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ORGANIZATIONAL DEMOGRAPHY: THE DIFFERENTIAL EFFECTS OF AGE AND TENURE DISTRIBUTIONS ON TECHNICAL COMMUNICATION

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Although previous researchers have proposed organizational demography as an important determinant of communication, no one has tested this relationship directly. Further, distinctions between the impacts of different demographic variables on communication have not been explored. This study used sociometric data collected from a U.S. electronics firm to examine such relationships. The results show a relationship between age and tenure distributions and the frequency of technical communication. Moreover, the results suggest that inside project groups, age distributions exert greater influence than tenure distributions on the frequency of technical communication but that the reverse relationship holds for technical communication outside project groups.

The literature suggests that an organization's demographic composition influences communication because people tend to communicate with those who are similar to themselves (Kanter, 1977; Pfeffer, 1981, 1983; Simmel, 1950). Although this explanation has been applied to a variety of important outcomes, such as turnover (Wagner, Pfeffer, & O'Reilly, 1984) and performance ratings (Tsui & O'Reilly, 1989), little empirical evidence exists for the connection between organizational demography and communication frequency. O'Reilly, Caldwell, and Barnett's (1988) recent examination of the relationship between demography and employees' perceptions of work group integration supported the existence of this connection. However, that study did not directly assess communication frequency. Further, to our knowledge, no work on organizational demography has examined the potentially differential effects of various demographic variables on communication frequency. Researchers generally characterize organizations as demographically homogeneous or heterogeneous, employing either a single demographic variable or a set of demographic variables. Yet there is no a priori

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reason to believe that age, race, and tenure exert the same influence on the frequency of communication. The current study served two purposes. First, within an organizational setting, we examined the relationship between age and tenure similarity, the two most frequently discussed demographic variables, and communication frequency. Second, we tested hypotheses concerning the differential impacts of those demographic variables on communication inside and outside project groups.

THEORY

Organizational Demography, Technical Communication, and Performance

Research and development organizations provide a particularly appropriate setting for examining the factors that influence communication. Oral communication with individuals inside and outside project groups is the primary medium through which engineers and scientists transfer technical information (Allen, 1977). Such communication permits individuals to synthesize complex ideas rapidly and to give one another immediate feedback. Thus, this method of communication provides an efficient medium for the transfer of information and ideas (Mintzberg, 1973; Myers & Marquis, 1969; Tushman, 1978). Not surprisingly, numerous studies have confirmed a relationship between oral communication and project performance in R&D laboratories (cf. Allen, 1970; Katz, 1982; Pelz & Andrews, 1976; Rubenstein, Chakrabarti, O'Keefe, Souder, & Young, 1976). Although the exact nature of the relationship between this mode of technical communication and project performance depends on factors such as task and project type (Chakrabarti & O'Keefe, 1977; Katz & Tushman, 1978; Tushman, 1978), studies have generally agreed that frequent communication from at least some project group members to colleagues both inside and outside their project group is vital to high project performance.

The positive association between technical communication and project performance indicates the importance of designing internal structures in research and development organizations that facilitate technical communication. Yet, aside from that provided by studies of task characteristics and physical proximity (Barnlund & Harland, 1963; Hackman, 1968; Katz & Tushman, 1979; Tushman, 1978), little evidence exists on the determinants of technical communication. Pfeffer (1981, 1983) suggested that the distribution of employees in an organization along some demographic dimension such as age, tenure, or gender influences communication frequency and thus produces organizational outcomes. In universities, for example, time gaps between adjacent faculty hires create "lumpy" tenure distributions. As these gaps increase, communication between different tenure groups becomes more difficult; the process isolates particular groups, encourages conflict and power struggles, and hence promotes more voluntary resignations than might otherwise occur (McCain, O'Reilly, & Pfeffer, 1983). If organizational demography does influence the frequency of communication, the demo-

graphic attributes of organizations, because they are easily measured and in some cases easily altered, may provide project and human resource managers with a useful tool for facilitating high performance in research and development organizations.

Communication Frequency and Demography: Age and Tenure

March and Simon (1958) proposed that the frequency of communication between two employees increases with the efficiency or ease of communication. Related research has suggested that the presence of a shared language or coding scheme determines the efficiency of communication (Allen & Cohen, 1969; Dearborn & Simon, 1958; Katz & Kahn, 1966; Newcomb, 1953; Runkel, 1956; Triandis, 1960; Tushman, 1978). A language shared among the members of a group reflects similarities in how they interpret, understand, and respond to information. Individuals unfamiliar with this shared language are likely to distort and misinterpret information received from group members and thereby to find communication with group members difficult (Barnlund & Harland, 1963; Rogers & Bhowmik, 1971).

Within organizations, the development of a shared language between employees results at least in part from their similar backgrounds and experiences. The experiences employees share inside organizations produce a common vocabulary and common interpretations of events that facilitate work-related communication (Allen & Cohen, 1969; Lawrence & Lorsch, 1967). Employees' shared familiarity with a successful, previously completed project, for instance, contributes to a common vocabulary and understanding of current work. In contrast, the background and experiences employees share outside organizations create a shared language concerning a wide spectrum of non–work-related issues by influencing employee attitudes, interests, and beliefs (Rhodes, 1983; Ryder, 1965). For example, employees with children of the same age tend to have similar events occurring in their family lives, which produces a shared language, including a common vocabulary and interpretation of those events (Runkel, 1956; Triandis, 1960).

