

# ADVANCES IN SOCIAL NETWORK ANALYSIS

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# *Anthropological Contributions to the Study of Social Networks*

## *A Review*

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There are certain important branches of science, each of which deals with certain class or kinds of structures, the aim being to discover the characteristics of all structures of that kind. So atomic physics deals with the structure of atoms, chemistry with the structure of molecules, crystallography and colloidal chemistry with the structure of crystals and colloids, and anatomy and physiology with the structure of organisms. There is, therefore, I suggest, place for a branch of natural science which will have for its task the discovery of the general characteristics of those social structures of which the component units are human beings.

*A. R. Radcliffe-Brown,  
Structure and Function  
in Primitive Society (1952, p. 190)*

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Much has happened in the 40 years since Radcliffe-Brown wrote these words that might resemble his anticipated "branch of natural science" dedicated to the examination of the kinds of structures in which humans are involved. Although certainly not a discipline in the strictest sense, "social network analysis" or "structural analysis" (as referred to by some in sociology, and not to be confused with structuralism in anthropology) has evolved over this period and has some of the elements of Radcliffe-Brown's "branch" of science. The early concern for social structure by social anthropologists and Barnes's formalization of a social network, which up until that time had largely been used as a metaphorical convention, have led to the development of an "integrated scientific specialty" resembling what Kuhn would call normal science (Hummon & Carley, in press, p. 1). This review explores two questions: First, what roles have social and cultural anthropologists played in the development of this scientific specialty? Second, how have social network studies contributed to the advancement of anthropological knowledge?

To provide some continuity, this review will pick up from Mitchell's 1974 review of social networks in the *Annual Review of Anthropology*. As Mitchell did, we will continue the controversial discussion of whether there is something uniquely identifiable as social network theory, and it will be shown how the American tradition of cognitive anthropology has, since 1974, become an important influence in the developing paradigm called social networks.

In concluding his review, Mitchell left the reader with the clear impression that much remained to be done concerning the implementation of propositions from mathematical graph theory for the study of social networks (see also Barnes, 1969). In addition, he identified other analytical procedures (other than graph theory) that are "needed to handle the sort of problems that anthropological studies using social networks seem to involve" (Mitchell, 1974, p. 297). One such method, which he called "functorial mapping," had only begun to be recognized as important for analyzing structural problems in the study of social networks. It was, of course, the ideas of blockmodeling and structural equivalence introduced in the now classic article by Lorrain and White (1971). Referring to these "new" analytical procedures, Mitchell (1974) pointed out that the "data concerning all the links in a social network relating to some event or series of events in which the analyst is interested will have to be recorded in greater detail and more systematically than has customarily been done" (p. 297).

Twenty years later there are, indeed, more detailed and systematic methods available for collecting and analyzing social network data. But

much has not changed or, depending on one's perspective, has moved away from rigor. The concept of social networks is used widely in anthropology as a metaphor (e.g., O'Connor, 1990). Walsh and Simonelli (1986), for example, see scientific rigor as a hindrance, impractical and unnecessary for anthropological research on social networks. In this view the most "promising" work treats networks and related processes as a "given" (Walsh & Simonelli, 1986, p. 46). These authors, for example, describe the "function" of support networks among migrants using the concept as a "heuristic" device (p. 50). In a sense, viewing networks as a given relegates network explanations to the same circularity as many cultural explanations.

Bax (1979) attacks social network analysis, claiming that the "anti-theoretical thinking" inherent in this approach is the result of an almost exclusive preoccupation with the further refinement and development of analytical techniques.<sup>1</sup> Criticisms like these reflect strong sentiment among many anthropologists regarding what they see as the limits of the scientific method. This review recognizes the existence of such work but will focus exclusively on studies of social networks by anthropologists who are identified with scientifically based analytical approaches.

### *Anthropology and the Question of Network Theory*

Mitchell (1974) described how the "compact institutional analysis characteristic of the structural approach" that focused on small-scale societies seemed less suited for the study of humans in more complex settings. These inadequacies led to the modification of ideas concerning roles and to the development of transaction theories, action theories, and social exchange approaches (Whitten & Wolfe, 1974). In turn, work in these areas stimulated the need for network concepts and a network approach more generally.

At the time of Mitchell's review, social anthropologists who were influential in the development and use of social network analysis felt strongly that there was really no such thing as network theory per se. Barnes (1972) viewed the idea of social networks as an "orienting statement" and argued that a theory of social networks may never exist. Bott saw social networks as a basic idea that could be used in many "frames of reference." Kapferer (1973) recognized no network theory but saw the network approach as simply a method for data collection and analysis. Kapferer and Wolfe (1970), and Whitten and Wolfe (1974)

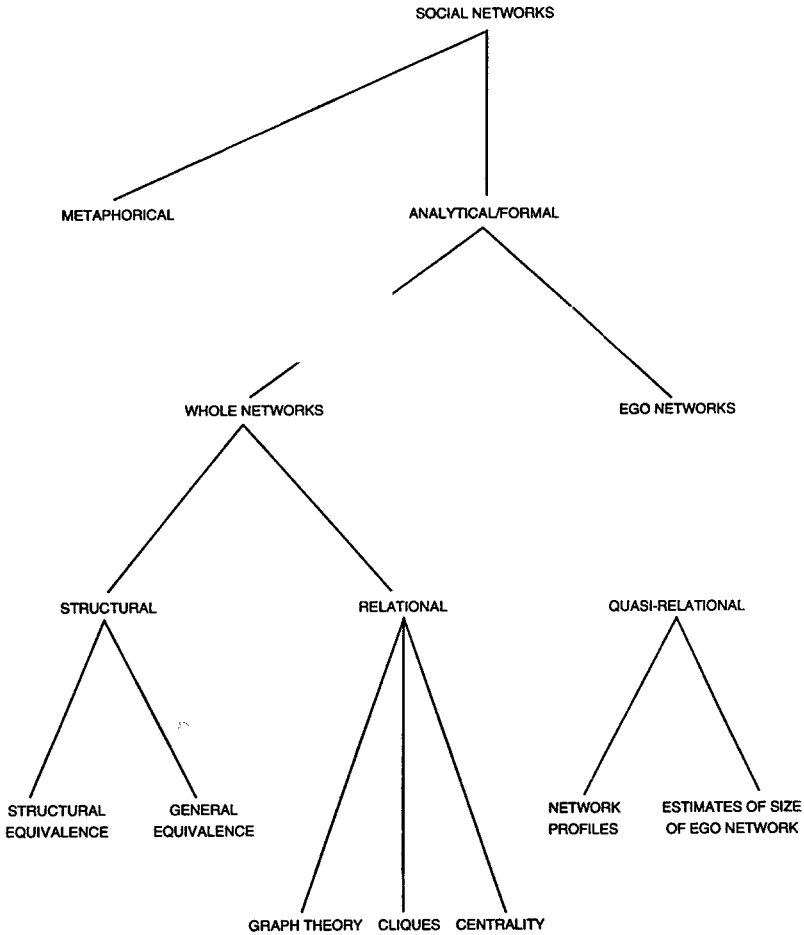
all proposed that exchange theory, action theory, or role theory were all suited for an adequate explanation of network phenomena. Mitchell's (1974) own view on the existence of network theory was much more upbeat:

My own view on the subject is that the debate is more about words than reality. There is no network theory in the sense of "basic assumptions together with a set of derived propositions which are interlinked and capable of being tested" (Kapferer, 1973, p. 84). But I suspect there are few theories in social anthropology of this kind at all. That propositions may be derived from a consideration of the characteristics of social networks is, I think, evident. (p. 283)

Mitchell has been vindicated.<sup>2</sup> Since 1974 there have been many changes and advances in the area of social network analysis. Developments in the application of graph theory (e.g., Barnes & Harary, 1983), algebraic approaches (e.g., Borgatti & Everett, 1989), stochastic models (e.g., Anderson, Wasserman, & Faust, 1992), and blockmodels (Faust & Wasserman, 1992) and related ideas on equivalence to social phenomena provide evidence that network or structural theory is emerging (see Wellman, 1988, for a discussion). In fact, 5 years before Mitchell's landmark article (and apparently unknown to Mitchell), Boyd (1969) articulated a set of algebraic problems in the study of kinship structure. Boyd's work would, in time, contribute much to social network analysis. In sociology, and paralleling the work of Boyd, sociologists were developing the structural framework for the study of social networks, and network computer programs were being written that would help overcome analytical barriers. Finally, Mitchell could not have anticipated the eventual influence of cognitive anthropology on what has come to be known as social network analysis.

