

NOTES

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Network Analysis

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INTRODUCTION

The concept of network analysis is as old as the fields of anthropology, sociology, and communication. Recently, however, network analysis has become the focus of increased interest in each of these fields as well as one of the most relevant methodologies for recent trends in communication theory. The network concept was introduced very early in the social science literature, first as a simple metaphor and more recently as an analytical tool for scientific study. As an analytical tool, communication network analysis is defined as "a method of research for identifying the communication structure in a system, in which relational data about communication flows are analyzed by using some type of interpersonal relationships as the units of analysis."¹

The recent interest and development of network analysis in the social sciences has common origins. In anthropology and sociology the network model of social systems is a logical outcome of four theoretical trends toward the following:

- (1) interest in relations rather than things,
- (2) interest in process rather than form,
- (3) interest in elementary phenomena rather than institutions, and
- (4) construction of generative models rather than functional ones.²

Network analysis offers an alternative to the structural-functional model of society that views society as an enduring system of groups, composed of statuses and roles, supported by values and connected sanctions that operate to maintain the system in equilibrium.³ This static view of society was challenged as inadequate to explain the level at which people actually interact with one another. Existing structural-functional theory failed to take into

account the range of social forms usually dismissed as informal organization. It is suggested that

instead of looking at the individual as a member of groups and institutions passively obedient to their norms and pressures, it is important to try to see the individual as an entrepreneur who tries to manage norms and relationships for his/her own social and psychological benefit.⁴

Similar criticism of the dominant research paradigm in the field of communication has been voiced: (1) a view of communication as a linear, one-way act (usually vertical), rather than a cyclical, two-way process over time, (2) a source bias based on dependency, rather than focusing on the relationship of those who communicate and their fundamental interdependency, (3) a tendency to focus on the objects of communication as simple, isolated physical objects, at the expense of the context in which they exist, and (4) a tendency to concentrate on the psychological effects of communication on separate individuals, rather than on the social effects and relationships among individuals within networks.⁵ In general, the recent trend in the field of communication is to view people as active members of a communication process rather than as passive receivers of messages. The history of network analysis demonstrates its usefulness for the study of intercultural processes in a variety of settings.

Intercultural communication is a process that involves the construction of new networks, and/or the restructuring or agumentation of existing networks. From this perspective, intercultural communication is a process of creating and maintaining *cultural boundaries*, or bridging the boundaries between diverse cultural groups. In his discussion of the priorities for research on intercultural communication, Becker suggested that we should study the way in which the existing structures (political, family, etc.) interact with communication events, the relationship of reference groups to communication processes in different countries, and whether different types of reference groups tend to be salient for intercultural communication than for intracultural communication.⁶ He also suggested that we study organizational communication in intercultural settings such as government agencies or industries that need to maintain offices in which daily intercultural interaction occurs. Network analysis is ideally suited to study these types of problems.

In intercultural settings where the conventional analytic tools such as norms or role expectations are not applicable to both cultures in contact, network analysis is recommended. Network analysis can reveal the pattern of

social relations, the way that such pattern emerge, and the processes by which relationship patterns change.

RESEARCH TRENDS IN NETWORK ANALYSIS

Early kinship studies by anthropologists can be perceived as network analyses even though this term was not used. These early anthropological studies provided a relevant substantive, as well as methodological foundation, for the study of networks in intercultural settings. Anthropologists are explicitly concerned with inter- and intracultural variability, or conversely, invariant patterns in diverse cultural settings. Thus, research is conducted either to test a hypothesis with data from different cultures in order to discover universal generalities regarding communication, or to test a hypothesis with data about two or more cultures in contact that can reveal the principles of intercultural communication.