The work-related and non–work-related communication patterns produced by these similarities are likely to persist because of the tendency for communication patterns to stabilize in organizations (Katz, 1980; March & Simon, 1958; Roberts & O'Reilly, 1978; Weick, 1979). As two individuals communicate over time, they develop a form of language compatibility that is unique to them. Two employees may, for instance, share a common organizational experience that facilitates initial conversations. As they continue to converse, they quickly develop additional similarities in attitudes, language, trust, and experience that facilitate subsequent communication (Kiesler & Kiesler, 1969; Williamson, 1985). In addition to these acquired similarities, continued communication among employees results in comfortable work patterns (Katz, 1982) and consequent feelings of security for those involved (Weick, 1979). Hence, initial conversations triggered by a single shared experience or other common background produce over time a form of

shared social investment that employees are reluctant to forfeit. As such social investments mount, communication patterns become increasingly stable.

Demographic attributes such as age, tenure, occupation, and gender provide surrogate measures for the common experiences and background that shape language development. For instance, employees with different occupations often share few job-related experiences and thus develop very different occupational languages (Triandis, 1959). Similarly, employees of different genders often have very different social, educational, and work experiences. These differences in background and experience may result in language differences that constrain communication among employees of different occupations or genders. Thus, because demographic attributes produce shared experiences and shared experiences create language compatibilities, people who share demographic attributes are believed to communicate more frequently than those who do not (March & Simon, 1958: 167; Pfeffer, 1983). Consequently, the degree to which an employee is demographically similar to others in an organization may be an important determinant of how frequently that employee communicates within the organization. In this study, we focused on the two most frequently examined demographic variables in organizations, age and tenure, both of which seemed likely to be important determinants of language.

Age. Employees of similar age, regardless of their expertise, status, or tenure in an organization, tend to have common non–work-related experiences. Ryder suggested that a group of individuals of similar age takes on "a distinctive composition and character reflecting the circumstances of its unique origin and history" (1965: 845). For instance, employees who were college students during the Vietnam War share memories of their experiences during those social upheavals. And employees who grew up during the Great Depression share memories of the effects of that economic disaster that distinguish them from younger employees. In addition to such historically generated similarities, employees of similar age tend to share common non–work-related experiences because they tend to be at similar points in their family lives (Lawrence, 1980). The youngest employees tend to be unmarried, and slightly older employees tend to be newly married with young children. Middle-aged employees may be divorced and have parents who need special care, and older employees tend to look forward to quiet lives without dependents and with grandchildren.

These common experiences outside the workplace appear to produce shared attitudes, interests, and beliefs among employees of similar age inside the workplace (Rhodes, 1983). For instance, studies have shown a positive association between age and job satisfaction (Hunt & Saul, 1975; Kalleberg & Loscocco, 1983). People tend to become more satisfied with work as they grow older, regardless of their tenure, gender, occupational level, income, and education. Research has also reported positive associations between age and job involvement (Saal, 1978) and between age and commitment (Morris & Sherman, 1981), and a negative association has been re-

ported between age and intention to quit (Mobley, Horner, & Hollingsworth, 1978). Because common attitudes, interests, and beliefs both produce a common language (Runkel, 1956; Triandis, 1960) and encourage communication (Byrne, 1969; Lazarsfeld & Merton, 1954; Rogers & Bhowmik, 1971), age similarity seems likely to enhance communication between two employees.

Although age similarity may produce similarity in general attitudes about work that facilitate communication, such attitudinal similarity is unlikely to have much direct bearing on conversations about technical work. Technical conversations are facilitated by a common technical language that is in most cases not directly related to similarity in age.[1] Thus, age similarity is more likely to facilitate nontechnical discussions at work. Nevertheless, the self-reinforcing nature of communication links (Homans, 1950; March & Simon, 1958) implies that the communication channels produced by non–work-related conversations will influence the ease of work-related communications. Employees may, for instance, initially converse about common interests outside the workplace. However, once they have established a communication channel, they may also use it for technical communication. Thus, although age similarity has its most direct effect on informal, non–work-related communication (Lincoln & Miller, 1979), it also has an indirect effect on more formal technical communication. Therefore,

> *Hypothesis 1: Employees who are relatively similar to each other in terms of age will communicate more frequently about technical issues than employees who are relatively dissimilar.*

Tenure. The employees of most organizations develop a unique common language that facilitates communication about work-related issues (Allen & Cohen, 1969; Guetzkow, 1965; March & Simon, 1958; Williamson, 1975, 1985). In research and development settings, this language facilitates communication about technical issues. As tenure in an organization increases, employees attain a better understanding of policies and procedures and a better understanding of the way technical work is accomplished. Thus, because tenure functions as an indicator of organizational experience, it also functions as an indicator of familiarity with the organizational language (March & Simon, 1958). Further, employees will find communication most efficient with other employees whose organizational language skills are at least as extensive as their own, and hence employees will seek communication with others whose tenure in an organization is at least as great as their own. But, since all employees are likely to seek communication with others whose tenure is at least as great as their own, only communication among

[1] An important exception is age functioning as a surrogate measure for familiarity with the technology used on a job. For instance, young engineers may receive common external training in state-of-the-art technologies while in college or graduate school. Such training may be difficult to obtain on the job. Hence, in some settings age, much like tenure, may serve as a surrogate measure for technical language development. However, this is likely to occur only in work settings involving technologies more advanced than that examined in this study.

employees of similar tenure is likely to be reciprocated. In addition, individuals of similar tenure may develop unique interpretations and understandings that stem from shared experiences on projects or commonly experienced organizational events. Such idiosyncratic language may cause individuals of similar tenure to be out of touch with their senior or junior colleagues and thereby encourage employees to communicate only with others in their tenure group.