### *Analytical Versus Metaphorical*

The hierarchical graph in Figure 5.1 represents one possible avenue for organizing the range and types of network approaches used in anthropology, and this review will use this organizational convention where appropriate. Aside from the first major bifurcation between the formal/analytical and metaphorical use of social networks, a distinction is made between the study of whole networks and ego networks. Within "whole networks" there is a division among studies of relations, studies



**Figure 5.1.** Organization of Types of Network Approaches Used in Anthropology

of structures, and statistical approaches to the study of networks. Although all “whole networks” can be represented in matrix form, and the relational or structural analysis of these matrices can lead to similar conclusions, there may be conditions where this will not be the case. In addition, some difference lies on whether a measure is determined on the basis of the internal structure of a matrix or simply on its marginals (e.g., network activity versus structural equivalence; see Johnson, Poteat,

& Ironsmith, 1991, for a discussion of this). More important, the structural ideas are more in line with the ideas of Nadel (1957) and Goodenough (1969) concerning status and role (Reitz & White, 1989). With regard to the structural approach, *i* and *j* can occupy the same position (e.g., play the same role, such as manager) without having any actual ties to one another or ties to any common others but having ties to the same "types" of others (e.g., general equivalence). The relational approach, as described here, depends directly on the nature of the actual linkages between *i* and *j* in terms of such things as clique membership (i.e., cliques represent areas of intense interaction in a network). A review of this line of reasoning can be found in Burt (1983) or Doreian (1989). Ego networks, on the other hand, can be viewed as quasi-relational (a series of ego networks for unrelated egos) and involve different data collection procedures (e.g., random sampling) and theoretical assumptions and explore different aspects of social networks. Finally, there are statistical approaches to the study of networks (for a review of work in this vein, see Wasserman & Faust, 1994).

### *Social Versus Cultural Anthropology*

It is evident that social anthropology was instrumental in the development of what we now know as social network analysis. Although Radcliffe-Brown viewed social structure as a network of social relations, it was such people as John Barnes, J. Clyde Mitchell, Bruce Kapferer, Elizabeth Bott, and Jeremy Boissevain, to name a few, who, dissatisfied with the traditional rigidity and limitations of traditional structural-functionalism in studies of complex systems, began to explore how actual ties, as opposed to institutional structure, influenced behavior. Still, it cannot be denied that these researchers' earlier work was influenced by their structural-functional roots, in which norm consensus and normative behavior was "achieved" (Mitchell, 1974, p. 285). A good example of this is Epstein's (1969b) study of gossip in which network structure was the independent variable while the dependent variable was norm development.

The theoretical training and orientation of these early network scholars limited the application of some concepts in anthropology such as culture, particularly as popularized in American anthropology. To many social anthropologists, the notion of culture was irrelevant or, even to some, problematic. As Radcliffe-Brown notes (1952):

While I have defined social anthropology as the study of human society, there are some who define it as the study of culture. It might perhaps be thought that this difference of definition is of minor importance. Actually it leads to two different kinds of study, between which it is hardly possible to obtain agreement in the formulations of problems. (p. 189)

Some scholars saw little difference between social anthropology and sociology, claiming that social anthropology was not a branch of cultural or general anthropology as asserted by some (Murdock, 1951) "but rather a kind of sociology" (Watson, 1984, p. 353). Further, some may have claimed the existence of deep hostilities between British social anthropologists and North American "cultural anthropologists" (Watson, 1984). For example, Murdock (1951) saw social anthropology as "simply that branch of cultural anthropology that deals with interpersonal relationships" (p. 471). This did not sit well with some social anthropologists, particularly in light of the belief of many that the concept of culture lacked utility and was conceptually ambiguous (Watson, 1984).

The polemics of this debate aside, it is clearly the case that these differences in perception limited the importance, application, and concern for social network concepts in cultural anthropology prior to the 1970s, the period in which "social network analysis" was so heavily influenced by social anthropologists. In the 1960s and, particularly the 1970s, within cultural anthropology both ethnohistory and cognitive anthropology came into being, although it was primarily an American movement. Based on the early writings of Goodenough, for example, and pioneered by such people as Charles Frake, Mary Black, Duane Metzger, Volney Steffler, A. Kimball Romney, and Roy D'Andrade, work in this area involved the search for a better understanding of culture as a more clearly defined concept that was manifested in research involving the systematic investigation of folk classification and belief systems. In addition, people began to explore the relationship between culture and cognition and began to look for human cognitive universals. Cognitive anthropologists were interested in learning, the classification or coding of knowledge or symbolic information and individual decision making. For a review of this area in these early years, see Durbin (1974).

The study of culture was seen as somewhat analogous to the study of language. As Honigmann (1976) saw it:

The cognitivist program was largely written by Americans who also favored the newly coined word "emic," taken from "phonemic" and contrasting with



"etic" (from "phonetic") to label their standpoint. British social anthropologists who emphasized norms, while cognitively inclined, were not emicists; they did not in the manner of a linguist discovering phonemes look for criteria implicitly or explicitly recognized by the actors themselves.

There could not be room for a fully emic point of view in a tradition, as one writer put it, "since it was generally believed that natives are assumed to have only a partial and inaccurate view of the types of social relationships making up their social system, and to be capable of analyzing the processes by which the system operates." (p. 252)

Social anthropologists did not ignore what the cognitivists saw as constituting culture (e.g., shared beliefs). Social anthropologists were just not interested in eliciting and measuring individual perception and cognition (i.e., the emic perspective). To some extent, one group was interested in the interaction between language, meaning, and behavior (e.g., behavior in an approach to a cognitive task), while the other was more interested in behavior, in which norms were seen to play an important role (as etically derived).

It should be pointed out that Noble (1973), in her essay on social networks as a conceptual framework in family analysis, questions whether there should not be more attention paid to individual action and motivation as psychologists were seen to do. She even recognizes Chomsky's focus on cognitive processes as opposed to patterns of overt behavior. In addition, Jongmans (1973), in the same edited volume, used the idea of "structural balance" for looking at perceptions of obligation. This was largely a social psychological way of viewing the problem (Heider, 1946).

