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The Snowball Effect: Turnover Embedded in Communication Networks

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This research investigated the relation between turnover and communication networks in three fast food restaurants. Although most research assumes an independent, stochastic quality to turnover, the assertion tested here is that turnover occurs in clusters. Specifically, it was hypothesized that these turnover clusters would be significantly related to the degree to which employees occupied similar informal roles as defined by perceived communication patterns. Fifty three employees (mostly adolescents) completed a communication network questionnaire. Over the ensuing 1-month period, 12 of the employees left the restaurants. By using a social network concept called regular equivalance, we were able to measure the degree to which employees were perceived similar to each other in these communication roles. Three separate analyses were conducted, each based on different assumptions about the data. A meta-analysis across the three sites in all three analytical approaches confirmed the hypothesized relation between turnover clusters and perceived roles.

The several thorough reviews of turnover research over the recent past have underscored the continuing interest in this area (e.g., Bluedorn, 1982; Mowday, Porter, & Steers, 1982; Mobley, 1982). Models of turnover have become increasingly complex, incorporating in excess of 40 organizational, individual, and societal variables in at least one case (Mobley, Griffith, Hand, & Meglino, 1979). This complexity suggests that it is time to explore new kinds of variables, rather than clouding the picture with more variables of the same nature.

For example, overlooked in the studies of turnover determinants is the possibility of a snowball effect—that is, that turnover itself causes more turnover. Such an effect can be inferred from Mowday et al.'s (1982) discussion of the negative effects of turnover on those who remain. To date, however, this possible contributor to the turnover process has not been investigated empirically.

Each of the models reviewed by the aforementioned authors takes a traditional view of the turnover process. That is, each assumes that turnover occurs atomistically within a workgroup. Each person's behavior in a workgroup is considered a stochastic function determined by various personal and situational characteristics attributed to the person. Once those attributes are known, a regression model predicts an independent probability of each person leaving.

An alternative approach is suggested by the snowball metaphor. A snowball does not randomly accumulate snowflakes in the area. Rather, snow adheres to the snowball in a discernible path. Similarly, the patterns of turnover will not be independently distributed across any workgroup. People are not independent actors. They affect each other in their behavior. Moreover, the degree to which they affect each other depends on the relationship between them. Social network analysis provides a framework for assessing these relationships and for predicting their effects on individual members.

This view poses methodological as well as conceptual problems for the regression approach used in the more traditional turnover models. It is imperative in any regression-based model that independence of observations be assumed. To the contrary, the model proposed here assumes just the opposite. Fortunately, these problems of independence have been resolved by recent developments in the area of social network analysis. These developments will be discussed in more detail below.

Role Equivalance in Informal Networks

The most powerful advance in network analysis in the past decade has been in the domain of structural equivalance (Lorrain & White, 1971). In their landmark article, Lorrain and White proposed that actors could be grouped into similar categories based on their patterns of interactions in a social system. Two people would be considered to have equivalent roles (or to be structurally equivalent) if they talked to exactly the same other people (although not necessarily to each other). To the extent that they talked to mostly the same people, they would occupy similar roles to each other. If they talked to no one in common, they would occupy very dissimilar roles. Breiger and his colleagues (Breiger, Boorman, & Arabie, 1975) developed an algorithm for operationalizing Lorrain and White's theory. Since then, many studies have used this algorithm (Arabie & Boorman, 1982) to identify and interpret informal groups in social systems. This idea has been generalized to a concept of role that is more directly relevant to organizations.

Sailer (1978) has argued that two people are equivalent in their roles if they communicate with equivalent others. Thus, two supervisors would be equivalent to each other because they

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each communicate with a group of equivalent linespeople and to equivalent middle managers. To the extent that they communicate with people who are in different roles, then these two supervisors would be less similar to each other. This differs from Lorrain and White's concept of structural equivalence because Sailer does not require that two people talk to the same others in order to be equivalent in their roles. Just as supervisors do not have to supervise the same exact people to be in equivalent role patterns, the informal role structure of any group in an organization is most appropriately assessed using this Sailer modification of the original Lorrain and White definition.[1]

To illustrate this Sailer concept, consider a group of seven organizational participants who work together. Assume over the years that they have developed a pattern of whom they go to when there is a problem or when they have a question about work-related matters. This pattern will be termed the *advice network*. For this illustration, assume persons B and C go to A for help and advice, D and E go to B, and F and G go to C. This hypothetical advice network is depicted in Figure 1.

