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A Note on the Relationship Between Centrality and Cultural Knowledge in a Professional Network

Devon D. Brewer
School of Social Sciences
University of California, Irvine
Irvine, CA 92717
BITNET: zdbrewer@uci

Abstract

This paper examines the relationship between centrality and cultural knowledge in a network of corporate contributions officers, based on data collected by Galaskiewicz (1985b). The results indicate a moderate association between officers' centrality and knowledge of local nonprofit organizations, with membership in professional associations and gender also playing independent roles in the distribution of knowledge.

It has been widely recognized in the social sciences that cultural knowledge in any community is unevenly shared by its members. It also has been frequently asserted that the pattern of social ties in a community underlies intracultural variation. Despite the long held interest in the social distribution of knowledge, a coherent and sustained program of systematic research on the subject has only recently come together.

Work by a number of researchers (e.g., Campbell, 1955; Hammer, Polgar, and Salzinger, 1969; Romney and Faust, 1982; Romney and Weller, 1984; Boster, Johnson, and Weller, 1987; Freeman, 1987; Freeman, Romney, and Freeman, 1987; Krackhardt and Kilduff, 1990; and Boster and Johnson, 1992) has shown that individuals' knowledge about a community's social structure and the characteristics of others is related to their positions in the community's social network.

This body of research has led to the general conclusions that the more people interact with others in the community, the more they agree and know about others in the community, and that the more integrated into a community a person is, the more s/he knows about the community's social structure. However, the available evidence does not indicate what aspect of greater interaction with others it is that increases knowledge of a social structure and others' characteristics. Being more central in a group may allow one to receive more second-hand information about the community's social structure and others' attributes from communicating with one's contacts, which would increase one's social knowledge of the community and its members. It is equally possible, as Linton Freeman pointed out to the author in personal communication, that people in more central positions can better observe, first hand, the community's social structure and others' characteristics, and that communication with others may not be the main source of acquiring this knowledge.

A better context for examining the role of social ties in the transfer of cultural knowledge is in areas of knowledge that do not focus on the social structure or attributes of persons in a community and where verbal communication clearly is at least one necessary part of the process of acquiring knowledge.

Boster (1986) was the first to demonstrate in an explicit network sense that cultural knowledge of non-social content also can be distributed according to the patterning of social ties. He showed that Aguaruna women who were more involved in extra-kin manioc exchange networks had greater knowledge (measured by cultural competence, an estimate of informant knowledge derived from analyzing the pattern of agreement among informants — see Romney, Weller, and Batchelder, 1986) about manioc identification than women whose exchange was limited to their respective kin groups. Deviations from the consensus, however, were patterned along kinship lines, as the women were much more likely to exchange manioc varieties with kin. While shared experience with the actual manioc plants was a component in learning the names for the different varieties, the names definitely could not have been acquired without verbal communication among the women regarding the plants' labels.

Similarly, Brewer (in press) observed that graffiti writers who were centrally positioned (centrality was informally measured) in local graffiti writer networks and who had more ties to writers in other communities knew more (i.e. had greater cultural competence) about the effectiveness of various strategies to control illegal graffiti than more peripheral writers to whom the central writers had first-order links.

This paper adds to the previous research by examining the relationship between centrality in a social network and cultural knowledge using data collected by Galaskiewicz (1985b). First, Galaskiewicz' research on the social distribution of knowledge is reviewed. Next, the procedures of reanalysis are described, and then the results are presented. The final section discusses these findings.

Galaskiewicz' Research on the Social Distribution of Knowledge

The primary focus of Galaskiewicz' research on the social distribution of knowledge has been to investigate how corporate contributions officers decide to which charitable nonprofit organizations (NPOs) they should donate (Galaskiewicz, 1985b; Galaskiewicz and Burt, 1991). Corporate giving officers are responsible for overseeing charitable donations to NPOs in publicly held business corporations (for a more detailed description of the study population, see Galaskiewicz, 1985a, 1985b). Underlying the process of deciding which NPOs to support financially, according to Galaskiewicz and other organizational researchers, is a sense of uncertainty about community needs and the nature and quality of the services provided by prospective donees, since corporations themselves are not the beneficiaries or consumers of the services the NPOs provide. This uncertainty has been hypothesized to stimulate officers to seek more information about NPOs from independent sources, especially peer contributions officers in other corporations, in order to make their contributions decisions effectively. Even when officers do not actively seek out peers for information about particular NPOs, it was thought that officers still acquire a large amount, if not most, of their knowledge about NPOs through communication with other contributions officers.