This is not to say that some British social anthropologists, however, were not interested in individual-based explanations for behavior. Following in the tradition of Bronishaw Malinowski and Raymond Firth, such scholars as Edmond R. Leach and, in particular, Fredrick Barth viewed individuals as making choices that would ultimately benefit them in terms of rewards, such as prestige and the accumulation of valued resources. Structure in this case is a product of the interactions involved in acquiring those benefits. Although these ideas were not cognitive in the sense of the "natives' point of view," there was a focus on individual action and choice and the approach came to be known as transactional analysis. Foster (1978) recognizes the importance of this emphasis on individual action and, more important, points to an inter-

esting linkage between these British scholars and the American cognitive anthropologists:

Perhaps the best-known development of these ideas in the British tradition is Frederick Barth's (1966) method of transactional analysis. In the United States, the development of individual-oriented research was closely tied to a body of work variously called cognitive anthropology, ethno-science, the new ethnography, ethnosemantics, componential analysis, and just plain formal analysis. (p. 248)

These important developments were critical in the cross-fertilization between cognitive anthropology and social network analysis. First, cognitive anthropologists were generally much more formally oriented than were other anthropologists. Analytical techniques for exploring and modeling the relationships among items and attributes in a semantic domain (multidimensional scaling, cluster analysis, and so on) could be readily transferred to the study of patterning in social relations. Second, many cognitive anthropologists were engaged in enterprises in which social structure, most often kinship, was a primary focus. This included how social structure or organization influenced decisions for postmarital residence (Quinn, 1975) or studies focusing on formal cognitive models of kinship (Romney, 1965). Third, prompted by Pelto and Pelto (1975), some cognitive anthropologists began to reject the traditional view of culture sharing as invariant and began to examine systematically intracultural variation. Some students of intracultural variation saw social structure as an important influence on that variation (Boster, 1985). Finally, the study of intracultural variation was aided by a formalization of the concept of culture. The cultural consensus model developed by Romney, Weller, and Batchelder (1986) starts from the idea that culture is consensus and provides formal guidelines for determining that which is cultural (that is, shared). The cultural consensus model addresses ambiguities associated with competing definitions of culture (Kroeber & Kluckholm, 1952) and offers a replicable method for exploring cultural knowledge and its variation.

Most of the cognitive anthropologists in the late 1960s and early 1970s were interested more in the structure of semantic domains, including kinship, than in the relationship between social structure and cognition. One notable exception was Volney Steffler, who lectured extensively on the important interrelationship between what he called

“heads” (individual cognition) and social organization. Unfortunately, Steffire’s ideas were not widely published and are only now reaching a wider audience. Simply, he viewed interaction in networks as a key to the development of shared meanings, expectations, linguistic behavior, and general consensus (Steffire, 1986).

This idea of interaction spheres having an influence on cognition is certainly not new. Festinger, Chachter, and Bak (1950) conceptualized how social structure mediated the influence of network members on one another’s attitudes. But this kind of social psychological thinking contrasts sharply with the network approaches of the social anthropological pioneers and has led to other studies of the relation between activity and perception in groups (Boster, Johnson, & Weller, 1987; Romney & Weller, 1984) and to studies of the relation between social interaction and intracultural variation (Johnson & Boster, 1990).

What has this historical difference in approach between cultural and social anthropology got to do with developments in social network analysis, particularly as they relate to anthropology? In a recent sociology of science study, Hummon and Carley (in press) identify six main path structures of citation in the journal *Social Networks*. Three of these paths have definite influence from anthropologists working on sets of specific theoretical and methodological issues in the study of social networks. Two of these paths have a clear cognitive influence, while the third relates to problems in the study of roles. The following sections examine these and other developments in terms of theory, models, and method and, more important, in terms of the exchange of knowledge and ideas between anthropology and social network analysis. In sum, one might make the following observation: In a sense, social psychology is to sociology as cognitive anthropology is to social anthropology.

### *Cognition and Networks*

A debate—largely conducted by anthropologists and, in its most heated period, spanning 12 years—surfaced when two scholars challenged what seemed to be a rather accepted belief that the self-reports of informants concerning, for example, “who did you interact with most today?” were accurate proxies for actual behavior. Killworth and Bernard (1976a), in the initial contribution to a series of articles, made the first of several compelling arguments that began to cast doubt on the correspondence between the self-report of informants, or cognitive

data, and actual observations of their behavior. A series of studies followed (Bernard & Killworth, 1977; Bernard, Killworth, & Sailer, 1980, 1982; Bernard, Killworth, Sailer, & Kronenfeld, 1984; Killworth & Bernard, 1979-1980; referred to here as BKS), producing several data sets that, as analyzed by the authors, seemed to point to little overlap between informants' reports and behavioral observations of network interactions.

These findings did not go unchallenged. A number of scholars reanalyzed the BKS data sets or conducted original research to specifically address this question. Romney and Faust (1983), for example, in a reanalysis of the BKS tech data (data on members of an office), showed that the accuracy of an informant depended on the extent to which he or she interacted with other members of the group. Those informants who interacted more frequently with group members reported more accurately on group behavior. In addition, the higher the judged similarity of two actors of the communication patterns of others, the more they tended to interact with each other. Romney and Weller (1984), in a reanalysis of all four BKS data sets, found that informant accuracy is even more a function of informant reliability or the correlation of each informant's response to the group aggregate. Hammer (1985), in investigating the correspondence between behavioral and cognitive data, used two of the BKS data sets and data from a donut shop (Hammer, Polgar, & Salzinger, 1969) and found such discrepancies to be systematic and to reflect aspects of an informant's observed and interactive relations.

In some original research on the question of the correspondence between behavioral and cognitive data, Freeman and Romney (1987) and Freeman, Romney, and Freeman (1987) explored factors affecting individual recall. They showed that, although informants may not be very accurate in their reports on who was present at a particular event, the reports are influenced by long-term patterns of participation and do accurately reflect the *usual* and *regular behaviors* of group or event participants (i.e., regular attendees).

Johnson and Miller (1986) compared three measures of social structure in a fish camp in Alaska (Johnson & Miller, 1983), one cognitive and two behavioral. They found that the correspondence between behavioral and cognitive data was dependent on the generalizability of the cognitive measures used. In this case, unconstrained judged similarity data of the perceived similarity among fishermen correlated higher with the two behavioral measures than the behavioral measures did with each other.

This debate, and the series of studies that inspired it, shed light not only on the issue of the reliability of cognitive network data, it also sparked interest in a whole range of matters concerning cognition and social structure. These include such concerns as the relationship between one's position in a network and perception of the structure of the group or simply knowledge of the group. This work also stimulated interest in how network position and subgroup membership affect factors in human cognition more generally.

Freeman, Freeman, and Michaelson (1988) further explored the question of accuracy by studying the ability of individual group members to define subgroup structure as compared against a behavioral standard. They found that the aggregate perception of subgroup structure corresponded very well with the subgroup structure determined by the observation of actual behavior. This was not unlike Bernard et al.'s (1982) finding that at the global level (aggregate) there was a much higher correspondence between recall and behavior. But this line of inquiry did not assess the accuracy of an individual informant nor did it explain precisely how informants were defining subgroup membership.

In a subsequent reanalysis of the data from their 1988 article, Freeman, Freeman, and Michaelson (1989) explored the accuracy of individual informants and the cognitive models used to determine subgroupings. Possible cognitive models of subgroup structure were tested against four models discussed by Sailer and Gaulin (1984), which conceptualized alternative ways individual observers might make sense of the patterns of social interaction of fellow group members. Freeman et al. (1989) found that individuals can indeed report accurately on the observable interaction patterns of *other* group members and that the four models all provided adequate alternative approximations as to how people might cognitively define observed subgroups. A definitive answer as to the precise models employed by humans in defining subgroup membership on the basis of observed interactions, however, could not be determined. These studies also have implications for ethnographic research and reliance on key informants in that members of communities, as studied here, all seemed to have a good deal of knowledge of group structure.

