A Galileo Analysis of Organizational Climate

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This article attempts to (a) establish a conceptual framework for climate research, (b) develop a research scheme based on this conceptual ground, and (c) examine the relationship between communication and the convergence of views regarding organizational climate. University faculty members comprise the sample for this study (N = 105). Using the Galileo multidimensional scaling model, a description of the faculty climate at a university is presented, as well as comparisons between the climates of groups of faculty. There is a substantial correlation between a person's attitude and his or her perception of the relation of others toward those same concepts. Faculty members who communicate more with their colleagues report less psychological distance between themselves and the university. In addition, an individual's climate space becomes more similar to the space of the group with whom he or she maintains denser communication ties as compared with the space of the group with whom he or she maintains less dense ties.

Social scientists have long known that certain social phenomena cannot be explained solely by the attributes of the individuals who constitute the social unit (Monge, 1987). Theoretical and empirical efforts to explain these social phenomena on levels higher than the individual are numerous. For instance, Durkheim (1963), almost a century ago, recognized the effects that "social facts" exert on individuals, viewing social facts as collective representations derived from the association of individual minds. Once created, these social facts are dissociated from their creators and become partially autonomous realities. As such, they acquire their own power and serve as forceful constraints on the individual's social behavior.

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At the organizational level, the study of climate represents one of the major efforts to explain the behavior of individuals by certain molar characteristics of the organization. Contrary to organizational sociologists, who concentrate on group level properties of the organization (e.g., the degree of centralization, formalization, complexity, or stratification), most organizational climate researchers are more interested in organizational members' perceptions of certain properties of their work environment. However, climate scholars do not agree on a theory and a related methodology to study climate (see, e.g., Glick, 1985). This divergence is further complicated by the mounting interest in organizational culture during the 1980s, in which additional ways of understanding organizational life were developed (Smircich, 1983).

The major purposes of this study are to (a) establish a conceptual framework for climate research, (b) develop a research scheme based on this conceptual ground, and (c) examine the relationship between communication and the convergence of views regarding organizational climate. The Galileo approach (see, e.g., Barnett & Woelfel, 1988; Woelfel & Fink, 1980) will be adopted to assess climate.

SOME UNSOLVED ISSUES IN CLIMATE RESEARCH

In a review of previous climate studies, Mailler (1986) observed that

> one of the most consistent themes throughout the review literature is a concern that researchers are over-ready to measure and analyze data about a concept that is not only initially ill-defined but also lacking a consistent and comprehensively applied theoretical context. (p. 8)

Yet we do find some clear definitions. For example, one of the classic and widely referenced definitions of organizational climate was provided by Tagiuri (1968):

> Climate is a relatively enduring quality of the internal environment of organization that (a) is experienced by its members, (b) influences their behavior, and (c) can be described in terms of the values of a particular set of characteristics (or attributes) of the organization. (p. 27)

Although the definition of climate is seemingly straightforward, research on climate has been fraught with conceptual deficiency and contradictory results. First, researchers generally agree that the intellectual roots of climate research come from Gestalt psychology, particularly from Lewin's conception of "life space" (Schneider, 1975, 1985), but the sense of totality and dynamism of this approach has not been adequately captured (but see Poole & McPhee, 1983). In addition, although researchers have relatively few problems dealing with climate at the individual (psychological)

level, there exists a certain degree of confusion in examining climate on aggregate levels. Finally, the distinction between climate and culture remains rather obscure (see Ashforth, 1985; Falcione & Kaplan, 1984; Glick, 1985; Poole, 1985; Schneider, 1985).[1]

The fuzziness of the climate construct is further reflected in the different measurement procedures employed in this area. As Falcione, Sussman, and Herden (1987) commented, anyone reviewing the existing literature will develop a discomforting feeling because "conceivably no two published studies are operationally defining climate in exactly the same way" (p. 196). This is not unexpected considering the conceptual discord in the climate literature.

A MULTIDIMENSIONAL FRAMEWORK FOR CULTURE AND CLIMATE

The Definition of Climate

Psychological, Group, and Organizational Climate

Psychological climate is the individual member's cognitive representation of an organization. This is composed of the set of attitudes and beliefs that reflects each individual member's perception of the prevalent values, norms, and expectations in his or her organizational environment. It is a reflected-on totality of facts that the organization impresses on each member. *Organizational climate*, on the other hand, is a set of attitudes and beliefs relating to the organization that is shared and collectively held by organizational members *as a whole*. It is an organizational attribute and represents the equilibrium position toward which all the psychological climates are seen to tend. (Note that this may be a dynamic equilibrium.) Finally, a *group climate* is the elaboration of organizational climate that permits group members to reinterpret the organization "in a manner consonant with their own particular reality and goals" (Poole, 1985, p. 99). The elaboration and reinterpretation of the organizational climate is manifested in the different belief and attitude structures held by various groups. Within each group climate, the uniquely arrayed concepts constitute a subuniverse of meaning that group members use to make sense of their environment. Therefore, given the establishment of assorted group climates, a variety of perspectives will surface, each viewing the organization from a different vantage point.

Thus the major conceptual difference between psychological and aggregate (i.e., group or organizational) climates is that the former is an aspect of a cognitive system, whereas the latter is an aspect of a social

system. (Note the similarity to McLeod & Chaffee's [1972] distinction between Sr and sR).

Components of Psychological Climate

Following the Galileo tradition (Woelfel & Fink, 1980), we take psychological climate as the individual's representation of his or her organizational environment, which consists of concepts representing *attributes* and *objects*. The attributes describe the organization in general or describe particular organizational practices and procedures. The objects include two points of perspective (i.e., the concepts *Yourself* and *Others*) and a referent point for the focus of the investigation (e.g., the organization, the industry, or the profession). The meaning of each point in the multidimensional climate space is determined by its distances from other concepts in the same spatial manifold. Therefore, the distance between a referent concept (e.g., the *Organization*) and each attribute concept represents the degree to which the organization is viewed as possessing that particular attribute (i.e., the shorter the distance, the more pertinent the attribute is in describing the organization). The locations of the two perspective concepts (*Yourself* and *Others*) represent a person's viewpoint and his or her perception of the viewpoint of the others, respectively. The distance from the self point to each of the climate concepts is defined as the individual's attitude toward each concept. Similarly, the distance from the *Others* concept to each climate concept can be thought of as the individual's perception of the relation of the generalized other toward each concept.[2] Finally, the distance between each possible pair of nonperspective concept points is defined as a belief (Foldy & Woelfel, 1990; Woelfel & Fink, 1980).