Note that this network parallels a typical formal organizational chart. This coincidence is intentional for demonstrative purposes, but one should not infer from this example that the informal organization usually mirrors the organizational chart. Seldom does it do so.

Using the Sailer concept of equivalence (White & Reitz, 1985), one can measure the equivalence, or at least, similarity of each pair of people in the hypothetical network. In this example, D, E, F, and G are equivalent in their roles. This is so because they go to the same others (B and C) and no one goes to them. On the other hand, B and C are equivalent because (a) they both go to A and (b) all those (D, E, F, G) who go to them are equivalent to each other.

The matrix in Figure 2 shows the results of the algorithm as applied to this simple example in Figure 1. Scores of 100 (e.g., for the pair B, C), indicate that each member of the pair has a role equivalent to the other. A score of 0 indicates that the members of the pair have maximally dissimilar roles (such as the pair A, D, one member of which no one goes to, the other of which goes to no one). Intermediate scores indicate varying degrees of similarity in their patterns of communication. For example, B and A both have people coming to them. However, D and E (who go to B) are not equivalent to B and C (who go to A). Therefore, A and B will not be equivalent either; their similarity is attenuated by the degree to which those going to them are dissimilar to each other. Thus, A and B are only moderately similar to each other (score = 40).

To emphasize a point, equivalence between two people is not based on whether they go to each other. For example, D and G do not go to each other; they do not even go to the same people. Yet they are perfectly equivalent in roles (similarity score = 100). Conversely, D goes to B and yet is not very similar to B (similarity score = 40).

Importance of Perceived Similarity

Thus, each pair of actors in a workgroup can be evaluated as to how similar they are in their patterns of communication with fellow workers. Burt (1982), one of the most avid users of structural equivalence algorithms in empirical research, has emphasized an additional important point: When one is to predict the effect that a network of interactions has on any given individual's attitudes, it is important to differentiate between the actual and perceived networks. It is the network that is perceived by the individual that enables that individual to evaluate whether he or she is similar to a co-worker. To the extent that they perceive each other to be similar, then they are more likely to affect each other's behavior.

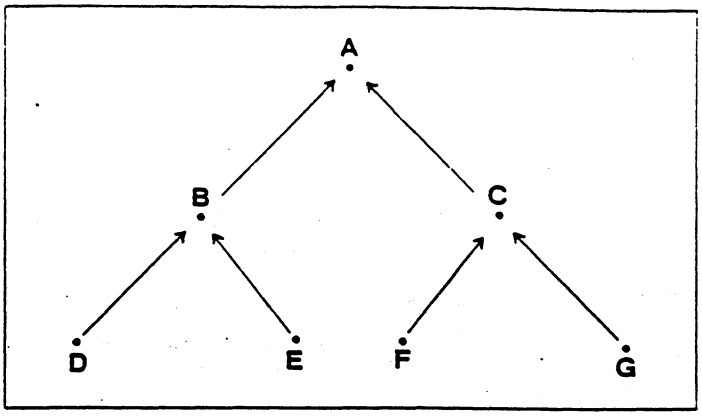

Figure 1. Hypothetical advice network of workgroups (B → A indicates that Person B goes to Person A for help and advice).

For example, suppose two supervisors viewed each other as equivalent to themselves. If one were to leave, the second is likely to view that leaving as relevant information for him or herself. The reevaluation process that Mowday et al. (1982) propose would be activated in such a situation. On the other hand, suppose that the two were quite dissimilar to each other in their informal communication patterns (e.g., one may be an isolated custodian while the second is an active middle manager). In this case, one's leaving may be viewed as irrelevant. The two have little in common, and as such little dissonance is created when one quits. In this way, role equivalence creates a bond between participants in a workgroup. The role similarity is determined by the informal communication patterns. The resulting bond increases the effect that one's behavior has on another.

The purpose of this research is to test this proposition that such similarity in informal communication patterns can increase the effect of turnover behavior on a co-worker. Specifically, the more similar co-workers are to each other, the more likely it is they will leave together (or stay together). If this is the case, then turnover should occur in clusters, which can be predicted by the informal communication channels.