This concern for informant recall and the models people use to cognitively define and organize human groups is related to the question of how individuals store their social networks in their heads. Killworth and Bernard (1982), in keeping with their interest in both cognitive and behavioral network data, applied the idea of a "mental map" to investigate how world maps can be drawn from people's cognitive under-

standing of their own social networks. Similar to some of their small world experiments, they asked informants to name an individual who might happen to know any one of 100 foreign targets. Based on informant responses, they produced a similarity index between all pairs of the 100 targets, and subjected the subsequent similarity matrix to multidimensional scaling. The aggregated "mental map" of informants loosely resembled a Mercator projection of the world. From an anthropological standpoint, this study is important in that it "opens the way to a systematic, cross-cultural study of how people store their complex social networks in their minds" (Killworth & Bernard, 1982, p. 308). This work is related to a series of other studies by these authors discussed in another section.

Although not specifically termed a network study, Boster in a series of articles (1985, 1986) found that deviations from a shared cultural model of Aguaruna Jivaro manioc identification was patterned according to the sexual division of labor, individual expertise, and, more important, membership in kin and residential groups. Subsequent work extended this to include the influences of exchange relations. This (in combination with the findings of Romney and Weller, Romney and Faust, and Freeman, Romney and Freeman) stimulated Boster, Johnson, and Weller (1987) to explore the relationship between variation of knowledge among individuals and the social relations and positions of those individuals. Cognitive (e.g., pile sort, triads) and network data (e.g., work relations, advice relations) were both collected from employees in a university administrative office. Applying the cultural consensus model, they found that consensus about the similarities of office actors and the structural position of these actors influences their approach to the consensus. However, the expectation that two individuals who are judged as similar will themselves agree with each other was not confirmed. Those individuals who agree with each other are not necessarily those who are judged similar by other informants. Michaelson and Contractor (1992) extended this idea to explore how structural position influenced perceived similarity. In a study of students in a communication class, they found that the perceived similarity of other classmates corresponded better with general equivalence models than with structural equivalence models, suggesting perceived similarity may be more a function of the roles actors play rather than just simply their patterns of interaction.

Krackhardt (1987) has contributed significantly to this line of inquiry by studying actors' perception of the structure of the entire group

network, as opposed to simply asking each informant to report on his or her own network ties. Krackhardt argues that data of this type are uniquely appropriate for investigating (a) the symmetry between an actor's perception of his or her network position and that position as perceived by other network actors, (b) the effects of network position on the individual perception of structure, and (c) the effects of network position on agreement with others on network structure (see also Krackhardt & Kilduff, 1990).

If network position and degree of activity in a network influence informant accuracy and knowledge of the group, will position, group membership, or activity influence knowledge or cognition concerning other domains of interest? Johnson and Boster (1990; also discussed in Johnson, 1990) examined the relationship between perception of similarity of different kinds of meat and meat products found at the grocery store and membership in upper- and lower-middle-class networks. Based on a snowball sample through a town in Missouri, they partitioned the network on the basis of on "which side of the tracks" one resided. In comparing these two subgroups, one upper middle class and one lower middle class, the approach to the cognitive task (i.e., unconstrained judged similarity of fresh and processed meats) varied as a function of subgroup membership. The upper-middle-class subgroup sorted on the basis of degree of processing while the lower-middle-class group sorted on the basis of type of meat irrespective of processing (e.g., canned, fresh, frozen versus beef, poultry, fish, pork). In addition, both groups differed on the frequency with which they ate meals with others in their network. The upper-middle-class subgroup ate meals much more often with one another than did members of the lower-middle-class subgroup (i.e., dinner parties, lunch at the country club). Many of the social activities of the lower-middle-class subgroup centered on the church. In addition to the importance in accounting for differences in approach to a cognitive task on the basis of subgroup membership, this study has important implications for understanding differences in "taste" as a function of social class (Bourdieu, 1984).

In some related research, this emphasis on the individual behavior or action of individuals has also been stressed by Foster and Seidman (1989) and they developed a set of procedures that, as they put it, "are adapted from a body of research in cognitive anthropology" (p. 52). These authors examined networks and individual action, applying it in their research on kinship and on brand congruence within friendship networks on a college campus (Reingen, Foster, Brown, & Seidman,

1984). They found that clique membership had a significant effect on brand choice.

Similar to Foster and Seidman's focus on individual action is the idea of innovation adoption as influenced by the structural characteristics of a network. In a test of Burt's (1983) proposition that two structurally equivalent actors will adopt an innovation at about the same time, Johnson (1986) examined the diffusion of two innovations through the same network of commercial fishermen. He found that Burt's model accounted for the adoption process under the proviso that the definition of structural equivalence or "perceived social similarity" varies as a function of information availability. When available information about an innovation was low, it was in the best interest of individuals to share it only with socially close others, thus maintaining a competitive advantage. In a similar study, Johnson and Orbach (1990a) showed how structural equivalence influenced the individual decisions of commercial fishermen to migrate in the course of their yearly fishing activities. The theoretical importance of these studies is the linkage between perceived social similarity, as determined by the patterns of social relations, and individual choice.

Truex (1981) studied informants' cognition on kinship relations so as to produce a "hypothetical" model of recruitment in mobilizations for the accomplishment of various tasks. What is important about this study is its attempt to consider not just simply the semantic aspects of kinship, the focus of most cognitive anthropologists, but the dynamic potential of kin relations for providing resources and different forms of aid. He found three levels of the normative expectations of kin with highest expectations for closest kin or direct lineals and lowest expectations for distant consanguines and affines. This focus on the role aspects within kinship systems is unusual and follows to some extent in the role elicitation work of Goodenough (1969) and Boyd, Haehl, and Sailer (1971). Unfortunately, this important work has gone largely uncited. It is to the work on networks and kinship that we now turn and, as we shall see, the treatment of roles in the network analysis of kinship has also been rarely addressed.

### *Kinship and Networks*

Aside from ethnography, there is probably no other area of study that has been more associated with anthropology than kinship. In addition,



the thinking of early structural scholars, although not very methodologically sophisticated, did follow a kind of network logic (Foster & Seidman, 1979). Yet, with only a few exceptions, network concepts, methods, and approaches were used little in the study of kinship. A good example of this is presented by Foster and Seidman (1979) in their reexamination of Fortes's study of kinship among the Tallensi (Fortes, 1940, 1945, 1949). It is, of course, unrealistic to expect that Fortes, or any of the other kinship scholars of that time period, would have taken a formal network approach when the formalization of a social network itself in anthropology had yet to be developed. Ironically, by the time more formal social network concepts (e.g., density) and approaches (e.g., graph theory) had begun to be more widely accepted and understood, kinship as a focus of study had become unfashionable (Barnes, 1980). Furthermore, it was the very people who contributed to making the study of social networks a legitimate enterprise in anthropology (i.e., social anthropologists studying more urban complex societies) that rejected the importance of more traditional institutional constraints on behavior such as kinship.<sup>3</sup> Social networks, particularly in urban settings, were seen as the solution to the problems inherent in the static structural-functional approach of which kinship was an integral part. In addition, and as noted by Truex (1981), cognitive anthropologists began to study kinship not in the network sense of accounting for actual kinship relations but, instead, through examining the semantic structure of kinship domains.