Components of Organizational Climate

Consistent with our definition of psychological climate, we can designate a collective cognitive space, which is an aggregate of the individual climate spaces; it represents the attitudes and beliefs collectively held by the organizational members. Operationally, this composite space can be obtained by taking the central tendency for each specified distance over all psychological spaces. Within the organizational climate space, the location of the concept *Yourself* may be considered as the "true" generalized viewpoint—"true" in the psychometric sense that individual differences are averaged out. On the other hand, the location of the *Others* concept indicates the organizational members' perception of their collective viewpoint. Just as each individual may misinterpret the others, members of a social entity are not always able to grasp the "true" generalized view because of institutional segmentation and inevitable failures

of communication. The paradox of pluralistic ignorance (e.g., when most people agree on something but think that there is disagreement; see Scheff, 1967) is a typical example of the difference between the perceived and the "true" generalized viewpoint. It is this perceived viewpoint that constrains and molds behavior (see also Berger & Luckmann, 1967; Schutz, 1962, for a discussion of reciprocal perspective taking and the creation of social reality).

Components of Group Climate

In the group climate space, each concept point represents the average location of a climate concept for the particular group members. In this sense, the distance between the concept of the *Organization* and each of the attribute concepts represents the belief that the group members hold regarding the degree to which the organization can be described in terms of those attributes. The aggregate *Self* represents the group's generalized viewpoint, and its distance from other concepts represents the attitudes of the group toward the organization and its salient characteristics. The *Others* point denotes the group's perception or reification of the generalized viewpoint of the organization; its relation to other concepts represents the group's perception of the relation of the organizational members toward the organization and its salient attributes.

Communication and The Convergence of Organizational Climate

Conceiving climate as the result of mutual perspective taking leads us to a constructivist view of communication that emphasizes the sharing and creation of meanings among interactants in a communication system (Delia, 1977, p. 71). Rooted in the constructivist view, Woelfel and Fink (1980) conceptualized communication as a thermodynamic process. Like the collision of a pair of molecules that results in their exchange of energy and momentum, the interaction of two individuals results in a transfer of information regarding each other's cognitive structure. As a thermodynamic system, two conditions must be met for communication to take place. First, there must exist a difference in potential between the individuals' cognitive structures. Second, the individuals must be connected by a physical medium or link. As Woelfel and Fink (1980) put it, "The channel or link offers the opportunity for communication, while the difference in potential provides the motivation or force" (p. 184).

According to the second law of thermodynamics, the differences in potential between various parts of an *isolated* system would tend to vanish, leading to a total homogenization of the system. This implies that differences in locations of similar concepts among individual climate

spaces will tend to vanish as the system evolves toward greater entropy. Therefore, communication will lead to a convergence of beliefs and attitudes among individuals who constitute the system (see Barnett, 1988; Barnett & Kincaid, 1983; Kincaid, 1988; Kincaid, Yum, Woelfel, & Barnett, 1983; Woelfel, Cody, Gillham, & Holmes, 1980; Woelfel & Fink, 1980). Operationally, such a system is predicted to tend toward the weighted mean of the individual cognitive structures. The aggregated cognitive structure, which is the organizational climate, can be seen as an equilibrium value to which individuals will tend if communication is allowed to continue indefinitely (Woelfel & Fink, 1980).

However, living systems are not totally isolated. Certain exchanges of energy or information between a system and its environment always take place. Recent developments in the field of thermodynamics pay specific attention to the nonequilibrium state of the nonisolated system (see, e.g., Prigogine, 1978; Prigogine & Nicolis, 1977; Prigogine & Stengers, 1977), using the term *dissipative structures* to describe this type of dynamic state. A system in a nonequilibrium state can be stable as long as the system keeps interacting with its surroundings. Applying these ideas to organizations implies that a total homogeneous perception of the organizational climate is impossible: Organizational members are always in contact with the outside world, and the outside world provides sources for the heterogeneous perception of the organization. Furthermore, certain organizational members form subsystems, maintaining denser communication ties among themselves than with other members of the organization. These subsystems ought to experience a net increase in their internal homogeneity, thereby creating different group climates.

Hypotheses

Reciprocity

Climate is the result of interactants' mutual perspective taking, which always takes place in a "loop": Each individual understands the generalized view of the others through a sequential, self-correcting process that is variously labeled as "mind reading" (Dewey, 1958), "role taking" (Mead, 1934), "tacit coordination" (Schelling, 1960), and "a series of diminishing mistakes" (Deutsch, 1963, p. 35). Once the generalized other's view is formed in the individual, it also acquires an authority and constraint that can influence the individual's own attitude. Therefore, in this loop of "reciprocity of perspectives" (Schutz, 1962), an individual's own attitude and his or her view of the relation of the generalized others to the same concepts become an interdependent system (Coleman, 1968). To test this reciprocal relationship, our first hypothesis is

H1: There exists a reciprocal relationship between an individual's own attitude and his or her perception of the relation of generalized others to the organization.

Self-Organization Convergence

Our second hypothesis examines whether an individual who communicates more with others in the organization has less psychological distance from the organization. One's psychological distance toward the organization can be represented by the distance from the *Self* to the *Organization*, which can be interpreted as an index of how important or central the organization is to the individual (Barnett, Serota, & Taylor, 1976; Neuendorf, Kaplowitz, Fink, & Armstrong, 1987; Serota, Cody, Barnett, & Taylor, 1977).[3] Therefore, a greater amount of communication should move one's *Self* point toward the *Organization* point, because the more communication one has with members of the organization, the more important or central the individual should believe the organization to be.

In proposing a hypothesis regarding this relationship, we should point out that this relationship is processual and time dependent, so that we need to control for one's longevity or tenure to properly evaluate this hypothesis.[4] Therefore, our second hypothesis is as follows:

H2: Controlling for tenure, the greater the amount of communication, the less the psychological distance between the concepts *Yourself* and the *Organization*.

Self-Group Convergence

Our final hypothesis examines whether the time one spends communicating with a particular group increases the similarity of the individual's climate space and the collective climate space of that group. This hypothesis is based on Woelfel and Fink's (1980) assumption that the potential difference between two communicating systems will dissipate. In the long run, connected nodes (individuals) should converge on an equilibrium point with maximum entropy, and "the rate of convergence on the equilibrium point is proportional to the density of the links" (Woelfel & Fink, 1980, p. 192). This means that an individual's climate space will become more similar to the space of the group with whom he or she maintains a denser communication tie as compared with the space of the group with whom he or she maintains a less dense tie. Taking into account the longevity or tenure of organizational members in examining this convergence (because the Woelfel and Fink proposition concerns rates of convergence), Hypothesis 3 becomes the following:

H3: Controlling for tenure, an individual's climate space will become more similar to the climate space of the group with whom he or she spends more

time communicating as compared to the space of the group with whom he or she spends less time communicating.

