



ELSEVIER

Social Networks 23 (2001) 245–260

---

---

**SOCIAL  
NETWORKS**

---

---

[www.elsevier.com/locate/socnet](http://www.elsevier.com/locate/socnet)

# The distant core: social solidarity, social distance and interpersonal ties in core–periphery structures

Michael Bourgeois, Noah E. Friedkin\*

*Department of Sociology, University of California, Santa Barbara, CA 93106, USA*

---

## Abstract

We examine three hypotheses at the foundation of theories concerned with the organization of social space and social solidarity in differentiated groups. The most important of these hypotheses is that interpersonal ties between actors in different positions of a social structure foster social solidarity; however, the theories are silent on the question of whether this effect of interpersonal ties is maintained regardless of the distance that separates the positions of two actors in the group's social space. In addition, the current zeitgeist on the organization of social space hypothesizes that interpersonal solidarity and ties are negatively associated with the distance that separates the positions of actors in social space. Although interpersonal ties foster solidarity, social distance reduces the likelihood of interpersonal ties and solidarity. Our evidence suggests unqualified support only for the first hypothesis. Surprisingly, the expected negative effects of social distance on interpersonal ties and solidarity appear to be properties of particular forms of social organization and are not ubiquitous implications of social differentiation. These negative effects are more or less pronounced (even reversible) in core–periphery structures depending upon the distance between the core and peripheral positions in the social space of the group. © 2001 Elsevier Science B.V. All rights reserved.

*Keywords:* Core–periphery; Social solidarity; Social distance; Interpersonal ties

---

## 1. Introduction

Social differentiation has been an important focus of investigation since Durkheim (1893) sought to understand how social solidarity might be maintained in a complexly differentiated population of actors. Recent approaches to this classic problem — the formation and maintenance of social solidarity in differentiated social structures — suggest that agreements on issues, objectives, and standards are based importantly on networks of interpersonal ties, linking actors in different parts of the social structure, and on the flows of information and

---

\* Corresponding author.

*E-mail address:* [friedkin@sscf.ucsb.edu](mailto:friedkin@sscf.ucsb.edu) (N.E. Friedkin).

influence in these networks (Doreian and Fararo, 1998; Friedkin, 1998). These network approaches generally posit a state of social differentiation (i.e. a distribution of actors in multidimensional social space) in which the likelihood and strength of an interpersonal tie are negatively associated with the distance that separates the positions of actors in the social space of a group. These approaches posit that social differentiation is consistent with the presence of a social network that fosters boundary-spanning solidarity, i.e. interpersonal agreements and influences between actors at some distance from each other in social space. The main structural foundations for significant boundary-spanning solidarity are the bridges and weak ties that link actors in different subgroups and the ridge structures that are based on intersecting cohesive subsets of actors (Blau, 1977; Friedkin, 1998; Granovetter, 1973).

Our investigation of the problem of solidarity in differentiated social structures was initially designed as an effort to specify the form of the association between social distance and social solidarity. If negative effects of social distance on social solidarity are sufficiently pronounced (or if social distance interacts with ties and erodes the positive effect of ties on solidarity), then solidarity in interpersonal relations would be likely only in ties between actors in the same or proximate social positions. Blau (1977) has argued that integrative boundary-spanning contacts might occur between actors who share a common status on multiple dimensions that define the social space of a group (e.g. education, age, income, occupation, residential location) but who differ on other salient dimensions (e.g. race, sex). Such actors would occupy proximate (non-identical) locations in social space and the ties between them would foster their social solidarity (interpersonal influence and agreement). Our present investigation was motivated by the question of whether a positive association between interpersonal ties and solidarity would hold for actors regardless of the distance between the positions of the actors in social space. We suspected that this association might be attenuated for actors who occupy sufficiently distant social positions.

Our present findings suggest that *regardless of the social distance between the positions of two actors in social space*, social solidarity is substantially more likely between two actors who are in contact than between two actors who are not in contact. However, during this investigation, we encountered several anomalous findings that have altered our thinking about the organization of social space. In some groups, we found that the likelihood of an interpersonal tie is *positively* associated with the distance between the positions of two actors in social space. We also found that controlling for the presence of an interpersonal tie between two actors, in some groups the likelihood of interpersonal solidarity between two actors is *positively* associated with the distance between the positions of the two actors in social space. The expected negative effects of social distance on interpersonal ties and solidarity appear to be properties of particular forms of social organization and are *not* ubiquitous implications of social differentiation. It appears that these negative effects are more or less pronounced (even reversible) in core–periphery structures, depending upon the distance between the core and peripheral positions in the social space of the group.

## 2. Hypotheses

This article is organized around three hypotheses that deal with the distance between actors' social positions, actors' interpersonal ties, and social solidarity:

- H1:** The greater the distance between the positions of two actors in social space, the lower the likelihood of an interpersonal tie between the two actors.
- H2:** The greater the distance between the positions of two actors in social space, the lower the likelihood of interpersonal solidarity between the two actors.
- H3:** The greater the distance between the positions of actors in social space, the weaker the positive association of an interpersonal tie and social solidarity among them.

