Available online at www.sciencedirect.com
ScienceDirect
Organizational Behavior and Human Decision Processes 107 (2008) 15–28
ORGANIZATIONAL BEHAVIOR AND HUMAN DECISION PROCESSES
www.elsevier.com/locate/obhdp

# Organizational network perceptions versus reality: A small world after all? ☆

Martin Kilduff[a], Craig Crossland[b,*], Wenpin Tsai[b], David Krackhardt[c]

[a] University of Texas at Austin, McCombs School of Business, Management Department, Austin, TX 78712-0210, USA
[b] The Pennsylvania State University, Management and Organization Department, 416A Business Building, University Park, PA 16802-1914, USA
[c] Carnegie Mellon University, Pittsburgh, PA 15213, USA

Received 3 May 2006
Available online 5 March 2008
Accepted by Jerald Greenberg

## Abstract

Given the complexity of organizing and keeping track of even a small organizational network, boundedly rational people may have learned to use small world principles in perceiving friendship networks: arrange people in dense clusters, and connect the clusters with short paths. Analysis of 116 perceived friendship networks from four different organizations showed that these perceived networks exhibited greater small world properties than the actual friendship networks. Further, people perceived more friendship clustering than actually existed, and attributed more popularity and brokerage to the perceivedly-popular than to the actually-popular.
© 2008 Elsevier Inc. All rights reserved.

*Keywords:* Cognitive schema; Small worlds; Friendship networks

How do people keep track of and make sense of social network connections in organizational settings? Even a relatively small organizational network, consisting of 20 people, requires the individual to monitor hundreds of possible relationship pairs. This level of complexity is likely to pose a cognitive challenge (Kilduff & Krackhardt, 1994), but the accurate mapping of relationships is often of critical importance to individuals trying to form project teams or build alliances across groups (Janicik & Larrick, 2005). Given that much managerial work involves talking to key people in social networks (e.g., Gronn, 1983; Mintzberg, 1973), a clear understanding of the structure of such networks would seem to be a managerial imperative (Krackhardt & Hanson, 1993). The potentially dire consequences of misperceptions of informal networks have been spelled out in one particularly vivid case study of sabotage at work (Burt & Ronchi, 1990). Organizing and keeping track of organizational relationships is likely to be especially challenging for a difficult-to-discern relationship such as friendship that involves people's innermost feelings of affection that may not be on public display.

One possibility is that boundedly rational people keep track of friendship relations in organizational

☆ We thank Frank Flynn, Jeffrey Loewenstein, Ajay Mehra, Ray Reagans, and Ray Sparrowe for helpful comments on an earlier draft, the editor and the reviewers for their expert guidance, and audiences at the University of Texas at Austin (November 2005), the Notre Dame social capital interdisciplinary conference (April 2006), the University of Kentucky Intraorganizational Network Conference (April 2007), and the University of Washington (October 2007) for opportunities to present and discuss this work. This work is sponsored by a research grant from Smeal College of Business at Penn State to Kilduff and Tsai.

* Corresponding author. Fax: +1 814 863 7261.
*E-mail addresses:* mjkilduff@gmail.com (M. Kilduff), crc198@psu.edu (C. Crossland), wtsai@psu.edu (W. Tsai), krack@cmu.edu (D. Krackhardt).

0749-5978/$ - see front matter © 2008 Elsevier Inc. All rights reserved.
doi:10.1016/j.obhdp.2007.12.003

settings by adapting rules known, in network research, as small world principles (Watts, 1999). As applied to perceived networks, these rules involve arranging people in clusters and connecting the clusters (using perceivedly-central people as cognitive reference points). We build on research suggesting that concepts, such as small worlds, developed in the network literature, may be useful in studying the schemas individuals use to make sense of complex network structures (Janicik & Larrick, 2005, pp. 360–361). The cognitive simplification of friendship networks in favor of more small worldedness would include more clustering and more connections for perceivedly-popular people both within clusters and between clusters. Such cognitive simplification can facilitate the system-wide organization of perceptions, and reduce the cognitive burden of trying to keep track of hundreds of discrete relationships.

In the original small world research, 396 "starter" individuals in Nebraska and Boston were each asked to mail a folder directly to a "target" person if they knew this Boston-area stockbroker personally; or, if they did not know the target personally, to mail the folder to a personal acquaintance who would be more likely to know the target (Travers & Milgram, 1969). In this initial study, only 64 folders (29% of the total) reached the target. The mean number of intermediaries for these completed chains was 5.2. Follow-up research involving 540 white starter persons in Los Angeles attempting to generate acquaintance chains to either a white or a black-target person in New York showed a completion rate of 33% for white-target chains and 13% for black-target chains (Korte & Milgram, 1970).

Other research on the small world problem is summarized in Kochen (1989) and Kleinfeld (2002). In general, the original research focused on the length of acquaintance chains between two people chosen from a large population, but also noticed the role of sociometric "stars" in funneling the messages to target persons (e.g., Travers & Milgram, 1969; see also Rapoport, 1957). More recently, researchers, building on this prior work, have investigated many different network systems for evidence of two network properties—high local clustering and short average paths—that are normally divergent but are characteristic of small worlds (Watts & Strogatz, 1998). Local clustering means that actors in the network tend to clump together in several distinct clusters, whereas short average path length means that any actor in the network can reach any other actor through a small number of intermediaries. The US hub-and-spoke airline system is an example of a small world network, whereas the interstate highway system is not. Fig. 1 shows a network that, like the interstate highway system, exhibits little clustering, and features relatively long paths from one side of the network to the other (e.g., any of the nodes on the left-hand side of the graph are separated from those on the right hand side by five or six links). Fig. 2 shows an individual's perception of the same network featured in Fig. 1, but this time there is more clustering (around node 10, for example) and the nodes on the left can reach the nodes on the right with fewer links.

Despite intense activity devoted to networks as diverse as the World Wide Web (Barabasi, 2003) and partnerships between creators of Broadway musicals (Uzzi & Spiro, 2005), small world research has failed to investigate the possibility that social network cognitions might be organized according to small world principles (Kilduff, Tsai, & Hanke, 2006). There is recent evidence that the intrinsic appeal of the idea that we are all connected in a small world network is not matched by evidence that such clustering and small path lengths are characteristic of human communication across class and ethnic barriers (Kleinfeld, 2002). Small worlds may be less frequent in networks than previously thought (e.g., Dunne, Williams, & Martinez, 2002). Indeed, there is compelling evidence across a range of indicators that the world of social interaction between people is becoming less rather than more connected (McPherson, Smith-Lovin, & Brashears, 2006; Putnam, 2000).

We provide one response to the call for more psychological research on the small world problem (Kleinfeld, 2002) by alerting researchers to the likelihood that, irrespective of whether a particular friendship network exhibits small world features, people may find it useful to organize their perceptions of this network according to small world principles. Cognitive distortion in terms of more small worldedness can facilitate the rapid cognition and memorization of complex social relations, and may provide a comforting sense of connectivity across social divides. Our work, therefore, is innovative in extending small world ideas from the realm of large, complex networks to the realm of cognition.

