WHAT STIMULATES TEAMS TO ENGAGE IN LEARNING BEHAVIOR? THE INFLUENCE OF COMPOSITION AND CONTEXT

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Abstract

This paper examines team learning behavior; a set of actions that teams engage in to improve their outcomes. We propose that team learning behavior is a compound process that is provoked by specific circumstances, both internal and external to the team. We investigate demographic composition as one potential impetus subsistent in the team itself. In addition, we identify concrete factors in a team's organizational context that motivate learning. Hypotheses were tested using data on 156 teams in five pharmaceutical firms. Regarding internal context, demographic heterogeneity was significant *if* resulting subgroup formation was controlled for; both very homogeneous and very heterogeneous teams were more inclined to engage in learning behavior. Contrary to common belief, results also demonstrated that the existence of mild subgroups in teams triggers learning behavior. Concerning external context, the results indicate the relevance of leader encouragement, team empowerment, and the availability of a knowledge management system.

Over the last few decades, we have witnessed an increasing emphasis in organizations on issues such as flexibility, innovation, and learning. In response, organizations have adopted flat, decentralized structures in which teams are expected to play an important role coping with the uncertainty in the organization and its environment (Guzzo, 1995; Mohrman, Cohen, and Mohrman, 1995). It is often argued that teams are the most efficient vehicles for creating knowledge in modern organizations (Argyris, 1993; Nonaka and Takeuchi, 1995). Therefore, understanding team learning is of critical importance. Some have even argued that "unless teams can learn, the organization cannot learn" (Senge, 1990: 10).

In fact, research on how teams can be employed to obtain and process data to generate high-quality solutions in complex and changing environments has a long tradition. Socio-technical systems theory, for instance, discussed how teams in the right organizational context can perform complex tasks while remaining flexible to cope with unforeseeable circumstances (e.g. Trist and Bamforth, 1951; Hackman and Oldham, 1980; Trist, 1981). Studies of organizations designed using such socio-technical principles generally showed a positive impact on productivity and financial performance (for reviews, see Goodman, Devadas, and Hughson, 1988; Beekun, 1989). Advancing from this tradition, team design theory has explored how a team's external context, in terms of elements such as external leadership and autonomy, can impact team effectiveness (e.g., Gladstein, 1984; Hackman, 1987). To date, however, this line of research has predominantly focused on team effectiveness and performance in general. While the ability to learn has been delineated a prime (potential) benefit of teams, very little work has been done regarding this antecedent of team effectiveness in specific. To gain insight into the contextual designs that stimulate teams to develop new knowledge and adapt to changing circumstances, we need research that focuses on these issues per se.

A notable exception is the work of Edmondson (1999). Edmondson showed that the general level of support that a team feels it receives from its organizational context contributes to a climate of psychological safety and enhanced efficacy, which encourages teams to engage in learning behavior. We extend this line of research by identifying several specific elements in an organization's context that stimulate teams to engage in learning behavior. In this paper, we argue for the relevance of team empowerment and the availability of a system for knowledge management, and discuss the role of a team's external leader.

A second important contribution of our work to existing research on teams and learning behavior is our examination of the impact of a team's internal context, i.e., its demographic composition. We propose that the behavior that fosters learning is not only sparked by a team's organizational context but also by the make-up of the team in terms of the demographic characteristics of its members. In this domain, a long line of research has examined the relationship between a team's demographic heterogeneity and its performance. The general argument in favor of a positive relationship hinges on the idea that the interaction between a diversity of team members and their combined cognitive capacity will lead to more creativity, better information-processing, and higher quality of decision-making (e.g., McGrath, 1984; Jackson, 1992). On the other hand, a diversity of backgrounds and viewpoints may hamper communication and social integration (e.g., Katz, 1982; O'Reilly, Caldwell, and Barnett, 1989; Zenger and Lawrence, 1989). Over the years, research on the relationship between heterogeneity and performance has not reached a consistent conclusion (Williams and O'Reilly, 1998). It has been suggested that this may largely be due to the rather coarse-grained nature of the empirical examinations; in most studies heterogeneity and performance are directly related to each other, without attention to intervening variables – studies referred to by Lawrence (1997) as "black box" research. Recently, authors have started to open up the black box by examining different types of diversity and different intervening variables, such as integration, communication, and conflict (Ancona and Caldwell, 1992; Smith et al.,

1994; Jehn, Northcraft, and Neale, 1999; Pelled, Eisenhardt, and Xin, 1999). Our research adds insight on the influence of team heterogeneity by concentrating on one of the antecedents of team performance: team learning behavior.