The first hypothesis, concerning the negative effects of social distance on the likelihood of an interpersonal tie, is deeply embedded in sociological thinking about social differentiation (Blau, 1977; Friedkin, 1998; McPherson and Ranger-Moore, 1991). In Blau (1977), the statement that “social associations are more prevalent among persons in proximate than between those in distant social positions” (p. 43) is an *axiom* on which Blau constructs a theory of social space. The greater the difference between two actors on dimensions that define the social space of a group, the greater will be the distance between them in social space, and the lower will be the likelihood of an interpersonal tie. Ties are difficult to form and maintain over large distances in social space because such distance usually implies fewer opportunities for contact and more disagreement on issues. For many theorists, this implication of social differentiation is not problematical, however, see Skvoretz (1983).

The second hypothesis, concerning the negative effects of social distance on the likelihood of interpersonal solidarity between two actors, is also widely postulated in structural analyses (Heinz et al., 1993; Laumann and Pappi, 1976). Laumann (1973, p. 5) writes that there is “ample theoretical and empirical justification” for assuming the following *distance-generating mechanism* among social positions:

Similarities in status, attitudes, beliefs, and behavior facilitate the formation of intimate (or consensual) relationships among incumbents of social positions. The more dissimilar two positions are in status, attitudes, beliefs, and behavior of their incumbents, the less likely the formation of intimate (or consensual) relationships and, consequently, the “farther away” they are from one another in the structure.

This distance-generating mechanism also should apply to actors who are in contact, although they occupy different social positions: the greater the differences between such actors on dimensions that define the social space of a group, the greater will be the distance between them in the social space, and the less likely their solidarity. Strong ties (entailing frequent contact and positive affect) may be difficult to form and maintain over large distances in social space, because social distance implies fewer opportunities for contact; infrequent contact reduces tie strength and, in turn, decreases the likelihood of interpersonal solidarity.<sup>1</sup> Thus, whether or not two actors are tied, social distance should be negatively

<sup>1</sup> Some work on opinion discrepancies in dyads could be interpreted as indicating that interpersonal influence is more likely among actors in proximate social positions (who agree on some issues and disagree on others) than it is among actors in identical and distant social positions, who either tend to agree or disagree on most issues (Doreian and Stockman, 1997; Festinger, 1954; Hovland et al., 1953). However, in the experimental work on this relationship social influence is indicated by an opinion change in the dyad. Clearly, in field settings, the absence of an opinion change among persons who share similar opinions does not imply the absence of interpersonal influences among them that may be serving to anchor their opinions and, therefore, we do not propose that interpersonal influence is necessarily weak among actors who occupy the same social position.

associated with social solidarity. However, the strength of this association may differ for actors who are in contact and those who are not.

The third hypothesis concerns the effect of social distance on attenuating the positive association of an interpersonal tie and social solidarity. A positive association between interpersonal contact and solidarity is well-established, and it is now recognized that even weak boundary-spanning contacts can foster solidarity (Granovetter, 1973). However, for contacts that span sufficiently large distances the frequency of interpersonal communication in a tie may become negligible and, thus, the tie may become a less effective structural basis of social solidarity (Friedkin, 1993).<sup>2</sup> Similarly, social solidarity in ties may be dampened markedly by social distance if social distance erodes other bases of interpersonal solidarity (e.g. perceived expertise, ability to mediate rewards or punishments, interpersonal identification, and legitimate authority). Moreover, if social distance erodes the necessary conditions of interpersonal solidarity (e.g. equal status, cooperative interdependence, tie strength), then contact per se may not suffice to establish interpersonal solidarity.<sup>3</sup> If social distance affects the content of ties in these ways, then solidarity contacts may be likely only in those boundary-spanning ties that occur between actors in *proximate* social positions.

### 3. Methods

Our examination of these hypotheses is based on a field study of school board policy groups. A school board is the governing authority of a public school district. Board deliberations are open to public scrutiny and influence so that the members of the local community, along with the district's administrators, may become active in the board's decision making. The social heterogeneity of a school board's policy group may be considerable, so that these groups allow a study of boundary-spanning ties.

#### 3.1. Data

These data were collected during case studies of six school districts of varying size and complexity in Michigan. Henceforth, we will refer to these groups as Groups I–VI. In each district, the policy group was defined by a snowball procedure. This procedure combined positional, reputational, and behavioral selection criteria. The initial sample included the members of the district's school board, the district's superintendent, the district's school principals, and all others identified in local newspapers or board minutes as currently or recently active in board meetings, district elections, or other efforts to affect board decisions.<sup>4</sup> These individuals nominated persons on the district staff and in the community who

---

<sup>2</sup> Granovetter's (1973) analysis suggests that bridging ties can be conduits for the flow of useful information. He does not argue that such ties are frequently activated (they tend to be weak rather than strong interpersonal attachments); however, when the actors who are involved in bridges do interact, the information that is exchanged tends to be novel because it arises in parts of the structure with which the actors are not regularly engaged.

<sup>3</sup> These preconditions of solidarity have been the focus of investigation of the so-called *contact hypothesis* in social psychology (Amir, 1969; Brown et al., 1999).

<sup>4</sup> School principals were not included in the initial sample of Group III and none received the nominations sufficient for inclusion in the policy group.

were known or reputed to be currently or recently active in attempts to influence school board decisions. These nominees were asked for further nominations according to the same criteria. To guard against idiosyncratic nominations, persons were added to the sample only if they were mentioned at least twice. The nominating procedure continued until dual nominations no longer occurred. The groups that emerged contained between 42 and 67 members.

Questionnaires were administered to all the persons who had been identified as policy group members. The questionnaire contained items concerned with group members' interpersonal relations, attitudes and opinions on various topics, and socio-economic characteristics. The response rates to the questionnaire were high: 97% in Group I (57/59), 89% in Group II (54/61), 90% in Group III (38/42), 98% in Group IV (59/60), 99% in Group V (66/67), and 88% in Group VI (37/42). We draw on some of these questionnaire data for our measures.