Evans-Pritchard's classic study of Nuer political organization is a good example of an anthropological study that extended beyond kinship analysis to basic social interaction.⁷ He was able to predict the ways that various kinds of local groups formed alliances during times of conflict by using spatial groupings and agnatic descent relations among local groups. His procedures for reducing the individuals into social groups is essentially similar to clique analysis in network analysis. Kapferer's analysis of conflict among industrial workers in Zambia demonstrated the superiority of network analysis over normative analysis in explaining such questions as who can challenge whom and who will become aligned with whom in conflict situations.⁸ Other anthropologists such as Barnes and Bott also utilized network analysis to explain non-kinship relationships.⁹

The preoccupation with kinship relations prompted anthropologists to be conscious of relational data. Wolfe commented that whether anthropologists intend to or not, they always learn a great deal about the network or relations of their informants and this prepares them for serious concern about the forms and functions of social networks.¹⁰ Although sensitivity to the intricate networks of personal interaction increased, the early application of network concepts in anthropology remained primarily metaphorical and descriptive rather than analytical.

The early work of Moreno in psychology was an exception to this trend.¹¹ He developed sociometry, a method for obtaining quantitative data about interaction patterns among the individuals of a group. All members are asked to list which other members of the group are his or her best friends, most desirable as a team member or work partner, most knowledgeable

about some topic, and so on. The resulting sociometric data is then cast into the form of a sociogram, a graphic means for displaying the patterns of social relations in a system. With this same method, Moreno also led the way in the development of indices of network characteristics, such as cohesion and leadership, which laid the foundation of contemporary network analysis.

Social network analysis received an important stimulus from Bott's frequently cited study of 20 families in London.¹² Using network techniques, she discovered that the network connectedness of her respondents intervened between the independent variables of social class and neighborhood, and the dependent variable of conjugal role allocation. Her research and Barnes's study of Norwegian parish network structure helped to form the "Manchester School" of British anthropologists that created a set of useful concepts and analytical indices for network analysis.¹³ The analytical tools and systematic measures developed by this research group shifted the network concept from metaphor to a precise analytical tool useful for the development of social theory.

Two factors slowed the development of network analysis during the 1960s. Because computer technology and programming was not adequately developed at that time, network analysis was limited to the number of interpersonal links that could feasibly be analyzed by hand, networks of no more than approximately 100 individuals. Meanwhile, this period experienced a rapid growth of the random survey method whose purposes and advantages are in most respects the opposite of network analysis. Probability sampling seeks the selection of statistically independent units, usually individuals separated and out of the context of their social relationships. Snowball sampling, in which each single unit that is sampled is allowed to identify other units that it knows or with whom it is connected, provided an appropriate compromise, but one which was rarely employed. Thus, the sample survey methodology discouraged the study of relationships, while it encouraged the study of individual characteristics.

Nevertheless, some researchers were able to incorporate a valuable kind of network analysis in survey research, primarily by focusing on what has become known as personal networks. The analysis of personal networks is limited to what Barnes called the "primary star," which is the set of direct links that a person has with others in its network, and to the "primary zone," the primary star together with the interconnections among those connected to the primary star (which can be selected by probability sampling techniques).¹⁴ The rest of the members of the primary star's network (community, organization, etc.) are omitted and with them the opportunity to

study the characteristics of the network as a whole. The study of the primary zones does provide valuable information, however, about the relationships and immediate social environment of the primary star, which would be completely missed with standard sample survey methods. A number of researchers have demonstrated the feasibility and advantage of this type of network analysis within sample survey designs.¹⁵

By the 1970s, the limited capacities for computer network analysis began to disappear rapidly. Computers are indispensable for the analysis of a large number of network links. Today, there are several computer programs that can handle most of the size and complexity problems that discouraged early researchers. Richard's NEGOPY Program can handle up to 4,096 individual nodes and up to 32,767 links,¹⁶ while Alba and Kadushin's SOCK/COMPLT Program can handle a 9,999 by 9,999 matrix, which is more than adequate for most problems in social science.¹⁷ Other programs such as direct factor analysis with SOCMET,¹⁸ smallest space analysis,¹⁹ and blockmodeling with CONCOR²⁰ do not allow for such large numbers of links, but offer other innovative techniques useful for the analysis of intact networks. Graph theory, topology, and matrix algebra are also providing concepts and theorems for the mathematical study of abstract networks. Computer technology also provides another important advantage. The programming requirements for strict mathematical algorithms eliminates much of the researcher's subjectivity in specifying the structure of networks.