An additional, important contribution is our argument – largely overlooked in team heterogeneity research – that it greatly matters whether the differences that exist within a team are generally dispersed across different members, or coincide within subgroups (cf. Lau and Murnighan, 1998). For example, two teams with equal levels of heterogeneity due to demographic dissimilarities among members, may have very different levels of subgroup formation resulting from these differences and, as a consequence, display very different levels of team learning behavior. The existence of subgroups, for instance, influences to what extent individual members are able to express themselves and to what extent they identify with the team (Tajfel and Turner, 1986; Platow, McClintock, and Liebrand, 1990; Brewer, 1993). Moreover, singling out the effects of subgroups enables a better view of the influence of team heterogeneity per se. We argue, and then empirically demonstrate, that team heterogeneity and subgroup formation need to be examined in concert, in order to understand their respective impact.

TEAM LEARNING BEHAVIOR DEFINED

Team learning behavior can be described as a set of "activities carried out by members through which a team processes data that allow it to adapt and improve" (Edmondson, 1999: 351). In this sense, we focus on the process of learning, i.e., the actions that lead to improvement, rather than its outcome. Learning behavior is the activities that teams engage in to generate solutions for non-routine issues. It consists of multiple, interdependent activities, because solutions have to be searched for, chosen, and implemented.

This notion of a series of sequential actions has led several authors to describe learning as a cycle of activities (Argyris and Schön, 1978; Kolb, 1984; Edmondson, 1999). First, a team has to generate ideas on how to improve their work. This can be referred to as exploration or the stage of *experimentation* (Argyris, 1976; Levitt and March, 1988; March, 1991), in which team members search for potential improvements. Second, a team must arrive at a common belief structure regarding the proposed solution. When teams have engaged in experimentation, different members may have developed different mental schemes concerning the experience. To come to a consensus, a "negotiated belief structure" must be developed (Walsh, Henderson, and Deighton, 1988: 194). This can only be accomplished through *communication.* Communication allows members to transfer and combine insights (Jelinek, 1979; Zenger and Lawrence, 1989), and enables them to reflect on a potential solution (Argyris and Schön, 1978). Finally, the negotiated belief structure needs to be translated into concrete, generalized concepts, decisions, or action items (Argyris and Schön, 1978; Kolb, 1984). From the shared experience a workable outcome needs to be developed. Research has indicated that teams frequently think they have agreed on a shared understanding, which subsequently falls apart when they start to execute it (Mohrman, Cohen, and Mohrman, 1995). This emphasizes the need for *codification*; the process through which tacit knowledge becomes explicit (Polanyi, 1962). Codification entails the recording of what has been discussed (e.g., putting it on paper, entering it into meeting minutes, adding it to a database). Codifying a new model decreases ambiguity and enables a team to put knowledge and ideas into practice. In sum, we define team learning behavior as a cycle of experimentation, reflective communication, and codification.

STIMULANTS OF TEAM LEARNING BEHAVIOR

As the previous definition has emphasized, learning behavior is a complex process that involves non-routine information processing. Organizations cannot prescribe or pre-arrange the process. It

is the team itself that initiates the different activities that, in concert, will generate solutions that enhance its effectiveness. To engage in these activities, team members need to feel motivated, safe, and able (Edmondson, 1999; Gibson, 1999). There must be ample room for original and divergent opinions within the team, which must also be able to act as a group (Brewer, 1993), and implement solutions as they deem necessary (Hackman, 1987). Consequently, certain specific conditions may trigger teams to engage in learning behavior, and attempt to improve their own effectiveness, while others do not (Argyris and Schön, 1978; Hedberg, 1981). These stimulants are found both in the team itself based on its composition, and also reside outside the team in the organizational context in which the team is embedded.

Team Composition

Teams that are diverse with respect to demographic attributes such as age, gender, ethnicity, group tenure, and functional area have been shown to behave differently than teams whose members are similar in terms of their backgrounds (e.g., Pelled, Eisenhardt, and Xin, 1999). Learning behavior can be provoked by the composition of the team, in terms of these differences and similarities in backgrounds, because such characteristics play a role in the generation and adoption of new ideas.