The data

The main data set analyzed by Galaskiewicz (1985b) and Galaskiewicz and Burt (1991) includes responses from 61 corporate giving officers in the Minneapolis/St. Paul area. All of the officers were employed by firms with more than 200 employees. The data relevant to the present paper are of three basic types: sociometric data, characteristics of the officers and their firms, and officers' evaluations of local NPOs. The sociometric data consist of a 61 X 61 binary nonsymmetric matrix A_{ij} in which a cell has a "1" if the contributions officer (the person most responsible for charitable activities) in firm i reported person-ally knowing someone ". . . involved in corporate contributions, i.e. on a first-name basis, would feel comfortable calling for lunch or drinks after work, etc.," (Galaskiewicz, 1985b: 647) in firm j, or a "0" otherwise. Thus, the data is not exactly of the person by person type. Galaskiewicz and Burt (1991) noted that this network exhibits an overall core-periphery structure.

The data on the officers and firms' characteristics include eleven variables. Seven variables concerning the officers' characteristics are dichotomous: gender, prior work experience in human services, status in firm (whether their job was as a semi-professional or professional contributions officer), whether an officer consults with a peer in another corporation or foundation to get more information on prospective donees (NPOs), and membership in each of three local professional associations for contributions staff (BARC, MCF, WFCP). Data was also collected on officers' educational history (high school, undergraduate, graduate) and birthplace (Minneapolis/St. Paul, North Central U.S., elsewhere). Although not analyzed by Galaskiewicz (1985b) and Galaskiewicz and Burt (1991), the present paper also includes the average assets and revenues for officers' firms between 1979 and 1981 as measures of firms' financial size.

To tap officers' knowledge of NPOs, respondents were presented with a list of 326 NPOs (representing a 20% stratified systematic sample of nonprofit public charities [excluding private foundations and churches] in the Minneapolis/St. Paul metropolitan area) and asked which ones they recognized. In addition, for those NPOs recognized, respondents indicated which were providing essential services and had made outstanding achievements in their respective fields.

Summary of Galaskiewicz (1985b) and Galaskiewicz and Burt's (1991) findings

Galaskiewicz (1985b) found that the more proximate two officers were in the officer network, the more they agreed with each other in their recognition and evaluation of the NPOs. By taking the intersection of A (officer in firm i knew someone in firm j, and vice versa), calculating the path distances between each pair of officers, and

then submitting this path distance matrix to multidimensional scaling, Galaskiewicz obtained a measure of inter-officer network proximity from the resulting interpoint distances in a two-dimensional scaling. He measured agreement between pairs of officers in their recognition and evaluation of NPOs with Jaccard coefficients. This index of similarity can be expressed simply as the number of shared elements (i.e. intersection) in two sets (e.g., NPOs two officers both recognized) divided by the number of items in the union of the two sets (e.g. the total number of unique NPOs recognized by a pair of officers). Galaskiewicz calculated Jaccard coefficients for each pair of officers on each level of evaluation (recognition, essential services, and outstanding achievements). The zero-order Pearsonian correlations between officers' interpoint distances and Jaccard coefficients were .10, .05, and .09 (all $p < .001$ since the dyad was the unit of analysis) for recognition, essential services, and outstanding achievements, respectively.

Galaskiewicz and Burt (1991) extended these initial findings. In their analysis, officers' responses regarding the NPOs were coded on a three category response variable (1 = did not recognize, 2 = recognized, 3 = recognized and outstanding achievements). Galaskiewicz and Burt (1991) employed network autocorrelation techniques and demonstrated, for a subset of ten NPOs which had been given the highest and most variable evaluations, that agreement in recognition and evaluation of these NPOs was associated with structural equivalence ($r = .54$). This correlation was greater than the one observed between agreement and "cohesion," which was measured by comparing officer i's evaluations with all officers who had direct ties to firm i, $r = .29$.

They also noticed that more prominent officers (officers' prominence scores were strongly associated with eigenvector measures of prestige and centrality) tended to recognize more of these ten NPOs than less prominent officers.

Purpose of this paper

The reanalysis reported in this paper builds upon the work of Galaskiewicz (1985b) and Galaskiewicz and Burt (1991). The present paper differs in two principal ways by focusing on officers' *centrality* in the network (rather than structural equivalence, dyadic/"cohesive" ties, or network path distance proximity) and their *knowledge* of the NPOs (instead of only agreement in their evaluations). The primary hypothesis tested is whether the information in the sociometric data can predict which officers are the most knowledgeable (regarding the NPOs). Specifically, the hypothesis postulates that officers who are more central in the network should possess greater knowledge of the NPOs. If cultural knowledge is transmitted through social ties involving communication, then positions within in a network where information flow is most focused should also be the loci where cultural knowledge, as accumulated and shared information, is greatest.

