i's choice status is greater or less than j's. A positive correlation indicates that the further two actors are from each other in status, the more they differ in their patterns of attachment to others.

The correlations are strong, significant, and in the predicted direction for all the groups except, again for the Bales groups of size 5: in general, role dissimilarity between any two actors can be precisely predicted from their distance in status, as measured by the difference in the volume of attachments directed at each. In the Newcomb study, the correspondence between role dissimilarity and status distance was .27 in the first week but reached .44 by week 15. The result for week 1 is not extreme in comparison to those observed by randomly permuting the sociometric

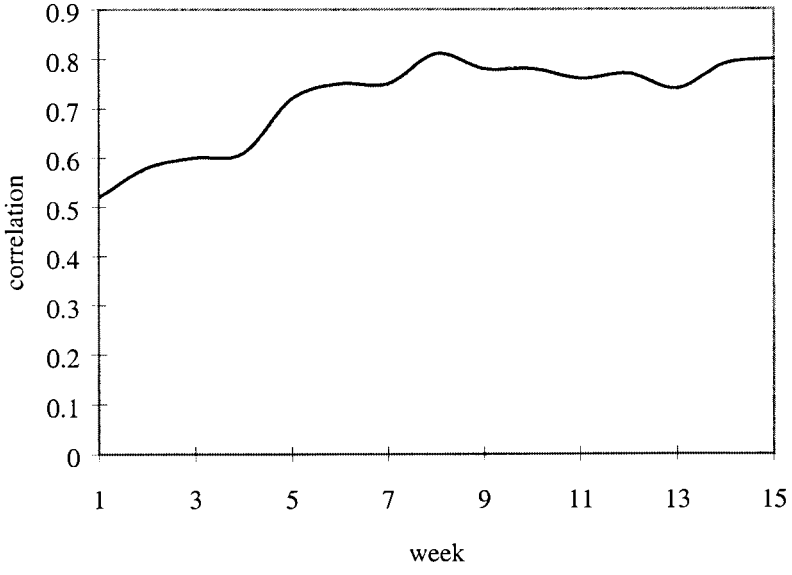

FIG. 2.—Time evolution of correspondence between status distance and asymmetry, Newcomb fraternity.

data, but throughout the second half of the study the correlations are statistically significant at the .01 level. (In randomly produced networks, the ninety-fifth percentile is about .25 for networks of size 17 generated under the assumption of a uniform distribution. Randomly permuting the observed attachments across dyads—the method used to calculate statistical significance in tables 1 and 2—produces a similar null distribution but reveals that the correlations observed in early weeks are not significantly larger than those yielded by random reassignments of attachments.) Figure 3 reveals, again, a steady trend toward a higher correlation over 15 weeks, indicating convergence toward the equilibrium structure.

Column 4 of table 1 offers a test of proposition 4 that is analogous to the test for 2: for the Bales groups, which vary in size, I report the regression across all possible pairs of role dissimilarity on status distance. From equation (8) the model predicts, as for dyad asymmetry, a slope that declines with group size. The coefficient estimates in column 4 again confirm this prediction.

Table 2 presents results for the correspondence between choice status and volume of attachments directed toward others. (The Newcomb data, with fixed outdegree as noted earlier, are not suitable for this analysis.) Except, again, for the smallest Bales group, the relationship is consistently in the predicted direction and statistically significant—reaching a corre-

TABLE 2
CORRELATION OF CHOICE STATUS WITH ATTACHMENTS DIRECTED TO OTHERS

Context (*n*)	Correlation	Slope
Bales:		
(5)	.58	.30
(6)	.93**	.57
(7)	.91**	.50
(8)	.79**	.46
Quintuplets (5) ...	.96**	.88

NOTE.—*P*-values are based on nonparametric estimates of the likelihood of observing a correlation of a given size or greater across random permutations of the observed network of interactions. See note to table 1 for more detail.
* $P < .05$, one-tailed.
** $P < .01$.

lation of .96 in the case of the Blatz data. The second column reports the slope of the relationship, which as predicted in proposition 6 is always less than unity—implying greater dispersion in attachments received than in volume of attachments directed outward.