APPLICATIONS

The application of the network perspective to intercultural setting has occurred in five main areas of research, which we will discuss before turning our attention to some of the key methods of network analysis. Although the previous literature may be easily grouped into these five areas—cultural diversity, diffusion of innovations, rural-urban migration, acculturation of immigrants, and ethnicity—the application of network analysis is by no means limited to these areas alone.

Cultural Diversity

Anthropological network studies have been conducted in such diverse cultural groups as African tribal kinship networks, the Japanese middle class, or a Korean fishing village. This type of anthropological study focused on the development and maintenance of interpersonal and group relationships, but very seldom actually used the terms "network" or "communication." For instance, in his study of Japan's new middle class, Vogel

says that "the most striking characteristic of Japanese society is the existence of a series of tightly-knit groups, connected by a controlled and limited amount of movement."²¹ He then continues to discuss group memberships, differences between acquaintances, benefactors, true friends, and the functions of intimate groups, all relevant to network analysis.

This type of anthropological study provides a substantial foundation for the study of intercultural communication because without an understanding of each cultural group's network patterns—unique or universal—and factors that regulate such network development and maintenance, it is very difficult to understand processes related to intercultural communication networks. For instance, it has been proposed that individuals from low-context cultures and high-context cultures gather different kinds of demographic information during an initial interaction and then draw different inferences from it.²² For a high-context cultural group, such as the Taiwanese, such information as school, age, and marital status are important to anchor the other person in a proper social position while for a low-context cultural group such as North Americans, this information is usually considered to be too personal initially. Obviously, difficulties could arise when two people from cultures of different levels of context orientation meet one another. The formation of a network tie between them may take longer simply because of their different network experiences.

Koreans' close interpersonal networks are maintained by the cultural concept of *uye-ri* (faithfulness or long-range reciprocal obligations) and consequently when Koreans are interacting with individuals from other cultures who do not have a comparable concept, it is difficult for them to form close, enduring relationships.²³ Thus, an understanding of the cultural mechanisms of network formation and maintenance are indispensable for an understanding of *intercultural network formation*.

Diffusion of Innovations

There are at least three reasons why network analysis was used quite early in the study of the diffusion of innovations from one culture or subculture to another: (1) since the 1950s, national and international funding agencies have made funds readily available to study and improve the process by which modern technology can be diffused to increase the rate of growth in developing countries, (2) early research revealed that the diffusion of innovations is very much influenced by interpersonal communication in the persuasion and decision stages, and (3) research in cultures outside the United States contradicted the notion that adoption is an individual decision as opposed to a network process involving group initiation, group pressure, and sometimes even group decision making.

In a case study of a Korean village, Kincaid and Yum found that the adoption of family planning contraceptives was closely related to the success of the village Mothers' Club whose members maintained closely interconnected communication networks in the village.²⁴ The complete survey of 24 Korean villages found a relationship between the degree of interconnectedness of the village family planning communication network and the tendency of a village to converge toward a preference for one contraceptive in particular, as if the village women as a group were choosing which method the "village" should use.²⁵ Network analyses under the rubric of diffusion of innovations have been conducted in India, Bangladesh, the Philippines, Mexico, Korea, China, Taiwan, and Nigeria, among others.²⁶ Unlike the early anthropological studies, these diffusion studies explicitly analyzed network structure in settings where two subcultures of one society interacted.

Rural-Urban Migration

The study of rural-urban migrants also focuses on the processes by which one or more subcultures comes into immediate contact with host culture in an urban setting. This subject has received special attention from British anthropologists studying social change in Africa.²⁷ A "sets of relations" model or network model has been formulated as an alternative to the "detribalization" and "alternation" models of rural-urban ties in African cities, and found to be more appropriate for understanding the processes of adjustment and the patterns of migration.²⁸ With the network model, rural-urban migration patterns are understood through the analysis of extensive contacts between the city and the country, and such contacts are conceptualized as networks of kin and friends based on ethnic origin who share resources and visit frequently.²⁹ Mayer's study of the social networks of South African tribesmen demonstrated that different cultural values manifested in networking style either permitted or inhibited them from expanding their communication networks in order to link themselves to urban institutions.³⁰

Using participant-observation data from migrants in Nairobi, Ross found that an individual's social network is determined more by ethnicity and social class than by neighborhood, with ethnicity four times more powerful as a predictor of friendship patterns than class.³¹ Education, income, and even length of residence in Nairobi were not related to the choice of one's closest friend from one's own ethnic group.