Procedure

Four officers' firms did not receive any sociometric choices nor did these officers report knowing contributions personnel at any of the other firms. These four officers were omitted from further analysis because the aim was to observe the distribution of knowledge across a network, and not among unconnected isolates. The 57 X 57 binary nonsymmetric matrix was then converted into a three valued matrix according to the following rule: cell a_{ij} has a "0" if neither i nor j chose one another, a "1" if either i chose j or j chose i, but not both (i.e. an unreciprocated tie), or a "2" if i and j both chose each other (i.e. a reciprocated tie). The rationale for doing this is twofold. First, 63% of the choices in the 57 X 57 binary nonsymmetric matrix were not reciprocated.

The average officer had only 24% of his/her choices reciprocated, with the percentage of reciprocated choices ranging from 0% to 76%. By transforming into a valued matrix, it was not necessary to ignore nearly two-thirds of the sociometric data. Second, Granovetter (1973) points out that in a free-choice sociometric interview, mutual choices can be indicators of strong ties, while unreciprocated choices would tend to reflect weaker ties. Galaskiewicz (1985b) noticed that officers i and j might not know each other personally even when a reciprocated tie exists because they might know other contributions staff who work with the officers interviewed, but not actually each other. A similar scenario could relate to the unreciprocated choices in the data. For instance, officer i could know someone involved in contributions at firm j, but not the officer interviewed, while at the same time officer j was not aware of a colleague's tie with the officer interviewed in firm i. Even if the responding officers did not know each other personally, or were involved in an unreciprocated choice situation as described above, it is assumed in this analysis that there was at least some information flow among contributions staff within the same firm.

Three different measures of centrality were used in this analysis because there was no theoretical indication about which of the specific processes modeled by different centrality measures might best represent the process generally stated in the hypothesis. The first, Freeman, Borgatti, and White's (1991) flow betweenness algorithm, is

based on the role each point plays in terms of network flow for all independent paths between all pairs of points in a valued or binary graph. Stephenson and Zelen's (1989) information centrality index was also used. This measure is based on the inverse of path distances between all pairs of points for all paths, with appropriate adjustments made for overlapping paths and valued ties. Thus, points that are closer (in a path distance sense) to other points and have more connections (greater degree) of higher values with other points will have higher information centrality scores. The third centrality measure employed was Bonacich's (1971) eigenvector measure, which is the eigenvector of the largest eigenvalue of a binary or valued adjacency matrix (i.e. individuals' centrality scores are the loadings on the first factor from a factor analysis of the adjacency matrix).

In this analysis, an officer's cultural knowledge of local NPOs is loosely measured by the total number of NPOs they recognized. This index is similar to the total amount of lexical items in a semantic domain an informant can mention in an open-ended free listing task (e.g. "What are all the kinds of fabrics?"). Brewer, Romney, and Batchelder (in preparation) have discovered that in semantic domains such as birds, countries, diseases, fabrics, and flowers, free listing capacity was correlated approximately .41 with cultural competence (an estimate of an informant's knowledge level based on the pattern of agreement among informants — see Romney, Weller, and Batchelder, 1986) in triads judged similarity tasks. This correlation is probably depressed because in all domains studied there was relatively little genuine variation in knowledge (cf. Weller, 1987). Although admittedly crude, this recognition measure is the only way to gauge knowledge in this data set, since Jaccard coefficients, correlations between respondents on the three category response variable used by Galaskiewicz and Burt (1991), or any other measure of agreement, cannot be meaningfully submitted to any procedure that estimates individuals' knowledge level based on patterns of agreement (cf. Weller, 1984; Boster, 1985; Romney, Weller, and Batchelder, 1986; Romney, Batchelder, and Weller, 1987). This is not to deny that more specific and greater amounts of knowledge are required for evaluation of NPOs beyond recognition; it is just that this information cannot be effectively used in estimating officers' knowledge in this particular case. However, the recognition measure used here does take advantage of officers' responses for all 326 NPOs, in contrast to Galaskiewicz and Burt's (1991) use of the subset of only ten NPOs.