The compound nature of team learning behavior requires that members enable each other to express their individual opinions, in order to engage in constructive conflict and develop innovative solutions, while retaining the ability to harmonize and converge on an implementable solution. On the level of the individual, insights from optimal distinctiveness theory (Brewer, 1991; 1993) suggest that members prefer a situation in which assimilation in the group is combined with the possibility of self-expression. A team composition that stimulates learning behavior accomplishes this for its members; it provides for a coherent group that members feel positive about (Tajfel, 1982; Tajfel and Turner, 1986; Brewer, 1993), while simultaneously

providing for an environment in which members feel confident enough to bring their own unique insights and viewpoints to the table (Brewer, 1991; Edmondson, 1999; Kramer, 1999). In a team where members share a similar background in terms of age, gender, ethnicity, tenure, and functional area, communication and social integration are likely to be of high quality (e.g., Katz, 1982; O'Reilly, Caldwell, and Barnett, 1989; Zenger and Lawrence, 1989; Smith et al., 1994). Members are apt to express individual ideas *and* collaborate (Ancona and Caldwell, 1992) because they are likely to be understood and acknowledged (Schein, 1985).

On the other hand, it has been suggested that teams that are more diverse will have a richer array of information and viewpoints available (Bantel and Jackson, 1989; Wiersema and Bantel, 1992). Indeed, heterogeneous teams seek more information from their environment (Ancona and Caldwell, 1992). In addition, they carry the potential of functional task-related conflict, which can lead to higher-quality solutions (e.g., Jehn, Chadwick, and Thatcher, 1997; Jehn, Northcraft, and Neale, 1999). However, research has also suggested that the lack of supportive communication and cohesion may impede the materialization of many of these potential benefits (Ancona and Caldwell, 1992). Assessments become shallow, true debate is avoided, and solutions fail to get implemented due to disagreement in the team (Ancona and Caldwell, 1992; Sutcliffe, 1994; Miller, Burke, and Glick, 1998). What has been largely overlooked in the literature so far, however, is that teams with moderate levels of heterogeneity may or may not display the emergence of subgroups. Below, we will argue that heterogeneity per se negatively influences the extent to which a team engages in learning behavior, because it results in a loss of communication and cohesion. However, unless they become very salient, subgroups may unleash the beneficial effects of heterogeneity – richer information and debate – which (at least partially) compensates for the negative influences of heterogeneity.

Heterogeneity in backgrounds. For a team to learn, members must feel confident to develop and express their innovative ideas (Edmondson, 1999), while allowing for convergence and the development of shared understanding. Hence, members must be able to simultaneously incur a "social identity" from the group and feel secure to maintain a "personal identity" (Brewer, 1991; 1993). A team that consists of people with similar demographic backgrounds represents a fertile ground for learning behavior. Homogeneity in backgrounds creates a feeling of cohesion that minimizes the fear that can inhibit cooperation (Kramer, 1990). Members of a homogeneous team share a common language and a common understanding, which creates a safe and open atmosphere (Schein, 1985), which will spur exploration and debate. In addition, homogeneous teams have high levels of efficacy (Zarnoth and Sniezek, 1997; Gibson, 1999); that is, a strong belief in their ability to bring about effective change. When diversity increases, group integration suffers, and communication and convergence become increasingly toilsome, which inhibits learning behavior.

When a team's demographic heterogeneity is extreme, however, a different pattern emerges. In a qualitative field study, Earley and Mosakowski (2000) observed that when a team is highly diverse, members become very much aware of their differences. As a result, they tend to be very open, and try to understand the different viewpoints that exist within the team. Indeed, experimental research indicated that group members become increasingly considerate of each other's needs when the uncertainty about their relationships increases (Clark, Dubash, and Mills, 1998). Hence, when heterogeneity in terms of background is very high, group members become motivated to honor and incorporate each other's opinions (Brewer, 1993), and to converge upon a solution that is acceptable to everyone. To facilitate this, teams develop rules and procedures that guide their interaction, resolve disputes, and assure everyone has an opportunity to have his or her say (Azzi, 1993; Earley and Mosakowski, 2000). Despite considerable individual differences between members, which are accepted by the group, members also identify with the team as a

whole (Tajfel and Turner, 1986; Brewer, 1993). In sum, the group is a group because *everybody* is different; very heterogeneous teams resemble homogeneous teams through a notion of "unity in variety", which fosters learning behavior. Thus, both very homogeneous and very heterogeneous teams foster learning behavior:

Hypothesis 1: The relationship between a team's demographic heterogeneity and team learning behavior is curvilinear (U-shaped).