Hypothesis. Turnover will occur in clusters as defined by the perceived social network, such that those who are perceived similar in position to each other in the communication network will either stay together or leave together.

[1] Sailer's modification has been formalized and expanded by White and Reitz (1983, 1985) who have coined the term *regular equivalence* to differentiate it from Lorrain and White's *structural equivalence*. Copies of either Fortran or Basic programs (called REGGE) to calculate regular equivalence may be obtained from either Douglas White or Linton Freeman, School of Social Sciences, University of California, Irvine.

	A	B	C	D	E	F	G
A	—	40	40	0	0	0	0
B	40	—	100	40	40	40	40
C	40	100	—	40	40	40	40
D	0	40	40	—	100	100	100
E	0	40	40	100	—	100	100
F	0	40	40	100	100	—	100
G	0	40	40	100	100	100	—

Figure 2. Similarity scores between pairs in hypothetical network depicted in Figure 1. (Doug White's REGGE program was used to calculate these similarity scores. The program was run with three iterations.)

Methods

A questionnaire was administered to employees in three fast-food restaurants (N = 16, 27, and 20, respectively, in restaurants A, B, and C). The average age of the employees was 19, with 73% being 18 years old or less. Forty-eight percent of the employees was female. The only full time (40 hours or more per week) employees were the store managers; however, all the people in the sample worked at least 20 hours per week. The average job longevity for the employees was less than 8 months, although this number is skewed because turnover averages 200% per year.

The questionnaire asked each person in the workgroup to list their perception of whom people go to for help and advice at their restaurant. The responses were used to assess how similar people are in terms of the role they had in giving and receiving advice from others. These data enabled us to identify an informal leadership hierarchy beyond that described by the organizational chart. The directions in part for this section were as follows:

> In this section, you will find several lists of people who work with you. Each list is started with the question, "Who would this person go to for help and advice at work?" That is if this person had a question or 'ran into a problem at work, who would they likely go to ask for advice or help? Please answer the question by placing a check next to the names of all the people the person is likely to go to.

The network data collected in this study were perceptual. Each individual provided an entire picture of his or her perception of the social network in which he or she is embedded. This permits the testing of the perception-based hypothesis directly.

The turnover data were collected during the 1-month period following the questionnaire administration. All turnover was counted, including one transfer and one involuntary turnover.

The reasons for including both of these events in the turnover count were two. First, both of these turnover events resolved a personnel problem in the organization. Had the turnover not occurred, a voluntary separation was likely anyway. Thus, the processes that led to the transfer and to the involuntary termination were similar to voluntary terminations, leading one reasonably to expect that the effects they would have on co-workers would be similar. The second reason that these events were not excluded was that the disruption in the social network was just as severe. A person leaving creates a hole in the network, no matter what the reason. It is this disruption that, it is argued here, snowballs.

The hypothesis was tested using the Quadratic Assignment Procedure (QAP), developed by Hubert and his colleagues (Hubert & Schultz, 1976). The QAP answers the question of whether two N × N matrices representing similarities or connections between the row and column entities (usually people) are similar to each other beyond a level that one could have expected through chance arrangement. This procedure has several advantages over traditional linear model hypothesis testing. First, it directly tests whether two structured matrices are similar to each other—a task out of the scope of linear models. The QAP test takes advantage of all the dyadic information represented in each matrix. That is, QAP compares each dyadic cell in Matrix A with the corresponding dyadic cell in Matrix B. The dyad is retained, then, as the appropriate unit analysis.

The second advantage of QAP is that it does not make parametric assumptions about the data. Ordinal, even categorical data can be tested using QAP without violating any of the distribution assumptions behind the procedure. Moreover, although it retains the dyad as the unit of analysis, it also takes into account the nonindependence of the dyads. Significance levels are calculated by generating a reference distribution of all possible permutations of outcomes, given the structure of each matrix. The actual similarity between the two matrices is compared to this reference distribution of possible similarities. As Hubert and Schultz have shown, an analytic solution to the problem closely approximates this reference distribution. It is this analytic solution that is used to calculate the Z scores reported in this article.

Analysis and Results

Turnover in the three restaurants combined to 25% in the 1-month time period under study (range: 20% to 38% in the three sites). The differences in turnover rates, $\chi^2(2, N = 63) = 1.69$, and questionnaire response rates (range 81% to 85%), $\chi^2(2, N = 63) = .13$, were not significant among the three restaurants.