## Cognitive small worldedness

Small worldedness in perceptions of friendship networks in organizations emerges, we suggest, through the operation of cognitive schemas, defined as mental structures that enable people to anticipate the general features of recurring situations (Neisser, 1976, pp. 51–78). Schemas enable people to interpret complex social information, fill in missing data by supplying default options, and categorize events, things, people, interactions, and other stimuli into familiar categories (see Isenberg, 1986, for a review). Schema use allows fast and often unconscious pattern matching and decision-making, but at the expense of misperception and bias (see Gladwell, 2005, for a popular review). Emergent small worldedness consists of a set of constituent schemas involving clustering and connectivity that help per-

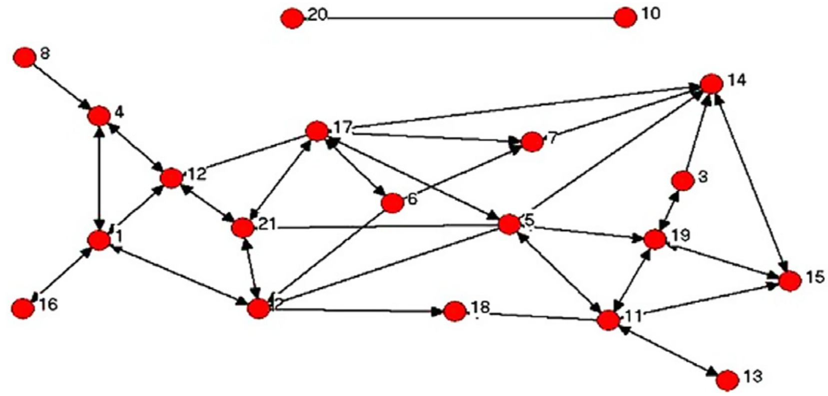


Fig. 1. Actual friendship network of High-Tech Managers (small worldedness = 2.23).

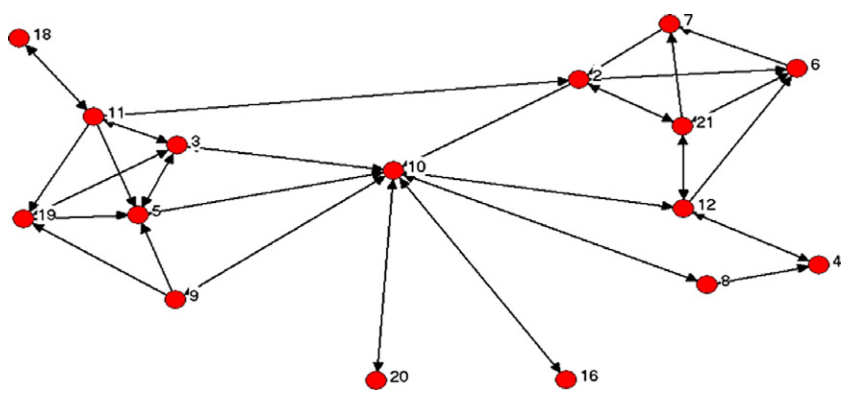


Fig. 2. Example of one High-Tech Manager's cognitive map (small worldedness = 5.39).

ceivers organize, simplify, and anticipate the friendship relations within a bounded social system.

Schema use may allow perceivers to represent the whole set of friendship relations in memory as a single entity, thus economizing on memory demands (cf. Fiske & Taylor, 1991). As explained by von Hecker (1993), individuals when entering a new social situation are motivated to generate an overall picture of the whole group, find out about subgroups or cliques that might exist in it, and find an adequate position in the group for themselves. Some social networks do exhibit dense clusters of actors spanned by relationships that provide convenient conduits for information flow across the network, and are in this sense examples of small worlds: they feature actors clustering together in different parts of the network combined with a high level of connectivity across the network as a whole (e.g., Kogut & Walker, 2001). People can learn to recognize and remember novel network patterns (cf. Janicik & Larrick, 2005). Indeed, people can acquire the use of a schema from even a single example if they have background knowledge and experience in the domain (Ahn, Brewer, & Mooney, 1992). To the extent that individuals are cognitive misers who rely on schemas to organize perceptions, individuals' cognitive maps are likely to exhibit schema properties (such as clustering) in excess of the schematic properties of the actual network being perceived. As Freeman (1992, p.122) explained: "people exaggerate the structure present in their experience in order to build a simplified cognitive conception."

We start the discussion of the psychological processes by which small world properties emerge by addressing the question of why people within a bounded social system are likely to perceive more clustering of friends than is actually the case. We note that people tend to perceive friendship relations within a bounded social system as clustered. For example, junior high school students when asked whether there are "some people who hang around together a lot" respond by producing social maps of the entire social system in which each person is allocated to a single cluster (Cairns, Perrin, & Cairns, 1985). Schema theory suggests that to reduce the complexity of the social world, perceivers will construct and use categorical representations of salient entities (Quinn, Macrae, & Bodenhausen, 2003). And, indeed, groups based on friendship relations are seen as having more entitativity (i.e., more perceived unity as an entity) than groups based on other social categories (such as race or gender) or groups based on tasks (e.g., co-workers assigned to a project) (Lickel et al., 2000). Thus, a cluster of people among whom there are perceived to be friendship relations is likely to appear to the perceiver as a distinct categorical entity with properties of its own separate from other entities in the social space.

A friendship cluster within a bounded social system is likely, therefore, to take on the appearance to the perceiver of a cognitive category based on perceived affiliation patterns (Freeman, 1992). Categorization can proceed on the basis of at least two different processes—similarity and interaction. The similarity approach has been widely applied to many natural categories such as birds and animals (Rosch, 1973). To the extent that, for example, creatures are similar to each other in having feathers and being able to fly, perceivers tend to classify them together within the category birds (Rosch, 1973). Categorization based on interaction has been specifically suggested as relevant to groups that arise from the relationships among members (Wilder & Simon, 1998) and it is this suggestion that we take up here.

Instead of having to keep track of each individual's friendship relations, the perceiver is able to assign many individuals to friendship groups. We know that membership in a particular group is often fuzzy, with no sharp boundaries concerning membership and non-membership (Osherson & Smith, 1981). But perceivers are likely to fill in some of the "blanks" within clusters to create more clear-cut friendship structures than actually exist (De Soto, 1960). People are likely to see clustering between interacting individuals even though actual interaction patterns may be less well formed (Freeman, 1992). Given the cognitive advantages of assigning people to groups (within which friendship relations can be assumed to be fairly dense) as opposed to keeping track of their relations as individuals, we anticipate that individual perceivers will tend to recall more clustering of people into groups that is actually the case.

**Hypothesis 1**. Individual cognitive maps of an organizational friendship network will exhibit more clustering than is the case in the actual friendship network.

To the extent that clusters of friends are represented in memory as distinct "intimacy groups" (Lickel et al., 2000), certain members of such groups are likely to be seen as more central than other members, based on the number of friendship ties to others in the group. Central members of categories in general are often seen as ideal examples that "stand for" the category (Osherson & Smith, 1981). Such ideal members are perceived to exemplify the salient attributes associated with the group, and to be closer to other members of the group than less prototypical members (Barsalou, 1983; cf. Labianca, Moon, & Watt, 2005). Thus, Sally, because she is friends with many other people in the cluster, may be seen as an exemplar of the group to which she belongs. These central individuals are likely to be useful cognitive reference points (Rosch, 1975) in allowing perceivers to keep track of the complexity of the social environment in terms of clusters rather than collections of dyadic relations.

Indeed, the usefulness of central individuals as prominent social figures around which the perceiver can categorize others ("Joe seems to belong to the group that Sally is in, whereas Alfred seems to belong to the group that Jane is in") suggests that the representation of social relationships in memory is likely to be distorted in favor of increased centralization around individuals perceived to be popular. There is a tendency for perceivers to distort perceptions of categories so as to enhance the centrality of those perceived to be ideal or prototypical representatives of the categories (Rosch, 1973). Perceivers are likely to evaluate others who are seen to be close to or in the social group in relation to prototypical members, asymmetrically enhancing the perceived centrality of members perceived to be cognitive reference points (Rosch, 1975). People in central positions are typically perceived to be "better" than those in more peripheral positions; further, these people perceived to be centrally located are also attributed increased influence in the social sphere (Raghubir & Valenzuela, 2006). The result of schema activation, therefore, will be to distort perceptions in favor of features anticipated by the schema (Markus, 1977). In this case, we anticipate that perceivers will exaggerate the popularity of those individuals perceived to be popular.