Ethnicity

Only a few studies have explored ethnic variability in terms of network structure and functions. Most sociologists and anthropologists, however,

agree that ethnicity is one of the most important factors that determines basic human bonds. Nisbet claimed that "ethnicity—the social demands of being, for instance, a black, or a Mexican-American—is one of the most influential of expressions of what is by its nature a personal type of social aggregate."³² Patterson, on the other hand, states that ethnicity is one of the most important factors that decides group allegiance, but if there is a conflict between class and ethnic allegiance, people usually opt for class.³³ This contradicts Ross's empirical findings in Nairobi, but the contradiction is probably a general difference between the cultures of Kenya and the United States.³⁴

Researchers who have investigated social networks as social support systems have also reported ethnic variability. Garrison reported that Black Americans do not share the characteristics of Puerto Rican social networks, nor of mixed white Americans.³⁵ Puerto Ricans have social networks concentrated in their local neighborhoods, whereas Black American network extend beyond their own local neighborhoods. By advocating the use of *indigenous*, natural helping networks of different ethnic groups, other researchers have implied the same ethnic variability.³⁶ Yum's study of five ethnic groups in Hawaii revealed not only significant network variability between the three immigrant groups (Koreans, Filipinos, and Samoans) and the two host groups (Japanese and Caucasian Americans), but also among the three immigrant groups and between the two host ethnic groups.³⁷

Acculturation of Immigrants

A substantial amount of research was conducted by the Chicago school of sociologists on European immigrants during the 1920s and 1930s, especially on the problems of adjustment and acculturation. This research pattern has repeated itself with the new influx of large immigrant groups to the United States since 1960 from Hispanic and Asian cultures. Many of the recent studies deal with the patterns of relationship development of immigrants, but only a few studies specifically measure and analyze network concepts. Although they employ survey methods more often than ethnographic methods, many of the findings of the recent network analysis of immigrant groups are strikingly similar to the results from the study of rural-urban migration.

In general, one would expect recent immigrant groups to be attracted initially to their own ethnic social networks, with a lessening of the rigidity of ethnic boundaries the longer the immigrant group has been in the host society. Indeed, members of certain ethnic groups do seek each other's companionship for a variety of reasons, which creates and maintains predominantly ethnic friendship groups or cliques.³⁸ Yum and Wang, however, found that

even after a substantial length of residence in the host country, some ethnic groups continue to maintain rather strong ethnic boundaries and keep unique ethnic network patterns.³⁹

When network variables are employed as independent variables, they are often found to be important predictors of the tolerance of ethnic differences,⁴⁰ interethnic stereotyping,⁴¹ immigrants' level of information about social agencies, jobs, housing, or health problems,⁴² identity conservation,⁴³ among others. When network variables are used as dependent variables, the purpose is usually to explain differences in their structural patterns. Diverse factors such as sex, age, personality, physical environment and climate, ideology and cultural values, social influences such as kinship, occupation, power, education, and mobility have been explored.⁴⁴

METHODS OF RESEARCH

Network analysis starts with a collection of *relational data* from either survey, participant observation, or unobtrusive methods, followed by one or more of the following research procedures:

- (1) Identifying cliques within the total system and determining how these structural subgroupings affect communication behavior in the system.
- (2) Identifying certain specialized communication roles such as liaisons, bridges, and isolates.
- (3) Measuring various communication structural indexes (such as communication connectedness, for example) for individuals, dyads, personal networks, cliques, or entire systems.⁴⁵

Survey Methods

In surveys, relational data are gathered by the respondents' recall of their links. They are asked such sociometric questions as "With whom in this system (neighborhood, organization, etc.) do you talk to most frequently?" The question often specifically addresses particular topics, such as "Who have you talked to within the last week (or other time period) about

_____?" where the blank is the topic of interest (finding a job, housing, news events, etc.). The same type of question is used to elicit information about the respondents' friends, although a more indirect approach may be more valid, "Who would care for your house if you had to travel out of town?" Moreno claimed that concrete, rather than abstract questions yield more meaningful sociometric data.⁴⁶ On the other hand, if the question is too narrow it may elicit too small a number of links to the respondent to reveal

much about the network patterns of the respondents' personal networks or only a few respondents would report any links that network data would be skewed due to large number of zeros.