The results provide striking confirmation for all of the six propositions. But what is perhaps more noteworthy than the statistically significant correlations is the fact that the predictions were based not on a commonsense view of how social attachments ought to be distributed, but rather on analysis of a formal model. In other words, the hypotheses, while formally derived from the model's basic assumptions, do not follow trivially from those assumptions. Hypotheses in the social sciences are more frequently operational restatements of basic theoretical premises; here, the hypotheses are nonobvious logical implications of those premises. Their independent confirmation with data collected for other purposes offers validation not merely of the current model, but of the general enterprise of constructing and analyzing formal sociological theories.

DISCUSSION

The model presented in this article generates a set of predictions that, as I have shown, accord fairly precisely with extant network data. The propositions also accord informally with some stylized facts about relational structures. For example, by specifying the conditions under which small differences in talent, attractiveness, and other kinds of "quality" can be amplified into large status differences, the model offers an account of why social roles in organizations, professions, and other medium-size or large groups are often described in ethnographic accounts (e.g., Kanter

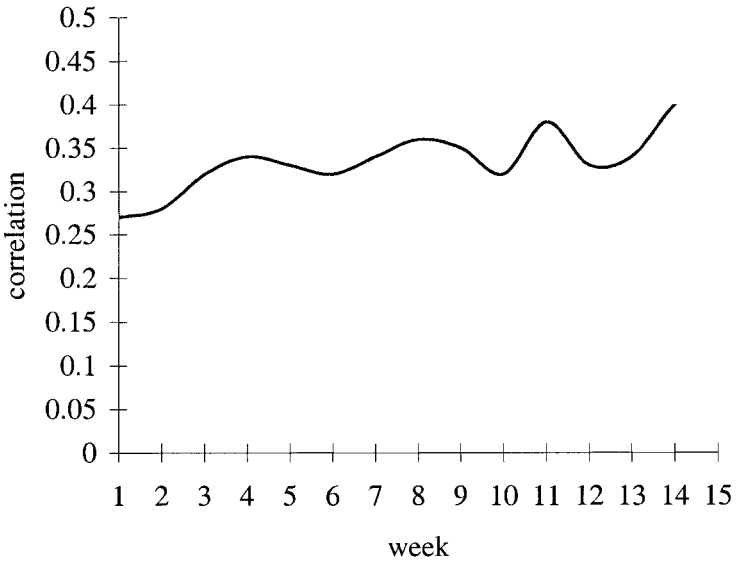

FIG. 3.—Time evolution of correspondence between status distance and role dissimilarity, Newcomb fraternity.

1977; Morrill 1995) as clearly differentiated—for example, into "stars" and everyone else—rather than smoothly distributed. More significantly, the previous section showed that specific predictions, at the individual, pair, and group levels, can be subjected to empirical test using relational data from a suitable context. In this instance, the data conformed quite well to the predictions.

Although the hypotheses were generated under the assumption of equilibrium, it is not the case that real-world settings must be completely stable for the model to be applicable. Even if their behavior never reaches a steady state, individuals adjusting their actions in response to the choices of others will on average push the system in the direction of the equilibrium state; consequently, the system will spend a disproportionate amount of time at or near the equilibrium state.[9] In addition, the equilibrium condition tells us what trends over time ought to look like, as they indeed do in the case of Newcomb's fraternity. The patterns predicted on the basis of the model's equilibria can therefore reflect central tendencies even for those social settings in which behavior is rarely static.

[9] This is true even for some chaotic systems. What makes a dynamical system chaotic is not that there are no patterns to the states it visits, but that it is impossible to use information on the current state to predict its precise state at some sufficiently distant time in the future. The set of likely states may nonetheless be small. See Ruelle (1991).

The less static the behavior, however, the greater the likelihood of competing influences on the observed structure of any relational system. A fair test thus requires the inclusion of controls for those factors that might confound the hypothesized patterns. As a general matter, then, tests of the theory using data from natural settings will need to take fuller account than I have done in the present study of factors beyond sociometric structure.