The tendency for communication patterns to stabilize may further concentrate communication around those similar in tenure. Assume for the moment that existing communication patterns in an organization are randomly determined and are thus independent of tenure, and that through social investments they have stabilized over time. A group of individuals entering such a setting with a strong desire to establish communication links has two options. The first is to establish ties with employees who already have deeply entrenched communication networks (Wagner et al., 1984). The second is to establish ties among themselves. Penetrating established communication networks is difficult for new employees. Such activity disrupts current networks (Roberts & O'Reilly, 1979) and hence threatens to destroy the value of social investments inherent in these networks for longer-tenured employees. On the other hand, because all new entrants share a need to develop communication links, new entrants will find it relatively easy to communicate with other new entrants. Therefore, because of similarity in organizational language and the presence of social investments,

> *Hypothesis 2: Employees who are relatively similar to each other in terms of their organizational tenure will communicate more frequently about technical issues than employees who are relatively dissimilar.*

Technical Communication and Demography: Inside and Outside Project Groups

In the preceding discussion, we argued that an organization's age and tenure distributions exert a systematic effect on technical communication: as demographic similarity increases, technical communication should increase. However, technical communication differs inside and outside project groups. Communication inside project groups generally involves communication among employees who work near one another, collaborate daily on project tasks, and are supervised by the same individual. In contrast, communication outside a project group yet within an organization generally involves communication among employees who do not collaborate daily on project tasks, work at a distance from one another, and are supervised by different individuals. In this section, we propose that although age and tenure similarity both contribute to the frequency of technical communication, their contribution differs inside and outside project groups.

Two assumptions guided our hypotheses about the effects of age and tenure similarity on technical communication. First, because tenure similarity directly facilitates work-related technical communication and age sim-

ilarity primarily affects technical communication indirectly through non–work-related communication, we assumed that tenure similarity exerts a stronger influence on technical communication than age similarity.

Second, we assumed that the effect of tenure similarity on the frequency of technical communication diminishes over time. Because individuals enter organizations relatively uninformed, they have strong incentives to develop the language skills that facilitate effective communication. As a result, employees make their most rapid gains in organizational language skills during an initial socialization period. However, after employees learn basic language skills, further gains in language development make increasingly less dramatic differences in their ability to communicate effectively. Thus, language differences associated with differences in tenure are likely to diminish over time. For example, when two employees have been in an organization one and four years respectively, the difference of three years of organizational experience between them may substantially impede communication. However, ten years later, substantial language differences between these employees may not exist, and therefore the three years difference in organizational experience may have no effect on their ease of communication. However, because social investments that stabilize communication patterns are unlikely to diminish over time, the relationship between tenure similarity and frequency of technical communication may not disappear.

Using these two assumptions, we derived hypotheses concerning the relative effects of age and tenure similarity on the frequency of technical communication among employees inside and outside project groups.

Inside project groups. The impact of tenure similarity on technical communication is likely to diminish rapidly within project groups. The typical engineering project involves considerable interdependence of project members. This interdependence creates strong incentives for current members to help new members quickly overcome language and skill deficiencies that would impede the group's performance. In addition, the relatively small number of employees inside project groups produces a high density of communication (Collins & Guetzkow, 1964), thereby further facilitating the speed with which new members develop work-specific language skills. As a result, new members are assimilated rapidly inside project groups, and their levels of technical communication inside project groups do not differ from the communication levels of their senior colleagues (Lee & Allen, 1982). Hence, location inside project groups minimizes the effect of tenure similarity on technical communication. In contrast, the effects of age similarity on technical communication, discussed earlier, seem unlikely to change over time. This assumption seems reasonable because age similarity affects technical communication only indirectly, primarily through non–work-related communication. Thus,

> *Hypothesis 3: The age similarity of project group members has a greater impact than their tenure similarity on the frequency of technical communication inside project groups.*

Outside project groups. Although the impact of tenure similarity on technical communication outside project groups should also diminish over time, it is unlikely to diminish as quickly as it will inside a work group. Employees in different project groups tend to be much less interdependent than employees within the same group. Consequently, it seems likely that long-tenured employees have fewer incentives to teach new employees in other project groups the language skills required to communicate effectively outside their project groups. Moreover, the relatively low density of communication outside project groups means that the requisite language and skills for communicating outside a group are likely to develop rather slowly. Thus, the association between tenure and outside-the-work-group language skills is likely to persist longer than the association between tenure and inside-the-work-group language skills. Therefore, given that in general, tenure similarity has a greater effect on technical communication than age similarity,

> *Hypothesis 4: The tenure similarity of employees who are not members of the same project group should have a greater impact than their age similarity on the frequency of technical communication outside project groups.*

METHODS

Data

Data for this study were obtained from the population of engineers and engineering managers in a research division of a medium-sized U.S. electronics firm. The division is geographically isolated from the rest of the firm and primarily conducts development work, as opposed to basic research or technical service projects (cf. Katz & Tushman, 1979). The division's work can be characterized as moderately rather than highly technological. The division, which we hereafter call the organization, has 19 project groups ranging in size from three to nine members. All project groups are located on the same floor in one building. Each engineer has an office or working area surrounded by a five-foot partition. Most project groups meet informally weekly. The average age of engineers and engineering managers is 39 (s.d. = 9.8, range = 26–65), and their average tenure is 5.7 years (s.d. = 5.3, range = 0–24). The organization has a dual-track engineering–management career that includes six levels. Questionnaires were distributed to the organization's 92 engineers and engineering managers. Nearly all questionnaires were returned (N = 88), yielding a 96 percent response rate. In addition, we obtained demographic data on the 92 employees from the company's personnel records.