These, however, were not the only limiting factors in bringing together networks ideas and kinship in a more widespread manner. There was little communication among, or even awareness of, several important scholars during the 1960s and early 1970s who were interested in understanding kinship from a decidedly structural or network point of view. The two most striking examples concern the work of White (1963), a sociologist, and Boyd (1969), an anthropologist, both of whom had considerable mathematical training. Each was working on problems in kinship from an algebraic perspective, while others were applying graph theory. These two approaches addressed different conceptual problems in the study of kinship. This is illustrated by Sailer's (1978) discussion of the difference between cliques (as formalized using graph theory) and the blockmodel:

Cliques, however, are not to be confused with roles. Here is an example of the difference. One would expect the cliques in a kin network to be entities

such as families, clans, lineages, etc. The roles of interest in a kin network, though, are kin-types, e.g., father and son. Families are certainly interesting structures in their own right, but they are not roles. Rather, they are nodes in a higher order relation. Clusters and cliques, as structures, correspond to such concepts as the family or clan. The mathematical structure that corresponds to the role, such as father or boss, is the "block." A "blockmodel" is a set of such blocks and the relationships between them. The cluster concept is still relevant, however. A "block" can be defined as a set of actors clustered together by virtue of their structural equivalence. (p. 75)

Although there is a relationship between positional or "block" methods and clique-finding algorithms, the two generally are used in solving fundamentally different theoretical problems in the study of kinship. Graph-theoretic and related clique approaches have been the most commonly used techniques to date. Most notable among the kinship analyses employing these approaches are Jackson (1976), Hage (1979), Hage and Harary (1983), and Foster and Seidman (1979, 1989).

In a series of articles, Foster and Seidman (1979, 1989; Seidman & Foster, 1978) attempt to solve a nagging problem in defining subgraphs that will have general applications in the study of kinship. Recognizing that the definition of a clique as a maximally complete subgraph was theoretically, conceptually, and empirically too restrictive, they searched for a definition that was more sociologically interpretable, particularly with regards to kinship (e.g., lineages and clans). Their solution was the  $k$ -plex, which can be defined as a graph where each node or actor is adjacent to all but  $k - 1$  other nodes or actors. Thus a 1-plex is a maximally complete subgraph (maximal in the sense that adding any additional ties would violate the definition of clique under these constraints). Using this clique-finding procedure, they applied it to Fortes's Tallensi analysis as an example (Foster & Seidman, 1979). Claiming that Fortes's thinking was basically graph theoretic, they proposed "to substitute some of the content of graph theory for the 'logic of kinship' as the calculus of structural analysis" (p. 336). Central to their analysis was the idea of basic structures, which was a subgraph that can be defined on the basis of some inherent properties without reference to a "particular representative" (p. 337). These basic structures are often found to be isomorphic with portions or subsets of graphs and "when such subsets are sociologically interpretable, we call them basic structural units (BSUs)" (p. 339). BSUs are the foundation of their analysis and have interesting properties in that they can represent global, as well as local, structures. Thus a large, complex network of local BSUs

(person cliques) can be reduced to reveal simpler global structure (cliques of cliques).

Given that Fortes's original analysis was for the entire Tallensi society (35,000 people), the approach advocated by Foster and Seidman has implications for both macro- and microproblems. In addition, they found that the  $k$ -plex concept was useful in formalizing Fortes's notion of a clan as a network of lineages and in addressing the idea of "guy ropes," a set of structural conditions that maintain balance and stability.

In a series of other examples, Hage (1976a, 1976b, 1979) and Hage and Harary (1982a, 1983) explore how graph-theoretic notions of structural balance, rank, signed relations, and transitivity again provide a formal characterization for kinship systems described by other anthropologists. One example is Hage and Harary's (1983) reinterpretation of Silerbauer's work on kinship among the Bushmen of the Kalahari using coloring to partition the categories of respect and disrespect. In addition, balance theory characterized patterns of joking relations well in that one should only joke with a joking partner of his joking partner, avoid the avoidance partner of his joking partner, and not joke with the avoidance partner of a joking partner. In another example, they reexamine Whitten's study of marriage among the Canelos Quichua of eastern Ecuador. Here they show how "intransitive cyclical structures can provide real as well as imaginary solutions to problems of status asymmetry" (Hage & Harary, 1983, p. 73) by illustrating graphically how to produce a structural escape from the indebtedness of a man to his wife's brother. Hage and Harary's 1983 book gives numerous other examples of the applicability of graph theory to the study of kinship systems.

But what of the other role-based approach to the study of kinship? Boyd's 1969 article on kinship algebras was important at the time in terms of representing a new and promising algebraic framework for the study of kinship relations as networks. There appears to be little subsequent work by others following this line of inquiry, at least in terms of kinship analysis. Although clearly anthropological in its importance, the article was published in the *Journal of Mathematical Psychology* and has received only a few citations in anthropology. However, the article did inspire others in profound ways. This is from the Acknowledgments in Lorrain and White's (1971) classic article on blockmodels:

The determinant stimulus that led us to the ideas set forth in the present paper came from Boyd's 1966 dissertation (the core of which was subsequently

published—Boyd 1969), where the decisive step was made, introducing and exemplifying a particular type of reduction of a network. (p. 49)

This is not to say that Boyd abandoned this line of reasoning (e.g., Boyd et al., 1971) but that subsequent work built upon his original ideas without necessarily any concern for the study of kinship per se (see Boyd, 1979-1980, 1989, 1991, 1992).

Schweizer (1988) has more recently applied these ideas in his use of structural and regular equivalence to study ties among Javanese households. In this case, the structure of network links is partitioned by three equivalence methods into subsets based on kinship roles, generational status, religious activity, and economic exchange, all partitions that would be difficult to discern with the use of traditional kinship representation and analysis. In pursuit of improved methods for graphically representing kinship systems, White and Jorian (1992) have recently presented the idea of P graph analysis. This method has the potential to solve many of the problems inherent in graphically representing complex kinship networks and will facilitate the empirical testing of theoretical kinship models of both a network and an algebraic form.

In concluding this section, we look to a 1980 article by J. A. Barnes, in which he anticipated future directions in the study of kinship. He did see network analysis as playing an important role in the future of kinship analysis but also saw that much needed to be done in terms of implementation and integration (Barnes, 1980). In the 13 years since Barnes's article, this is still largely the case. Much of the work reviewed in this section has itself been largely ignored, at least as far as kinship research is concerned. Whereas Foster and Seidman's development of the  $k$ -plex as a clique-finding algorithm and their subsequent development of a computer program to do  $k$ -plex analysis has been recognized (primarily by sociologists), its application in the study of kinship never really developed.<sup>4</sup> Similarly, Hage and Harary's work has been acknowledged more for the application of graph-theoretic ideas in areas other than kinship (analysis of myth, social networks more generally). Further, it is difficult to determine how the more recent contributions of White and Jorian (1992) and Schweizer (1988) will be used in future work on kinship.

Given the unpopularity of pure kinship analysis and the continuing disappearance of "traditional" societies worldwide, it may be more realistic to view kinship as just one of many elements in a network model. Plattner (1978), for example, shows how the socioeconomic

structure of two occupations in a Mexican town corresponds with the structure of kin relations. In another Mexican example, Thomas (1978) examines the relationship between kinship involvement (based on a kind of centrality) and the accumulation of wealth. In sum, the importance of kinship cannot be denied, but the reality of external constraints (e.g., increased industrialization) will necessarily limit the preeminence of pure kinship analysis in anthropology in the future.