**Hypothesis 2**. Within individuals' cognitive maps the most popular people will be seen as more popular than the most popular people in the corresponding actual friendship network.

Thus, central individuals function, we suggest, as prominent features of the social landscape—cognitive reference points which people use to make sense of the social environment (cf. Rosch, 1975). Following the principle that people tend to economize on memory demands (Fiske & Taylor, 1991) we anticipate that individuals perceived to be central in the social network are likely to perform double duty in helping the perceiver to join the network together (i.e., reduce average perceived path length) as well as helping to establish categorical clusters. People perceived to be central will also be perceived to be brokers in the sense of spanning across the different friendship clusters. Because of their prominence in the social world of the perceiver, central people (relative to more peripheral people) are likely to be more noticed, more gossiped about, and more available as cognitive inputs. Thus, if the perceiver notices that a central person has friends who themselves are not friends, this is likely to be salient information that will be incorporated within the individual's cognitive map. The friendship choices of people perceived to be peripheral are less likely to be noticed. People tend to bias their estimates of covariation in favor of instances that co-occur frequently (Arkes & Harkness, 1980). We know that perceivers can develop schematic anticipation for missing friendship links on the basis of experience with such missing links (Janicik & Larrick, 2005). To the extent that the perceiver sees that person A's friends are not themselves friends with each other, person A is likely to play the role in the perceiver's cognitive map of broker in spanning across different friendship clusters (cf. Granovetter, 1973).

By keeping track of the friendship ties of the most perceivedly-prominent people, the perceiver is able to establish a measure of how much communication or antipathy is circulating among the different groups in the work environment without having to keep track of all the different possible connections between individuals in different groups. Just as people tend to pay more attention to the social connections of prominent people in society or show business than to the connections of less prominent people, perceivers in organizational settings are also likely to be more focused on the friendship links of the sociometric stars than of the sociometric wallflowers. The net result will be a brokerage concentration bias such that the alignment of perceptions of brokerage with perceptions of popularity will be greater in perceived networks than in actual networks.

**Hypothesis 3**. Popularity and brokerage will be more closely correlated in perceived networks relative to actual networks.

Having detailed the constituent schemas that contribute to the emergence of small worldedness in perceptions, let us briefly review the big picture. Bound together by proximity (e.g., neighboring offices) and common fate (e.g., shared vulnerability to trends in demand for skills), people within an organizational unit (e.g., a department) tend to see each other as members of a distinct social system (Campbell, 1958; von Hecker, 1993). Through repeated interactions over time, each social system member develops a cognitive map of the friendship relations between people in the organizational unit (Cairns et al., 1985; Kilduff & Krackhardt, 1994). Within each individual cognitive map of the organizational unit, clusters of friends have particular salience as coherent entities (Lickel et al., 2000) or categories (Freeman, 1992). This category-driven processing exaggerates perceived clustering through such processes as filling in the blanks of missing relations (De Soto, 1960; Freeman, 1992) and over-attributing connections to perceivedly-popular people. Individuals also notice violations of anticipated patterns and learn to expect such violations—specifically, individuals can learn, on the basis of experience, to anticipate gaps between people who have mutual friends in common (Janicik & Larrick, 2005). Perceivers may be particularly likely to notice the extent to which perceivedly-popular people appear to be spanning across structural holes, and perceivers may, therefore, over-attribute brokerage to such perceivedly-popular people (thereby reducing perceived path lengths). In summary, perceivers will see the whole system of friendship relations within a bounded social context as exhibiting more small world properties (such as clustering and short path lengths—Watts & Strogatz, 1998) than is actually the case.

**Hypothesis 4**. Individual cognitive maps of an organizational friendship network will exhibit greater small world properties than are present in the actual organizational friendship network.

Thus, our research focuses on the question of whether individuals' cognitive maps of the difficult-to-discern friendship network of the whole organization tend to exhibit a bias toward small worldedness, including a tendency to exaggerate three network features: (1) network clustering; (2) the popularity of central people; and (3) the brokerage of central people. In order to pursue this research question, we looked for network data with the following desirable characteristics. First, each individual in the network should provide perceptions of the links between all the people in the network. That is, the data comprise a set of cognitive maps, with each map representing one individual's mental picture of all the relations perceived to be present in the particular network (Kilduff & Tsai, 2003, pp. 77–79). Second, the actual network being studied must be a difficult-to-discern network, such as friendship, rather than an objectively visible network, such as formal work relationships, in order for us to be able to study the extent to which cognitive maps exhibit schematic processing. To satisfy these conditions we accessed cognitive social structure data (Krackhardt, 1987) and explored our ideas using four organizational friendship network data sets.

## Methods

### *Sample*

Across four sites described below the same questionnaire was used, and participants were promised and given an overview of the research results. We excluded non-respondents from the analyses. High response rates (varying from 86% to 100%) helped alleviate concerns about non-response bias. Respondents were not compensated for participation unless noted below. The sample consisted of 116 cognitive networks collected across the following four sites. *High-Tech Managers* comprised the complete set of 21 managers (all male) of High-Tech Hardware, a 10-year-old machinery firm with approximately 100 employees. All 21 people participated in the study. *Government Office* comprised 36 government employees with public policy advisory duties at the federal level. Thirty-one out of the 36 employees participated in the study. *Silicon Systems* comprised 36 semiskilled production and service workers (28 men and 8 women) from a small entrepreneurial firm. Thirty-three of the employees participated in the study and each was paid $3. Two of these individuals were subsequently removed from the analyses as the extremely low density of their cognitive maps led to small worldedness values that were more than fifteen standard deviations above the mean. This left a total of 31 employees. *Pacific Distributors* comprised 33 people (15 men and 18 women) selected as key personnel from the headquarters of an electronic components distributor with 162 employees. All 33 people participated in the study and each was paid $10. (For more details on these data sets see Krackhardt & Kilduff, 1999).

## Measures

### Individual cognitive maps

In order to assess each individual's perception of the friendship network, each person provided a complete map of how he or she perceived friendship relations within their organization. For example, at the High-Tech Managers site, Art French was asked a series of 21 questions concerning the friendships of himself and his 20 co-workers. The questions were in this form: "Who would Sam Bryson consider to be a personal friend?" Each question was followed by the list of 20 co-workers' names. Art French then checked the names that indicated his perception of who Sam Bryson considered to be his personal friends. This process was then repeated with each individual in the network. Each respondent, therefore, provided a complete cognitive map of his or her perceptions concerning who were friends with whom in the organization, resulting in a total of 21 cognitive maps of the single organizational friendship network (see Kilduff & Krackhardt, 1994; Krackhardt, 1987, 1990; Krackhardt & Kilduff, 1999, for more details of cognitive social structures).

### Actual network

To measure actual friendship links, we followed previous research (Krackhardt, 1990) that considers a friendship link as actually existing when both parties to the link agree that it exists. Thus, a friendship link (also known as a tie) was deemed to exist from person $i$ to person $j$ only if person $i$ claimed person $j$ as a friend and person $j$ agreed that person $i$ claimed person $j$ as a friend. An actual directed friendship tie between two members of a dyad was said to exist, therefore, only when both members of the dyad reported that the directed tie existed. Our results were unchanged if we constructed the actual network using the rule that a tie existed if either the sender or the receiver stated that it existed.