Control Variables

Several control variables were important for this study. First, we controlled for any direct effect of organizational tenure on technical communication. As an employee's organizational tenure increases, interpersonal relationships develop, and opportunities to speak with others may increase;

therefore, technical communication should increase. Thus, tenure may influence technical communication independent of an employee's similarity in tenure to others in the organization. Second, we controlled for the effect of career level on technical communication. As employees advance to higher career levels, the task characteristics of their jobs may require more frequent communication. Further, an employee's career level influences technical communication through the impact of formal hierarchy on status and interaction channels (Homans, 1974; Lincoln & Miller, 1979). Finally, we controlled for the effect of project-group size on technical communication inside project groups. As the size of a project group increases, with other effects held constant, the average amount of technical communication for each group member should decline (Thomas & Fink, 1963).

We did not control for age, gender, education, or the effect of project-group size on technical communication outside project groups. The literature suggests that age influences communication because the more similar people are in age, the more likely they are to hold similar attitudes, interests, and beliefs, and thus the more likely they are to communicate with one another (Riley, Johnson, & Foner, 1972; Ryder, 1965). However, the explanation for this relationship is not chronological age per se but age similarity, a variable measured directly in this study. The only reason for specifying age as a control variable would be if people in work organizations were known to communicate more frequently at one age than another. Thus, if 35-year-olds talked with others more frequently than 45-year-olds, or if people talked with 35-year-olds more than with 45-year-olds, age would be an important control variable. However, to our knowledge, no theoretical statements or empirical results exist that suggest such a relationship. Hence, we did not include age as a control variable.[2] The proportion of women in an organization is also believed to influence communication frequency (cf. Kanter, 1977; Spangler, Gordon, & Pipkin, 1978). However, there were only four women (4.3%) in the organization studied, a number so small that gender seemed unlikely to have a major effect on the results.

Allen (1967) showed that educational similarity influences communication frequency. For instance, engineers with advanced degrees tend to talk more frequently with others who hold advanced degrees than with those holding only bachelor's degrees. However, a comparison of the technical

[2] Many studies routinely include age as a control variable because it frequently predicts behavioral variation. However, until recently, scholars have paid little attention to why that is so, and thus have included age more out of habit than for theoretical reasons (Ferris, 1988). Recent work (Lawrence, 1987, 1988) has suggested that age produces the results that have been observed only because it acts as a surrogate for other processes. This study attempted to be more judicious by employing an independent variable, age similarity, that more closely measures the theoretical constructs studied here.

However, we computed the regression equations presented in the Results section including both age and age similarity as predictors of communication frequency. Although including age slightly reduced the significance of other coefficients, none of the age coefficients were significant, and the results were consistent with those reported. Therefore, for both theoretical and empirical reasons, we omitted age from the analysis.

communication of two educational groups in the organization studied here showed no significant differences in communication frequency by educational level. Engineers of educational levels up to and including having a bachelor's degree did not differ significantly in the average frequency with which they communicated with (1) other engineers having a similar education and (2) other engineers with graduate education ($t = .89$, $df = 78$). In addition, engineers with graduate education did not differ significantly in the average frequency of their communication across the two groups ($t = .88$, $df = 70$). Finally, project-group size may influence technical communication outside a group if the variation in project-group size is large relative to the organization's size. That is, as project-group size increases, the number of people outside the project group decreases, and thus the number of external people with whom a project-group member may communicate decreases. However, the correlation between project-group size and technical communication outside the project groups was not significant ($r = .12$, n.s.). Thus, we did not include project-group size as a control variable in the analysis of communication outside project groups.

Measures

Frequency of technical communication. Two measures of the frequency of technical communication, technical communication inside project groups and technical communication outside project groups, were obtained from employees' responses to the relational question: How often do you discuss technical issues you face in your work with each person on this list? We gave employees a list of all research and development engineers and engineering managers in the organization. Then, using a 5-point Likert-type scale ranging from "never" to "roughly every day," employees indicated the frequency with which they discussed technical issues with each person on the list. People may overreport or underreport the frequency of their communications with others; thus, we computed both the measure of inside-project-group communication and the measure of outside-project-group communication using the average frequency with which others indicated speaking with an employee. Measured in this manner, differences in question interpretation and response patterns across employees had a similar effect on the technical communication values for each employee.[3] Descriptions of the two measures follow.

[3] The four individuals who did not return questionnaires are included in the analysis. To complete the relational responses for responding employees who work in project groups with nonrespondents, we substituted self-reported communication with the nonresponding individuals. A *t*-test of communication frequency values showed no difference between employees whose values include self-reports and those whose values do not ($t = .02$, $df = 16$, $p = .98$). The same procedure was used to compute the outside-project-group communication measures.

Eleven employees who returned questionnaires were not on the original list of employees. Although the questionnaire provided space for adding extra names, respondents did not have an equal opportunity to be reminded of their contacts with those 11 employees. Consequently, for those individuals, we used self-indications of the frequency of their communication with other employees in calculating the communication measures.

Technical communication inside a project group was defined as the average frequency with which project-group members indicated communicating with an employee ($\bar{x}$ = 2.75, range = .9–4.0). Thus, if Mary is in a project group of four employees, Mary's technical communication inside her group is measured by taking the relational responses of the other three employees in her group and computing the average frequency with which those employees indicate they communicate with Mary.[4] Ten employees who participated in two project groups were included twice in the inside-project-group analysis, once for each project group.