There are several points of convergence between the present model and research in the small-group/expectation states tradition. Most important, as in the present study, the expectation states research program has consistently posited a link between interaction patterns and emerging status hierarchies, as reflected in either conversational participation rates or measures of influence (Berger et al. 1974, 1977; Fişek et al. 1995). More specifically, expectation states thinking anticipates the idea of self-reinforcing hierarchy on which the current model depends by suggesting that interaction occurring early in the life of a group sets up expectations for performance that are reinforced by later interaction, leading to a stable hierarchy with no necessary basis in ability differences. Recent synthetic work (Fararo and Skvoretz 1986; Skvoretz and Fararo 1996) has also connected expectation states thinking to developments in social network analysis. These authors represent status differences rather than actual interaction as social relations, and explore the kinds of social structures—for example, fully transitive or only partially transitive dominance orders—that can emerge under a model of expectation formation.

Nonetheless, the theory I propose offers novel insights and the potential for broader application than extant work in the small-group tradition. In the first place, the model examined here is meant to apply to interaction networks in general, not just to behavior in task groups. The broader scope of interpretation is justified empirically by the successful application to the quintuplet and fraternity data, neither of which involves task performance. Second, certain important regularities identified empirically in the small-group tradition—notably the positive relationship of attachments sent to attachments received, and the correspondence between status proximity and structural similarity—are derived analytically as predictions. Prior research has, in contrast, incorporated these regularities as basic axioms rather than deriving them from more primitive assumptions (see Fişek 1974; Balkwell 1995; Robinson and Balkwell 1995; Skvoretz and Fararo 1996). This difference implies that the current theory achieves greater parsimony in accounting for observed patterns. In addition, my reliance on closed-form analytic solutions rather than simulation (Skvoretz and Fararo 1996) or numerical analysis (Fişek 1974; Fararo and Skvoretz 1986) ensures that the hypotheses follow rigorously from the model and that their dependence on parameter values is known; both

simulation and numerical analysis, in contrast, require the analyst to sample from the space of parameter values, with corresponding uncertainty about what the model predicts in other regions of the parameter space.

CONCLUSION

The aim of the theory offered here is to bridge a divide between the individualist perspective on hierarchy, in which status differences correspond directly to variation in individual traits, and the structuralist perspective, in which privileged status positions are enacted and protected by those who will benefit from them, and are largely unrelated to individual qualities. Invoking the venerable notion that status hierarchies result from a self-fulfilling process in which individuals' social evaluations are sensitive to the evaluations of others, I developed a formal model that both expresses this idea and permits the derivation of further implications from it. I suggested that, along with the influence process by which status guides individual choices, the individual attributions or social attachments that express status are subject to considerations of symmetry, which may vary in importance relative to status. In short, ego is drawn to match his or her attachments to group-level attributions of status (which themselves are merely the aggregate pattern of attachments), but this impulse is tempered by the desire for reciprocation from alter. To take an illustratively extreme case, I may very much want to express devotion to the queen of England because millions of others have directed their attention toward her, but I reserve some of my time and attention for other people (whom I actually know) because I receive so little of the queen's time or attention. Nonetheless, she gets some of my attention (and possibly even affection, depending on how susceptible I am to social influence) despite the fact that the most I can expect from her is to wave and smile beneficently at a crowd of which I am a member. I demand considerably more attention from my less aristocratic associates because they bring less status to the association; yet I am also more likely to receive it because they too can expect more attention from me than from royals.

The most important substantive implication of the model is that it provides a specific account of the way socially influenced judgments amplify status differences relative to the situation in which actors respond only to observable individual qualities. This analytical result demonstrates that a social process can transform modest individual differences into large differences in how much attention or approval individuals receive. In other words, it can *simultaneously* be true, as economistic models suggest, that competitive processes distribute rewards as a function of

individual qualities, and, as sociological models propose, that these rewards are nevertheless filtered through structural positions that distribute advantage unevenly. "Advantage" may not mean transfer of rewards from one person to an otherwise identical person, but rather exaggeration of the reward accruing to one and diminution of the reward accruing to another, relative to the actual (exogenous) difference between them.