### 3.2. Measures

Our analytic units are dyads, the  $N(N - 1)$  ordered pairs of actors in a policy group, where  $N$  is the size of the group. We restrict the analysis to dyads in which both actors are survey respondents. For each dyad, we constructed measures of the occurrence of an interpersonal tie, the occurrence of two forms of social solidarity (perceived agreement and acknowledged influence), the social distance separating the two actors in the social space of the policy group, and the centrality of the positions of the actors in the group.

#### 3.2.1. Interpersonal tie

Actor  $i$  is tied to actor  $j$  if actor  $i$  reports frequent discussions with actor  $j$  on matters having to do with the school district, turning to actor  $j$  when in need of information or advice about matters in the district, or a close friendship with actor  $j$ . This is a directed measure of an interpersonal attachment: actor  $i$  may be tied to actor  $j$ , but actor  $j$  may not be tied to actor  $i$  if he or she reports no attachment based on frequent discussion, information or advice-seeking, or friendship.

#### 3.2.2. Social solidarity

We employ two measures of social solidarity at the dyadic level: perceived agreement and acknowledged interpersonal influence. Perceived agreement indicates the commonality of opinions, objectives, and standards that is the hallmark of social solidarity; and acknowledged interpersonal influence indicates the direct (unmediated) interpersonal influence that is an important foundation of such commonality. Perceived agreement and acknowledged interpersonal influence foster positive affect in interpersonal relations, although interpersonal solidarity may exist *without* such affect. For the measure of acknowledged influence, group members were asked to indicate which persons on the list of policy members "probably had some influence on your own opinion on school related matters during the last year or so". Acknowledged influence occurs if actor  $i$  reports that actor  $j$  had such an influence. For the measure of perceived agreement, group members also were asked to indicate which persons on the list of policy members are "usually on the same side of issues" as themselves on school district matters. Perceived agreement occurs if actor  $i$  reports that actor  $j$  is usually on the same side of issues. These are directed measures of interpersonal solidarity:

actor  $i$  may acknowledge some solidarity with actor  $j$ , but actor  $j$  may not acknowledge any solidarity with actor  $i$ .

### 3.2.3. *Social distance*

Our measure of social distance is the Euclidean distance between the social positions of actors in a multidimensional social space, where two actors occupy proximate social positions to the extent that their profiles of interpersonal ties to and from other actors are identical. To define actors' social positions, we employed the matrix of interpersonal ties (described above) and derived a measure of the social distance between each pair of actors with the approach described by Friedkin (1998). This approach is a refinement of an approach developed by Burt (1982) and involves three steps: (a) the computation of a measure of the probability that actor  $i$  will activate a tie with actor  $j$  based on structural features of the network of ties in which the two actors are embedded; (b) the computation of a measure of the profile similarity of actors' tie activation probabilities; and (c) the computation of the Euclidean distance between the positions of actors in a multidimensional social space that represents the disparities between actors' profiles of tie activation. This general approach to the description of social differentiation is supported by a substantial literature (Burt, 1982; Friedkin, 1998; Wasserman and Faust, 1994); repeatedly, it has been found that actors who have similar profiles of interpersonal relations are more likely to have a similar status on salient socio-demographic variables than are actors who have dissimilar profiles of interpersonal relations.

### 3.2.4. *Core and peripheral social positions*

Actors are designated as *core* if they occupy a central social position in their policy group and *peripheral* if they do not occupy such a position. To describe the centrality of social positions, the matrix of social distances was subjected to a hierarchical cluster analysis (diameter method) and position-clusters were defined at the mean level of social distance in the matrix. In each of the groups, both the density matrix of ties and tie activation probabilities among the derived position-clusters revealed a clear *core-periphery structure* in which position-clusters were linked to one another mainly on the basis of their links with one position-cluster, that was occupied by a small number of actors with high point-centralities in the network of interpersonal ties (Borgatti and Everett, 1999; Breiger, 1979; Freeman, 1979; Friedkin, 1991). In one group, there were two core positions that occupied proximate locations in the social space of the group and these were combined into one cluster. In each of the groups, the occupants of core position-clusters were predominately school board members or high officials in the central office of the school district.

## 4. Findings

Table 1 reports logistic regression coefficients for the likelihood of an interpersonal tie as a function of the social distance between actors in their group. The surprising findings occur in Groups II and III, where the expected negative effect does not occur. Indeed, in Group III, there is a positive association between social distance and interpersonal ties. This positive association appears to be the consequence of a particular form of core-periphery structure

Table 1  
Logistic regression coefficients for the probability of an interpersonal tie as a function of social distance

	Group I	Group II	Group III	Group IV	Group V	Group VI
(a) All dyads						
Social distance	−6.9903***	−0.3607	1.7598***	−7.1689***	−5.9950***	−4.3752***
Constant	2.6873***	−1.0720***	−2.6074***	2.8394***	2.4458***	1.2191***
(b) Dyads among peripheral actors						
Social distance	−9.0405***	−4.1006***	−4.2684***	−7.1389***	−6.8990***	−5.8912***
Constant	3.3570***	0.5325**	−0.6651*	2.4029***	2.2850***	1.4839***
(c) Dyads with a central actor						
Social distance	−6.4441***	−2.7826***	−1.2770*	−7.4807***	−6.4065***	−5.6401***
Constant	4.5157***	2.6399***	0.2401	3.4056***	3.4177***	3.0538***

\*  $P < 0.05$ .