Technical communication outside a project group was defined as the average frequency with which non–project-group members indicated communicating with an employee ($\bar{x}$ = .39, range = .05–1.0). Thus, if Bob is in a project group of four employees, Bob's technical communication outside his group is measured by taking the relational responses of the 88 employees who do not belong to it and computing the average frequency with which those employees indicate they communicate with Bob.

Age and tenure similarity. The measures of demographic similarity were those used by Wagner and colleagues (1984), except that we changed the sign of each measure for ease of interpretation. Thus, an employee's similarity to other employees in his or her comparison group increases rather than decreases with the value of these measures. The objective in defining demographic similarity measures is to represent the extent to which an employee is a member of a group of individuals close in age or close in tenure. The more similar an employee is to the employees closest to him or her in age or tenure, the more likely the individual is to belong to a group with whom communication is relatively easy. For this reason, it is important to select a similarity measure that captures an employee's demographic position within some subgroup of an organization rather than demographic position within an entire organization.

A subgroup of ten employees, a number that we arbitrarily selected as being neither too small nor too large, was used to calculate the within-the-organization similarity measures.[5] The resulting age- and tenure-similarity measures thus represent an employee's similarity in age or tenure to the ten individuals in the organization closest in age or closest in tenure to that employee. Because project groups in this study already represented

[4] There are several ways of controlling for the effects of group size on the frequency of communication inside project groups. The measure used in this study captures average communication frequency per person. We controlled for the relationship between communication frequency and project-group size directly by including project size in regression analyses. An alternate approach is to control for this relationship in a dependent measure. Katz and Tushman (1979), for instance, divided the total amount of project communication for each individual by the logarithm of the possible interactions ($\log_2[n(n - 1)]$), as suggested by MacKenzie (1966). Using this weighting of inside-project-group communication frequency does not change the results of this study.

[5] Regression results using several subsets larger than ten were examined. The larger subsets all weakened the regression results, although not substantially (cf. Wagner et al., 1984).

reasonably small organizational subgroups of fewer than nine members, we used entire project groups to calculate each within-project-group similarity measure.

Age and tenure similarity within the organization were defined as

$$D_i^O \equiv -\min_{S_n \subset O}\left[\frac{1}{n-1}\sum_{j \neq i \in S}(x_i - x_j)^2\right]^{1/2}$$

where D_i^O is the age or tenure similarity for employee i within organization O, S_n is any subset of n employees in O, and x is an employee's age or tenure.

Age and tenure similarity within project groups were defined as

$$D_i^G \equiv -\left[\frac{1}{n-1}\sum_{j \neq i \in G}(x_i - x_j)^2\right]^{1/2}$$

where D_i^G is the age or tenure similarity for employee i within project group G, n is the number of employees in G, and x is an employee's age or tenure.

Career level was defined as an employee's position on the organization's six-level engineering-management hierarchy. *Project-group size* was defined as the number of employees within each project group.

Tables 1 and 2 provide the means, standard deviations, and correlations of the measures used for the inside-project-group and outside-project-group analyses.

RESULTS

Inside-Project-Group Analysis

Table 3 presents the analysis examining communication inside the project groups. The first model in Table 3, which includes only the control

TABLE 1
Inside-Project-Group Analysis: Means, Standard Deviations, and Correlations[a]

Measures	Means	s.d.	Correlations 1	2	3	4	5
1. Technical communication	2.75	0.86					
2. Project-group age similarity	−11.81	5.06	.43***				
3. Project-group tenure similarity	−6.88	4.36	.30**	.50***			
4. Career level	3.21	1.30	.17	.02	.00		
5. Organizational tenure	6.06	5.73	−.25*	−.50***	−.68***	.11	
6. Project-group size	5.63	1.97	−.61***	−.34***	−.36***	−.15	.19

[a] $N = 102$.
* $p < .05$
** $p < .01$
*** $p < .001$

TABLE 2
Outside-Project-Group Analysis: Means, Standard Deviations, and Correlations[a]

Measures	Means	s.d.	Correlations 1	2	3	4
1. Technical communication						
2. Organizational age similarity	−1.40	1.33	.04			
3. Organizational tenure similarity	−0.76	1.33	−.19	.42***		
4. Career level	3.14	1.31	.51***	−.14	−.13	
5. Organizational tenure	5.67	5.34	.33**	−.43***	−.91***	.16

[a] $N = 92$.
* $p < .05$
** $p < .01$
*** $p < .001$

variables, shows that, as expected, the size of a project group has a significant impact on technical communication inside the group. As project-group size increases, the frequency of communication decreases. However, neither of the other control variables, career level or organizational tenure, makes a significant contribution to the explained variation in technical communication. Model 4, including both the control and independent variables, supports Hypothesis 1, which states that employees who are relatively similar to one another in terms of age will communicate more frequently about technical issues than employees who are relatively dissimilar. The coefficient for within-project-group age similarity is significant and in the expected direction, suggesting that the smaller the age differences between an employee and the other employees in his or her project group, the more frequently he or she will communicate with them concerning technical issues. The analysis shown for model 4 does not support Hypothesis 2, which states that increasing tenure similarity encourages technical communication. The coefficient for project-group tenure similarity is not significant, suggesting that the variable's effect diminishes rapidly inside project groups, as argued in Hypothesis 3, and, in fact, disappears completely. Indeed, the results for model 4 support Hypothesis 3, which states that project-group age similarity has greater impact on technical communication inside project groups than project-group tenure similarity. Not only is the coefficient for project-group age similarity significant, while that for project-group tenure similarity is not, but a comparison of the standardized regression coefficients suggests that the effect of project-group age similarity on technical communication is several times greater than the effect of project-group tenure similarity.