### Small worldedness and clustering ratio

The small world quotient (also referred to in this paper as *small worldedness*) represents the extent to which a network displays small world properties and is related to two criteria (Watts & Strogatz, 1998): the extent to which, relative to a random graph of the same size, the network displays much higher clustering combined with a characteristic path length of the order exhibited by the random graph. The *clustering coefficient* is a measure of the average interconnectedness of ego's alters in a network. For a friendship network, it is calculated as the extent to which friends of ego are also friends of each other, averaged across all egos in the network (Watts, 1999). The *path length* between two actors in a network is the smallest number of ties that need to be traversed to connect those actors (Watts & Strogatz, 1998). The average path length in a network is the average of all individual path lengths between all connected individual actors. (See Appendix A for relevant formulae.)

To determine the level of small worldedness in a specific network, the clustering coefficient and average path length values are adjusted to take into account the properties of a random network of the same size and density, thus controlling for the fact that networks of higher density tend to have more clustering and shorter path lengths. In a random network of $n$ nodes and $k$ average ties per node, the expected clustering coefficient is $k/n$, while the expected path length is $\ln(n)/\ln(k)$ (Dorogovtsev & Mendes, 2003). The actual clustering coefficient and path length are then divided by their respective expected values, producing a *clustering coefficient ratio* and a *path length ratio*. Following prior work in this area (Kogut & Walker, 2001), we evaluated network small worldedness by dividing the clustering ratio by the path length ratio to create a clustering-to-length ratio henceforth referred to as the small world quotient. Previous research has suggested that a small world quotient of about 4.75 or higher offers clear evidence of a small world (Montoya & Sole, 2002; Watts & Strogatz, 1998).

### Popularity concentration

To test hypothesis 2's prediction concerning the over-perception of popularity, we measured relative popularity concentration for each of the four actual networks and each of the 116 perceived networks.[1] First, for each of these networks, we determined each node's indegree centrality (Freeman, 1979), that is, the number of times each node in the network received a tie. Then, we calculated both the average indegree of the three most popular nodes in each actual and perceived network and the average indegree for all nodes in each network. Third, we divided the first number by the second number, generating a *popularity concentration* ratio. For example, in the High-Tech Managers actual network, the most popular individual was

[1] We thank an anonymous reviewer for detailed suggestions concerning this measure.

selected as a friend by five other people (indegree = 5), whereas the other two most popular individuals had indegree scores of 4. We therefore divided 4.33 (the average indegree score of the three most popular people) by 2.43 (the average indegree score across all people in the network) to produce a popularity concentration ratio of 1.78.

*Brokerage concentration*

To test hypothesis 3's prediction concerning the relationship between popularity and brokerage, we constructed a *brokerage concentration* measure. For each network (the four actual networks and the 116 perceived networks), we determined the number of *indegree ties* attributed to each node (as an indication of actor popularity) and the *betweenness centrality* attributed to each node (as an indication of actor brokerage). Betweenness centrality is a measure of how often a given node lies on the shortest path between all possible node pairs in a network (Freeman, 1979). We then calculated the correlation between these two variables (indegree ties and betweenness centrality) to generate a brokerage concentration score for each network. High scores mean that brokerage varies with popularity and that brokerage is concentrated among popular people.

*Control variables*

*Tenure* measured the number of years of employment for each individual.[2]

*Balance theory measures.* Reciprocity and transitivity are central to tests of balance theory (Crockett, 1982), and it is important to establish that the current research goes beyond balance theory schemas studied in previous work (e.g., Davidsen, Ebel, & Bornholdt, 2002; Krackhardt & Kilduff, 1999). *Reciprocity* measured the proportion of reciprocated ties within each perceived and actual network. If *i* sent a tie to *j*, that tie was counted as reciprocated if *j* sent a tie to *i*. *Transitivity* measured the proportion of network "triples" that was transitive in each perceived and actual network. For example, if *i* sent a tie to both *j* and *k*, a transitive triple was counted if *j* sent a tie to *k*.

*Analysis*

To test whether the level of small worldedness differed between actual and perceived networks (H4), we ran multiple regression analysis. Because the data featured repeated observations per individual (each individual was associated with an actual network and a perceived network), and the actual network was the same for each individual at a particular research site, we estimated a robust standard errors regression model using the Huber/White/Sandwich estimator (White, 1980). We created a binary variable (labeled *perceived network*) to distinguish between actual and perceived networks. This variable was given a value of 0 for each individual's actual network and 1 for each individual's perceived network. We regressed small worldedness on this 0/1 binary variable. If small worldedness was greater in perceived than in actual networks, we would expect a significant positive coefficient for this variable. We included several control variables in our analyses, including tenure, reciprocity, transitivity, and three dummy variables for the four research sites (omitting Pacific Distributors to avoid multi-collinearity). We used this same procedure to test whether the clustering ratio (H1), the popularity concentration ratio (H2), and brokerage concentration (H3) differed between actual and perceived networks. We also replicated the analyses using repeated measures Ancova and found the results were unchanged.

The distributions of two of the dependent variables (small worldedness and clustering ratio) were right skewed, raising the possibility that analyses would be affected by extreme outliers. We used two different analytical techniques to test for outlier effects. First, using the process referred to as Winsorizing (after the statistician Charles P. Winsor's suggestion to replace extreme observations in a sample by the nearest unaffected value—see Dixon, 1960), we changed all values of the affected variables greater than three standard deviations above or below the mean to the three standard deviation value (cf. Brav, 2000). We repeated this procedure using a two-standard-deviation criterion. The direction and significance of the results were unchanged by these adjustments for extreme values. The second technique involved log-transforming all nonzero small worldedness and clustering ratio observations. This procedure also produced no significant changes in our results. Given the stable patterns of results, we report results without the Winsorizing or log-transformation adjustments.

*Disconnected networks*

Calculating small worldedness on a network in which one or more nodes are disconnected from the other nodes might underestimate average path length and thereby overestimate the extent of small worldedness. The underestimation of path length could occur because the average path length is calculated based on path lengths within each set of connected nodes in the network (i.e., within each component—Wasserman & Faust, 1994, p. 109) rather than based on path lengths across the whole network. To check for possible effects of disconnectedness on our results, we excluded disconnected actors from the analyses in both actual

[2] Results did not change when we substituted age for tenure. We did not include both age and tenure in our models due to the high correlation between these two variables ($r = .63$).

and perceived networks using two different methods: (a) actors were excluded in all networks only if they were disconnected in actual networks; (b) actors were excluded from the analysis of an actual or perceived network only if they were disconnected in that particular network. These analyses produced stronger contrasts between actual and perceived small worldedness in line with our hypotheses. Rather than remove actors from our analyses, we report tests for the complete set of actual and perceived networks.

## Results

Table 1 contains descriptive data and zero-order correlations for all network-level variables addressed in our statistical tests for the 116 cognitive maps. Perceived small worldedness was not significantly correlated with reciprocity ($r = .02$, *ns*) but was significantly and negatively correlated with transitivity ($r = -.23$, $p < .05$). It is interesting to note (in analyses not reported in the table) that people who perceived path lengths to be relatively short tended to also perceive the networks as clustered and as exhibiting small world properties: there was a significant and negative correlation between the path length and clustering ratios ($r = -.49$, $p < .01$); and a significant and negative correlation between the path length ratio and small worldedness ($r = -.37$, $p < .01$). Table 2 presents details concerning the small worldedness of the actual friendship networks in the four different sites. Recall that a small world network (relative to a random network of the same size and density) has a higher clustering coefficient together with an average path length of the same magnitude. Thus, the Silicon Systems' network exhibits a much higher clustering coefficient than would be expected by chance combined with an average path length slightly lower than would be expected by chance, and these two features combine to produce a relatively high small worldedness quotient of 5.38.