\*\*  $P < 0.01$ .

\*\*\*  $P < 0.001$ .

in which actors in the core position of the group are distant from and in contact with actors in the peripheral positions. When the occurrence of this particular form of core–periphery structure is taken into account (by partitioning the dyads into those with no central actors and those with at least one central actor), the expected negative effect of social distance on tie-occurrence appears in each of the groups.<sup>5</sup>

Table 2 reports logistic regression coefficients for the occurrence of two forms of social solidarity (acknowledged interpersonal influence and agreement) as a function of the interaction of social distance and the occurrence of an interpersonal tie. This table also reports estimated probabilities of the occurrence of solidarity at the minimum and maximum distance between actors in the social space of a group. Because these minimum and maximum distances are close to 0 and 1 in each group, it is convenient to evaluate the probabilities at those values. At zero distance, the probability estimates give the likelihood of social solidarity among actors who occupy the exact same location in social space. The estimated probability of social solidarity  $P(S)$  in a dyad is given by

$$P(S) = \frac{\exp(z)}{1 + \exp(z)}$$

where  $z = b_0 + b_1 \text{TIE} + b_2 \text{DIS} + b_3 \text{TIE} \times \text{DIS}$  and the set of coefficients  $\{b_0, b_1, b_2, b_3\}$  are estimated logistic regression coefficients.

We hypothesized that the likelihood of interpersonal solidarity is negatively associated with the distance between actors' positions in social space, controlling for the presence of an interpersonal tie. Again we encountered some unexpected results in Groups II and III, where social distance appears to be *positively* associated with social solidarity. These are the same two groups in which we observed the unexpected positive association between

<sup>5</sup> For simplicity, we have not distinguished between dyads with one and two central actors. The latter are a small fraction of those dyads with a least one central actor and, hence, this partitioning of dyads essentially reflects a control for the positional composition of a dyad as being either within the periphery or between the core and periphery of a social structure.

Table 2

Logistic regression coefficients and estimates of the probability of acknowledged influence and agreement in dyads

	Group I	Group II	Group III	Group IV	Group V	Group VI	
Acknowledged influence							
(a) All dyads							
Logistic regression coefficients							
Tie	0.3368	3.8260***	4.9048***	1.7511***	0.9775***	1.9983***	
Distance	-2.8802***	2.4653***	3.5119***	-2.6110***	-2.3704***	-1.0583	
Tie × distance	3.8928***	-1.1420	-3.1586***	0.8421	2.0126***	0.6218	
Constant	-0.0987	-4.4521***	-4.2046***	-0.5945*	-0.3264	-1.5178***	
(b) Dyads among peripheral actors							
Logistic regression coefficients							
Tie	0.1776	2.6226***	4.0320***	2.5307***	1.0149**	2.8149***	
Distance	-3.6420***	-1.1256	1.3118	-2.4411***	-3.0337***	-0.0104	
Tie × distance	3.6228***	0.6266	-1.2718	-0.1550	2.8798***	-1.0424	
Constant	0.2381	-2.6596***	-3.4160***	-1.3447***	-0.4507	-2.4314***	
Estimates of the probability of interpersonal influence							
Distance	Tie						
0	0	0.559	0.065	0.032	0.207	0.389	0.081
0	1	0.602	0.491	0.649	0.766	0.637	0.595
1	0	0.032	0.022	0.109	0.022	0.030	0.080
1	1	0.598	0.369	0.658	0.196	0.601	0.339
(c) Dyads with a central actor							
Logistic regression coefficients							
Tie	4.5994**	8.2179***	3.5197***	1.0472*	0.4958	-0.8301	
Distance	0.1171	1.9665	0.9167	-2.9497***	-2.3165***	-6.0940***	
Tie × distance	-2.8587	-6.6090**	-1.6209	1.4954	1.6220*	4.2661**	
Constant	-0.9985	-2.9911*	-1.9538*	0.1915	0.3518	2.5700***	
Estimates of the probability of interpersonal influence							
Distance	Tie						
0	0	0.269	0.048	0.124	0.548	0.587	0.929
0	1	0.973	0.995	0.827	0.775	0.700	0.851
1	0	0.293	0.264	0.262	0.060	0.123	0.029
1	1	0.703	0.642	0.703	0.446	0.538	0.478
Acknowledged agreement							
(d) All Dyads							
Logistic regression coefficients							
Tie	1.0176***	2.9013***	2.5167***	0.9813**	0.3498	1.8904***	
Distance	-2.3547***	0.6039	1.9104***	-4.5463***	-3.7874***	-1.6353***	
Tie × distance	1.9221***	-1.0972*	-1.5825*	1.1652*	2.2064***	-0.1325	
Constant	0.0015	-2.0949***	-2.3617***	1.1748***	0.8000***	-0.6527*	
(e) Dyads among peripheral actors							
Logistic regression coefficients							
Tie	1.1019***	2.0184***	0.7109	1.4140**	0.5042	1.3121*	
Distance	-2.9211***	-0.7339	0.2252	-4.4738***	-4.3367***	-2.1185***	
Tie × distance	1.1663	0.6475	2.8762	1.1248	2.6575***	1.7695	
Constant	0.2664	-1.4641***	-1.7349***	0.7165*	0.7982***	-0.6797*	

Table 2 (Continued)