In all situations, but especially in intercultural settings, the researcher should be very sensitive to the respondents' sense of privacy, because some cultural groups perceive network data as very private in nature and perhaps vulnerable to misuse. Some respondents may have strong clique identification, but would rather not reveal their associations publicly. Hence, procedures to ensure confidentiality and mask the identity of network choices should be followed. Once the names of contacts have been elicited, the researcher usually wants to ask for descriptive information, such as the frequency of interaction with network members, their ethnic background, relationship to the respondent, occupation, education, length of acquaintance, age, sex, and so forth, depending on the purpose of the study. In surveys such information is obtained indirectly—by asking the respondent his or her knowledge about his or her network ties. In studies of all the members of a social system, this kind of information could be obtained directly from the interview of each member.

Obviously, sampling is very important. If the research is interested in whole social systems, then the sampling unit should be the intact system (e.g., family, neighborhood, organization, etc.), then all of the members of the system will be interviewed. Rogers and Kincaid's survey of twenty-four intact villages in Korea is a good example of how this can be done.⁴⁷ An advantage of this approach is that analysis can be carried out on several levels from the entire system through subgroups or cliques down to the individual respondent. As with all survey designs, the results can only be generalized to the level of the unit that is randomly sampled.

With a random sample of individuals, only personal network analysis of the primary star and his or her primary zone is possible. This approach is similar to that used in the study of significant others.⁴⁸ It is somewhat limited in terms of what can be learned about the overall structure of the whole social system, but it has the advantage of being capable of incorporation into large-scale sample surveys that can satisfy other research objectives as well.

Snowball sampling offers a compromise between standard survey procedures and the study of intact systems through complete saturation sampling (all members). It follows a multistage sampling design in which a primary sample of individual respondents name their network links, and then those links in turn are directly interviewed in a second stage of data gathering.⁴⁹ If desirable, the second stage respondents can then name third stage contacts, and so on indefinitely as the "snowball" increases in size very rapidly.

Snowball sampling is especially useful for the study of intercultural communication, because very often only a few, if any, contacts of a person sampled randomly in the general population can be classified as intercultural. The researcher is thus able to follow the snowball procedure, but only continue the second stage selection with the intercultural communication links. The snowball sampling technique allows for a more efficient use of initial contacts in an intercultural setting.

Observation

Participant observation, the principle tool for anthropological fieldwork, has one advantage over direct questioning about interpersonal contacts in that the phenomenon in question can often be directly verified by the researcher in the field. Bernard and Killworth collected network data from the same subjects by means of both self-report questions of the sociometric type and direct observation, and found the former quite inaccurate compared to the latter.⁵⁰ Their serious criticism to self-report methods of network analysis was challenged by Romney and Faust.⁵¹ In a reanalysis of Bernard and Killworth's data, they demonstrated that the recall data that appeared inaccurate at the individual level was quite comparable to the observational data *for the purpose of identifying cliques*. Thus, the appropriateness of the data collection method depends upon the purpose of the researcher and the type of network analysis that he intends to perform on the data.

Unobtrusive Methods

An unobtrusive method of measurement is one in which the researcher is removed from the events being studied and thus can have no effect on the process that produces the data.⁵² For network analysis, unobtrusive measurement of the frequency of telephone conversations has been obtained from a group of blind persons who belonged to a special teletype conference hookup,⁵³ a computer conference system,⁵⁴ recordings of ham radio conversations,⁵⁵ and content analysis of the New York Times to determine the relationships among major corporations from 1877 to 1972.⁵⁶ Another instructive example is the network analysis performed by Stockman on unobtrusive data about voting on colonial and socioeconomic development issues to reveal the emergence of a clique of Latin American, African, and Asian nations in the U.N.⁵⁷

In intercultural studies, such data as the international flow of mail or long distance telephone calls could be analyzed to explore macrolevel networks among nations. Ethnic organizational memberships, church memberships, or ethnic voting patterns provide valuable data about group allegiance.