METHOD

Sample Selection

The subjects for this study are all faculty members of two colleges (the College of Business and Management and the College of Education) at a large East Coast university. Faculty members have been found to have different perceptions of the organizational climate than other university constituent groups (Hartnett & Centra, 1974; Moran & Volkwein, 1988; cf. Treadwell & Harrison, 1994), and they are representative of a somewhat homogeneous population.

Questionnaire Design

Measure for Climate Space

Following procedures recommended by Woelfel and Fink (1980), concepts related to the perception of the university were collected in a pilot study employing interviews with 36 faculty members. Each faculty member was asked to respond to the following question: What are the major issues or topics relating to the university that you find yourself discussing most often with other faculty members during an ordinary week?

More than 40 topics were generated in this manner. Three faculty members (two from the Department of Speech Communication and one from the College of Education) were asked to group and label these topics.[5] This procedure generated eight concepts to be used as the attribute concepts in the final questionnaire. These concepts were *Research, Teaching, Ideal University, Politics on Campus, Administration, Instability, Quality Education,* and *Budget.* In addition to these concepts, we included three "object" concepts, representing the "self" point (*Yourself*), the "others" point (*University Faculty*), and the referent point (*University Today*). This total of 11 concepts requires 55 paired-comparison judgments.[6]

To determine the criterion pair for the questionnaire, a second pilot study was conducted using 14 faculty members.[7] According to Neuendorf et al. (1987), "A 'yardstick' . . . ought to consist of a pair of concepts that are judged to be a distance apart that is (1) moderate and (2) relatively consistent across subjects" (p. 189). On the basis of these criteria, the distance between *University Faculty* and *Instability* was chosen as the criterion pair for this study.

Measure of Communication

Each respondent was given a list of all faculty members of his or her department so that all communication contacts within the department could be indicated. Respondents were also asked to indicate the names and departments of their contacts outside their departments. The amount of communication was measured by asking respondents to indicate how often (in minutes) during a typical week they communicated with each contact about the concepts generated from the interview data (i.e., *University Today, University Faculty, Research, Teaching, Ideal University, Politics on Campus, Administration, Instability, Quality Education,* and *Budget*). The concept *Yourself* was not included in this list.

Data Collection

Questionnaires were distributed to all faculty members of the two colleges of the university. Of the 357 questionnaires distributed, 142 were returned in the stamped, self-addressed envelopes, among which 105 were usable for data analysis. This results in an effective response rate of 29.41%. The job tenure for each faculty member (in years) was obtained through the Department of Personnel Service at the university.

Data Transformation

Estimates of psychological distance were transformed as follows: First, all values exceeding 3,000 were set to 3,000 to eliminate outliers. Second, typical of paired-comparison direct-magnitude estimation, a total of 43 respondents (40.95%) did not adopt the modulus (100) as the standard distance for the criterion pair. Any person who did not use the specified modulus had his or her scores corrected by a simple transformation.[8] Third, following the procedures recommended by Fink (1979) and Miller (1988), we used the geometric mean as the index of central tendency for an aggregated climate space.[9]

Measurement of Organizational and Group Climates

To examine the group climate spaces, we divided all the respondents into three more or less equivalent (in size) groups on the basis of their job tenure. These groups were labeled the HI tenure group ($n_{HI} = 37$, tenure $\geq$ 17 years), the MI tenure group ($n_{MI} = 34$, tenure = 5 to 16 years), and the LO tenure group ($n_{LO} = 34$, tenure ≤ 4 years). The geometric mean distances and the coordinates among the 11 concepts within each group's climate space were computed.[10] For the group climates, we were interested in the

degree of convergence among members of each group. Therefore, we calculated three similarity or agreement indexes for each climate space. These indexes are (a) the Attitudinal Similarity Index (ASI), which indicates the degree to which members of a group have similar attitudes toward climate concepts; (b) the Belief Similarity Index (BSI), which indicates the degree to which members of a group have similar beliefs or perceptions of the university; and (c) the Climate Similarity Index (CSI), which indicates the degree to which members of a group have similar overall climate perceptions. Operationally, the ASI is the root mean square of the standard errors of the distance between *Yourself* and each of the climate concepts (i.e., $[\Sigma(SE)^2/k]^{1/2}$, where k = the number of paired distances; $k_{ASI} = 10$); BSI is the root mean square error of the distance between *University Today* and each of the concept points other than *Yourself* ($k_{BSI} = 9$); and CSI is the root mean square error of the distances between all the possible pairs of concepts in the climate space ($k_{CSI} = 55$).[11] Because these indexes are root mean square errors, smaller values indicate a greater degree of within-group homogeneity. Comparisons between tenure groups were performed by using a variation of the "jackknife" procedure, which generates pseudo t tests (Mosteller & Tukey, 1977). Because the HI and LO tenure groups should manifest the greatest differences in their respective climate spaces, comparisons in the ASI, BSI, and CSI used only these two groups.

Reliability

The reliability of the paired-comparison distance estimates was estimated by computing both the fixed- and random-effects dependability coefficients (Miller, 1988). The fixed- and random-effects dependability coefficients are .955 and .950, respectively. This means that about 95% of the variance that is due to the (logarithmically transformed) paired comparison estimates is systematic, indicating very satisfactory reliability for the Galileo-type data.

RESULTS

Description of Sample

The 105 respondents include 45 professors (42.86%), 30 associate professors (28.57%), 11 assistant professors (10.48%), 12 lecturers or instructors (11.43%), and 7 faculty research associates (6.67%). Their average tenure is 12.30 years (SD = 9.47). The majority of these respondents are male (67.6%). No significant differences were found in the gender distri-

bution or the length of tenure between faculty respondents and all faculty members forming the population for this study. (Within the population of 357 faculty members, 67.3% are male; the average tenure is 12.75 years, with an *SD* of 9.38.) Thus the respondents are representative of the faculty members of the two colleges in terms of gender and tenure.

The average number of communication contacts for each faculty member was 18.07 (*SD* = 10.11, median = 16). The average number of communication contacts outside of the faculty member's own department was 2.12 (*SD* = 4.06, median = 0). More than half (58.1%) of the respondents did not mention any communication with faculty members from departments other than their own.

The Organizational Climate of the University

Table 1 presents the geometric mean distances among the 11 concepts in the organizational climate space of the university. A Galileo representation using the first three real dimensions of this climate space is presented in Figure 1 (see Table 2 for the coordinates).