		Group I	Group II	Group III	Group IV	Group V	Group VI
Estimates of the probability of interpersonal agreement							
Distance	Tie						
0	0	0.566	0.188	0.150	0.672	0.690	0.336
0	1	0.797	0.635	0.264	0.894	0.786	0.653
1	0	0.066	0.100	0.181	0.023	0.028	0.057
1	1	0.405	0.615	0.889	0.228	0.407	0.570
(f) Dyads with a central actor							
Logistic regression coefficients							
Tie		2.8305*	2.3392	2.5884**	0.2793	-0.3998	0.0848
Distance		1.0231	-2.6082*	0.6586	-4.9994***	-3.4625***	-4.1376***
Tie × distance		-0.9468	-1.5502	-2.0362	1.5845*	2.5100***	1.1218
Constant		-1.4624	1.7352	-1.1501	1.9008***	1.1081**	1.8400**
Estimates of the probability of interpersonal agreement							
Distance	Tie						
0	0	0.188	0.850	0.240	0.870	0.752	0.863
0	1	0.797	0.983	0.808	0.898	0.670	0.873
1	0	0.392	0.295	0.380	0.043	0.087	0.091
1	1	0.809	0.479	0.515	0.225	0.439	0.251

\*  $P < 0.05$ .\*\*  $P < 0.01$ .\*\*\*  $P < 0.001$ .

social distance and interpersonal ties, and once again the results appear to be related to the tendency in these groups for actors in core positions to be distant from and in contact with actors in peripheral positions. Controlling for this tendency, we find that in the *absence* of an interpersonal tie, social distance is negatively associated with social solidarity in those groups where the level of social solidarity is relatively high among actors in proximate social positions. In many cases, the decline in the probability of solidarity is drastic.<sup>6</sup> When the level of social solidarity is low among actors in proximate social positions, social distance and solidarity are not associated.<sup>7</sup> Similarly, in the *presence* of an interpersonal tie, social distance is either negatively associated or not associated with social solidarity. However, the decline in the probability of solidarity with social distance is less pronounced in these tied dyads than in the comparable untied dyads; the presence of a tie appears to dampen the negative effects of social distance on interpersonal solidarity.

We hypothesized that the greater the distance between the two actors' positions in social space, the weaker the positive association of an interpersonal tie and social solidarity among actors. Our findings do not support this hypothesis. In most cases, there is not a significant

<sup>6</sup> A substantial level of solidarity may exist among actors who are located in proximate social positions even though there is not an interpersonal tie between them. This observation does not imply that a high level of solidarity can exist in the absence of a network of interpersonal ties that links these actors indirectly. It is within the context of such a network that a substantial likelihood of interpersonal influence and agreement may occur between actors who are not in personal contact.

<sup>7</sup> The one exception to this generalization is the significant increase in the probability of acknowledged influence (0.048–0.264) that occurs in Group II among dyads with at least one central actor.

interaction of ties and distance (indicating that the effect of a tie upon solidarity is maintained regardless of distance) or there is an interaction in which the effects of a tie *increase* with the social distance that is spanned by the tie (just the opposite of our expectation). An attenuation of the effects of a tie occur only in Groups II and III, which are sites of various odd observations, as we have reported. The findings are more coherent when we control for the tendency in these groups for actors in core positions to be distant from and in contact with actors in peripheral positions, and they indicate that the effects of a tie are *not* attenuated by social distance.<sup>8</sup>

Although the positive *effect* of a tie on interpersonal solidarity is not attenuated by social distance, social distance will diminish solidarity in the presence of a tie when (at a sufficiently large social distance) the negative impact of that distance outweighs the positive impact of a tie that spans that distance. The probability of solidarity in tied dyads is usually (but not always) lower among dyads in distant positions than among dyads in proximate positions in the social space of their group. However, in the present data, the probability of solidarity among tied actors in distant positions is never less than 0.196 and often is substantially greater than this level. When social distance lowers the likelihood of social solidarity, the positive effect of an interpersonal tie works to substantially diminish the negative outcomes of social distance.

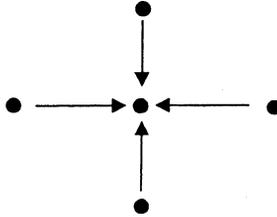
## 5. Discussion

Our investigation was motivated by the possibility that solidarity might be negligible in interpersonal ties between actors who occupy sufficiently distant positions in the social space of their group. Social solidarity among tied actors might decline with social distance either because the positive effects of an interpersonal tie are attenuated by social distance or because the negative effects of social distance upon solidarity override the positive effects of an interpersonal tie. We find that the effects of an interpersonal tie are not attenuated by social distance and that noteworthy levels of social solidarity are maintained in boundary-spanning interpersonal ties, even when these ties span large social distances. The positive effects of ties are not restricted to ties that occur between actors who occupy core and peripheral positions.