INDICES OF NETWORK STRUCTURE

Many methods of analysis of network data have been developed over the years to reveal some of the hidden structures or patterns in the data. Unfortunately for those new to network analysis, the past has created a tangled proliferation of terminology to refer to very similar concepts and measures.⁵⁸ The discussion here is limited to the most important concepts for research in intercultural settings.

Density

Network density refers to the extent to which the members of a network are directly interconnected.⁵⁹ A highly interconnected network, if graphed, would appear extremely dense with lines linking all of the members to one another. Other terms have been used to capture this basic concept: cohesiveness,⁶⁰ zone integration,⁶¹ dispersion,⁶² and individual integration for personal networks.⁶³

The formula for calculating the index eliminates whatever ambiguity in terminology that exists. The density of a network is the ratio of the total number of actual direct links in a network to the total possible number of such links:

$$D = \frac{a}{n(n-1)/2}$$

where a = the actual number of direct links in the network and n = the total number of persons in the network (the denominator is the familiar formula for total number of combinations). The values for density have the property of ranging from 0.00 to 1.00, with high values indicating a high degree of interconnectedness.

High density in a network may be an indication that most of the members' links are among themselves rather than to others outside the immediate network where new information so often originates. Thus, Yum found that high density in the personal networks of immigrants in Hawaii was negatively related to the amount of information they had about a variety of social service agencies for immigrants in their community, controlling for other factors.⁶⁴ It is more difficult for information and "outsiders" to penetrate into dense, tightly knit networks, but once in a certain part of the network, overall density ensures that you will quickly make contact with the rest of it. By the same logic, very dense local networks are more likely to be high in homogeneity and conformity in terms of attitudes, beliefs, values, norms, and behavior compared to less dense networks.

Connectedness

Connectedness takes indirect as well as direct network links into account. Its construction is based on *linkage distance*, the number of links in the shortest path connecting two individuals, and hence, includes indirect (through other individuals) links as well as direct ones.⁶⁵ Each network member's *connectedness* (average linkage distance) is simply the sum of all of his or her shortest step-distances to all other members of the network divided by the total number of members of the network minus one ($n - 1$). Each member's own average linkage distance can then be averaged with the scores for the rest of the network's members to compute an average connectedness for the network as a whole based on the notion of linkage distance.

Connectedness is an important alternative to density because it takes into account the indirect, multistep linkages that are ignored in the density formula. Connectedness is a more accurate measure of the efficiency with which information flowing through a network would reach all members. A relatively dense network, for example, could be structured in such a way (e.g., many dense cliques not connected to one another) that information would not easily diffuse throughout the whole network. The common organizational chart in the form of a pyramid is nothing more than a network structure that combines a high level of connectedness in terms of linkage distance with the minimum degree of density in terms of direct links.

Centrality

Centrality is another measure of interconnectedness among members of a network. It is similar to connectedness in its conceptualization, but different in usage and emphasis. Centrality is defined as the degree to which an individual has a short average distance to others in a network.⁶⁶ It provides an index of the degree to which a person is accessible to other persons in a network, and the relative position of each person within the network. Boissevain proposed the following formula to calculate the centrality index:⁶⁷

$$C = \frac{\text{sum of shortest distances from every member to every other member}}{\text{sum of shortest distances from person A to every other member}}$$

Centrality is not only an index of centrality, but also a good index of information flow and the management of information. In small group experiments, Klein noted that in a differentiated network (where the centrality of the members differ) where only a limited number of transmissions are permitted, the most central person or subgroup will be the best informed and

most influential.⁶⁸ Centrality would be especially useful for the study of intercultural organizations, where information and decision making are supposed to pass through formal channels. In such cases, the informal network structure is usually quite different from the formal one, so the centrality index would allow for a revealing comparison. We can imagine a situation, for example, where a foreign manager's power is weakened because of his low degree of centrality in the important information flow among local employees.