Table 1 shows that the two attribute concepts farthest away from *University Today* are *Ideal University* (156.25 units) and *Quality Education* (103.86 units). This result indicates (a) that the faculty members view the university as relatively poor in its provision of quality education and (b) that they believe that the university is relatively far from ideal. The results also show that the university is perceived to be more oriented toward research (the *University Today-Research* distance = 47.13 units) than toward teaching (the *University Today-Teaching* distance = 63.35). The attribute concepts found to be very close to *University Today* are *Politics on Campus* (48.07 units), *Administration* (39.60 units), and *Instability* (66.31 units). These concepts are also the farthest away from an ideal university; the distances between *Ideal University* and each of these concepts are 130.08 units (*Politics on Campus*), 107.53 units (*Administration*), and 157.24 (*Instability*). Unlike the *University Today*, the *Ideal University* is believed to be equally related to teaching and research (the *Ideal University-Teaching* distance = 50.38 units, and the *Ideal University-Research* distance = 51.43 units).

Although the faculty members possess similar psychological distances toward research and teaching (the *Yourself-Research* distance = 27.41 units, the *Yourself-Teaching* distance = 24.22 units; $t[104] = .59$, $p = .56$), they believe that other faculty members are closer to research than teaching (the *University Faculty-Research* distance = 46.14 units, the *University Faculty-Teaching* distance = 64.17 units; $t[104] = -3.21$, $p = .002$). The faculty members view themselves as more associated with research and teaching than their colleagues (the difference between the *Yourself-Research* and *University Faculty-Research* distances = 18.73 units, $t[104] = -2.96$, $p = .004$;

TABLE 1

Geometric Mean Distances Among 11 Concepts in the Organizational Climate Space ($N = 105$)

Concept		1	2	3	4	5	6	7	8	9	10
1.	*University Today*										
2.	*University Faculty*	39.13									
3.	*Yourself*	64.96	50.27								
4.	*Research*	47.13	46.14	27.41							
5.	*Teaching*	63.35	64.17	24.22	56.68						
6.	*Ideal University*	156.25	108.48	61.06	51.43	50.38					
7.	*Politics on Campus*	48.07	70.60	151.07	127.10	116.73	130.08				
8.	*Administration*	39.60	100.96	127.85	121.83	128.80	107.53	39.93			
9.	*Instability*	66.31	100.00	98.46	129.41	102.78	157.24	52.05	73.10		
10.	*Quality Education*	103.86	74.46	25.44	33.80	19.29	20.26	147.05	97.88	178.54	
11.	*Budget*	82.53	117.39	113.20	50.23	77.99	55.56	54.05	36.49	69.23	64.87

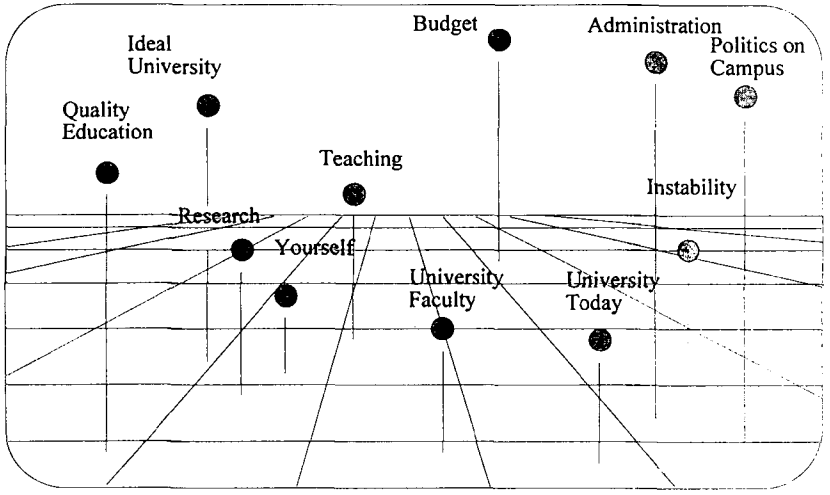

Figure 1: A Galileo Representation of the First Three Real Dimensions of the University Climate Space

the difference between *Yourself-Teaching* and *University Faculty-Teaching* distances = 39.95 units, $t[104] = -5.74$, $p = .001$).

The faculty members think that they are closer to *Quality Education* than most of the university faculty members (the *Yourself-Quality Education* distance = 25.44 units, the *University Faculty-Quality Education* distance = 74.46 units; $t[104] = -7.37$, $p = .001$). Similarly, they associate themselves more with *Ideal University* than they think their colleagues do (the *Yourself-Ideal University* distance = 61.06 units, the *University Faculty-Ideal University* distance = 108.48 units; $t[104] = -4.86$, $p = .001$). On the other hand, it seems that the faculty members believe that they are less involved in politics on campus than most of the faculty (the *Yourself-Politics on Campus* distance = 151.07 units, the *University Faculty-Politics on Campus* distance = 70.60 units; $t[104] = 5.69$, $p = .001$).

Tenure Group Communication and Climate

There are significant differences in the degrees of agreement between the HI and LO tenure groups. As one can see from Table 3, all of the similarity indexes of the HI tenure group are smaller than those of the LO tenure group. The *t* tests using jackknife procedures (see Table 4) indicate that two of the three similarity indexes between the two groups are significantly different.[12] Members of the HI tenure group have a greater degree of agreement in both their beliefs and in the overall perception of

TABLE 2

Coordinates and Eigenvalues of the Organizational Climate Space ($N = 105$)

Concept	Coordinates										
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
1. *University Today*	38.97	–40.70	–29.76	–23.74	–8.17	5.67	0.72	–19.40	4.50	35.58	33.52
2. *University Faculty*	–0.14	–41.90	–26.62	35.48	4.34	–6.24	–0.00	23.70	–13.78	25.32	–4.63
3. *Yourself*	–44.40	–44.94	20.44	–9.97	23.15	–7.81	–0.81	–4.07	30.44	2.72	–35.92
4. *Research*	–41.49	–13.61	–7.19	–10.13	–28.26	–21.48	–0.76	–8.30	–15.81	–30.63	–11.18
5. *Teaching*	–34.60	–22.49	25.69	5.70	–10.07	27.07	–0.63	–7.38	–19.77	–5.03	–29.01
6. *Ideal University*	–64.07	50.11	24.19	20.84	7.83	–6.59	–1.18	–19.71	–4.16	25.11	35.18
7. *Politics on Campus*	75.52	22.90	–13.38	30.12	–12.19	3.48	1.38	–12.39	28.57	–23.88	–12.69
8. *Administration*	48.63	42.71	–25.49	–14.39	29.03	–1.46	0.89	–7.03	–24.12	–7.71	–30.61
9. *Instability*	82.89	–21.45	47.67	–5.17	7.29	–3.52	1.52	12.27	–7.89	–22.52	40.67
10. *Quality Education*	–74.78	16.91	–30.74	–9.52	6.72	11.24	–1.37	18.06	12.00	–33.24	36.68
11. *Budget*	13.47	52.46	15.20	–19.20	–19.67	–0.34	0.25	24.24	10.02	34.28	–21.99
Eigenvalues (roots) of eigenvector matrix	31,730	14,773	7,563	4,268	3,204	1,619	12	–2,811	–3,698	–6,924	–9,180