Subgroup formation. Beyond demographic heterogeneity there is another way in which the differences and similarities between members influence team learning behavior. When differences in gender, team tenure, functional background, etc. coincide in the same members, subgroups may form based on shared characteristics (Lau and Murnighan, 1998). For subgroups to emerge there must be overlap between certain members which is not shared by others. Hence, subgroups do not occur in highly heterogeneous teams because in such teams no one is alike, nor in very homogeneous groups where everyone is alike. Subgroups only occur in teams of moderate heterogeneity. The more overlap there is of different individual member characteristics, relative to other members, the more distinct the subgroup.

In teams with moderate heterogeneity, mild subgroups may have a positive effect on a team's inclination to engage in learning behavior. As outlined above, compared to homogeneous teams, more heterogeneous teams may lack the psychological safety and efficacy necessary for learning behavior (Edmondson, 1999). The formation of mild subgroups may compensate and restore this climate. The 'back-up' provided by the subgroup makes members feel secure enough to introduce new ideas, or express a differing viewpoint (Brewer, 1991; Crott and Werner, 1994; Lau and Murnighan, 1998). In such a team, people know that they have a fellow team member that usually shares their point of view or, at least, is supportive and understanding of it. Such a

'back-up' may not always entirely agree, but is unlikely to ridicule or embarrass the person, and is likely to give support when other members do (Azzi, 1993). Subgroups also strengthen members' self-efficacy (Bandura, 1997), which not only stimulates them to act upon and express their opinion, but is also known to enhance the accuracy and quality of their input (Zarnoth and Sniezek, 1997). Moreover, research in small groups indicates that views held by only one person are often ignored, and information that is held by only one member is usually omitted from a discussion (Stasser, Taylor, and Hanna, 1989; Azzi, 1993). Therefore, mild subgroups are expected to have a positive effect on a team's inclination to engage in learning behavior.

When subgroups become highly distinct, however, they become counterproductive. If subgroups are not extreme, open communication, adaptation and convergence of opinions are possible (Brewer, 1991; Roccas and Schwartz, 1993), and the different subgroups do not experience each other as threatening (Wilder and Shapiro, 1991; Crott and Werner, 1994). Yet, when sharply defined, members start to identify with the subgroup, rather than the team as a whole (Tajfel and Turner, 1986). They tend to thoughtlessly follow the opinions of their counterparts (Abrams et al., 1990; Mullen, 1991), and disputes may unfold along known dividing lines, representing the different 'camps' within the team (Earley and Mosakowski, 2000). This entrenchment causes subgroups to polarize (Mullen, 1991; Bornstein and Ben-Yossef, 1994; Baron et al., 1996). Team members perceive members of other subgroups as negative and inordinately favor their own subgroup (Tajfel and Turner, 1986; Roccas and Schwartz, 1993) . As a result, exploration suffers, interaction between team members is hampered, and deadlocks prevent conflicts from being resolved (Lau and Murnighan, 1998). Research indicates that when subgroups become salient, convergence of opinions is inhibited (Abrams et al., 1990). Moreover, polarized groups have been shown to be myopic in the information they consider, to develop distorted perceptions of reality and biased opinions of themselves and the other groups (Tajfel, 1982; Turner, 1987; Platow, McClintock, and Liebrand, 1990; Schaller, 1991). Hence, mild subgroups are expected to

have a beneficial effect on team learning behavior, but extreme subgroups lead to prejudice and rigidity and, as a result, affect learning behavior in a negative way:

Hypothesis 2: The relationship between subgroup formation and team learning behavior is curvilinear (inverted U-shaped).

Organizational Context

In addition to a team's internal context, features of the organization in which the team is embedded may stimulate or hamper learning behavior. Organizational support in general has been shown to create an atmosphere of psychological safety and efficacy which fosters team learning behavior (Edmondson, 1999). We extend research investigating organizational context by delineating specific factors in the organization that provoke a team to engage in learning behavior. For example, by affording teams the freedom and ability to develop and implement improvements, and by encouraging them to make use of this potential, members are more likely to actively search for ways to improve their effectiveness. Making a team responsible for its own performance and providing it with the appropriate tools raises awareness of the relationship between the team's actions and its performance. In order to inspire members to search for novel solutions, teams must feel that such behavior is valued within their organization (Hedberg, 1981).