### *Ethnography and Networks*

There is no doubt that networks were an important element in the earlier work of social anthropologists in urban settings (Epstein, Mitchell, and so on), but it was more than the complexity of urban life that led these researchers to rely on these concepts so centrally in their work. Had they been survey researchers, it is doubtful that the notion of a social network would have had such a prominent place in their studies. Because they were ethnographers, engaged in the web of everyday life, an understanding of social networks was critical for obtaining the latest gossip, seeking information on hard-to-see events (e.g., rituals, drug use), and establishing friendships that would ultimately lead to the development of key informant relationships. It was the ethnographic context itself that, explicitly or implicitly, made understanding networks of relations so important. Wolfe (1978) too saw a contrast between survey research and the natural linkage between networks and ethnography:

Ethnographic experience, in contrast, makes deliberate use of all connections possible, as a matter of course, to get entree and develop rapport. Whether she or he intends to or not, the anthropologist must learn a great deal about the network of relations of her or his informants. (p. 57)

Aside from the more intuitive conceptual use of the idea of networks, there are three fundamental problems in conducting ethnography that have been explicitly addressed through the use of social network concepts and analytical techniques. First, there is a problem in discovering and observing the activities of hard-to-find populations or subpopulations. Partridge used a snowball technique (although he did not call it that) to move through a Colombian community to more accurately

characterize cannabis use (see Kimball & Partridge, 1979). Second, ethnographic research can be complex in that it involves a variety of settings including work, leisure, home, and church. Sanjek (1978) describes how the network-serial method, first described by Epstein (1969a), can be used to gain a sample of settings in which informants provide self-reports of their network activities (i.e., ego-centered networks). Finally, the question of sampling and representativeness in ethnographic research was important even before Mead (1953) expressed the need to be concerned about validity and the "proper specification of the informant" (p. 646) lest ad hoc selection lead to bias. Lex and Wolfe's (1967) concerns were specifically expressed in network terms when they stated: "So varied is the total network that one ethnographer's sampling must always be in doubt" (p. 2).

These issues are addressed by Werner and Schoepfle (1987) in their discussion of a "networking" sample (p. 189) and in more detail by Johnson (1990) in his discussion of snowball sampling and informant selection. To Werner and Schoepfle, the proper selection of consultants (similar to key informants) is dependent on the proper identification of the range of social groups across a system of actors. Consultants would be recruited from the range of such groups and would be experts or specialists "on some aspect of daily life" (Werner & Schoepfle, 1987, p. 189).

Johnson (1990) provides several examples of the use of snowball sampling, different measures of centrality, and network partitioning in selecting informants. He sees the use of these techniques as a means for producing a "theoretically" representative sample of informants. In one example, a snowball sample through a community of commercial fishermen yields a binary matrix that is partitioned into subgroups on the basis of structural equivalence (i.e., similarity in patterns of relations). Displaying the network of relations with the use of correspondence analysis, subgroups (as determined by cluster analysis) are encompassed by circles, and directed links between subgroups are shown. Informants are selected on the basis of membership in each of the subgroups and on the basis of betweenness centrality as manifested in linkages between subgroups. Thus information can be obtained on the activities, or other important information, concerning the subgroups in a systematically determined fashion. Also, key informants located in strategic places (e.g., as determined by centrality or betweenness) provide the ethnographer with more efficient and valid means for accessing a variety of kinds of data.<sup>5</sup>

Network analysis has also played an important part in the validation of ethnographic observation, interpretation, and explanation through triangulation. For example, Mitchell (1989) reanalyzed Kapferer's (1972) data on networks in a tailor shop using blockmodeling, clustering, and betweenness measures. Kapferer's original partitioning of the network into clusters, although based largely on what Mitchell saw as "personal judgement," was supported in this reanalysis. While Mitchell labeled Kapferer's analysis "personal judgement," it can be seen as judgment guided by a sound ethnographic understanding of the research context. Morrill (1991) provides a good recent example of the beneficial mix of ethnographic and formal network methods in the study of conflict management among corporate executives. Reitz (1988) was also concerned with correspondence between formal methods for partitioning networks into subgroups (i.e., operationalizes the idea of a group) and the ethnographic interpretation of such subgroups. Finally, and probably more important, formal social network analysis in combination with the richness of ethnographic description and analysis can significantly enhance both the validity and the readability of a given work. The study by Bernard and Killworth (1973) on the social structure aboard a research vessel is a wonderful early example of how the joint use of these approaches can make for a better overall research enterprise.

### *Urban Social Networks*

Considering the historical importance of urban research on the development of network concepts and methods, we will briefly examine a sample of some of the more recent work in this tradition. In a 1978 special issue of *Urban Anthropology*, a number of anthropologists explore the importance of social networks in everyday urban life. Included was work on the urban elderly by Sokolovsky and Cohen (1978) that is similar to the Sokolovsky, Cohen, Berger, and Geiger work (1978) on the personal networks of ex-mental patients. Kapferer (1978) argues for a redefinition of the concept of marginality and cautions that the concept should only be applied in specific urban situations. Foster and Seidman (1982) defined urban structures on the bases of a collection of overlapping cliques. Finally, Weisner (1978) examined the nature of rural-urban ties and urban migration, finding that rural-urban networks were highly interconnected and that these

linkages were three-dimensional, involving clan affiliations, social status, and residence.

Mitchell (1987) conducted a study of the personal networks of 10 urban homeless women in exploring the concepts of strong and weak ties. This work corroborates other research in finding that strong ties among the women are primarily linkages involving emotional support or aid. Johnson and Orbach (1990b) examined how the process of urbanization (i.e., institution of zoning) and migration into a once rural area has led to the "gentrification" of commercial fishing that was clearly evident in the patterning of social relations (i.e., structural equivalence). They show how these patterns have definite political implications in terms of both the institution and the enforcement of zoning regulations. Finally, Greenbaum and Greenbaum (1985), using a personal network approach, examined how residential proximity and ethnicity influence the morphology and character of ego networks (e.g., ethnic composition, number of relations). Counter to expectations, they found that length of residence tended to restrict the proximity of relations and that variation in ethnic composition had little effect on the structure of personal networks.

### *Ego Networks*

Research examining the characteristics of an ego's network has historically been the most commonly used approach in the study of social networks. This goes back to the earlier work of Bott, Kapferer, and other social anthropologists engaged in the study of urban complex social systems. The initial popularity of this approach, as opposed to the study of whole networks, is understandable given the limited number of analytical and computational tools (e.g., network analysis programs and large, fast computers) available at the time and the boundary specification problem inherent in the study of complex urban populations. In addition, the study of ego networks fits well into the ethnographic tradition of using key informants and participant observation. With the advent of greater computing power and the development of techniques for the study of whole networks, studies of ego networks have become relatively less common, but no less important. Aside from urban research, the primary focus of ego-centered approaches falls into two primary areas of research. The first concerns the relationship between social support, as determined by the characteristics of an ego's



network, and health or well-being or some other dependent variable (for a more general in-depth review of this area, see Walker, Wasserman, & Wellman, this volume). The second general area has focused on the characterization of ego networks within a population in terms of such things as size: Who do people know and how do they know them? An understanding of these characteristics can provide for interesting cross-cultural comparisons and aid in revealing the global aspects of networks.

Bernard and Killworth and several of Bernard's students have produced a large body of work investigating the global character of networks and estimations of the size of an individual's personal network. Much of this earlier work focused on the small world problem (Killworth & Bernard, 1979) in which Killworth and Bernard model the decision making of intermediaries in a small world experiment in terms of a Markov process. In a related study, Killworth and Bernard (1978) perform what they call a reverse small world experiment, where they try to estimate both the number and the kinds of people known to an informant. This particular experiment is important because it provided a basic method for investigating the size and character of an informant's network. The development of this technique allowed these researchers to investigate a series of questions concerning the size of people's networks and variation in size as a function of individual attributes, social group membership (e.g., upper class), or membership in a culture. It is this concern for variation in the characteristics of personal networks within and between cultures that is of particular interest to anthropologists, and these researchers have paved the way for investigations of this type.

Driven by the questions first posed by the small world experiment (Poole & Kochen, 1978) and in pursuit of answers to questions posed in earlier research (Killworth & Bernard, 1979), Bernard, Killworth, and McCarty (1982) conducted an experimental investigation of 50 informants to examine who people know and why. Each of the 50 informants was allowed to ask any question concerning 50 target persons. Once informants felt they had enough information, they provided acquaintances from their own networks who might know, or at least serve as a first step in finding, the target. Location, occupation, age, and sex accounted for 50% of questions ever asked about targets. In another related study, Killworth, Bernard, and McCarty (1984) examined ways to measure patterns of acquaintanceship using the reverse small world methodology.