TABLE 3
Comparisons of Similarity Indexes Between the Climate Spaces of HI and LO Tenure Groups[a]

Tenure Group	*Overall* (n = 37)	$HI_{(1)}$[b] (n = 26)	$HI_{(2)}$[b] (n = 26)	$HI_{(3)}$[b] (n = 26)
HI				
Attitudinal Similarity Index (ASI)	21.126	25.296	31.584	21.319
Belief Similarity Index (BSI)	19.419	27.143	21.434	18.841
Climate Similarity Index (CSI)	24.567	28.029	26.663	21.072
	Overall (n = 34)	$LO_{(1)}$[b] (n = 24)	$LO_{(2)}$[b] (n = 24)	$LO_{(3)}$[b] (n = 24)
LO				
Attitudinal Similarity Index (ASI)	36.282	43.734	29.583	30.299
Belief Similarity Index (BSI)	36.760	30.561	31.712	29.024
Climate Similarity Index (CSI)	46.301	39.042	36.227	32.281

a. HI tenure group: ≥ 17 years of tenure; LO tenure group: ≤ 4 years of tenure.
b. Jackknifed pseudo values.

the climate of the university. Because we have only two groups, it is hard to tell if these differences are due to different tenure per se.

The net amount of in-group communication among group members is hypothesized to be the cause of greater within-group agreement. Members of each tenure group spend significantly more time communicating with their own group members than with members of the other group. On the average, LO tenure group members spend 175.32 (*SD* = 259.72) minutes per week communicating with each other, as compared with 101.24 (*SD* = 201.36) minutes per week communicating with members of the HI tenure group. Similarly, HI tenure group members spend 292.03 (*SD* = 309.29) minutes per week communicating with each other, as opposed to 51.65 (*SD* = 113.97) minutes per week communicating with members of the LO tenure group. The HI tenure group's net amount of within-group communication (*M* = 240.38 minutes per week, *SD* = 294.47) is significantly higher than the LO tenure group's net amount of within-group communication (*M* = 74.08 minutes per week, *SD* = 315.72). This higher net amount of communication within the HI tenure group should explain why its members possess greater degrees of attitudinal, belief, and climate similarities than those of the LO tenure group.

Hypothesis 1: Reciprocity

This hypothesis predicts that an individual's attitude and his or her perception of the relation of the generalized others toward the university

TABLE 4

Pseudo Means and Results of *t* Tests of ASI, BSI, and CSI for HI and LO Tenure Groups[a]

	HI Group *Mean*[b] (n = 3)	*HI Group* SD	*LO Group* *Mean*[b] (n = 3)	*LO Group* SD	t	df	p
Attitudinal Similarity Index (ASI)	26.066	5.175	34.521	7.798	–7.17	4	.199
Belief Similarity Index (BSI)	22.473	4.247	30.329	1.513	–20.23	4	.039
Climate Similarity Index (CSI)	25.255	3.686	35.850	3.396	–31.58	4	.022

a. HI tenure group: ≥ 17 years of tenure; LO tenure group: ≤ 4 years of tenure.
b. Jackknifed pseudo values.

are two interdependent variables that constitute a "causal circle" (Strotz & Wold, 1985). To test this hypothesis, the faculty members' attitudes toward four university-related concepts (*University Today, Politics on Campus, Administration,* and *Budget*) were selected, because these four university-related concepts (unlike attitudes toward research, teaching, quality education, or the ideal university) are more of a reflection of work practices and interaction with other faculty members.

A structural equation model (Jöreskog & Sörbom, 1989a) of the nonrecursive model shown in Figure 2 was analyzed using the PC version of the LISREL 7.13 (Jöreskog & Sörbom, 1989b) computer program.

This structural equation model contained two latent variables that represent one's overall attitude (η_1) and one's perception of the generalized other's relation (η_2) to the university. Because the distance between the "self" point and each of the other concepts within the climate space can be defined as the person's attitude (Foldy & Woelfel, 1990), η_1 was measured by the pairwise distances between the concept *Yourself* and each of the four university-related concepts. These indicators were the distances between *Yourself* and *University Today* (y_1), *Yourself* and *Politics on Campus* (y_2), *Yourself* and *Administration* (y_3), and *Yourself* and *Budget* (y_4). Similarly, one's perception of the generalized other's relation to the university (η_2) was measured by the four pairwise distances between the concept *University Faculty* and each of the same university-related concepts (i.e., the distances between *University Faculty* and *University Today* (y_5), *University Faculty* and *Politics on Campus* (y_6), *University Faculty* and *Administration* (y_7), and *University Faculty* and *Budget* (y_8)).[13] Because, without additional constraints, the β_{12} and β_{21} paths are individually underidentified, our analysis tests the plausibility of a model with correlated ηs against a model in which the ηs are independent.

The covariance matrix of the eight indicators, logarithmically transformed, is shown in Table 5.

The chi-square value for the model is 47.85 with 15 degrees of freedom ($p < .001$). The null hypothesis underlying the χ^2 goodness-of-fit test for the model is that the population (unrestricted) covariance matrix and the population model-based (restricted) covariance matrix are equal. Therefore, we are looking for a nonsignificant χ^2 value to "support . . . the hypothesis that the imposed structure accounts for the observed covariance" (Fink & Monge, 1985, p. 182). We also used the rule of thumb of dividing the chi-square value by its degrees of freedom (see, e.g., Wheaton, Muthén, Alwin, & Summers, 1977). The resulting χ^2/df ratio is 3.19, which indicates that the model is a reasonable fit to the observed data. This reasonable fit is also manifested through other goodness-of-fit measures (e.g., goodness-of-fit index = .897, adjusted goodness-of-fit index = .752, and root mean square covariance residual = .309). The proposed model is

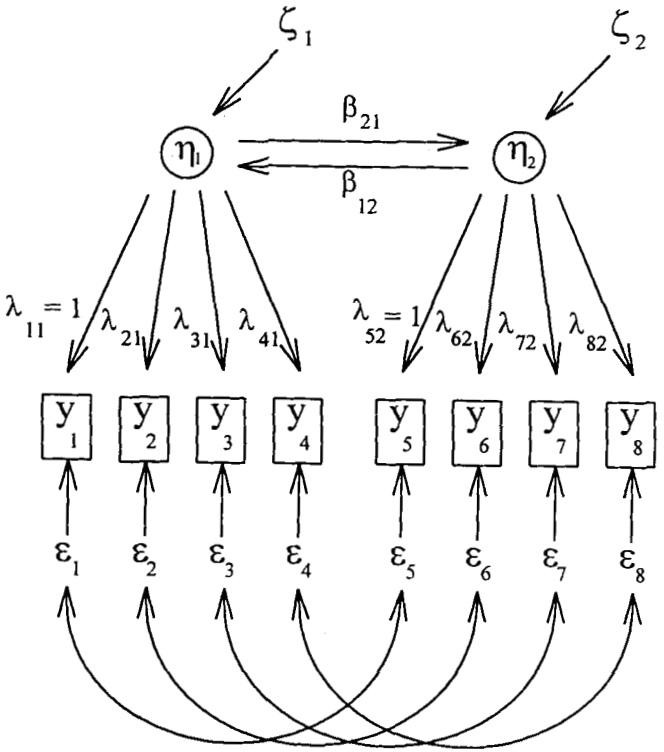

Figure 2: A Nonrecursive LISREL Model of the Faculty Member's Attitude and His or Her Perception of the Generalized Attitude Toward the University

Unobserved variables:

η_1: One's attitude toward the university.