This sort of hierarchy, the model demonstrates, results from a social process to which all actors, not just those who benefit from it, contribute. A further point to notice, stemming directly from the decentralized nature of the production of hierarchy, is that the model also provides for situations in which status differences *understate* exogenous differences in individual qualities: when the insistence on reciprocity in status-conferring attachments is sufficiently great, status hierarchies can be nearly flat even when underlying individual attributes vary considerably. Social influence on quality judgments, then, is double-edged.

Formalization of the model offered a range of empirically testable propositions, even in the absence of information about the values of s and ω. Analysis of the model's equilibria generated specific predictions about sociometric structure under fairly general conditions. I showed, for example, that the model implies greater symmetry in the attachments of status equals than in the attachments of people who differ sharply in status. I showed in addition that the model implies greater role similarity (patterns of attachment to third parties) the closer people are to each other in choice status. These two relationships were hypothesized to be sensitive to group size. Finally, analysis of the model furnished the prediction that actors high in choice status would also direct more attachments to others; the slope relating choice status to attachments directed to others was predicted to be less than unity, implying greater dispersion in the former than the latter.

Sociometric data from a range of settings exhibited impressive consistency with these predictions, except in the case of groups small enough to render large correlations commonplace. Further research will both expand the set of predictions and the evidentiary base on which to test them; these preliminary results, however, offer strong encouragement for research in this direction.

Although the degree to which social influence (ω) shapes status-conferring judgments could not be assessed directly from the data employed here (if it were easy to do so, there would most likely never have been a debate over the origins of hierarchy), it is in principle possible to rank social situations in terms of the relative weight of exogenous and endogenous influences on social judgments, and to use this ordinal ranking to test the model's predictions about the impact of social influence on the extent of status inequality. In the context of work organizations, for in-

stance, ω should be higher (implying greater status inequality for sufficiently low s) when it is difficult to disaggregate group achievements into individual contributions. In informal social groups, greater homogeneity among members (as in the case of genetically identical infants) should be associated with higher values of ω, inasmuch as there are fewer externally provided cues that could anchor judgments of difference independently of the distribution of attachments. (Note that the theory advanced here does not require exogenous "quality" Q to index anything of real intrinsic value; all that Q represents is a ranking on which actors can agree without reference to one another's judgments.) In general, the more diffuse or diverse the activities in which group members collectively participate are, the higher the value of ω should be: as members find it more difficult to coordinate *ex ante* (i.e., without observing each other's attributions) on status rankings, the endogenous component of the establishment of status should become more significant. These principles should inform the construction of further empirical tests.

A more narrowly focused remark is in order regarding the place of the present theory in the social network tradition from which it issues. Most of the effort in the network literature has been devoted either to developing techniques for representing or describing network structure or to investigating the impact of observed relational patterns on social outcomes (mobility, collective action, interpersonal conflict, etc.). The general strategy in the former, principally methodological effort has been to construct indices of structural position (such as centrality) or reduced-form maps (e.g., blockmodels or spatial topologies) that offer interpretable models of hard-to-interpret empirical networks. The strategy in the second, more substantive effort has been to discover associations between individual-level outcomes and structural position as reflected by some network index or between collective outcomes and some measured characteristic of overall network structure. Both kinds of scholarship therefore tend to treat network data as determined exogenously, which is to say by some process that is not explicitly modeled. It is rare for researchers in the area to offer explanatory models of network structure itself—models, that is, that tell us what sort of structures to expect in what situations (see, however, Boorman 1975; Davis 1970; Holland and Leinhardt 1970; Lévi-Strauss [1949] 1969; Homans and Schneider 1955).