The hypothesis predicted that employees would leave in clusters that would map onto perceived role similarity clusters. This hypothesis was tested using three separate approaches with different assumptions underlying each approach. The first used all the information available: It tested the hypothesis for each individual employee's perception of the social network. That is, each person had a perception of the entire network. Each perceived network is translated into a role similarity matrix using Sailer's definition. Each similarity matrix can then be compared to the turnover matrix and tested to see if the two are significantly related.

Although this test took advantage of all the information, it was subject to methodological criticism, because the meta-analysis was based on correlated observations (i.e., each individual was observing the "same" network). The second test eliminated the statistical independence problem, but in the process destroyed the perceptual map information. This test used one representation of the network for each site by aggregating perceptions of whether Person i goes to Person j. This single representation then was tested against the turnover matrix.

The third test represented a compromise, restoring much of the perceptual information and retaining statistical integrity for the significance test. First, individual perceptual maps are translated into similarity measures, as done in the first test above. Then these similarity measures are aggregated into one similarity matrix, as in Test 2. This summary matrix for each site is tested against the turnover matrix for significance.

Before we proceed to the specifics of the testing procedures, we should note that the aggregations for Tests 2 and 3 do not alter the basic dyadic nature of this study. The aggregations are of people's perspectives. The dyadic relation between each (i, j) pair is still the unit of analysis that forms the basis for the significance tests which follow. As will be shown below, the robustness of the findings is emphasized by the similarity in the results of each test.

Test 1: Individual Perceived Networks

The first step was to determine the perceived similarity between pairs of co-workers. Let k represent the respondent who filled out the questionnaire, i represent the co-worker who seeks advice at work, and j represent the co-worker who potentially could be approached by i for advice. Then, let $A(i, j, k)$ (referring to the raw advice matrix) be a matrix of dimension $N \times N \times K$ (that is, K is the number of respondents, N is the number of co-workers, including K), such that $A(i, j, k) = 1$ if k perceives that i goes to j for help or advice at work, and $A(i, j, k) = 0$ otherwise. This matrix can be separated into k adjacency matrices, $A(i, j)$, each representing who goes to whom for advice as perceived by k. Using the algorithm proposed by White and Reitz (1985), each $A(i, j)$ is transformed into a Regular Similarity matrix, $RS(i, j)$, representing k's perception of how similar (in the Sailer sense) i is to j. If the hypothesis is correct, then each individual's map of the role similarity should closely correspond to the turnover clusters. This was tested by creating a Turnover matrix ($N \times N$) whose cells $T(i, j) = 1$ if i and j both either left or stayed (that is, both i and j behaved in similar ways), and whose cells $T(i, j) = 0$ if either i or j (but not both) left (that is, i and j behaved dissimilarly). This matrix was then compared to the $RS(i, j)$ matrix for Person k to see if, in general, their similar behavior in turnover (the 1's in the $T[i, j]$ matrix) matched the perceptions that k had of how similar the two people (i and j) were in their roles in the advice network. The Quadratic Assignment Procedure (QAP) yielded a normalized statistic (expressed in Z scores), which would be large to the extent that this match up was greater than would occur by chance reassignment of turnovers (i.e., if a different group, but the same number, of people had left). In addition to the significance test, a gamma (Goodman & Kruskal, 1963) was calculated between the matched cells of the two matrices, $RS(i, j)$ and $T(i, j)$, where i not $= j$. It is suggested by Hubert that this gamma should be used as a general indication of the strength of relationship between the two matrices being tested. Gamma, a nonparametric correlation measure, is particularly appropriate here, because one of the matrices is composed of a dichotomous variable turnover.

The results of these tests are summarized in Table 1. Each person (k) was tested against the $T(i, j)$ matrix, producing a Z score and a gamma. For each site, the gammas and the Z scores were averaged. Because the standard error was estimated, a t test was used to test the null hypothesis that, on the average, no relation exists between turnover clusters and perceived similarity. Each site was considered an independent test. The overall relation was assessed using Rosenthal's (1978) suggested meta-analysis approach. Each of the three tests was transformed into a Z score that corresponds to the same significance level. These three scores were then summed and divided by the square root of N ($N = 3$ sites), yielding a joint Z. The overall significance level is determined by this joint Z value in the normal distribution.