η_2: One's perception of the generalized other's view toward the university.

Observed variables:

y_1: *Yourself-University Today* distance.

y_2: *Yourself-Politics on Campus* distance.

y_3: *Yourself-Administration* distance.

y_4: *Yourself-Budget* distance.

y_5: *University Faculty-University Today* distance.

y_6: *University Faculty-Politics on Campus* distance.

y_7: *University Faculty-Administration* distance.

y_8: *University Faculty-Budget* distance.

found to be a significant improvement over the null model: null model $\chi^2(28, N = 100) = 375.26$; $\chi^2_{\text{difference}}(13, N = 100) = 327.41$. Bentler and Bonett's (1980) normed fit index (Δ) is .872, which indicates that less than 13% of fit is unexplained by the proposed nonrecursive model (see Fink & Monge, 1985). However, there is evidence that the factor structure as hypothesized was too restrictive (because of finding an inadmissibly high squared

TABLE 5
Covariance Matrix for the Eight Indicators in the Nonrecursive Model Regarding University-Related Attitudes ($N = 100$)

Paired Distance		y_1	y_2	y_3	y_4	y_5	y_6	y_7	y_8
y_1	*Yourself-University Today*	2.561							
y_2	*Yourself-Politics on Campus*	1.108	1.833						
y_3	*Yourself-Administration*	1.238	1.176	1.932					
y_4	*Yourself-Budget*	1.007	0.841	1.117	1.570				
y_5	*University Faculty-University Today*	2.083	1.177	1.033	0.907	2.940			
y_6	*University Faculty-Politics on Campus*	0.607	0.617	0.512	0.345	0.659	1.376		
y_7	*University Faculty-Administration*	0.627	0.558	0.685	0.589	0.583	0.879	1.151	
y_8	*University Faculty-Budget*	0.324	0.290	0.454	0.381	0.401	0.034	0.295	0.820

multiple correlation for y_7, indicating a Heywood case; see Fink & Mabee, 1978).

To test whether the covariance between η_1 and η_2 is significantly different from zero, we compare our hypothesized model with one in which the βs are set to be zero, and in which all the other remaining specifications are the same. This new model has χ^2 (16, N = 100) = 84.01; the test for the covariance equaling zero has $\chi^2_{\text{difference}}$ (1, N = 100) = 36.16, $p < .001$. Thus we conclude that the covariance is significantly different from zero.

For the heart of the model, that is, the reciprocal relationship between η_1 and η_2, we examine the structural equations

$$\eta_1 = \beta_{12}\eta_2 + \zeta_1 \quad [1]$$

and

$$\eta_2 = \beta_{21}\eta_1 + \zeta_2. \quad [2]$$

We assumed that β_{12} equals β_{21}; their common value is estimated as .282 (SE = .075, t = 3.739, $p < .001$). β_{12} and β_{21} reflect the equilibrium values of the dynamic processes represented by Equations 1 and 2. The squared multiple correlation is .169 for Equation 1 and .357 for Equation 2.

Hypothesis 2: Self-Organization Convergence

This hypothesis predicts that, controlling the effect of tenure, there exists a positive relationship between the *Yourself-University Today* distance and the amount of communication. Hypothesis 2 was tested with the following equation:

$$Y = f(X_1, X_2) + E, \quad [3]$$

where Y = the distance between *Yourself* and *University Today*, and f = a linear function of monotonic transformations of X_1 and X_2, X_1 = the amount of communication (in minutes per week) with other faculty members of the university, X_2 = tenure (in years), and E = the error term.

A multiple regression analysis was executed by a PC version of the SHAZAM computer program (White, 1990).[14] The squared multiple correlation coefficient (R^2) for Equation 3 is .097, $F(2, 102) = 5.465$, $p = .006$. β_1 and β_2 (the standardized regression coefficients for the transformed X_1 and X_2, respectively) were found to be –.293 (t[102] = –3.111, $p = .002$) and –.087 (t[102] = –.925, $p = .357$).[15] Although tenure is not significantly related to the dependent variable, the amount of communication has a significant (and negative) effect on the faculty member's perceived psychological distance from the university, and the two independent variables together account for almost 10% of the variance in the dependent variable.

Hypothesis 3: Self-Group Convergence

This hypothesis predicts that, controlling for the effect of tenure, an individual's climate space will become more similar to the space of the group with whom he or she has a greater amount of communication as compared with the space of the group with whom he or she has less communication. To test this hypothesis, each faculty member's climate space was rotated and translated to a least squares best fit with the spaces of the HI, MI, and LO tenure groups.[16] The root mean square of the difference between all points in the individual space and their counterparts in each group space was taken as the degree to which the individual's climate space is similar to the space of that particular group. Because respondent was asked to list the names of his or her communication contacts, these contacts were able to be categorized into the three tenure groups on the basis of the same cutoff points as those employed to classify the respondents. The individual's amount of communication with each of the three tenure groups was subsequently calculated.

We report the results from one of the three possible equations that could be used to test Hypothesis 3:[17]

$$Y = f(X_1, X_2) + E, \qquad [5]$$

where Y = the mean difference between the person's and the HI tenure group's climate space + the mean difference between the person's and the LO tenure group's climate spaces (i.e., the relative dissimilarity to the HI tenure group, as opposed to the absolute similarity), f is a linear function of monotonic transformations of X_1 and X_2, X_1 = the amount of communication with the HI tenure group minus the amount of communication with the LO tenure group (i.e., the net amount of communication to the HI tenure group, as opposed to the total amount), X_2 = the person's tenure, and E = the error term. A Y value greater than 1 indicates that the individual's climate space is more dissimilar to, or farther away from, the space of the HI tenure group (as compared with the space of the LO tenure group), whereas a Y value smaller than 1 indicates a climate space that is more similar to the space of the HI tenure group (as compared to the LO tenure group). Because the X_1 value for each individual was obtained by subtracting his or her amount of communication with the LO tenure group from his or her amount of communication with HI tenure group, a positive X_1 value indicates a positive net amount of communication with the HI tenure group, whereas a negative X_1 value indicates that the person has a greater amount of communication with the LO tenure group than with the HI tenure group. Therefore, in Equation 5, we hypothesize a negative relationship between Y and X_1.[18] Because a smaller Y value indicates a greater degree of similarity to the climate space of the HI tenure group, Y should be negatively related to X_2 (tenure).