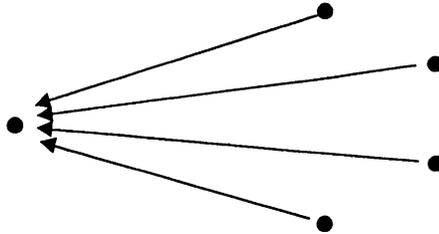
When we initiated this investigation, we were not especially interested in the *negative* effects of social distance upon interpersonal ties and social solidarity. We assumed that such effects would be observed and that no one would be interested in them, because they are part of the *zeitgeist* of structural analysis. Therefore, we were surprised when they did not occur in all of the groups. As is so often the case, when theoretical expectations are confronted with disconfirming evidence, it is obvious in retrospect how these unexpected findings might arise — they are straightforward outcomes of a certain form of the highly centralized network of interpersonal ties in core–periphery structures. Core–periphery structures are usually conceptualized as a “star” in which the core position is located in the center (or

<sup>8</sup> One case of a significant attenuation of the effect of a tie upon solidarity occurs in Group II for acknowledged influence among dyads with at least one central actor. The partial derivative for the effect upon the log-odds of solidarity is 8.2179 for proximate actors and 1.6089 for distant actors.

centroid) of the social space of a group and the peripheral positions are arrayed around it, for instance,



However, a core–periphery structure also may take a form in which the core is located in a region of the social space of a group that is distant from the peripheral positions, for instance,



Consider an extreme case of a core–periphery structure consisting of two positions and  $N$  actors in which there is a small number ( $n$ ) of core actors who have ties to each other and from a large number ( $N - n$ ) of peripheral actors who have no ties to each other. If the social space of the group is defined in terms of the dissimilarity of actors' profiles of sent and received ties, then the  $n$  core members occupy one social position and the  $N - n$  peripheral actors occupy another position. In this structure, apart from the small number of contacts among the core actors, most of the ties are *between* the core and peripheral actors, and there is a *positive* association between social distance and the likelihood of an interpersonal tie.

In the Appendix A, we show that the *sign* of the association between social distance and the likelihood of an interpersonal tie depends on the occurrence of ties to peripheral actors. The density of ties from the core to peripheral positions and within the peripheral position determines: (a) the social distance between the positions of core and peripheral actors; and (b) the sign of the association between interpersonal ties and shared social position. The more centralized the social structure (i.e. the lower the densities of ties to and within the peripheral position), the greater the social distance between the positions of core and peripheral actors and the more positive the association between an interpersonal tie and shared social position. In decentralized structures, where the densities of ties to and within the peripheral position are sufficiently high, the social distance between the core and peripheral positions will be modest and the association between an interpersonal tie and shared social position will be negative.

Thus, the expected negative effects of social distance upon the occurrence of interpersonal ties and solidarity are properties of particular *forms* of social organization and are not ubiquitous implications of social differentiation. This conclusion begs the more fundamental

question of *why* peripheral actors should maintain solidarity attachments to core actors who are at a large distance from them in the social space of the group. We believe that such solidarity ties are based upon an uncontested concentration of formal authority in a core position. The core positions in each policy group are mainly composed of school board members or high officials in the central office of the school district. Because the ultimate decision making authority in the school district is held by these actors, many ties will be initiated with them in order to influence their decisions, or will be initiated by them in order to exercise and maintain their influence. If, in addition, there is no dissatisfaction or organized opposition to the authority of such actors, then there will be no substantial motivation for the peripheral actors to communicate with one another, except to facilitate the decisions of the core actors; hence, the density of ties among the peripheral actors will be low. Although the core and peripheral actors may occupy distinctive and distant positions in the social space of the group (because of the highly differentiated concentration of power in the group), the interest in maintaining boundary-spanning ties between these positions remains great.

This argument also provides a possible explanation of our finding that there is a positive association between social distance and social solidarity (controlling for the occurrence of a tie) in the same groups where there is a positive association between social distance and the likelihood of an interpersonal tie. Interpersonal influences are concentrated in the relations between the core and peripheral actors, who are located in distant social positions, rather than being more decentralized among the peripheral actors. Hence, the ties among proximate peripheral actors are perceived as less influential than the ties between distant peripheral and core actors. In more decentralized influence systems, where there is a substantial density of ties among the peripheral actors, the distance between the core and periphery will be less and social solidarity between actors who are tied will tend to decline with the social distance that is spanned by the tie; however, as we previously noted, this decline is often modest, so that a substantial level of solidarity is often maintained in ties that span large distances in the social space of a group.

A variety of conditions may foster the decentralization of the bases of power in a group. Although authority is formally vested in the school board and central office of a school district, community actors may be influential on the basis of their expertise, charisma, or other material and symbolic resources. Such community actors may be activated by their substantive disagreement with formal authorities on issues related to school district policies, and they may be representatives of long-standing conflicts in the community on these issues. Any condition in a group that adds to the density of ties and interpersonal influences among the community actors will subtract from the influence of formal authorities (foster a more decentralized network of interpersonal influences). The decentralization of influence should lessen the social distance between the community actors and formal authorities, although it may involve an increase in social differentiation among the community actors.

Our findings also raise interesting questions about the *metric* of social distance in social spaces that have been constructed on the basis of the dissimilarity of actors' profiles of interpersonal ties. A substantial body of empirical findings support the construct validity of this network approach to the description of social differentiation. Hence, we are inclined to maintain a positive viewpoint on the construct validity of the large distance that sometimes occurs between core and peripheral positions in the social space of a core–periphery

structure.<sup>9</sup> If these large distances indicate the occurrence of a marked differentiation and concentration of the bases of social power, then the distance between the core and peripheral positions in the social space of the group is a measure of this power differential. However, our findings suggest that investigators should be careful when making assertions about unexamined correlates of social distance in the social space of groups. In many groups, social distance corresponds to decreased opportunities for interaction and increased differences of opinion in relevant issue-domains. However, it is evident that these associations cannot be treated as axiomatic features of differentiated social spaces.