The overall gamma is the simple average of the three sample gammas. It should be noted that correlation statistics, such as gamma or Pearson's r, are not normally distributed, but rather are skewed toward 0. This leads to conservative estimates of the population parameter when simple averages are calculated, as is done in Table 1. Also in the interest of conservatism, the correlations are not weighted by the sample N sizes. Because the largest sample had the strongest correlation (as is true in practically all the analyses reported in this work), this reduces the magnitude of what might be considered the appropriate overall strength of association. The size of both of these biases is not substantial, however, and the resulting overall average can be considered a reasonable, if somewhat conservative, estimate.

Table 1
Quadratic Assignment Procedure Test of Association Between Individual Perceptions of Role Similarity and Turnover

Group and measure	Result
Group A	
$\bar{Z}$	.055
N	13
SD	.9629
SE	.2780
t	.1993
p	NS
$\bar{\gamma}$	.00
Group B	
$\bar{Z}$	1.907
N	23
SD	1.9725
SE	.4205
t	4.536
p	<.0001
$\bar{\gamma}$	.23
Group C	
$\bar{Z}$	.515
N	17
SD	1.0228
SE	.2557
t	2.013
p	<.03
$\bar{\gamma}$	.07
Meta-analysis	
N	3
Joint Z	3.37
p	<.0005
$\bar{\gamma}$	.10

Given these caveats, a discernable trend is observed in Table 1. Two of the three sites show significant relations between the pattern of perceived role similarities and turnover. Combining these results, the significance level is persuasive (less than .0005). The strength of these results, on the other hand, is modest. Ranging from 0 to .23 by group, the average gamma is only .10.

Thus, using individual maps of the perceived role similarities in the test of the hypothesis, it is concluded that the null hypothesis of no relation is rejected in favor of a positive relation. The strength of that relation is questionable. One many wonder how an impressive significance level can be associated with such a modest correlation and N size. The answer lies in the fact that the standard error of the average associations between individuals' perceived maps and turnover is quite small. That is, the association may not be strong, but practically all the subjects "agree" it was there. This tight standard deviation leads to a small standard error and thus highly significant mean.

Test 2: Local Aggregated Networks and Turnover Clusters

It may be argued, and justifiably so, that averaging individuals' relationships between perceived networks and turnover clusters is an inappropriate test of the hypothesis, because these observations are not independent of one another (i.e., each person is presumably perceiving the "same" social network). A more appropriate test, this logic continues, would be to summarize the perceived network in one matrix and test that one matrix against the turnover matrix for the particular site. As an alternative test of the hypothesis, then, the following procedure was undertaken. The transformation of information for the Role Similarity matrix will be described first.

Recall that $A(i, j, k)$ is the original data matrix containing all k's perceptions of whether i goes to j for advice, for all i and j (i not $= j$). Let the Local Aggregated Advice matrix entries $LAA(i, j) = 1$ if and only if both $A(i, j, i) = 1$ and $A(i, j, j) = 1$. Let $LAA(i, j) = 0$ otherwise. In other words, if i and j both agree about the fact that i goes to j for help and advice at work, then in the summary matrix (termed the *Local Aggregated Advice* matrix, or *LAA*) cell $(i, j) = 1$. If they disagree, or if they agree that i does not go to j, the cell is set equal to 0. This strict intersection rule is consistent with the conservative stance repeatedly adopted in this research effort. If one person claims to be going to another for advice, but the second person denies it, such a claim is considered unreliable. When both agree that the first goes to the second, it is reasonable to assume that the connection actually does take place.

The term *local aggregated* refers to the fact that the summary matrix is determined by only the most immediate actors involved in the interaction. With no published exceptions (to the authors' knowledge), all self-report network data prior to the present study have been local aggregated.

With the same algorithm used to create the $RS(i, j)$ matrix, this summary matrix $LAA(i, j)$ is transformed into a regular similarity matrix, $LARS(i, j$; Local-Aggregated Regular Similarity matrix). Again, the cells take on continuous values from 0 to 100, where 0 indicates that i and j are totally dissimilar in their roles in the advice network, and 100 indicates that the two have identical roles. The hypothesis is tested by comparing this matrix with the $T(i, j)$ matrix. Each of the three sites yields one summary test (instead of averaging the tests of each individual's matrix). The QAP test results are given in Table 2.