The squared multiple correlation coefficient for Equation 5 is statistically significant, $R^2 = .109$, $F(2, 102) = 6.238$, $p = .003$. As proposed, there indeed exists a negative linear relationship between Y and X_1; the standardized regression coefficient $\beta_1 = -.223$, $t(102) = -2.228$, $p = .028$. Although a person's tenure (X_2) is also found negatively related to Y, this relationship is not quite significant at conventional levels; $\beta_2 = -.176$, $t(102) = -1.755$, $p = .082$.

DISCUSSION

We find a significant covariance between an individual's own attitude and his or her perception of the relation of the generalized other to the university. The fit of the structural equation model is somewhat problematic, but the results of the analysis of the model are consistent with the view that one's attitude toward the university is influenced by one's perception of how one's colleagues think about the university, and vice versa. The mirroring process found between one's relation to the university and one's perception of the relation of the generalized other to the university confirms what organizational climate researchers have long been theorizing about: the intersubjectivity of climate.

The statistically significant (and negative) correlation between the amount of communication and the *Yourself-University Today* distance appears consistent with the positive relationship between communication and job satisfaction found previously (Daly, Falcione, & Damhorst, 1977; Pincus, 1984). A number of researchers have suggested that closeness to the self-concept is associated with positive affect or preference (Woelfel, 1976, cited in Neuendorf et al., 1987). Therefore, the distance between *Yourself* and *University Today* may be considered as an index of organizational satisfaction such as is measured in the *ICA Communication Audit* (Goldhaber & Rogers, 1979). The positive relationship of satisfaction with communication found in previous organizational communication research provides some validation for the findings of the present study.

The HI tenure group is found to have a greater amount of net within-group communication than the LO tenure group, and the HI tenure group also has a greater degree of within-group agreement. These findings are consistent with the idea that subsystems whose internal communication exceed their external communication ought to manifest greater internal homogeneity (see Woelfel & Fink, 1980, pp. 190-192). The idea of using the *net* amount of communication is important because no group is isolated. The rate of a local region's convergence toward a homogeneous state resulting from internal communication always can be delayed or reversed by the exchange of new information from outside (Barnett & Kincaid,

1983; Woelfel & Fink, 1980). As a result, the amount of communication with outside group members provides a possible source of attitudinal or belief divergence.

Contrary to our study, Treadwell and Harrison (1994) reported that "faculty members with longer tenure . . . developed images that were increasingly dissimilar to their colleagues" (p. 79). Unlike our study, which used amount of communication and tenure simultaneously as predictors of climate similarity, their study examined the zero-order correlation between time and similarity. In addition, this study employed the strategy of looking at *net* (i.e., in-group minus out-group) amounts of communication rather than the gross (total) amount. These two strategies were crucial in enabling us to test the thermodynamic hypothesis regarding communication and the convergence of climate and may account for the difference in the findings of our study and theirs.

Future Research

Future climate studies should examine the climate perception from both egoistic and alter egoistic (i.e., the generalized other's) standpoints. Although there is consensus among Galileo researchers (e.g., Marlier, 1983; Neuendorf et al., 1987; Woelfel & Fink, 1980) that the self-concept should be included in the cognitive space along with other concepts of interest, few have recognized the important role that a concept such as *Others* plays in the understanding of the cognitive process. Many of our findings are a consequence of the inclusion of the *University Faculty* concept in the climate space.

Our results support the hypothesis that faculty members who spend more time communicating with other faculty members tend to feel "closer" to the university, and our third hypothesis regarding convergence is suggestive of the idea that human cognitive processes can be modeled analogously to physical processes. Conceptualizing communication as a thermodynamic process allows us to derive the prediction concerning the convergence of beliefs and attitudes. Furthermore, our result is consistent with previous findings based on similar convergence models (Barnett & Kincaid, 1983; Kincaid, 1988; Rogers & Kincaid, 1981). However, additional research, using time-series, longitudinal, or experimental methods, is needed to clarify the dynamics of the convergence process we examined.

Our study employed theoretical tools that imposed specific measurement rules: We used relatively precise measures of the amount of communication, and we differentiated in-group and out-group communication sources, net from gross amount of communication, and relative similarity from absolute similarity of climate. We suggest that these form a good scientific strategy and a good way to study communication processes.

NOTES

1. An examination of the terminology surrounding the study of culture and climate reveals many different terms applied idiosyncratically by different authors. For example, Treadwell and Harrison (1994) employed the term *organizational image* and defined this as a "set of cognitions, beliefs, attitudes, as well as impressions about organizationally relevant behaviors, that a person holds with respect to an organization" (p. 66). This individual measure is quite similar to psychological climate, but, unlike the methodology to be described below, Treadwell and Harrison differentiated organizational image from "more structured cognitions, such as . . . cognitive maps" (p. 66). We argue that the profusion of terminology has, if anything, obfuscated fundamental issues for organizational scholars. In addition, with few exceptions, different terminologies have not become associated with corresponding methodologies of organizational analysis.

2. Note that the individual's perceived distance between *Others* and any other concept represents first-order perspectival knowledge rather than metaperspectival information.

3. For instance, Barnett, Serota, and Taylor (1976), in a study of campaign communication and political attitude change, theorized that the political party or candidate closest to the self-concept would be the party or candidate most preferred by the voters. Albrecht (1979) found that the distance between the self-concept and the concept of *the Job* was closer for people who played a key role in the communication system (i.e., key communicators) than for nonkey communicators, because key communicators tend to perceive more involvement with their jobs.

4. Admittedly, this idea would be more adequately tested by a longitudinal design in which both communication and psychological distance are measured at multiple points in time. Using cross-sectional data to test a dynamic process is always risky unless we examine the possible effect of time on the subject matter: First, we have to assume that the observed data reflect an equilibrium relation among the variables involved in this dynamic process (Coleman, 1968, p. 444; Fink & Mabee, 1978). Second, we have to take into account the process that leads to this stable state. This means that we should control for the possible effect of time on the proposed relationship and include the organization member's longevity of employment in our hypothesis. However, because tenure in an organization is correlated with amount of communication, we will not be able to distinguish fully the effects of these two predictors.

5. One of the two faculty members from the Department of Speech Communication is a scholar in the field of organizational communication and climate, whereas the other is a rhetorician. In addition, a faculty member from the College of Education was also employed because almost half of our sample was drawn from this college, and thus we thought that this individual's judgment would be especially helpful.