Leader encouragement. The team's external leader – i.e., the manager to whom the team reports – plays a specific, important role in stimulating learning behavior (Hackman, 1987; Manz and Sims, 1987; Edmondson, 1999). An external leader can make a team aware of its performance and encourage it to collectively review and re-assess its work methods. Teams that feel their external leader is interested and involved in their work show favorable intragroup processes such as open communication, supportiveness, and discussion of strategy (Gladstein, 1984). Therefore, the role of the leader is that of involvement at arm's length; s/he does not

directly interfere but actively stimulates teams to take responsibility for their own actions, by encouraging planning and self-monitoring of performance. We label this "leader encouragement." Indeed, Manz and Sims (1987) demonstrated that external leaders' most important behaviors are those that facilitate team self-observation, self-evaluation, and self-reinforcement. All of these activities stimulate the team to rethink, alter and improve its performance (Argyris and Schön, 1978). Hence, we hypothesize that the team's perception of the degree of encouragement it receives from its external leader is positively related to the extent to which the team engages in learning behavior:

Hypothesis 3: Leader encouragement is positively associated with team learning behavior.

Empowerment. Organizations differ in the extent to which they empower their teams. By empowerment, we refer to the amount of autonomy a team experiences (Hackman, 1987), in terms of determining their own actions, planning and scheduling work, control over work-related decisions and job assignments. Although this topic has received much recent attention (e.g, Cohen and Ledford, 1994; Kirkman and Shapiro, 1997), it stems from the traditional concept of worker democracy (e.g., Cherns, 1976; Trist, Susman, and Brown, 1977). We argue that, for teams to engage in learning behavior, it is important that they have the latitude and ability to explore and implement potential improvements as they see fit. The more independence and discretion a team experiences, the more prone it will be to try to improve its actions. Contrary, a lack of substantial freedom pushes teams into known and fixed behavior (Argyris, 1976). A team that feels constrained by the (formal) organization will not seek to alter and improve its activities, but will instead have an inclination to rely on existing procedures. Empowerment reduces insecurity and defensiveness in a team. Research has indicated that empowered teams are more proactive, in the sense that they seek continuous improvement, revise work processes, and seek innovative solutions to work problems (Hyatt and Ruddy, 1997; Kirkman and Rosen, 1999).

Empowered teams have been found to frequently take action on problems and improve the quality of their work by initiating changes in the way work is carried out (Wellins, Byham, and Wilson, 1991). Thus:

Hypothesis 4: Team empowerment is positively associated with team learning behavior

Knowledge management system. Learning behavior is about creating and obtaining knowledge. Whereas leaders may encourage such behavior, and empowerment may give a team the leeway to engage in the process, other aspects in the organization's context may serve as 'tools' to facilitate learning. An important such element is a knowledge management system. A knowledge management system is a set of formal procedures and mechanisms that capture information regarding innovations and best practices throughout the organization (Nonaka and Takeuchi, 1995). For example, many organizations have some form of central data base through which new products or services, work methods, and marketing knowledge are collected and transferred (Moore and Birkinshaw, 1998). The availability of such a system in the organization spurs learning behavior in a number of ways. It signals to members that the development of better practices is desired (Hedberg, 1981). It aids the codification of knowledge, and consequently the storage, retrieval, and revision of what has been learned (Walsh and Ungson, 1991). Furthermore, it facilitates the transfer of knowledge (Argote and Ingram, 2000). By using the system, teams have access to knowledge in other (perhaps comparable) parts of the organization. This stimulates inquiry regarding whether they can adopt other practices, adapt them to their own, specific setting, or combine them with elements from their existing repertoire (Kogut and Zander, 1992). As such, a knowledge management system is a tool that stimulates teams to reconsider existing practices and search for ways to improve their work and implement novel solutions:

Hypothesis 5: The availability of a knowledge management system is positively associated with team learning behavior

METHODS

Sample and Procedure

Five companies from the pharmaceutical and medical products industry served as research sites for this study. Each of the organizations used teams across a number of functional areas, including human resources, sales, marketing, manufacturing, and research. Each of them had facilities in at least four geographic areas (U.S., Latin America, Southeast Asia, and Western Europe). All of the aforementioned functional areas in each organization in each geographic area were involved in the research. Human resource professionals in each organization were asked to select teams for interviews and surveys across a variety of functional areas, team types, and organizational levels.