As evidence accumulates that sociometric structure is associated with both individual- and group-level outcomes, however, explanatory models *of* sociometric structure will become increasingly imperative. Although economists have made some progress in this area (Dutta and Jackson 1997; Jackson and Wolinsky 1996), research in the structural tradition, notably by scholars interested in the time-evolution of social networks, has also begun, at least implicitly, to reflect this concern (Zeggelink 1994;

Friedkin 1993). A subsidiary goal of the present study has been to furnish an explicit theoretical foundation for such exercises: rather than generate propositions about network dynamics from empirical observation only, I constructed a model whose equilibria can be used to deduce either the form network structure can be expected to have when stable, or the direction in which it can be expected to evolve when not stable.

More generally, a formal model of this kind constitutes a systematic and falsifiable rendering of the popular idea that social networks are structures that actors simultaneously create through their actions and confront as social facts. The idea, often repeated in a general and informal way in metatheoretical essays, has a lot of surface appeal (as its frequent repetition shows); but to have significant content, it must be formulated in testable terms.

APPENDIX

The following are proofs of the propositions given in the main text.

Proof of Proposition 1

From equation (5),

$$a_{ij} - a_{ji} = \frac{(1-\omega)\{s[Q_i + (2s+\omega)Q_j]\}}{3s^2 - (2n-7)s\omega - (n-2)\omega^2} - \frac{(1-\omega)\{s[Q_j + (2s+\omega)Q_i]\}}{3s^2 - (2n-7)s\omega - (n-2)\omega^2}$$
$$= \frac{(1-\omega)(s+\omega)(Q_j - Q_i)}{3s^2 - (2n-7)s\omega - (n-2)\omega^2}. \tag{A1}$$

But, from equation (6), we also have

$$\sum_{k \neq j} a_{kj} - \sum_{k \neq i} a_{ki} = \frac{(1-\omega)[(2n-3)s + (n-1)\omega]}{3s^2 - (2n-7)s\omega - (n-2)\omega^2} \times (Q_j - Q_i).$$

Rearranging and substituting into (A1) yields

$$a_{ij} - a_{ji} = \frac{(s+\omega)}{(2n-3)s + (n-1)\omega} \times \left(\sum_{k \neq j} a_{kj} - \sum_{k \neq i} a_{ki}\right), \tag{A2}$$

from which proposition 1 follows directly.

Proof of Proposition 3

At equilibrium (by eq. [5]), for any three actors i, j, k,

$$a_{ik} - a_{jk} = \frac{(1-\omega)[sQ_i(2s+\omega)Q_j]}{3s^2-(2n-7)s\omega-(n-2)\omega^2} - \frac{(1-\omega)[sQ_j(2s+\omega)Q_k]}{3s^2-(2n-7)s\omega-(n-2)\omega^2}$$
$$= \frac{s(1-\omega)(Q_i-Q_j)}{3s^2-(2n-7)s\omega-(n-2)\omega^2}. \tag{A3}$$

But, from (A2),

$$Q_i - Q_j = \frac{3s^2-(2n-7)s\omega-(n-2)\omega^2}{(1-\omega)[(2n-3)s+(n-1)\omega]} \times \left(\sum_{m\neq i} a_{mi} - \sum_{m\neq j} a_{mj}\right).$$

Substituting into (A3),

$$a_{ik} - a_{jk} = \frac{s}{(1-\omega)[(2n-3)s+(n-1)\omega]} \times \left(\sum_{m\neq i} a_{mi} - \sum_{m\neq j} a_{mj}\right),$$

implying that, for $g = \sum_{m\neq i} a_{mi} - \sum_{m\neq j} a_{mj}$,

$$\frac{\partial(a_{ik}-a_{jk})}{\partial g} = \frac{s}{(1-\omega)[(2n-3)s+(n-1)\omega]}.$$

Q.E.D.