Modern relational approaches to mapping social differentiation do not assume the existence of a negative association between social distance and interpersonal ties (Breiger et al., 1975; Wasserman and Faust, 1994; White et al., 1976). When these approaches are employed, it is not uncommon to observe social positions within which the density of ties is low. However, low-density social positions appear to be far less frequent than high-density social positions. Hence, social differentiation that is based on multiple social positions usually entails a higher overall probability of ties within than between social positions, so that the likelihood of a tie is greater for two actors who share a social position than it is for two actors who are in different social positions. This common characteristic of differentiated social systems can be theoretically misleading when it is taken to imply that a negative association between social distance and interpersonal ties is an *intrinsic* property of social differentiation.

## Acknowledgements

This study draws on data collected by Charles Bidwell and Noah Friedkin with grant support from the Spencer Foundation. We are indebted to Mitchell Koza, Wayne Levy, Ellen Morrison, Kathryn Neckerman, and Lisa Sushelsky for their assistance in the collection of these data and to John Sutton, William Bielby and anonymous reviewers for their comments on this paper.

## Appendix A

In this appendix, we show that in a core–periphery structure the strength and sign of the association between social distance and the likelihood of an interpersonal tie can depend upon the density of ties from the core to peripheral positions and within the peripheral positions. For convenience, we consider the case of a core–periphery structure with just two positions in which there is a small number ( $n_C$ ) of core actors who are in contact with each other and with a large number ( $n_P$ ) of peripheral actors who send ties to the core actors and who also have some number of contacts with one another. Let the density matrix of this network be

$$\begin{array}{cc} & \begin{array}{c} \text{C} \\ \text{P} \end{array} \\ \begin{array}{c} \text{C} \\ \text{P} \end{array} & \begin{array}{cc} d_{CC} = 1 & 0 \leq d_{CP} \leq 1 \\ d_{PC} = 1 & 0 \leq d_{PP} \leq 1 \end{array} \end{array}$$

<sup>9</sup> The second author has observed this phenomenon in a variety of intra-organizational networks and for different measures of the dissimilarity of actors' profiles of interpersonal relations.

where C is the set of  $n_C$  core actors, P the set of  $n_P$  peripheral actors,  $d_{CP}$  the density of ties from core to peripheral actors, and  $d_{PP}$  is the density of ties among the peripheral actors. The values in this density table give the proportion of possible ties that are present between two sets of actors.

If  $N = n_C + n_P$  is the size of the group, then there are  $N(N - 1)$  ordered pairs of actors, or dyads. Actor  $i$  is *tied* or *not tied* to actor  $j$ , and actor  $i$  is located in the *same* or *different* social position as actor  $j$ . Hence, we can construct a four-fold table

	Social positions of actors $i$ and $j$	
	Same	Different
Interpersonal attachment from actor $i$ to actor $j$		
Tied	$A$	$B$
Not tied	$C$	$D$

where  $A, B, C$  and  $D$  are counts of the number of each type of dyad in the group. Since  $d_{CC} = d_{PC} = 1$ ,

$$A = d_{CC}(n_C^2 - n_C) + d_{PP}(n_P^2 - n_P) = (n_C^2 - n_C) + d_{PP}(n_P^2 - n_P),$$

$$B = d_{PC}(n_P n_C) + d_{CP}(n_P n_C) = (n_P n_C) + d_{CP}(n_P n_C),$$

$$C = (1 - d_{PP})(n_P^2 - n_P) + (1 - d_{CC})(n_C^2 - n_C) = (1 - d_{PP})(n_P^2 - n_P),$$

$$D = (1 - d_{CP})(n_C n_P) + (1 - d_{PC})(n_P n_C) = (1 - d_{CP})(n_C n_P)$$

The sum of these counts ( $A + B + C + D = N^2 - N$ ) is the total number of ordered dyads in the group.

A measure of the association between interpersonal attachments and social positions is Yule's  $Q$

$$Q = \frac{BC - AD}{BC + AD}.$$

A positive association ( $Q$ ) will indicate that between-position ties are more likely than within-position ties, and a negative association will indicate the opposite tendency. A measure of the distance between the core and peripheral social positions (C and P) is indicated by the expected proportion of matching ties among the sent and received ties of a core and peripheral actor

$$E(\text{S.E.}) = 1 - \frac{E \left[ \sum_k (m_{ik} - m_{jk})^2 \right] + E \left[ \sum_k (m_{ki} - m_{kj})^2 \right]}{2(N - 2)}$$

for  $k \neq \{i, j\}$  and where  $M = [m_{ij}]$  is the matrix of interpersonal ties. It follows that

$$E \left[ \sum_k (m_{ik} - m_{jk})^2 \right] = (1 - d_{CP})d_{PP}(n_P - 1) + d_{CP}(1 - d_{PP})(n_P - 1)$$

and

$$E \left[ \sum_k (m_{ki} - m_{kj})^2 \right] = (1 - d_{CP})(n_C - 1) + (1 - d_{PP})(n_P - 1)$$

given that  $d_{CC} = d_{PC} = 1$ . Hence, the expected structural equivalence of core and peripheral actors can be obtained directly from the density matrix.