Fig. 1 depicts the actual network of friendship relations at High-Tech Managers for which the small worldedness quotient equaled 2.23—below the 4.75 conventional level indicative of a small world. Fig. 1 shows a dispersed structure with no obvious hubs. Fig. 2 depicts one individual's cognitive map (small worldedness = 5.39) of the High-Tech Managers network, showing the clustering (around nodes 5 and 10, for example) and connections characteristic of a small world. Clearly, some individuals perceived more small worldedness than existed in the actual friendship networks whether or not the actual networks constituted small worlds.

Looking more specifically at the psychology underlying perceived small worldedness, we predicted there would be more clustering in individuals' cognitive maps than in the actual friendship networks (hypothesis 1). Was there evidence of such a clustering bias in these data? The clustering ratio comparisons in Table 3 show more perceived than actual clustering. The multiple regression analysis summarized in the first two columns of Table 4 show that these differences in clustering were significant. In model 1b, the perceived network variable is a positive and significant predictor of clustering ($B = 2.39$, $p < .01$).

Another feature of perceived small worldedness, we suggested, would be a popularity concentration bias, that is, a tendency for more friendship nominations to be attributed to perceivedly-popular people relative to the friendship nominations received by actually-popular people (hypothesis 2). Support for this hypothesis is shown in the higher popularity concentration ratios reported for perceived versus actual networks in Table 3. The analyses summarized in columns three and four in Table 4 show that these differences in popularity concentration were significant. In model 2b, the perceived network variable is a positive and significant predictor of popularity concentration ($B = 0.61$, $p < .01$).

Our test of the popularity concentration hypothesis examined the popularity of the three most popular people, raising the question of whether these results would be different if we had examined the popularity of a different number of people. To check, we constructed the popularity concentration ratio using data from (a) the two most popular individuals in each network; and (b) the single most popular individual in each network.

Table 1
Descriptive statistics and correlations for perceived network data

| | *N* | Mean | *SD* | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|
| 1. Small worldedness | 116 | 8.57 | 14.96 | | | | | | |
| 2. Clustering ratio | 116 | 5.63 | 7.06 | .05 | | | | | |
| 3. Popularity concentration | 116 | 3.14 | 1.11 | .09 | .57[c] | | | | |
| 4. Brokerage concentration | 114 | 0.71 | 0.13 | .03 | .00 | .28[c] | | | |
| 5. Tenure | 116 | 6.07 | 6.16 | −.06 | −.08 | −.03 | −.01 | | |
| 6. Reciprocity | 116 | 0.46 | 0.15 | −.02 | .11 | −.24[c] | .06 | −.17[a] | |
| 7. Transitivity | 116 | 0.39 | 0.18 | −.23[b] | .00 | −.44[c] | −.34[c] | .14 | .16[a] |

[a] $p < .1$.
[b] $p < .05$.
[c] $p < .01$.

Table 2
Small world properties of four friendship networks

| | $N$ | $k$ | Clustering coefficient | | | Average path length | | | Small worldedness |
|---|---|---|---|---|---|---|---|---|---|
| | | | Actual | Expected | Ratio | Actual | Expected | Ratio | |
| High-Tech Managers | 21 | 2.43 | 0.22 | 0.12 | 1.92 | 2.95 | 3.43 | 0.86 | 2.23 |
| Government Office | 31 | 3.64 | 0.32 | 0.12 | 2.70 | 2.62 | 2.66 | 0.99 | 2.74 |
| Silicon Systems | 31 | 2.75 | 0.39 | 0.09 | 4.37 | 2.76 | 3.39 | 0.81 | 5.38 |
| Pacific Distributors | 33 | 8.94 | 0.50 | 0.27 | 1.84 | 1.91 | 1.60 | 1.19 | 1.54 |

Table 3
Descriptive statistics for actual versus perceived networks (with standard deviations in parentheses)

| Sample | $N$ | Small worldedness | | Clustering ratio | | Popularity concentration | | Brokerage concentration | |
|---|---|---|---|---|---|---|---|---|---|
| | | Actual | Perceived | Actual | Perceived | Actual | Perceived | Actual | Perceived |
| High-Tech Managers | 21 | 2.23 | 9.01 (12.05) | 1.92 | 5.04 (7.17) | 1.78 | 3.11 (1.11) | 0.66 | 0.71 (0.15)[a] |
| Government Office | 31 | 2.74 | 10.11 (14.40) | 2.70 | 7.46 (6.63) | 2.47 | 3.17 (1.08) | 0.80 | 0.70 (0.14) |
| Silicon Systems | 31 | 5.38 | 12.37 (22.21) | 4.66 | 7.11 (9.81) | 3.15 | 3.43 (1.13) | 0.81 | 0.74 (0.12)[b] |
| Pacific Distributors | 33 | 1.54 | 3.28 (3.33) | 1.84 | 2.90 (1.50) | 2.05 | 2.87 (1.09) | 0.62 | 0.71 (0.11) |
| Four samples combined | 116 | 3.13 | 8.57 (14.96) | 2.82 | 5.63 (7.06) | 2.41 | 3.14 (1.11) | 0.73 | 0.71 (0.13)[c] |

*Note*. A small world quotient of about 4.75 or higher is taken as evidence that the network constitutes a small world (Montoya and Sole, 2002; Watts and Strogatz, 1998).
[a] $N = 20$.
[b] $N = 30$.
[c] $N = 114$.

Table 4
Summary of regression analyses predicting actual versus perceived clustering, popularity concentration, and brokerage concentration

| Variables | Clustering models | | Popularity models | | Brokerage models | |
|---|---|---|---|---|---|---|
| | 1a | 1b | 2a | 2b | 3a | 3b |
| Constant | 0.79 (2.58) | −1.33 (2.85) | 4.50[c] (0.44) | 3.96[c] (0.43) | 0.76[c] (0.07) | 0.73[c] (0.06) |
| High-Tech Managers | 3.84[a] (2.04) | 2.79 (2.15) | −0.10 (0.25) | −0.36 (0.23) | −0.08[b] (0.03) | −0.10[c] (0.04) |
| Government Office | 5.47[c] (1.52) | 4.37[c] (1.60) | 0.58[c] (0.20) | 0.30 (0.19) | −0.01 (0.03) | −0.03 (0.03) |
| Silicon Systems | 6.35[c] (1.60) | 5.28[c] (1.50) | 0.96[c] (0.20) | 0.69[c] (0.18) | 0.02 (0.03) | 0.00 (0.03) |
| Tenure | 0.02 (0.04) | 0.03 (0.04) | 0.01 (0.01) | 0.01 (0.01) | 0.00 (0.00) | 0.00 (0.00) |
| Reciprocity | −7.60[b] (3.47) | −2.69 (4.52) | −2.97[c] (0.65) | −1.72[c] (0.65) | 0.22[c] (0.08) | 0.29[c] (0.08) |
| Transitivity | 8.46 (5.29) | 6.37 (5.47) | −1.73[b] (0.69) | −2.26[c] (0.66) | −0.36[c] (0.10) | −0.39[c] (0.11) |
| Perceived network | | 2.39[c] (0.85) | | 0.61[c] (0.10) | | 0.03[b] (0.01) |
| $F$ | 6.11[c] | 5.32[c] | 17.97[c] | 16.26[c] | 13.95[c] | 12.10[c] |
| $R^2$ | 0.12 | 0.16 | 0.35 | 0.44 | 0.32 | 0.33 |

*Note*. Unstandardized coefficients are reported, with robust standard errors in parentheses. $N = 116$, except for brokerage models where $N = 114$.
[a] $p < .1$.
[b] $p < .05$.
[c] $p < .01$.

The direction and significance of the results were unchanged when using these alternative measures.