Diversity

Network diversity is a measure of the cultural heterogeneity of a network, and at the individual level, a measure of the cultural variety of a person's own contacts. Diverse networks are less likely to consist of one's own relatives, or persons with the same educational, occupational, ethnic background, and so forth. Mitchell used the term "range" to refer to this type of social heterogeneity.⁶⁹ Rogers and Kincaid used "heterophily" to refer to the degree that pairs of individuals who interact are different in certain attributes, such as their beliefs, values, education, social status, and so forth.⁷⁰

Certain cultural groups, such as Koreans and Japanese, restrict the definition of friendship normatively to those of the same sex and age range. Such a cultural norm would make it difficult for someone from another culture who does not meet these criteria to become a close friend. The diversity index would capture the extent to which such norms operate in a social network. For continuous variables such as age, occupation, education, and so on, the standard deviation of the values of each network member on a particular variable would measure diversity. For discrete variables such as ethnicity and sex diversity can be measured by the ratio of each person's links which are different to the total number of links. Like most of the other measures above, diversity is also a good indication of a network member's potential access to diverse inputs of information. Yum's study of immigrants revealed a significant, positive correlation between personal network diversity and level of information.⁷¹

Multiplexity

Gluckman first used the term "multiplex" to refer to links between individuals that serve a multiple interests, such as person A being simultaneously a neighbor, an employee of the same company, a friend, a relative and alumnus with person B.⁷² A uniplex link, on the other hand, is characterized by only one such role relationship. In a small traditional communities, one would expect to find a high proportion of multiplex links in a network, while in a large, industrialized urban community one would expect to find a

higher proportion of uniplex links. Interestingly, culture in general can create an exception to this expectation. In Japan, a highly industrialized urban society, the multiplex linkage is still quite common, to a great extent due to the functioning of many large corporations that provide housing in a common area for its employees, which seeks graduates from the same schools, and which even can arrange the matchmaking to meet a potential spouse.

It is believed that multiplex links are stronger and more enduring than uniplex links simply because of the greater difficulty in severing more than one type of relationship. Also, we would expect one type of relationship in a multiplex link to reinforce the others. There is also probably some tendency for uniplex links to become multiplex if they persist over time simply because the opportunity is there.

DISCUSSION

Gudykunst has noted that one of the factors that has hindered the development of intercultural communication as a scientific discipline is the lack of appropriate research methodologies, especially those that can capture the process nature of communication.⁷³ Network analysis can make a substantial contribution in this regard. It was developed to get at underlying social processes, such as information exchange. A network at any given time is created and maintained by processes, and as such, its structure represents a good picture of what has happened in the past, or what is currently taking place.

Of the general areas of intercultural communication research reviewed by Gudykunst three would benefit immediately from the use of network concepts and methods: perceived similarity, intercultural effectiveness, and intercultural contact.⁷⁴ Most research on perceived similarity attraction has measured at the psychological level, usually for two individuals who interact. It is well known, however, that an individual's behavior is also affected by structural, contextual factors, perhaps by such network characteristics as the similarity or overlap of those who interact, or the degree of network homogeneity (diversity) and normative pressure. Such elusive concepts as social distance take on new significance because of the opportunity to create better scientific measures using network methods. The research on intercultural effectiveness has used the network concept of homophily-heterophily,⁷⁵ but the majority of that research has focused on individual traits, either cognitive or behavioral. The network characteristics of the different cultures of each person involved could be an important influence on intercultural effectiveness. A dense network, for instance, exerts strong control over its members, and regulates contacts with outsiders. Thus, even if a person has the

optimal individual characteristics for intercultural effectiveness, the network structure in which the interaction occurs could still deter his or her effectiveness.

Intercultural contact research suffers from a lack of standardization of contact forms and structural patterns. Network analysis provides an unambiguous measurement of structure as well as the diversity of contacts. The concept of "high versus low context cultures," which heretofore has only been assumed to operate in comparative studies, could be more thoroughly studied itself by the empirical methods of network analysis. Such a development would lead to a more precise testing of intercultural communication processes.

There are two main problems in applying network analysis to intercultural settings: the problem of establishing boundaries around network data, and the problem of measurement with potentially large cultural variations. Since network analysis often deals with informal structure, as opposed to geographical locations or formal organizational units, it is often difficult to decide in a nonarbitrary manner who belongs inside or outside a given network of interest (or when two networks are one network). It is not uncommon for the boundary to be set by the limitation of the researcher's resources of both time and money. Depending on the definition of the links, a snowball network design could extend indefinitely until most of the people in the world are encompassed. It would be a mistake to impose a geographical boundary in a study of an ethnic group in the United States, since it is so common for members to move from their initial residential neighborhoods as they become more affluent.