Proof of Proposition 5

From (5),

$$a^*_{ij} = \frac{(1-\omega)\left[(2s+\omega)Q_j + sQ_i + \frac{s\omega(3s+2\omega)\sum_k Q_k}{(s+\omega)[3s-(3n-5)\omega]}\right]}{3s^2-(2n-7)s\omega-(n-2)\omega^2}.$$

Summing across i, and assuming that Q is centered on its mean so that $\sum_k Q_k = 0$, (implying, furthermore, that $\sum_{i\neq j} Q_i = -Q$), we have

$$\sum_{i\neq j} a_{ij} = \frac{(1-\omega)[s(n-3)-\omega]}{3s^2-(2n-7)s\omega-(n-2)\omega^2}, \tag{A4}$$

which gives j's indegree. Likewise, summing a_{ji} across all i to obtain j's outdegree yields

Dividing (A5) by (A4) and simplifying gives

$$\frac{\sum_{i \neq j} a_{ji}}{\sum_{i \neq j} a_{ij}} = \frac{s(n-3) - \omega}{(2n-3)s + (n-1)\omega},$$

from which it follows self-evidently that

$$\sum_{i \neq j} a_{ji} = \frac{s(n-3) - \omega}{(2n-3)s + (n-1)\omega} \sum_{i \neq j} a_{ij.}$$

Q.E.D.

REFERENCES

Anderson, Elijah. 1990. *Streetwise: Race, Class, and Change in an Urban Community*. Chicago: University of Chicago Press.

Asch, Solomon E. 1956. *Studies of Independence and Conformity*. Washington, D.C.: American Psychological Association.

Bales, Robert F. 1970. *Personality and Interpersonal Behavior*. New York: Holt, Rinehart & Winston.

Balkwell, James W. 1995. "Strong Tests of Expectation-States Hypotheses." *Social Psychology Quarterly* 58:44–51.

Becker, Gary S. 1964. *Human Capital*. New York: Columbia University Press.

Bendix, Reinhard. 1978. *Kings or People : Power and the Mandate to Rule*. Berkeley: University of California Press.

Berger, Joseph, Thomas L. Conner, and M. Hamit Fişek. 1974. *Expectation States Theory: A Theoretical Research Program*. Cambridge, Mass.: Winthrop Publishers.

Berger, Joseph, M. Hamit Fişek, Robert Z. Norman, and Morris Zelditch, Jr. 1977. *Status Characteristics in Social Interaction: An Expectation States Approach*. New York: Elsevier.

Bielby, William T., and James N. Baron. 1986. "Men and Women at Work: Sex Segregation and Statistical Discrimination." *American Journal of Sociology* 91: 759–99.

Bienenstock, Elisa J., and Phillip Bonacich. 1997. "Network Exchange as a Cooperative Game." *Rationality and Society* 9:37–65.

Blatz, William E., N. Chant, M. W. Charles, M. I. Fletcher, N. H. C. Ford, A. L. Harris, J. W. MacArthur, M. Mason, and D. A. Millichamp. 1937. *Collected Studies on the Dionne Quintuplets*. Toronto: University of Toronto Press.

Blau, Peter M. 1964. *Exchange and Power in Social Life*. New York: Wiley.

Boorman, Scott A. 1975. "A Combinatorial Optimization Model for Transmission of Job Information through Contact Networks." *Bell Journal of Economics* 6:216–49.

Bourdieu, Pierre. 1984. *Distinction: A Social Critique of the Judgment of Taste*. Cambridge, Mass.: Harvard University Press.

Breiger, Ronald L. 1976. "Career Attributes and Network Structure: A Blockmodel Study of a Biomedical Research Specialty." *American Sociological Review* 41: 117–35.

Burt, Ronald S. 1987. "Social Contagion and Innovation: Cohesion versus Structural Equivalence." *American Journal of Sociology* 92:1287–1335.

_____. 1992. *Structural Holes*. Cambridge, Mass.: Harvard University Press.

Cole, Jonathan R., and Stephen Cole. 1973. *Social Stratification in Science*. Chicago: University of Chicago Press.