To confirm that the high correlation between within-project-group age and tenure similarity ($r = .50$, $p < .001$) did not produce these results, we computed separate analyses for these variables, shown under models 2 and 3. The relative stability of the standard errors in each model provides additional confidence in the results for model 4. Even when assessed indepen-

TABLE 3
Determinants of the Frequency of Technical Communication Inside Project Groups[a]

Measures	Models[b] 1 Control Variables	2 Age Similarity	3 Tenure Similarity	4 Full Model
Career level	.071	.065	.071	.067
	.054	*.053*	*.055*	*.053*
	.108	.100	.109	.102
Organizational tenure	−.023	−.009	−.024	−.013
	.012	*.014*	*.016*	*.017*
	−.160	−.060	−.165	−.090
Project-group size	−.245***	−.222***	−.246***	−.226***
	.036	*.037*	*.038*	*.038*
	−.567	−.514	−.568	−.524
Project-group age similarity		.036*		.038*
		.016		*.017*
		.214		.221
Project-group tenure similarity			−.001	−.010
			.023	*.023*
			−.007	−.052
Constant	4.06	4.29	4.06	4.28
R^2	.41	.44	.41	.44
Adjusted R^2	.39	.41	.38	.41
F	20.65***	17.39***	15.32***	13.83***

[a] N = 102.
[b] The values shown in each block are the unstandardized regression coefficient, the standard error (in italics), and the standardized regression coefficient.
* $p < .05$
** $p < .01$
*** $p < .001$

dently, project-group age similarity maintains its significant relationship with technical communication, whereas project-group tenure similarity does not.

Outside-Project-Group Analysis

Table 4 presents the analysis examining communication outside the project groups. The first model in Table 4, including only the control variables, shows that career level and organizational tenure have a significant impact on technical communication outside project groups. As career level and organizational tenure increase, communication frequency increases. The results presented for model 4, which includes the control and independent variables, support Hypotheses 1, 2, and 4. Consistent with Hypothesis 1, the results suggest that employees who are relatively similar to others in terms of their age will communicate more frequently outside project groups about technical issues than employees who are relatively dissimilar. The positive coefficient for organizational age similarity indicates that for any

TABLE 4
Determinants of the Frequency of Technical Communication Outside Project Groups[a]

Measures	Models[b] 1 Control Variables	2 Age Similarity	3 Tenure Similarity	4 Full Model
Career level	.067***	.069***	.066***	.068***
	.013	*.012*	*.012*	*.011*
	.468	.487	.461	.480
Organizational tenure	.009**	.013***	.030***	.033***
	.003	*.003*	*.007*	*.007*
	.263	.380	.867	.942
Organizational age similarity		.039**		.036**
		.013		*.012*
		.279		.258
Organizational tenure similarity			.094***	.088**
			.027	*.026*
			.666	.628
Constant	.13	.15	.08	.11
R^2	.33	.39	.41	.46
Adjusted R^2	.31	.37	.39	.43
F	21.33***	18.49***	19.83***	18.31***

[a] N = 92.
[b] The values shown in each block are the unstandardized regression coefficient, the standard error (in italics), and the standardized regression coefficient.
* $p < .05$
** $p < .01$
*** $p < .001$

employee and the ten people most similar to him or her in age, the smaller the age differences between the focal employee and the others, the more frequently the employee communicates with employees outside his or her project group. Consistent with Hypothesis 2, the results suggest that employees who are relatively similar to each other in terms of their organizational tenure will communicate more frequently about technical issues than employees who are relatively dissimilar. The positive coefficient for organizational tenure similarity indicates that for any employee and the ten people hired the closest in time to that employee, the smaller the time gaps in hiring, the more frequently the employee communicates with others outside his or her project group. Thus, both organizational age similarity and organizational tenure similarity contribute to the explained variation in technical communication outside project groups.

Finally, the results presented for model 4 are consistent with Hypothesis 4, which states that organizational tenure similarity has a greater impact on technical communication outside of project groups than organizational age similarity. A comparison of the standardized regression coefficients suggests that the effect of organizational tenure similarity on technical communication is more than twice that of organizational age similarity.

The high correlations among organizational age similarity, organizational tenure similarity, and organizational tenure raise potential multicollinearity problems with the outside-project-group analysis. As with the inside-project-group analysis, models 2 and 3 show separate analyses for the organizational age and tenure similarity measures. The relative stability of the standard errors of these variables and the results of several additional analyses[6] provide further confidence in the results of model 4.

DISCUSSION

The results of this study show a relationship between organizational demography and communication frequency. Two measures of organizational demography, age similarity and tenure similarity, appeared to influence the frequency of technical communication in the research division of an electronics firm. However, these similarity measures do not contribute equally to explaining the variation in technical communication inside and outside project groups. As predicted, inside project groups, the age similarity of group members exerts more influence on technical communication than their tenure similarity. The opposite relationship seems to hold outside project groups, where the similarity of organizational members' tenure exerts more influence on technical communication than their similarity in age.