Boundary problems are especially serious if the researcher wants to construct indices of structure such as density, connectedness, or centrality, since the size itself contributes so much to the outcome of the measure. Of course, this is not a problem created just by the method: the lack of well-defined boundaries on communication is a natural characteristic of most social systems, regardless of the methods used to study them. Network analysis merely reveals this phenomenon rather than ignores it. The method dramatizes the arbitrariness of lifting the "individual" out of his or her social milieu for analysis as a separate, isolated entity. Thus, the concept of culture itself is given a new life in terms of "things" shared (information, values, etc.) within social networks whose links cannot be ignored or cut without something being lost.

The network methodology also underscores the difficulties in measuring relational concepts when two or more different cultures are included. Different cultures have different interpretations for what is meant in English by a

"close friend," or even the difference between a "friend" and "acquaintance" and a "relative." Reliance on the respondent's subjective recall of this information further complicates the measurement process. How to measure networks links with such emotional factors involved as friendship, calls for much more thorough procedures than in studies where only one culture is involved.

Participant observation also has its shortcoming in intercultural research, because it is limited to systems relatively small in size, and it can be more obtrusive in one culture than in another culture. Again, it is network concepts that draw attention to the problem. Participant observation is inherently more difficult and limited in cultures characterized by social networks that are dense, homogeneous, characterized by strong normative pressures, multiplex links, and impervious to outsiders. The "participation" experience of the researcher-observer in such a setting has to be much more restrained and limited than in social networks with the opposite structural characteristics.

Two areas of intercultural communication research in particular would benefit from the use of network methods. The first area is the differences between inter- and intracultural relationships: the network context in which they are imbedded, their degree of multiplexity, and especially important, how the two types of relationships differ in terms of their initiation and development over time.

The second question is stimulated directly by the network approach: the investigation of the role of intermediaries (the brokers, the arbitrators, the negotiators, and social arrangers) both within distinct cultures, and then within intercultural settings. The marriage matchmaker, those who intervene in conflict situations, those who help facilitate business deals—they are all important network roles for creating and maintaining communication networks. How do members of an immigrant ethnic group that avoid lawyers and psychiatrists in their own culture (if, indeed, they were ever available) cope with their personal problems in an intercultural setting where the use of such formal sources of help is the norm?

These are a few of the many questions that arise or take on a new significance when conceived in network terms. Without a doubt, network applications to intercultural settings demand greater theoretical clarification, as does the field of intercultural communication in general. But the methodological tools are there for our use. If we can avoid the pitfall of overemphasizing the methods per se at the expense of the important theoretical questions, then the field should benefit from the application of network analysis.

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Measuring Human Emotion

Proposed Standards

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THE NEED FOR STANDARDS

As Niels Bohr has said, "Science is the observation of phenomena and the communication of the results to others, who must check them."¹ While simple in principle, Bohr's remark describes a social and symbolic process. The "communication of results" only rarely involves actual shipment of the object of study from one scientist to the next, but almost always involves a symbolic exchange of information. Experience must be encoded into symbols to be communicated, and it is the symbolic representations of observations that are actually compared, never the "observations" themselves.

As students of human communication are most well aware, all human communication is fraught with difficulties, including communication among scientists about observations they have made and must check. These difficulties are compounded when conventions about language are only informally developed.

Physical scientists have approached this problem primarily through the medium of conventional standard-setting bodies. These bodies are based on an understanding of the conventional nature of language, including scientific language, and represent socially sanctioned efforts to establish and enforce common rules for encoding and communicating about observations. The present worldwide system of measures, for example, is a result of an international agreement known as the Treaty of the Meter. This treaty establishes the continuing International Committee on Weights and Measures. Each six years this body convenes an international general conference on weights and measures that approves changes and extensions to the original 1960 agreement. The resulting *Système Internationale des Unités*, or International System (SI), has brought considerable order to our collective understanding of "physical" experience.