Thus, we found support for the propositions that people (a) perceive more friendship clustering than actually exists, and (b) attribute more popularity to the perceivedly-popular than to the actually-popular. We now turn to a third bias—brokerage concentration—that, from a small world perspective, is expected to differentiate between perceived and actual networks. The brokerage concentration bias involves people attributing more brokerage to the perceivedly-popular than is the case for the actually-popular (hypothesis 3). If the brokerage concentration bias exists, then popularity and brokerage will tend to be more closely related in perceptions compared to actuality. We found moderate support for this hypothesis. The brokerage concentration statistics in the last two columns of Table 3 show that brokerage concentration was greater in the perceived than in the actual networks at only two out of the four sites. However, model 3b in Table 4 shows that, controlling for the significant effects of research site, reciprocity and transitivity, the perceived network variable was a positive and significant predictor of brokerage concentration ($B = 0.03$, $p < .05$).

Because of conceptual and empirical overlap between the clustering, popularity concentration, and brokerage concentration variables, the statistical tests are not independent of each other. To correct for this, we conducted a Mancova test to see if there was an overall effect of perceptions of networks on the three interrelated dependent variables taken as a set. There was an overall significant effect of perceived network (Wilk's lambda = 0.84, $F(1, 107) = 6.92$, $p < .01$), controlling for significant effects of reciprocity, transitivity, and research site (tenure was not significant).

Recall that hypothesis 4 suggested that, overall, individuals' perceptions of friendship networks would display greater levels of small worldedness than existed in the actual networks. Was there support for this prediction? The answer is yes, as the comparisons showing more perceived than actual small worldedness across all four research sites in Fig. 3 and Table 3 indicate. One-tailed *t*-tests comparing the mean small worldedness reported in Table 3 for the actual versus perceived networks were significant at the $p < .01$ level, except for Silicon Systems where the difference between the actual and perceived mean small worldedness was only marginally significant ($p < .1$). An omnibus *t*-test across all four samples (with each network weighted by size) showed a significant difference between actual and perceived small worldedness ($t = 3.92$, $p < .01$, one-tailed). This result is confirmed by the regression analysis reported in Table 5. Model 2 in this table shows that the perceived network variable was a significant and positive predictor of small worldedness ($B = 4.85$, $p < .01$), controlling for the effects of research site, tenure, reciprocity, and transitivity.

In a post hoc analysis suggested by a reviewer, we analyzed possible determinants of the bias toward small worldedness exhibited in perceptions. We created a "bias" variable that represented, for each individual, the absolute log difference between perceived and actual small worldedness. We used the logged value of this absolute difference score given that the distribution of scores exhibited skewedness. In a regression analysis predicting the extent to which perceptions differed from reality with respect to small worldedness, we included all the control variables from Table 4, but replaced the perceived network variable with four variables representing gaps between perception and reality with respect to clustering ratio, path length ratio, popularity concentration and brokerage concentration. The overall model that included these four independent variables was significant ($F = 20.87$, $p < .01$) and improved variance explained by 35% over a model that included just the control variables. The small worldedness bias was significantly related to differences between perception and reality with respect to clustering ($B = 0.60$, $p < .01$), path length ($B = 0.53$, $p < .01$), and popularity concentration ($B = -0.40$, $p < .01$), with the brokerage concentration gap nonsignificant ($B = -0.86$, *ns*).

To summarize the results of the hypothesis tests, we found support for the idea that small worldedness tends to characterize perceptions of friendship networks. Specifically, people tend to perceive greater clustering, greater popularity concentration, and a tighter link between popularity and brokerage than actually exist.

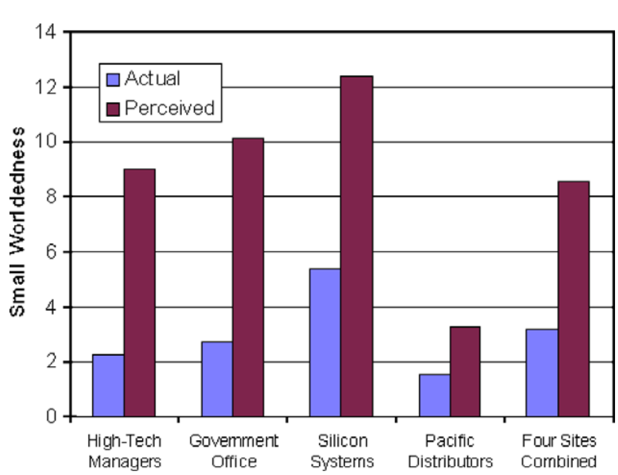


Fig. 3. Actual and perceived small worldedness of four friendship networks.

Table 5
Summary of regression analyses predicting actual versus perceived small worldedness

| | Model | |
|---|---|---|
| | 1 | 2 |
| Constant | 13.25[b] (5.44) | 8.95[a](4.94) |
| High-Tech Managers | 3.72 (2.74) | 1.58 (3.02) |
| Government Office | 6.21[c] (2.15) | 3.99[a] (2.33) |
| Silicon Systems | 8.15[c] (2.11) | 5.98[c] (1.97) |
| Tenure | 0.04 (0.10) | 0.05 (0.10) |
| Reciprocity | −19.19[c] (5.67) | −9.22 (6.33) |
| Transitivity | −6.69 (8.51) | −10.93 (9.52) |
| Perceived network | | 4.85[c] (1.58) |
| $F$ | 4.12[c] | 3.80[c] |
| $R^2$ | 0.10 | 0.14 |

*Note.* Unstandardized coefficients are reported, with robust standard errors in parentheses. $N = 116$.
[a] $p < .1$.
[b] $p < .05$.
[c] $p < .01$.

## Discussion

The counterintuitive idea presented in our paper is that a network pattern surprising to find in actuality (one that leads people to exclaim "It's a small world!") may be a feature of human cognition that biases perceptions of network relationships. The results, derived from analyses of 116 perceived friendship networks and four actual networks, show a surprising degree of small worldedness in individuals' perceptions. Even small networks exhibit complex patterns of relationships, as Fig. 1 reminds us.

The level of complexity found in even small networks can challenge individuals' perception and recall abilities (Kilduff et al., 2006). In order to organize and recall complex social structures such as organizational friendship networks, people appear to bias perceptions toward more clustering, together with greater centralization and brokerage for perceivedly-central people. Compatible with the tendency to perceive more brokerage than actual exists, the post hoc analysis showed shorter path lengths in perceptions compared to reality. Small world principles may help facilitate the organization of perceptions into a reassuring pattern of clustering and connectivity. On the other hand, if people cognitively cluster colleagues at work to a greater extent than is actually the case, and tend to over-attribute popularity and brokerage to those they perceive to be popular, schema use may come at the price of an exaggerated belief in cliques, an over-reliance on perceived brokers, and a tendency to neglect the perceivedly-marginal. Further, to the extent that the individual perceives the workplace friendship network to be clustered in terms of in-groups and out-groups, with social capital centralized around a small set of key intermediaries, the likelihood of this perceived pattern being reinforced by the individual's action may be enhanced.

We have limited our analysis to friendship networks that are sufficiently opaque in their structuring to permit individual cognitive distortions, and which are sufficiently important in their operations to affect many aspects of organizational functioning (Krackhardt, 1992). Previous small world research has tended to ignore social cognition, perhaps because most small world research has derived from either physics or sociology. Cognitive schema research has neglected the question of how individuals organize their perceptions of entire social structures, preferring to investigate the schematic processing of relations surrounding the perceiver (see Crockett, 1982, for a review). As far as we know, this paper represents the first attempt to examine the social cognition of networks from the small world perspective.