These studies provided the foundation for investigations into intra- and cross-cultural variation in the size and characteristics of personal networks. Bernard et al. (1988) "look for the rules that govern who people know and how they know each other" (p. 155). They are concerned with finding those rules that are culture-independent and any variation that might be due to measurement problems. They carry on in their experimental tradition in the study of social structure in three distinct cultures: Mormons in Utah, Paiutes in Arizona, and Ponapeans in Micronesia and include a comparison with a Gainesville, Florida, sample. In the first of a series of findings, it was apparent that Ponapeans and Paiutes made significantly more choices than both the Mormons and the Gainesville informants. They speculate this could be due to the effects of size and complexity of a network on recall. They go on to show the differential importance of occupation, sex, location, and the perceived similarity of targets in making choices.

In the above experiment, Bernard et al. (1988) question their findings on the basis of measurement problems (i.e., differential response to their test). Spawned by a comparison of data obtained from the network component of the General Social Survey and the Reverse Small World procedure (Bernard, Shelley, & Killworth, 1987), Bernard et al. (1990) more recently attempted to answer this question, as well as others, through a comparison of four methods for studying personal networks. The comparison consists of a method for eliciting intimates described by Burt (1984), a social support inventory used by McCallister and Fischer (1983), the Reverse Small World instrument described above, and a global network method developed by Poole (Poole & Kochen, 1978) and improved by Freeman and Thompson (1989). The sample of informants included a group from Jacksonville, Florida, and one from Mexico City. In comparing the two groups, they found that the Jacksonville informants reported more network members than the Mexico City informants independent of the method employed. In addition, they replicated aspects of former studies. Killworth, Johnsen, Bernard, Shelley, and McCarty (1990) attempted to more closely estimate the size of informants' networks for both the Jacksonville, Florida, and the Mexico City samples. Discussing both the difficulties and the potential sources of error in making estimates of this type, they estimated network size for the Jacksonville respondents to be  $1,700 \pm 400$  and for Mexico City about 600.

In a study related to both reverse small world methodology and more recent work by the authors on estimation of hard-to-count populations

(Bernard, Johnsen, Killworth, & Robinson, 1989), Shelley, Bernard, and Killworth (1990) tried to operationalize the strength of network ties. Strength in this context is a function of the amount of time it took both to send and to receive messages from other members of their network. Perceived closeness was found to relate to the speed with which messages are transmitted and received. In addition, relatives transmitted faster than friends or acquaintances, and women faster than men. Finally, McCarty (1992) interviewed 47 informants in depth so as to discover the nature of perceived cliques among 60 alters that ego "knows." This approach allowed for an understanding of the factors underlying perceived clique membership within ego-centered networks.

Although we have included this body of work in the ego-network section, it could just as well have been included under cognition. This work also contributes to our understanding of a variety of intracultural and cross-cultural constraints on human recall and how and what people know and remember about the social networks of which they are a part.

We now turn briefly to some related research that follows in the urban tradition of Mitchell and Barnes but deals specifically with health and gerontological issues. Hurd, Pattison, and Llamas (1981) and Muriel Hammer (1963, 1981, 1983) are examples of both early and later work that has recognized the link between networks and health.<sup>6</sup> Most of these studies have explored the linkage between the characteristics of personal or ego networks (e.g., amount of social support) and health and well-being, both physical and mental. Sokolovsky et al. (1978) collected data on the personal networks of ex-mental patients in a Manhattan single room occupancy hotel. Their analysis shows that schizophrenics with smaller, less connected networks were at higher risk for rehospitalization. In a study on the impact of relocation of the urban elderly into single room occupancy hotels, Eckert (1983) found that both mental and physical impacts of the move on the elderly were mediated by the morphological and functional characteristics of the elderly's personal networks. Extending this line of inquiry to the rural elderly, Van Willigen (1989) showed how the rural elderly trade larger networks postretirement for more social involvement and are therefore not socially isolated. McClain (1987) examined how personal networks influence decisions concerning choosing home or hospital birth. In this case networks played a more significant role among mothers choosing home birth. Finally, Shelley (1992) demonstrated how the personal networks of patients with end stage renal disease affect health outcomes. In comparing the networks of hemodialysis and peritoneal dialysis patients,

she uncovered the relationship among network density, depression, health, and network size.

### *Whole Networks*

This section provides a brief summary of some of the methodological, theoretical, and substantive work by anthropologists studying whole networks. We begin with a short description of developments in positional or structural analysis originating with the pioneering work of Boyd (1969). Since Boyd's elaboration of a homomorphic reduction and Lorrain and White's subsequent refinements and extensions, the idea of clustering on the basis of position as opposed to interactive intensity (cohesion) has benefited from the work of Sailer (1978) and, more recently, John Boyd, Martin Everett, Steve Borgatti, Katherine Faust, Doug White, and Carl Reitz, to name a few anthropologists or individuals with at least some anthropological sympathies. Much of this work has focused on resolving a number of technical issues but has been limited in terms of substantive applications (aside from Sampson's monastery data). As a result, we concentrate on the contributions of anthropologists to this ongoing technical work, particularly in terms of the relation between various models and theoretical and conceptual work in the social sciences.

The sociological importance of social positions and corresponding roles has been described earlier in our discussion of kinship. There are a variety of mathematical models (e.g., structural equivalence, automorphic equivalence, regular equivalence) that fit with the different conceptualizations of position and role found in the literature. Faust (1988), however, makes an important distinction between structural equivalence and general equivalence. In structural equivalence, the extent to which individuals occupy similar positions depends on the extent to which they share the same relations to the same others. On the other hand, in general equivalence the extent to which individuals occupy similar positions depends on the extent to which they share relations with the same "types" of others independent of whether they are the "same" others. General equivalence was alluded to by Sailer (1978) and formalized by White and Reitz (1983) in the development of regular equivalence. Since then Everett and Borgatti and others have further refined the mathematics behind the idea of general equivalence. For a

review of these see, for example, Everett (1985), Pattison (1988), and Borgatti and Everett (1989).<sup>7</sup>

Social anthropologists originally were attracted to the idea of a social network so as to escape the static nature of structural-functionalism. However, networks are still primarily treated in a cross-sectional manner in which the dynamic qualities of social networks, although given much lip service, are largely ignored. An early exception to this is Bernard and Killworth's (1973) study of conflict aboard an oceangoing research vessel. Although this work was mentioned earlier as a good example of the mix between ethnography and formal network methods, we can also view this piece as initiating important ideas about the formation and stability of group structure over time. They elaborate and formalize how the ability of humans to communicate effectively puts limits on the size of human groups at various levels. More important, they hypothesized that the structure of a closed group forms quickly (within 2 weeks) and stays relatively stable over time. These ideas were further refined and formalized in a subsequent paper by Killworth and Bernard (1976b) relating group formation and stability to the idea of dissonance.

This earlier research on the dynamics of group formation has influenced the work of Boster and Johnson (1992) and Johnson, Boster, and Palinkas (1991) in their studies of the winter-over crews at the South Pole station. One aspect of this research focuses on how quickly group structure forms and the stability of the structure during the winter-over isolation. Knowledge of these processes has implications, for example, for the production of improved procedures for composing groups for extreme environments (e.g., space stations). Romney, Borgatti, and Nakao (1989) have, in an application of three-way correspondence analysis, also shown the tendency for group structure to form quickly and stay stable over time. Others too have explored the dynamics of small groups, or groups more generally, in research on information flow, conflict and group fissioning (Zachary, 1977), the emergence of virtual groups (Stephenson, 1990), the formation of coalitions in an office (Thurman, 1979-1980), power struggles in a Chinese community (Schweizer, 1991), and a study of the social connections of three networks over time (Hammer, 1980).