With these two measures, we can examine the implications of variations in the density of ties within a core–periphery structure. Consider a group  $N = 40$  in which four actors occupy the core position ( $n_C = 4$ ). Based on the density matrix

	C	P
C	1	$d_{CP}$
P	1	$d_{PC}$

and our measures, we get

$d_{CP} = 0$			$d_{CP} = 0.25$			$d_{CP} = 0.75$		
$d_{PP}$	$Q$	$E(S.E.)$	$d_{PP}$	$Q$	$E(S.E.)$	$d_{PP}$	$Q$	$E(S.E.)$
0.0	0.981	0.500	0.0	0.989	0.395	0.0	0.997	0.184
0.1	0.783	0.500	0.1	0.864	0.418	0.1	0.966	0.253
0.2	0.585	0.500	0.2	0.728	0.441	0.2	0.928	0.322
0.3	0.387	0.500	0.3	0.581	0.464	0.3	0.881	0.391
0.4	0.189	0.500	0.4	0.419	0.487	0.4	0.822	0.461
0.5	−0.009	0.500	0.5	0.241	0.510	0.5	0.746	0.530
0.6	−0.208	0.500	0.6	0.045	0.533	0.6	0.642	0.599
0.7	−0.406	0.500	0.7	−0.173	0.556	0.7	0.495	0.668
0.8	−0.604	0.500	0.8	−0.417	0.579	0.8	0.267	0.737
0.9	−0.802	0.500	0.9	−0.690	0.602	0.9	−0.130	0.806
1.0	−1.000	0.500	1.0	−1.000	0.625	1.0	−1.000	0.875

When there are no ties from core to peripheral actors ( $d_{CP} = 0$ ), the structural equivalence of a core and peripheral actor is constant regardless of variation in the density of ties among the peripheral actors. When the density of ties among the peripheral actors is less than 0.5, a between-position tie is more likely than within-position tie (as is indicated by the positive value of  $Q$ ). As the density of ties among the peripheral actors is increased, the association goes from positive to negative. When there are ties from core to peripheral actors ( $d_{CP} > 0$ ), an increase in the density of such ties acts not only to increase the tendency for ties to be between positions, but also to increase the *distance* between the two positions.

Hence, a positive association between social distance and the likelihood of an interpersonal tie can occur in core–periphery structures where a relatively small number of actors in the core position receive ties from a large proportion of the peripheral actors. The density of ties to and among peripheral actors determines: (a) the social distance between the positions

of core and peripheral actors; and (b) the sign of the association between an interpersonal attachment and shared social position.

## References

- Amir, Y., 1969. Contact hypothesis in ethnic relations. *Psychological Bulletin* 71, 319–342.
- Blau, P.M., 1977. *Inequality and Heterogeneity*. The Free Press, New York.
- Borgatti, S.P., Everett, M.G., 1999. Models of core/periphery structures. *Social Networks* 21, 375–395.
- Breiger, R.L., 1979. Toward an operational theory of community elite structures. *Quality and Quantity* 13, 21–57.
- Breiger, R.L., Scott, A.B., Phipps, A., 1975. An algorithm for clustering relational data with application to social network analysis and comparison with multidimensional scaling. *Journal of Mathematical Psychology* 12, 328–383.
- Brown, R., James, V., Miles, H., 1999. Changing attitudes through intergroup contact: the effects of group membership salience. *European Journal of Social Psychology* 29, 741–764.
- Burt, R.S., 1982. *Toward a Structural Theory of Action*. Academic Press, New York.
- Doreian, P., Fararo, T., 1998. *The Problem of Solidarity: Theories and Models*. Gordon and Breach, Amsterdam.
- Doreian, P., Stokman, F.N., 1997. *Evolution of Social Networks*. Gordon and Breach, Amsterdam.
- Durkheim, E., 1893. *The Division of Labor in Society* (translated by George Simpson). The Free Press, New York.
- Festinger, L., 1954. A theory of social comparison processes. *Human Relations* 7, 117–140.
- Freeman, L.C., 1979. Centrality in social networks: conceptual clarification. *Social Networks* 1, 215–239.
- Friedkin, N.E., 1991. Theoretical foundations for centrality measures. *American Journal of Sociology* 96, 1478–1504.
- Friedkin, N.E., 1993. Structural bases of interpersonal influence in groups: a longitudinal case study. *American Sociological Review* 58, 861–872.
- Friedkin, N.E., 1998. *A Structural Theory of Social Influence*. Cambridge University Press, Cambridge.
- Granovetter, M.S., 1973. The strength of weak ties. *American Journal of Sociology* 78, 1360–1380.
- Heinz, J.P., Edward, O.L., Robert, L.N., Robert, H.S., 1993. *The Hollow Core*. Harvard University Press, Cambridge.
- Hovland, C.I., Janis, I.L., Kelley, H.H., 1953. *Communication and Persuasion*. Yale University Press, New Haven.
- Laumann, E.O., 1973. *Bonds of Pluralism: The Form and Substance of Urban Social Networks*. Wiley Interscience, New York.
- Laumann, E.O., Pappi, F.U., 1976. *Networks of Collective Action: a Perspective on Community Influence Systems*. Academic Press, New York.
- McPherson, J.M., Ranger-Moore, J.R., 1991. Evolution on a dancing landscape: organizations and networks in dynamic Blau space. *Social Forces* 70, 19–42.
- Skvoretz, J., 1983. Saliency, heterogeneity and consolidation of parameters: civilizing Blau's primitive theory. *American Sociological Review* 48, 360–375.
- Wasserman, S., Faust, K., 1994. *Social Network Analysis: Methods and Applications*. Cambridge University Press, New York.
- White, H.C., Scott, A.B., Breiger, R.L., 1976. Social structure from multiple networks. Part I. Block models of roles and positions. *American Journal of Sociology* 81, 730–781.