One explanation for these results may be that the effects of tenure similarity on communication frequency are more sensitive to situational characteristics than are the effects of age similarity. Tenure similarity is a significant predictor of technical communication in situations where shared work-related knowledge and skills do not develop rapidly and where employees have little incentive to assimilate new members. In organizations or large groups in which members have infrequent contact, the development of such knowledge and skills occurs relatively slowly. However, in small

[6]Several additional analyses were performed to assess the potential impact of multicollinearity on the results. The high correlations among organizational age similarity, organizational tenure similarity, and organizational tenure result primarily from a skewed organizational tenure distribution. Eighty-one employees had been with the organization for less than 9 years, and the remaining 11 employees had been with the organization 15 years or more (range = 15–24). As a result, the 11 employees had high values for organizational tenure and organizational tenure similarity. Deletion of those employees from the group as a whole reduced the correlations as follows: organizational age similarity and organizational tenure from $r = .43$ ($p < .001$) to $r = .17$ (n.s.); organizational tenure similarity and organizational tenure from $r = .91$ ($p < .001$) to $r = .27$ ($p < .05$); organizational age similarity and organizational tenure similarity from $r = .42$ ($p < .001$) to $r = .08$ (n.s.).

Additional analyses included regression analysis with the 11 high-tenured individuals deleted, regression analysis using the logarithm of the skewed independent measures, and analysis of covariance controlling and testing for differences between employees with organizational tenure of less than 9 years and employees with organizational tenure greater than or equal to 15 years. The results of these analyses suggest that the relationships presented in Table 4 are not an artifact of multicollinearity.

groups, shared work-related knowledge and skills develop rapidly, and current members are more likely to disrupt current communication patterns to assimilate new entrants. As a consequence, in such settings tenure differences exert less influence on technical communication. These situational characteristics appear not to influence the impact of age similarity on the frequency of technical communication. Thus, the results are consistent with the interpretation that the effects of age similarity on technical communication result primarily from basic social behaviors that occur independently of task characteristics.

The results from this study make several contributions. First, the empirical link between organizational demography and communication frequency supports one of the basic assumptions used in organizational demography research. Previous studies (Wagner et al., 1984; McCain, O'Reilly, & Pfeffer, 1983) have argued that demographic similarity produces important organizational outcomes, in part by altering levels of communication. However, those studies did not test the relationship between demography and communication. The results presented here provide empirical evidence that supports the theoretical validity of this basic assumption and hence encourages continuing work on the relationship between organizational demography and organizational outcomes. Second, although past work on organizational demography has tended to treat all demographic variables as having similar effects on organizational outcomes, this study suggests that such effects depend on the context in which each demographic variable is examined. Thus, future theory and research on demographic variables should pursue both their similar and distinct properties as predictors of organizational outcomes.

Finally, this study contributes to explanations of communication frequency. For several decades, research in social psychology has consistently found that dyads of similar individuals communicate more frequently and effectively than dyads of dissimilar individuals (Rogers & Bhowmik, 1971). Organizational demography builds on this relationship between similarity and communication by moving beyond the level of dyadic analysis. The demographic approach used in this study allows researchers to examine an individual's similarity relative to an entire group or subgroup of individuals. Hence, this approach permits predictions concerning communication frequency at the individual, group, and organizational levels.

The results from this study are limited in several ways. One limitation is that they are based on a single organization; thus, caution must be exercised in generalizing to other organizations. In addition, the project groups in this organization focus almost exclusively on development work. Since project type influences communication patterns (Katz & Tushman, 1979), it is possible that the strength of the relationship between age and tenure similarity and technical communication differs in organizations with a different mix of technical service, development, and basic research projects. Another potential limitation is that sociometric measures do not always produce accurate measures of actual communication patterns (Bernard &

Kilworth, 1977).[7] However, this criticism applies to all past research on technical communication, and past research has measured something about the way engineers perceive their communications that is related consistently with performance. Nonetheless, the correct interpretation of this relationship may not be that engineers' actual technical communication is associated with performance, but rather that engineers' perceptions of technical communication are associated with performance. Hence, a possible alternative interpretation of the results from our study is that age and tenure similarity influence engineers' perceptions of technical communication.

This alternate interpretation suggests that the meaning of the relationship between project-group size and technical communication inside project groups should be examined in more detail. If relational measures indicate engineers' perceptions of technical communication, factors that produce perceptual biases are likely to influence those perceptions. For instance, the availability heuristic (Tversky & Kahneman, 1974) suggests that employees are more likely to remember contacts with employees seen frequently than contacts with employees seen occasionally. Thus, the negative association between project-group size and technical communication may result because an individual's project group includes the employees the individual sees most frequently. The individual is most likely to remember communications with these employees, and therefore the frequency of remembered communications increases directly with the decreasing size of the individual's project group.

Another topic for additional research is the effect of organizational demography on communication-related outcomes. For instance, one important area of inquiry is the relationship between organizational demography and R&D project-group performance. Given the positive relationship previous research has found between technical communication and project-group performance (Allen, 1970; Ebadi & Utterback, 1984; Pelz & Andrews, 1976) and the positive relationship found in this study between demographic similarity and technical communication, we would expect projects whose members are demographically similar to show relatively high rates of communication and thus relatively high performance. However, an important caveat to this hypothesis is that, as discussed earlier, project-group type appears to determine the kind of communications necessary for high-performance groups. Moreover, in some cases, an overly homogeneous project group, by encouraging internal communication and discouraging external communi-

[7]Although Bernard and Kilworth (1977) raised an important criticism, studies of the discrepancy between real and perceived communication frequency require more study. For instance, one of the several studies conducted by Bernard and Kilworth involved a group of deaf individuals and a comparison of their memories of teletype communications with their actual teletype communications. This seems a reasonable test of the inaccuracy hypothesis; however, we also know that the medium people use in communicating influences the frequency and content of their interaction (Daft & Lengel, 1984). Thus, Bernard and Kilworth may have picked up differences in media use rather than differences in accuracy.

cation, might experience lower performance over time (Katz, 1982). Finally, at some point, increasing communication no longer increases performance but becomes excessive and counterproductive. Thus, an overly homogeneous group may experience lower performance than a more demographically diverse group.