Groups B and C show significant, if again somewhat weak, associations between the role similarity matrix and the turnover similarity matrix. Overall, the relation is reconfirmed as before: significant ($p < .05$) but not strong (unweighted average gamma = .16).

Test 3: Average Perceived Similarities

Although the above computations of local-aggregated networks addressed the problem of independent observations, they did so at considerable cost. It was argued earlier that it is the individual's perception of the network that affects him or her, and not links in the network as determined or perceived by others. The use of traditional local-aggregated networks abolishes the perceived network, beyond the individual's local input.

Table 2
Quadratic Assignment Procedure Test Association Between Local Aggregated Network of Role Similarity and Turnover

Group and measure	Result
Group A	
Z	−1.23
γ	−.11
p	*ns*
Group B	
Z	2.98
γ	.34
p	<.002
Group C	
Z	1.70
γ	.24
p	<.05
Meta-analysis	
Z (Joint)	1.99
γ	.16
p	<.05

To take advantage of all the perceptual information focused on an individual, a third test was performed. Instead of aggregating the raw data and then transforming to similarity (or distance) matrices, the aggregation was performed this time just prior to the QAP test.

Recall that $RS(i, j, k)$ is the matrix of role similarity scores perceived by k between i and j. Then let $APRS(i, j) = (RS(i, j, i) + RS(i, j, j))/2$. $APRS(i, j)$ or the "Average Perceived Role Similarity" is the average of i and j's overall perception of how similar i and j are. This summary matrix, then, retains all the perceptual information calculated in $A(i, j, k)$, distorted only to the extent that i and j disagree on their mutual similarity.

Table 3 displays the results of the QAP test between the summary matrix $APRS(i, j)$ and $T(i, j)$ for each site. One of the three sites (Group B) is significant. However, once again, the overall results were convincingly significant ($p < .004$) but not strong (average gamma = .15).

Discussion

Three separate analyses pointed to the same conclusion: Turnover does not occur randomly throughout a work group. Rather, it is concentrated in patterns that can be delineated by role similarities in a communication network. Although these are not the only analyses possible, the fact that this snowball pattern was so consistent across the three analytic techniques presented here emphasizes the robustness of this finding.

Of interest to the manager in these results are the implications they hold for dealing with turnover phenomena in the organization. Frequently, interventions to reduce turnover are spread out over organizational levels (see, for example, Krackhardt, McKenna, Porter, & Steers, 1981). A more cost-efficient approach might be to concentrate resources on those who are observing

Table 3
QAP Test of Association Between Average Perceived Role Similarity and Turnover

Group and measure	Result
Group A	
Z	.83
γ	.11
p	*ns*
Group B	
Z	4.66
γ	.42
p	<.0001
Group C	
Z	−.79
γ	−.09
p	*ns*
Meta-analysis	
Z (Joint)	2.71
γ	.15
p	<.004

similar co-workers leave. In doing so, expenses of turnover reduction programs could be minimized.

Before projected savings of such a strategy are calculated, however, it is important to recall the relative strength of the findings reported here. The snowball effects were attenuated by two major factors. First, methodological issues must be considered. The single-item measure of connection—which is the building block of our role equivalence assessment—may be unreliable. Unsystematic error may be present in the data, reducing any observed correlations. Given the lack of power gained from using holistic perceptions, it may be preferable in future research to invest in multiple indicators of local connections, rather than attempting to capture each individual's perception of the entire network. In a similar vein, the correlation statistic used here, the gamma, does not have the usual upper bound of +1 in such matrices. Thus the apparent low values may be misleading. At the least, they are conservative.

The second significant factor contributing to lower-than-expected correlations is inherent in the nature of the problem being studied. Turnover decisions are determined by a complex set of variables (Mobley, 1982), not simply whether a certain co-worker leaves. The data reported here suggest that turnover of role equivalent co-workers contributes only a part of the picture.

In conclusion, it has long been recognized empirically and theoretically that social processes affect individual attitudes and behaviors. That a person's social embeddedness is critical in this process is axiomatic. The recent advances in network analysis suggest innovative approaches for those studying turnover. Such innovations should lead us to more robust theory and stronger empirical results.

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