There is, however, a long tradition of work examining the schematic biases that characterize individuals' perceptions of social networks (e.g., De Soto, 1960; Kumbasar, Romney, & Batchelder, 1994). Indeed, social network research throughout its history has exhibited a productive tension between approaches that emphasize networks as perceptions (e.g., Heider, 1946, 1958) and approaches that emphasize networks as interpersonal interactions (see Kilduff & Tsai, 2003 for a review). Our contribution is most closely related to recent work suggesting that network patterns (such as clustering and structural holes) that researchers have discovered in actual networks are also discerned by perceivers who can develop schematic anticipation of such patterns (Janicik & Larrick, 2005; Krackhardt & Kilduff, 1999). We have endeavored to move this approach forward by considering how perceivers tend to mirror in a distorted way not just a few relationships at a time, but complete organizational networks.

One of the intriguing findings of our research is that small world properties were exhibited in perceptions even though, in some cases, the actual friendship network, which formed the basis of individuals' workday experience, did not exhibit these properties. Previous research has suggested that schematic anticipation can be triggered by even one vivid experience of the relevant phenomenon (Ahn et al., 1992). Friendship groups may be associated in cognition with kinship groups in terms of perceived intimacy (Lickel et al., 2000) and in the assumption that friendship, like kinship, involves the avoidance of careful counting of benefits given and received (see Silk, 2003, for a review of "the puzzle of friendship"). Thus, the emergent small world properties we have described may apply not only to the perception of friendship relations, but also to the perception of kinship relations, with perhaps some evolutionary underpinning in terms of a tendency to treat close associates like kin (e.g., Alexander, 1979).

A related question that emerges from the current research concerns the action implications of schema use. Do people who perceive the friendship network in an organization in terms of a small world (relative to those who do not perceive the organization in terms of a small world) tend to be more active in pursuing opportunities across the organization? Perceiving the organization as a small world may reassure the individual concerning the approachability of even distant people, given that short paths are perceived to pull the organization together. On the other hand, a tendency to misperceive clustering in friendship networks, together with a tendency to attribute more importance to perceivedly-popular people, may lead active networkers to be overly confident in picking key people in the network with whom to form attachments. Managers, for example, might assume that they are keeping in touch with all the important clusters, when, in fact, the clustering and connectivity they perceive are more figments of their imagination than accurate features of the social network.

Cognitive maps are the basis upon which action proceeds, in terms of negotiating pathways through the social structure. Individual perceptions of friendship networks are important because such perceptions help shape reputations (Kilduff & Krackhardt, 1994), and structure organizational culture (Krackhardt & Kilduff, 2002). Thus, schema use by individuals in their perceptions of social worlds may affect individuals and larger entities. To the extent that individuals have learned to structure their perceptions according to small world principles, there may be unanticipated consequences not just for the individuals concerned, but also for the collectivity to which they belong (Ibarra, Kilduff, & Tsai, 2005). The small world of individual perceptions may have large effects on the actual world of organizational functioning.

### *Limitations*

One of the limitations of our research is its focus on relatively small organizational networks. To the extent that larger organizational networks pose even greater cognitive challenges than the small networks we studied, the reliance on schematic processing may well be more extensive. In larger organizations, the cognitive task of keeping track of relationships is likely to be more taxing than in small organizations. To the extent that people are cognitive misers, they are more likely to use schemas to organize perceptions in large relative to small organizations.

In building and testing theory from a small world perspective, we have left important work still to be done. In particular, a question for future experimental research concerns whether networks organized into small worlds are easier to learn than networks not organized into small worlds. Experimental research could explore whether small world principles constitute a default schema or whether experience with small world networks improves the learning of such networks (see Janicik & Larrick, 2005, for a discussion). Future research must also investigate the question of how people group actors into clusters. We have highlighted the possible importance of prototypical individuals in terms of establishing categories and connecting clusters (cf. Hogg & Terry, 2000), but more systematic research concerning these cognitive reference individuals would be useful.

A related question that could also be addressed through experimental research concerns the relative importance of the three constituent heuristics that we discuss in this paper. We have argued that small worldedness in individuals' cognitive representations of friendship networks emerges from the interdependent operation of several core schema: network clustering, over-attribution of popularity, and perceived brokerage of central people. However, our research design prevents us from being able to comprehensively evaluate the relative contribution of each schema and which schema, if any, is causally primal. We believe, however, that this issue provides a fruitful opportunity for future work.

## Conclusion

Ever since the groundbreaking research showing the apparent connectedness of distant strangers (Travers & Milgram, 1969), the intuitively appealing notion that we live in a small world has captured people's imaginations (Watts, 2003). Countering the fear that each of us lives in increasing isolation from others (cf. Putnam, 2000), small world research has offered the hope of a connected world. However, our research suggests the possibility that small worlds may be more prevalent in people's cognitions than in reality. Linking with others distant from ourselves may require greater time and effort than our cognitive representations lead us to believe.

## Appendix A. Variable calculation formulae

| Variable | Formula |
|---|---|
| Clustering coefficient (CC) | $\frac{\sum_{i=1}^{n} C_i}{n}$, where $C_i = \frac{A_i}{k_i(k_i-1)}$ and $A_i$ is the actual number of ties between node *i*'s $k_i$ adjacent nodes. |
| Expected network clustering coefficient ($CC_{expected}$) | $k/n$, where $n$ is the number of nodes in a network and $k$ is the average number of ties per node |
| Clustering coefficient ratio ($CC_{ratio}$) | $CC/CC_{expected}$ |
| Path length (PL) | $\frac{2}{n(n-1)}\sum_{i=1}^{n}\sum_{j=1}^{n} L_{\min}(i,j)$; where $L_{min}$ is the minimum path length connecting node i and node j |
| Expected network path length ($PL_{expected}$) | $\ln(n)/\ln(k)$, where $n$ is the number of nodes in a network and $k$ is the average number of ties per node |
| Path length ratio ($PL_{ratio}$) | $PL/PL_{expected}$ |
| Small world quotient (*SW*) | $CC_{ratio}/PL_{ratio}$ |

## References

Ahn, W. K., Brewer, W. F., & Mooney, R. J. (1992). Schema acquisition from a single example. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 18*, 391–412.

Alexander, R. D. (1979). Natural selection and social exchange. In R. L. Burgess & T. L. Huston (Eds.), *Social exchange in developing relationships*. New York: Academic.

Arkes, H. R., & Harkness, A. R. (1980). Effect of making a diagnosis on subsequent recognition of symptoms. *Journal of Experimental Psychology: Human Learning and Memory, 6*, 568–575.

Barabasi, A.-L. (2003). *Linked: How everything is connected to everything else and what it means*. New York: Plume.

Barsalou, L. W. (1983). Ad hoc categories. *Memory & Cognition, 11*, 211–227.

Brav, A. (2000). Inference in long-horizon event studies: A Bayesian approach with application to Initial Public Offerings. *Journal of Finance, 55*, 1979–2016.

Burt, R. S., & Ronchi, D. (1990). Contested control in a large manufacturing plant. In J. Weesie & H. D. Flap (Eds.), *Social networks through time* (pp. 127–157). Utrecht, Netherlands: Isor.

Cairns, R. B., Perrin, J. E., & Cairns, B. D. (1985). Social structure and social cognition in early adolescence: Affiliative patterns. *Journal of Early Adolescence, 5*, 339–355.