Results

The summary statistics for each of the centrality measures appear in Table 1. There was a substantial amount of variation in the number of NPOs the officers recognized, with a mean of 53.46 and standard deviation of 21.97 (minimum = 5, maximum = 115). The Pearsonian correlations among the centrality measures and recognition are shown in Table 2. Scatterplots of these variables did not exhibit any obvious nonlinear patterns. The total number of NPOs recognized was correlated approximately .5 with the various centrality measures. Therefore, the hypothesis that more central officers should "know" more about the NPOs received moderate support. In addition, all of the centrality measures were highly intercorrelated, though the information index was somewhat different from the flow betweenness and eigenvector measures, which were more strongly correlated with each other.

Table 1. Summary Statistics for Centrality Measures

Measure	Mean	S.D.	Centralization Score
Flow Betweenness	.02	.02	.05
Infomation[a]	.02	.01	< .01
Eigenvector	.02	.09	—

[a] The information centrality scores were computed by dividing each person's information by the sum of all person's information. The centralization score represents the variance of these centrality scores, as suggested by Wasserman and Faust (1992).

Table 2. Correlations Between Centrality and Recognition.

Measure	Recognition	Flow Betweenness	Information
Flow Betweenness	.45		
Information	.50	.77	
Eigenvector	.57	.92	.84

all correlations p < .001

The results on the relationship between centrality and recognition were not due to the fact that unreciprocated ties were included in the computation of centrality. For the 39 X 39 binary symmetric matrix based on the intersection of sociometric choices, correlations between recognition and centrality were of the same strength and direction for various measures of centrality: .43 ($p < .01$) for degree centrality, .42 ($p < .01$) for closeness centrality, .25 ($p < .15$) for betweenness centrality, and .34 ($p < .05$) for flow betweenness centrality (Freeman, 1979). Comparable results were obtained when the 57 X 57 binary symmetric matrix based on the union was analyzed. Furthermore, the correlation between recognition and centrality for those ten officers in the valued 57 X 57 matrix who had no outdegrees (i.e. made no sociometric choices) was .56 ($p < .1$), .65 ($p < .05$), and .67 ($p < .05$) for the flow betweenness, information, and eigenvector measures, respectively. For the other 40 officers who had at least one outdegree (sociometric choice), these correlation were .40 ($p < .01$), .43 ($p < .01$), and .56 ($p < .001$) for the same centrality measures. Therefore, even though ten officers made no sociometric choices to other firms, the indegrees to the these officers' firms still carried important structural information that related to the distribution of knowledge.

How good is a correlation of approximately .5 in this case? By comparing the bivariate relationships between other independent variables and recognition, the relative strength of centrality as a predictor of knowledge can be better understood. Consultation with peers regarding prospective donees, birthplace, and education all were unrelated to the number of NPOs recognized in t-tests or analyses of variance, and both assets and revenues of officers' firms were nonsignificantly correlated with recognition. However, several other variables were moderately associated with recognition. Officers who recognized more NPOs tended to be members in one or more of the local professional associations ($t = -5.50$, df = 43, p.001, eta = .61), female ($t = -3.44$, df = 13, p = .004, eta = .42), have prior work experience in human services ($t = -2.39$, df = 14, p = .03, eta = .33), and have professional job status ($t = -3.485$, df = 50, p = .001, eta = .43)(separate variances used in calculations; nonparametric results virtually identical to those reported here). Thus, centrality was just one of several variables that moderately predicted recognition.

An attempt was made to see which variables provided additional independent information in predicting recognition after controlling for centrality, since some of these variables were also associated with centrality. The partial correlations (controlling for each centrality measure in turn) between recognition and firms' assets and revenues were nonsignificant. For the categorical officers' characteristics variables, t-tests or analyses of variance were carried out on the residuals of the simple regression between recognition and centrality for each centrality measure. Members of local professional associations ($p = .004$, .014, and .119 for flow betweenness, information, and eigenvector measures, respectively) and women officers ($p < .001$ for all centrality measures) recognized significantly more NPOs than would be expected given their centralities. However, once centrality was controlled for, no differences in recognition remained between subgroups on any of the other variables (all $p > .05$ for each centrality measure, except for human service experience X information centrality - recognition residuals, Mann-Whitney $p = .05$). Interestingly, gender was not significantly associated with any other variable in the data set.