Roles in groups are also dynamic and may emerge and disappear depending on the needs of the group. The emergence of roles and the performance of small groups in isolation is discussed by Johnson and Finney (1986). Johnson and Miller (1983) describe the dynamics of role

emergence in their study of a commercial fish camp in Alaska. In this case, group structure allowed for the emergence of the role of "court-jester" during a stressful period (a strike) producing a positive, humorous reference point that led to better group cohesion.

A number of methods for the study of whole networks have been developed by anthropologists. These methods are particularly suited for investigating anthropological problems in fieldwork settings. Killworth and Bernard (1974) describe a clique-finding technique (CATIJ) that is based on the use of a card-sorting data collection procedure. This procedure allowed for both individual and aggregate cognitive pictures of a research ship's social structure, and its development was influenced by Bernard's earlier training in cognitive anthropology.<sup>8</sup> Sorting procedures of this type are well suited for field situations (Johnson, 1990) and have been used in other network studies (Boster et al., 1987; Johnson & Miller, 1983) that are centrally concerned with both individual and aggregate cognition. White and McCann (1988) describe the use of entailment analysis in the study of the eighteenth-century chemical revolution. As they put it, the technique "detects tendencies toward set-subset relationships among binary variables" (p. 381). The method has been applied not only to network analysis but in cross-cultural research (Burton, Brudner, & White, 1977) and in the study of cognition (Boster & Johnson, 1989). Similarly, Dow, Burton, White, and Reitz (1984), in attacking Galton's Problem in cross-cultural research, apply the idea of network autocorrelation and show how it is equally applicable in the study of social networks (Dow, Burton, & White, 1982).

Finally, in a series of articles (Hage & Harary, 1982b; Hage, Harary, & James, 1986) and culminating in a book (Hage & Harary, 1991), Hage and Harary apply graph theory to problems in exchange, power, and mediation among Oceanic peoples. These authors provide a comprehensive demonstration of the applicability of graph theory for modeling trade and transport networks (e.g., Kula ring) and other exchange relations (e.g., marriage exchange). They also relate these models to power, hierarchy, intimacy, stratification, and other factors important to Oceanic ethnology.

### *Summary and Conclusion*

Before answering the two questions originally posed concerning the give-and-take between anthropology and social network analysis, it is

instructive to review some of the findings of Hummon and Carley (in press) in their study on citation and normal science in social network research. In a 1988 survey of social network researchers, they found that three of the top five scholars perceived to have been most influential in the "social network" community prior to 1970 were anthropologists. By 1988 only one of the top ten scholars perceived to be prominent was an anthropologist (eighth position). These earlier anthropological scholars were, as one might imagine, social anthropologists and included Mitchell, Bott, and Barnes, all scholars who were pioneers in formalizing the concept of a social network. However, sociology came to dominate all but two of the top ten positions by 1988. The only anthropologist in this list, H. Russell Bernard, had written extensively in the area of social networks. More important, Bernard, although early concerned with network theory, had been instrumental in initiating and researching the "cognitive" controversy on the validity of retrospective network data and became most noted for this line of inquiry.

This dominance of sociologists by the 1980s is not surprising as evidenced by the informal citation analyses of some of the articles reviewed here. First, citations by anthropologists of the earlier social anthropological works had begun to subside by the mid-1970s and had become but a trickle by the 1980s. Second, the earlier work of Boyd, although mostly ignored in mainstream anthropology, had fostered a significant amount of important work in social network analysis conducted and cited primarily by sociologists. Third, even some of the promising work on networks and kinship analysis by Foster and Seidman was recognized more by sociologists than anthropologists, mostly for their development of the k-plex and the computer program SONENT rather than for any contribution to the study of kinship. Fourth, the graph-theoretic work of Hage and Harary, if used by anthropologists at all, has been employed mostly in solving non-social network problems. Finally, it is primarily in the areas of cognition and social networks and role analysis that a critical mass of anthropologists are citing one another's work and this is generally within the confines of the journal *Social Networks*.

In summarizing the contributions made by anthropologists to the study of social networks, some things become strikingly clear. A number of anthropologists have contributed much to the study of social networks in the area of role analysis, substantive applications of and theoretical developments in graph theory, network data collection and analytical techniques, the representation and analysis of kinship net-

works, and cognition and social networks. With few exceptions, however, these anthropological contributions have been largely ignored by mainstream anthropology. One can speculate as to why. It may be that at this point in time anthropologists are no longer interested in the study of social structure (see Whitten, 1984).<sup>9</sup> Or it could be that philosophical divisions in the discipline have led many to avoid and ignore the formal, scientific contributions of anthropologists engaged in social network analysis (see Romney, 1989, for a general discussion of this problem). Whatever the reason, it is clear that anthropologists have contributed much to the study of social networks and will in the future continue to contribute to that "branch of natural science" whose task is "the discovery of the general characteristics of those social structures of which the component units are human beings" (Radcliffe-Brown, 1952, p. 190).

## Notes

1. In all fairness to Bax, the once promising area of small group research was stifled by a split between researchers concerned with the mathematical aspects of small groups and those concerned with pure form (Johnson & Finney, 1986). The possibility of this occurring in social network analysis is real, but there is strong evidence suggesting that the "formalists" and "substantivists," so to speak, are still talking. In anthropology, for example, there have been successful collaborations between mathematicians and fieldworkers including Bernard and Killworth, Foster and Seidman, and Hage and Harary, to name a few. It is expected that these kinds of collaborations will continue into the future.

2. Like Mitchell and similar to Romney (1989), Killworth et al. (1984), and Bernard and Killworth (1976), this problem should be viewed in terms of models, measurement, and determining what is independent and dependent.

3. Even as recently as 1985, network-oriented researchers have stated the need to "move beyond kinship studies" in anthropological work on contemporary complex societies (Schweizer, 1985, p. 179).

4. This problem of lack of citation has been acknowledged as a general problem in anthropology by Romney (1989) and Johnson (1991).

5. Johnson, Boster, and Holbert (1989) simulated snowball samples to discover potential errors in estimating centrality. This was important in that it provided a basis for understanding the potential bias in selecting key informants on the basis of centrality measures.

6. Boissevain (1973) also recognized the potential impact of network structure on such things as mental health.

7. Steve Borgatti, an Irvine graduate, was the author of ANTRHOPAC, an important computer package used primarily by cognitive anthropologists. He is also a principal author of the new version of UCINET, one of the most comprehensive network computer packages now available. In support of the argument on the link between cognitive



anthropology and social network analysis, both packages have a high degree of overlap in analytical methods.

8. The development of CATIJ was a direct result of Bernard's interaction in graduate school with Kenneth Hale and Duane Metzger during his earlier training in cognition and linguistics (Bernard, personal communication).

9. In the introduction to a 1984 *American Ethnologist* special issue on social structure and social relations, which did not contain a "formal" network article, Whitten (1984) made the following observation in terms of a call for papers on this special issue: "Some of the comments made to the editor and associate editors subsequent to the call for papers are worth mentioning as they reflect, perhaps, collective perceptions held by many other cultural anthropologists from various vantage points within the United States: 'Issues of social structure are now dead'; 'The study of social structure is no longer at the cutting edge of cultural anthropology'; 'Nobody really does that kind of thing anymore.'" (p. 637).

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