6. The term *University*, as it appears in several of the concepts, represents the name of the university in question. The actual name is what appeared in the questionnaire.

7. Following Woelfel and Fink's (1980) recommendation, in this pilot study the question "If Red and White are 100 units apart, how far apart are _____ and _____?" was used to estimate the distances of all 55 pairs of concepts.

8. This correction is accomplished by the transformation equation $x' = x(100/y)$, where x is the original value of a nonyardstick response, x' is the transformed value, and y is the response to the yardstick (criterion pair) given by the individual.

9. These procedures involve "performing a logarithmic transformation on the data, calculating the mean, and then exponentiating this result" (Neuendorf, Kaplowitz, Fink, & Armstrong, 1987, p. 197). Because the logarithm of zero is undefined, the value of 1 was added to each raw value prior to taking the logarithm; this value was subsequently subtracted from the exponentiated score. Transformed data are used for all statistical analyses reported.

10. Note that, in the analyses reported below, the focal individual's distances enter into the aggregate space, which results in a nonzero correlation between indicators derived from the set of individual spaces and indicators derived from the corresponding spaces of the groups in which these same individuals are members. However, an individual accounts for less than 3% of the group data. In addition, the data have been transformed to, among other things, eliminate outliers, so that no one individual can significantly determine the aggregate space. Hence this artifact of the analysis cannot substantially determine the results presented below.

11. Thus the Climate Similarity Index (CSI) is not independent of the Attitudinal Similarity Index (ASI) and the Belief Similarity Index (BSI).

12. The jackknife procedure (Mosteller & Tukey, 1977) was performed in the following manner: First, three random subsamples were drawn from each tenure group; each is about two thirds the size of the tenure group from which it was drawn. Each subsample of the HI tenure group ($n = 37$, tenure ≥ 17 years) contains 26 cases; each subsample of the LO tenure group ($n = 34$, tenure ≤ 4 years) contains 24 cases. Second, for each subsample, the pseudovariance of each paired distance ($\hat{\sigma}^2_{*i}$) was calculated by using the formula $\hat{\sigma}^2_{*i} = r\hat{\sigma}^2_{all} - (r - 1)\,\hat{\sigma}^2_{(i)}$, where $\hat{\sigma}^2_{all}$ = the variance of the paired distances for the tenure group, $\hat{\sigma}^2_{(i)}$ = the variance of the paired distances for the ith subsample, and r = the number of subsamples for each tenure group. The pseudo-standard error is obtained by taking the square root of the pseudovariance and dividing it by the square root of the number of cases. Third, a pseudo-similarity index was obtained from each subgroup by calculating the root mean square of the pseudo-standard errors. Finally, the difference between HI and LO tenure groups was tested using a pseudo-t test (the size of each subsample = 3).

13. In our proposed nonrecursive model, we had 36 ($8 \times 9 / 2 = 36$) nonredundant elements in the unconstrained covariance matrix Σ_u. After making two metric assumptions (i.e., setting λ_{11} and λ_{52} to be 1), there were 18 parameters to be estimated (i.e., 2 in $\mathbf{B}$, 6 in Λ_y, 8 in Θ_ϵ, and 2 in Ψ). Whereas the paths between η_1 and η_2 are individually underidentified, the covariance between them is overidentified. Therefore, we estimated the model arbitrarily, constraining β_{12} and β_{21} to be equal for purposes of identification.

In addition, we freed four parameters: $\theta_{15} = \mathrm{Cov}(\varepsilon_1, \varepsilon_5)$, $\theta_{26} = \mathrm{Cov}(\varepsilon_2, \varepsilon_6)$, $\theta_{37} = \mathrm{Cov}(\varepsilon_3, \varepsilon_7)$, and $\theta_{48} = \mathrm{Cov}(\varepsilon_4, \varepsilon_8)$. This modification makes sense theoretically because the unique component of an individual's attitude toward a particular concept may conceivably covary with the unique component of his or her perception of the relation of the generalized other toward that concept. The proposed model met the necessary condition for identification by the counting rule, with degrees of freedom = 15. The model was compared with one in which the covariance between η_1 and η_2 is fixed to be zero.

14. We used the SHAZAM program to analyze the regression equation because this program not only provides various procedures to linearize the data but also tests for the normality and homoscedasticity of the resultant residual distribution.

15. Prior to the regression analysis, the data were transformed to meet the assumption of homoscedasticity and normality of residuals. These procedures involve (a) performing a logarithmic transformation on the distance between *Yourself* and *University Today*, (b) conducting a Box-Cox regression analysis on Equation 3, and (c) selecting the transformation function that best meets the statistical assumptions. A combined Box-Cox and Box-Tidwell transformation in which the endogenous and exogenous variables were transformed to different powers ($\lambda = 2.00$, $\mu_1 = 2.53$, and $\mu_2 = -.05$) was chosen. This transformation created residuals that best met the statistical assumptions of normality and homoscedasticity, resulting in a nonsignificant χ^2 test of the residuals' departure from these assumptions, $\chi^2(5, N = 105) = 6.54$, $p > .05$. For more on data transformation, see Bauer and Fink (1983); White, Wong, Whistler, and Haun (1990); and White (1980). Hypothesis 2 was tested by the following equation:

$$\text{Log}(Y)^{(2)} = b_1X_1^{(2.53)} + b_2X_2^{(-.046)} + E, \quad [4]$$

where $\text{Log}(Y)^{(2)} = \{[\text{Log}(Y)]^2 - 1\}/2$, $X_1^{(2.53)} = (X_1^{2.53} - 1)/2.53$, and $X_2^{(-.046)} = (X_2^{-.046} - 1)/(-.046)$.

16. The Galileo computer program adopts an "orthogonal Procrustes" procedure that involves "transforming a given matrix A into a given matrix B by an orthogonal transformation matrix T so that the sums of squares of the residual matrix $E = A \times T - B$ is a minimum" (Schönemann, 1966, p. 1). See also Note 10.

17. The other two regression analyses are the comparisons between the HI and MI (n = 34, tenure = 5 to 16 years) tenure groups, and between the MI and LO tenure groups.

18. Prior to the regression analysis, data were transformed to meet the homoscedasticity and normality assumption for the distribution of residuals. After a series of Box-Cox regression analyses, the following functional form was adopted (goodness-of-fit test for normality of residuals: $\chi^2 = 12.158$, $df = 5$; $.025 < p < .05$):

$$Y = b_1X_1^{(.52)} + b_2X_2^{(-.10)} + E, \quad [6]$$

where $X_1^{(.52)} = (X_1^{.52} - 1)/.52$, and $X_2^{(-.10)} = (X_2^{-.10} - 1)/(-.10)$.

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