Despite the earlier listing of association membership as a characteristic of officers, it seems better to view it as a structural variable. Association membership and centrality were moderately related (eta = .58, .65, and .75 for flow betweenness, information, and eigenvector measures, respectively; all t-tests and Mann-Whitney tests $p < .001$). More importantly, membership in one association most likely offered an officer access to some information of local NPOs held by other associations and also to more social ties with other officers because the memberships of the three associations overlapped substantially. This overlap can be seen in the association X association membership matrix in Table 3. Because information seemed to flow relatively easily within an association (". . .they [the associations] provided program activities which allowed these staff people to get to know one another and community problems better (e.g. breakfasts, conferences, seminars, etc.") (Galaskiewicz, 1985b: 647)), it seems plausible that membership in one association allowed an officer access to a substantial amount of knowledge about the NPOs held by members in other associations. This interpretation is supported by the fact that officers who belonged to more than one association did not recognize significantly more NPOs than officers who belonged to only one association. The mean numbers of NPOs recognized for officers belonging to zero, one, two, and three organizations were 42.75, 68.88, 71.71, and 57 (n = 1 officer), respectively. Officers belonging to two or three associations did not recognize significantly more NPOs ($t = -.12$, df = 16, $p = .90$) or have greater centrality ($t = -.39$, df = 13, $p = .70$) than officers belonging to only one association. Thus, the memberships of the three associations did not compose separate clusters of ties among officers (as did kin groupings among Boster's (1986) manioc cultivators), rather they consolidated the core of the officer network, which presumably homogenized the knowledge base (in terms of recognizing the NPOs) for these more central officers who were members of a professional association. From these data it was impossible to determine whether officers' greater centrality predisposed them to association membership or membership in an association allowed officers to develop additional ties which

produced their greater centrality, or some combination of these two processes. The main point here is that centrality and association membership should be viewed as complementary structural variables, and not as entirely different forces in the distribution of knowledge among contributions officers.

Table 3. Overlapping Association Memberships

	BARC	MCF	WFCP
BARC	18		
MCF	6	12	
WFCP	1	3	3

N = 24 contributions officers who were in one or more associations.

Discussion

The results should be viewed as preliminary and suggestive because of the coarseness of the recognition measure of knowledge and the lack of true person by person information in the sociometric data. Still, the results do indicate that officers' knowledge of NPOs, as measured by recognition, was concentrated in their social network in a manner at least partly described by centrality. In addition, membership in local professional associations (which appears to have structural implications) and gender also were independent factors in the distribution of knowledge among contributions officers.

That gender was so strongly related to recognition was unexpected. Perhaps the women officers tended to be more interested in charity beyond the responsibilities of their jobs and connections to contributions staff in other firms than male officers, and perhaps they paid closer attention to information about NPOs in the local media. It is also possible that women officers spent more time and effort learning about NPOs on their own, apart from their ties to other officers, or that women officers used whatever ties they had with other officers more effectively in learning more about the NPOs than men.

One variable that has been difficult to disentangle from the effects of social structural position on knowledge in past research and in the present paper is the length of experience an individual has in a domain and how long an individual has been a part of the community. While both Boster (1985, 1986) and Brewer (in press) found that structural position and knowledge were related, they also noticed, as did Garro (1986), that more knowledgeable informants also had more experience in the domains and communities under investigation. Variation in officers' recognition of NPOs could very well be due to length of tenure in their jobs and/or length of residence in the Minneapolis/St. Paul area, with more experienced officers more likely to be central in the officer network. Place of birth in the data set analyzed here probably does not index officers' baseline familiarity with local NPOs (separate from their ties to other officers and job duties) very well because of residential mobility. Likewise, prior work experience in human services would probably increase an officer's recognition of NPOs only if that work experience was in the Minneapolis/St. Paul area. Another possible factor in explaining officers' recognition is that officers in some, especially more central, firms may have heard about some NPOs solely because the NPOs themselves had directed their requests for charitable donations to their firms and not others.

Some next steps in research on the social distribution of knowledge should be to collect both behavioral and cognitive sociometric data that measure the strength of dyadic ties. Such sociometric data should be coupled with domain-specific cognitive data that are appropriate for cultural consensus analysis (or some variant thereof) to measure individuals' knowledge levels. In addition, systematic data should be gathered on individuals' length of experience in the community and with the domain under investigation. A more stringent test of the centrality - cultural knowledge hypothesis also would ideally examine a community of people that has multiple subgroupings, instead of an overall core-periphery structure. Boster's (1986) findings with the Aguaruna manioc cultivators (and their kin-oriented exchange structure) suggest that centrality would still remain associated with cultural knowledge in such a multiple subgroup structure.

Acknowledgements

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