Coleman, James S. 1961. *The Adolescent Society: The Social Life of the Teenager and its Impact on Education*. New York: Free Press of Glencoe.
_____. 1973. *The Mathematics of Collective Action*. Chicago: Aldine.
_____. 1990. *Foundations of Social Theory*. Cambridge, Mass.: Belknap Press.
Cook, Karen S., Richard M. Emerson, Mary R. Gillmore, and Toshio Yamagishi. 1983. "The Distribution of Power in Exchange Networks: Theory and Experimental Results." *American Journal of Sociology* 89:275–305.
Crane, Diana. 1972. *Invisible Colleges: Diffusion of Knowledge in Scientific Communities*. Chicago: University of Chicago Press.
Davis, James A. 1970. "Clustering and Hierarchy in Interpersonal Relations: Testing Two Graph Theoretical Models on 742 Sociomatrices." *American Sociological Review* 35:843–51.
Davis, Gerald F. 1991. "Agents without Principles? The Spread of the Poison Pill through the Intercorporate Network." *Administrative Science Quarterly* 36:583-90.
Dumont, Louis. 1970. *Homo Hierarchicus: The Caste System and Its Implications*. Chicago: University of Chicago Press.
Dutta, Bhaskar, and Matthew O. Jackson. 1997. "Stable Networks." *Journal of Economic Theory* 76:322–44.
Fararo, Thomas J., and John Skvoretz. 1986. "E-State Structuralism: A Theoretical Method." *American Sociological Review* 51:591–602.
Fişek, M. Hamit. 1974. "A Model for the Evolution of Status Structures in Task-Oriented Discussion Groups." Pp. 53–84 in *Expectation States Theory: A Theoretical Research Program*, edited by Joseph Berger, Thomas L. Conner, and M. Hamit Fişek. Cambridge, Mass.: Winthrop Publishers.
Friedkin, Noah E. 1993. "Structural Bases of Interpersonal Influence in Groups: A Longitudinal Case Study." *American Sociological Review* 58:861–72.
Fudenberg, Drew, and Jean Tirole. 1991. *Game Theory*. Cambridge, Mass.: MIT Press.
Galaskiewicz, Joseph. 1985. *Social Organization of an Urban Grants Economy : A Study of Business Philanthropy and Nonprofit Organizations*. Orlando, Fla.: Academic Press.
Gaventa, John. 1982. *Power and Powerlessness: Quiescence and Rebellion in an Appalachian Valley*. Urbana: University of Illinois Press.
Gibbons, Robert. 1992. *Game Theory for Applied Economics*. Princeton, N.J.: Princeton University Press.
Godelier, Maurice. 1982. *La Production des grands hommes: Pouvoir et domination masculine chez les Baruya en Nouvelle-Guinée*. Paris: Fayard.
Holland, Paul W., and Samuel Leinhardt. 1970. "A Method for Detecting Structure in Sociometric Data." *American Journal of Sociology* 76:492–513.
Homans, George C. 1961. *Social Behavior: Its Elementary Forms*. New York: Harcourt, Brace & World.
Homans, George C., and David M. Schneider. 1955. *Marriage, Authority, and Final Causes: A Study of Unilateral Cross-Cousin Marriage*. Glencoe, Ill.: Free Press.
Jackson, Matthew O., and Asher Wolinsky. 1996. "A Strategic Model of Social and Economic Networks." *Journal of Economic Theory* 71:44–74.
Kanter, Rosabeth M. 1977. *Men and Women of the Corporation*. New York: Basic Books.
Krackhardt, David. 1987. "Cognitive Social Structures." *Social Networks* 9:109–34.
Laumann, Edward O., and David Knoke. 1987. *The Organizational State*. Madison: University of Wisconsin Press.
Lévi-Strauss, Claude. (1949) 1969. *The Elementary Structures of Kinship*. Boston: Beacon.
Liebow, Elliot. 1967. *Tally's Corner: A Study of Negro Streetcorner Men*. Boston: Little, Brown.