Campbell, D. T. (1958). Common fate, similarity, and other indexes of the status of aggregates of persons as social entities. *Behavioral Science, 3*, 14–25.
Crockett, W. H. (1982). Balance, agreement, and positivity in the cognition of small social structures. *Advances in Experimental Social Psychology, 15*, 1–57.
Davidsen, J., Ebel, H., & Bornholdt, S. (2002). Emergence of a small world from local interactions: Modeling acquaintance networks. *Physical Review Letters, 88*, 128701.
De Soto, C. B. (1960). Learning a social structure. *Journal of Abnormal and Social Psychology, 60*, 417–421.
Dixon, W. J. (1960). Simplified estimation from censored normal samples. *Annals of Mathematical Statistics, 31*, 385–391.
Dorogovtsev, S. N., & Mendes, J. F. F. (2003). *Evolution of networks: From biological networks to the Internet and WWW*. Oxford, U.K.: Oxford University Press.
Dunne, J. A., Williams, R. J., & Martinez, N. D. (2002). Food-web structure and network theory: The role of connectance and size. *Proceedings of the National Academy of Sciences, 99*, 12917–12922.
Fiske, S. T., & Taylor, S. E. (1991). *Social cognition*. New York: McGraw-Hill.
Freeman, L. C. (1979). Centrality in social networks: I. Conceptual clarification. *Social Networks, 1*, 215–239.
Freeman, L. C. (1992). Filling in the blanks: A theory of cognitive categories and the structure of social relations. *Social Psychology Quarterly, 55*, 118–127.
Gladwell, M. (2005). *Blink: The power of thinking without thinking*. New York: Little, Brown and Co.
Granovetter, M. S. (1973). The strength of weak ties. *American Journal of Sociology, 78*, 1360–1380.
Gronn, P. C. (1983). Talk as the work: The accomplishment of school administration. *Administrative Science Quarterly, 28*, 1–21.
Heider, F. (1946). Attitudes and cognitive organization. *Journal of Psychology, 21*, 107–112.
Heider, F. (1958). *The psychology of interpersonal relations*. New York: Wiley.
Hogg, M. A., & Terry, D. J. (2000). Social identity and self-categorization processes in organizational contexts. *Academy of Management Review, 25*, 121–140.
Ibarra, H., Kilduff, M., & Tsai, W. (2005). Zooming in and out: Connecting individuals and collectivities at the frontiers of organizational network research. *Organization Science, 16*, 359–371.
Isenberg, D. J. (1986). Group polarization: A critical review and meta-analysis. *Journal of Personality and Social Psychology, 50*, 1141–1151.
Janicik, G. A., & Larrick, R. P. (2005). Social network schemas and the learning of incomplete networks. *Journal of Personality and Social Psychology, 88*, 348–364.
Kilduff, M., & Krackhardt, D. (1994). Bringing the individual back in: A structural analysis of the internal market for reputation in organizations. *Academy of Management Journal, 37*, 87–108.
Kilduff, M., & Tsai, W. (2003). *Social networks and organizations*. London, UK: Sage.
Kilduff, M., Tsai, W., & Hanke, R. (2006). A paradigm too far? A dynamic stability reconsideration of the social network research program. *Academy of Management Review, 31*, 1031–1048.
Kleinfeld, J. S. (2002). Could it be a big world after all? The 'six degrees of separation' myth. *Society, 39*, 61–66.
Kochen, M. (Ed.). (1989). *The small world*. Norwood, NJ: Ablex.
Kogut, B., & Walker, G. (2001). The small world of Germany and the durability of national networks. *American Sociological Review, 66*, 317–335.
Korte, C., & Milgram, S. (1970). Acquaintance networks between racial groups: Application of the small world method. *Journal of Personality and Social Psychology, 15*, 101–108.
Krackhardt, D. (1987). Cognitive social structures. *Social Networks, 9*, 109–134.
Krackhardt, D. (1990). Assessing the political landscape: Structure, cognition, and power in organizations. *Administrative Science Quarterly, 35*, 342–369.
Krackhardt, D. (1992). The strength of strong ties: The importance of Philos in organizations. In N. Nohria & R. G. Eccles (Eds.), *Networks and organizations: Structure, form, and action* (pp. 216–239). Boston, MA: Harvard Business School Press.
Krackhardt, D., & Hanson, J. K. (1993). Informal networks: The company behind the chart. *Harvard Business Review, 71*(4), 104–111.
Krackhardt, D., & Kilduff, M. (1999). Whether close or far: Social distance effects on perceived balance in friendship networks. *Journal of Personality and Social Psychology, 76*, 770–782.
Krackhardt, D., & Kilduff, M. (2002). Structure, culture, and Simmelian ties in entrepreneurial firms. *Social Networks, 24*, 279–290.
Kumbasar, E. A., Romney, K., & Batchelder, W. H. (1994). Systematic biases in social perception. *American Journal of Sociology, 100*, 477–505.
Labianca, G., Moon, H., & Watt, I. (2005). When is an hour not 60 min? Deadlines, temporal schemata, and individual and task group performance. *Academy of Management Journal, 48*, 677–694.
Lickel, B., Hamilton, D. L., Wieczorkowska, G., Lewis, A., Sherman, S. J., & Uhles, A. N. (2000). Varieties of groups and the perception of group entitativity. *Journal of Personality and Social Psychology, 78*, 223–246.
Markus, H. (1977). Self-schemata and processing of information about the self. *Journal of Personality and Social Psychology, 35*, 63–78.
McPherson, M., Smith-Lovin, L., & Brashears, M. E. (2006). Social isolation in America: Changes in core discussion networks over two decades. *American Sociological Review, 71*, 353–375.
Mintzberg, H. (1973). *The nature of managerial work*. New York: Longman.
Montoya, J. M., & Sole, R. V. (2002). Small-world patterns in food webs. *Journal of Theoretical Biology, 214*, 405–412.
Neisser, U. (1976). *Cognition and reality*. San Francisco: W.H. Freeman.
Osherson, D. N., & Smith, E. E. (1981). On the adequacy of prototype theory as a theory of concepts. *Cognition, 9*, 35–58.
Putnam, R. D. (2000). *Bowling alone: The collapse and revival of American community*. New York: Simon & Schuster.
Quinn, K. A., Macrae, C. N., & Bodenhausen, G. V. (2003). Stereotyping and impression formation: How categorical thinking shapes person perception. In M. A. Hogg & J. Cooper (Eds.), *The Sage handbook of social psychology* (pp. 87–109). London: Sage.
Raghubir, P., & Valenzuela, A. (2006). Center-of-inattention: Position biases in decision-making. *Organizational Behavior and Human Decision Processes, 99*, 66–80.
Rapoport, A. (1957). Contribution to the theory of random and biased nets. *Bulletin of Mathematical Bio-physics, 19*, 257–277.
Rosch, E. H. (1973). Natural categories. *Cognitive Psychology, 4*, 328–350.
Rosch, E. H. (1975). Cognitive reference points. *Cognitive Psychology, 7*, 532–547.
Silk, J. B. (2003). Cooperation without counting: The puzzle of friendship. In P. Hammerstein (Ed.), *The genetic and cultural evolution of cooperation* (pp. 37–54). Cambridge, MA: M.I.T. Press.
Travers, J., & Milgram, S. (1969). An experimental study of the small world problem. *Sociometry, 32*, 425–443.
Uzzi, B., & Spiro, J. (2005). Collaboration and creativity: The small world problem. *American Journal of Sociology, 111*, 447–504.
von Hecker, U. (1993). The significance of balance, generalization, and positivity as cognitive rules. *Zeitschrift fur Experimentelle und Angewandte Psychologie, 40*, 548–576.
Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications*. New York: Cambridge University Press.

Watts, D. J. (1999). *Small worlds: The dynamics of networks between order and randomness*. Princeton, NJ: Princeton University Press.

Watts, D. J. (2003). *Six degrees: The science of a connected age*. New York: W. W. Norton & Company.

Watts, D. J., & Strogatz, S. H. (1998). Collective dynamics of 'small-world' networks. *Nature, 393*, 440–442.

White, H. (1980). A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica, 48*, 817–838.

Wilder, D., & Simon, A. F. (1998). Categorical and dynamic groups: Implications for social perception and intergroup behavior. In C. Sedikides, J. Schopler, & C. A. Insko (Eds.), *Intergroup cognition and intergroup behavior* (pp. 27–44). Mahwah, NJ: Erlbaum.