Future research should also examine the distinctions between various definitions of demography and the effect those definitions may have on organizational outcomes. For instance, although Katz's (1982) work and ours both used demographic measures of tenure, the conceptual meaning of those measures differs. Katz examined group tenure, defined as the average time project-group members have worked together. The key dimension of group tenure is length of time. Although the relationship is not linear, the members of project groups of long tenure tend to communicate less frequently than the members of short-tenured project groups. In contrast, we examined similarity of organizational tenure which represents the differences in organizational tenure among project-group members. The key dimension of this measure is similarity. In project groups whose members are dissimilar in organizational tenure, communication tends to be less frequent than it is in project groups whose members are similar in organizational tenure.

The differences between the two demographic measures represent important conceptual differences. For instance, a project group's characterization along the time dimension does not necessarily predict the group's characterization along the similarity dimension. Members of a project group with short group tenure may be either very similar or very dissimilar in their organizational tenure. In addition, the potential range of these similarity differences must decrease as group tenure increases. Long group tenure requires that, on the average, the organizational tenure of group members will increase, which concatenates the possible range of tenure similarity. Thus, group tenure and organizational tenure similarity do not measure the same demographic concept.

Yet even if we use a measure of tenure similarity based on group rather than organizational tenure, group tenure and group tenure similarity still differ. For instance, when group tenure is either quite short or quite long, the group tenure similarity of project-group members will tend to be relatively high. When group tenure falls between short and long, the group tenure similarity of project-group members will tend to decrease. Regardless of whether an organizational or group tenure-similarity measure is used, group tenure examines mean effects, whereas tenure similarity examines distributional effects. These distinctions emphasize the importance of carefully defining demographic measures and considering the effects of their differences.

The relationship found in this study between organizational demography and technical communication suggests that demographic attributes may provide project and human resource managers with a useful tool for facilitating high performance in research and development organizations. On the project level, the results from this study suggest that ensuring diversity in

organizational tenure may be an effective approach for designing project groups. Given the relative importance of external communication for project-group performance and the relative unimportance of tenure similarity in producing communication inside project groups, such a design has a number of advantages. Tenure diversity provides a project group with a set of diverse contacts outside the group. In addition, the communication channels established between longer- and shorter-tenured employees inside project groups will probably spill over to contacts outside project groups. For instance, if Mary, a new employee, works on a project with Bob, a 20-year veteran, Mary will probably find it easier to contact Bob's friends outside the project group as a result of her association with Bob. Research shows that keeping such external communication channels open facilitates project performance (Katz, 1982). Tenure diversity also provides good training for new employees. Inside project groups, longer-tenured employees have strong incentives for getting new employees up-to-speed. Thus, organizations benefit because important work-specific knowledge and skills are passed on from one generation of employees to another.

Suggesting normative implications concerning age demography inside project groups is considerably more problematic. Although age homogeneity inside a project group may enhance technical communication, such similarity may simultaneously reduce the diversity of contacts outside the group and thereby negatively affect project performance. In addition, age homogeneity within project groups may produce age norms that influence project-group assignments (Lawrence, 1988). For instance, managers might assign only older engineers to challenging basic research projects because that age group has always staffed those projects. Although such an assignment policy produces age-homogeneous project groups whose members are likely to communicate frequently, it also creates project groups defined by age statuses: only one age group gets assigned to the challenging, state-of-the-art projects engineers prefer. The frustration this differentiation is likely to produce among excluded engineers may encourage some to leave for more promising jobs and others to decrease their efforts on the job (Lawrence, 1987). Thus, in human resource planning, a balance between homogeneity and diversity in age and tenure probably carries the most significant benefits for both employees and organizations.

On the organizational level, the results of this study suggest that demographic homogeneity enhances technical communication and thus may improve organizational performance. However, since year-to-year hiring and turnover patterns determine an organization's demographic distribution, altering demographic homogeneity, particularly in the short run, is problematic. In addition, it is not entirely clear what demographic distribution is optimal. Hiring large blocks of employees of the same age every few years may encourage communication within these large cohorts but at the same time create strong divisions between cohorts and severely isolate those not hired in peak years. A seniority-based layoff that removes entire cohorts of entrants may have an isolating effect similar to that of fluctuations in hiring.

On the other hand, steady year-to-year hiring may avoid the emergence of demographically based divisions and limit the number of isolated individuals but may also restrict the frequency of communication promoted by large cohorts. Clearly, there is a need for additional research on the differing effects of alternative demographic patterns on communication. Nonetheless, managers should pay attention to the long-term communication-related effects of staffing decisions. This study suggests that staffing decisions made today may influence the communication patterns of organizations 5, 10, perhaps 20 or more years into the future.

In summary, this research provides results encouraging further study of demographic variables in organizations. Certainly we need to learn more about how and under what circumstances different demographic variables produce organizational outcomes. Further, we need to learn more about the processes that intervene between demographic characteristics and organizational outcomes. This study suggests that organizational demography produces at least one organizational outcome, performance, through the relationship between demography and technical communication. However, other intervening variables, such as intercohort conflict, status differences, and social comparison processes, may also be important. The many explanatory possibilities of such intervening variables, in conjunction with the utility of demographic variables as managerial tools, make organizational demography a topic of continuing interest.

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