Markovsky, Barry, David Willer, and Travis Patton. 1988. "Power Relations in Exchange Networks." *American Sociological Review* 53:220–36.
Merton, Robert K. 1968. "The Matthew Effect in Science." *Science* 159:56–63.
Milgram, Stanley S. 1974. *Obedience to Authority: An Experimental View*. New York: Harper & Row.
Milner, Murray, Jr. 1994. *Status and Sacredness: A General Theory of Status Relations and an Analysis of Indian Culture*. New York: Oxford University Press.
Morrill, Calvin. 1995. *The Executive Way*. Chicago: University of Chicago Press.
Newcomb, Theodore M. 1961. *The Acquaintance Process*. New York: Holt, Rinehart & Winston.
Podolny, Joel M. 1993. "A Status-Based Model of Market Competition." *American Journal of Sociology* 98:829–72.
Podolny, Joel M., and Toby A. Stuart. 1995. "A Role-Based Ecology of Technological Change." *American Journal of Sociology* 100:1224–60.
Powell, Walter W., and Paul DiMaggio. 1991. *The New Institutionalism in Organizational Analysis*. Chicago: University of Chicago Press.
Ridgeway, Cecilia L., and Joseph Berger. 1986. "Expectations, Legitimation, and Dominance Behavior in Task Groups." *American Sociological Review* 51:603–17.
Ridgeway, Cecilia L., Elizabeth Heger Boyle, Kathy J. Kuipers, and Dawn T. Robinson. 1998. "How Do Status Beliefs Develop? The Role of Resources and Interactional Experience." *American Sociological Review* 63:331–50.
Robinson, Dawn T., and James W. Balkwell. 1995. "Density, Transitivity, and Diffuse Status in Task-Oriented Groups." *Social Psychology Quarterly* 58:241–54.
Rosen, Sherwin. 1981. "The Economics of Superstars." *American Economic Review* 71:845–58.
_____. 1982. "Authority, Control, and the Distribution of Earnings." *Bell Journal of Economics* 13:311–23.
Ruelle, David. 1991. *Chance and Chaos*. Princeton, N.J.: Princeton University Press.
Sahlins, Marshall. 1963. "Poor Man, Rich Man, Big-Man, Chief: Political Types in Polynesia and Melanesia." *Comparative Studies in Society and History* 5:285–303.
Sherif, Muzafer, and Carolyn W. Sherif. 1966. *Groups in Harmony and Tension: An Integration of Studies on Intergroup Relations*. New York: Harper & Row.
Skvoretz, John, and Thomas Fararo. 1996. "Status and Participation in Task Groups: A Dynamic Network Model." *American Journal of Sociology* 101:1366–1414.
Skvoretz, John, and David Willer. 1993. "Exclusion and Power: A Test of Four Theories of Power in Exchange Networks." *American Sociological Review* 58:801–18.
Sørensen, Aage B. 1996. "The Structural Basis of Social Inequality." *American Journal of Sociology* 101:1333–65.
Stewman, Shelby, and Suresh L. Konda. 1983. "Careers and Organizational Labor Markets: Demographic Models of Organizational Behavior." *American Journal of Sociology* 88:637–85.
Strang, David, and James N. Baron. 1990. "Categorical Imperatives: The Structure of Job Titles in California State Agencies." *American Sociological Review* 55:479–95.
Tilly, Charles. 1998. *Durable Inequality*. Berkeley: University of California Press.
White, Harrison C. 1970. Chains of Opportunity: System Models of Mobility. Cambridge, Mass.: Harvard University Press.
White, Harrison C. 1981. "Where Do Markets Come From?" *American Journal of Sociology* 87:517–47.
White, Harrison C., Scott A. Boorman, and Ronald L. Breiger. 1976. "Social Structure from Multiple Networks. I. Blockmodels of Roles and Positions." *American Journal of Sociology* 81:730–80.
Whyte, William Foote. 1943. *Street Corner Society*. Chicago: University of Chicago Press.

Willis, Paul. 1977. *Learning to Labor: How Working-Class Kids Get Working-Class Jobs*. Farnborough, England: Saxon House.

Yamagishi, Toshio, Mary R. Gillmore, and Karen S. Cook. 1988. "Network Connections and the Distribution of Power in Exchange Networks." *American Journal of Sociology* 93:833–51.

Zeggelink, Evelyn P. H. 1994. "Dynamics of Structure: An Individual-Oriented Approach." *Social Networks* 16:295–333.

Zuckerman, Harriet, and Robert K. Merton. 1971. "Patterns of Evaluation in Science: Institutionalisation, Structure, and Functions of the Referee System." *Minerva* 9: 66–100.