To facilitate the survey development, we first interviewed a total of 107 individuals, representing 52 teams. Between one and five individuals were interviewed from each team. In-depth personal interviews were performed with respondents from all five organizations in each of the four geographic areas, for a total of twenty-four sites. Four types of teams were included: *work teams* - ongoing teams responsible for producing goods and services; *project teams* - time-limited teams used for a one-time output such as a new product or service; *parallel teams* - teams that exist "in parallel" to the formal structure, encompassing people from many different work units; and *management teams* - teams responsible for the overall performance of a business-unit (Cohen and Bailey, 1997). We posed a series of questions pertaining to concepts such as team effectiveness, learning processes, developing and sharing knowledge, motivation, leadership, and receiving

feedback. The interviews were conducted in the native language of the interviewees, with the assistance of a team of bi-langual interviewers.

We used a combination of the results of the interviews and pre-existing standardized scales to derive the measures utilized in this study. A team of fifteen translators were used in an extensive translation-back translation procedure to foster cultural equivalence among the items. A number of items in the survey were altered in response to this. Next, the survey was extensively piloted. A bi-lingual pilot study was performed in 11 teams to further examine the validity of the items across the different translated versions; bi-lingual respondents in 11 teams were asked to fill out the survey in two different languages. This also led to a small number of alterations. Finally, a multiple constituency test was conducted to examine reliability of the scales at the team level of analysis. As a result, some items were dropped; others were subjected again to the translation-back translation procedure.

To test the hypotheses, the final set of survey scales was administered on site in each location to randomly selected teams. In each company, teams in each of the four regions were included in the survey administration. Respondents reported as a team at a pre-set time and location to fill out the survey. The final sample consisted of survey data obtained for 156 teams representing 724 individual team members. The average age of the respondents was 39; 26% was female; average tenure on the team was 3.4 years.

Measurement of the Independent Variables

Team heterogeneity. Demographic heterogeneity was assessed with respect to five demographic variables: gender, ethnic background, functional background, team tenure, and age (e.g., Pelled, Eisenhardt, and Xin, 1999). Unfortunately, a number of people had not filled out some of the corresponding questions. As a result, we were only able to obtain demographic data regarding

113 teams. The categorical variables heterogeneity in ethnic background (6 categories) and heterogeneity in functional background (8 categories) were each measured through Blau's (1977) index ($1-\Sigma pi^2$), where p is the proportion of group members in a category and i is the number of different categories represented in the team. Gender heterogeneity was measured as the percentage of the smallest representation on the team, where 50 percent represents the maximum heterogeneity. Following Allison (1978), we used the coefficient of variation (standard deviation divided by the mean) to measure the numeric variables age heterogeneity and tenure heterogeneity.

In addition, we constructed a composite measure of total team heterogeneity. Our theory emphasizes the relevance of common backgrounds of members in a team. Hence, we developed a measure computing the average overlap between team members. First, we computed the overlap between each pair of members in a team for each of the five demographic characteristics (i.e., gender, ethnic background, functional background, age, and team tenure). Following, the five scores were summed for each pair of members, indicating the total overlap per pair. Finally, average overlap was calculated by dividing the team's total overlap by the number of pairs in the team. The more overlap there exists between a team's members, the more homogeneous the group. The inverse was taken to arrive at a measure for heterogeneity. See the appendix for more details. Table 1 illustrates the computation of this composite measure of team heterogeneity for two hypothetical teams.

----- Please insert Table 1 about here -----

Subgroups. The measurement of subgroups follows from the same computations. It is calculated as the standard deviation of the total overlap per pair. The rationale is that, when there are pairs with a lot of overlap *and* pairs with very little overlap present in a team, subgroup formation is

eminent. In teams where no one has anything in common, or in teams where all members are alike, subgroups are absent. Table 1 displays two teams with an equal level of heterogeneity (cf. Lau and Murnighan, 1998). In team A, differences are distributed along the same pairs, such that subgroups are present. In team B, the differences are scattered among different pairs. As a result, subgroups are much weaker.

Leader encouragement. Using 7-point Likert scales, team members rated the amount of leader encouragement using three items adopted from Manz and Sims (1987). Team level indices were obtained by averaging and standardizing the individual-level responses. Confirmatory factor analysis (principal components) revealed one factor, as displayed in Table 2, explaining 75 percent of the variance in responses. Cronbach's alpha was .83. In addition, we computed the intraclass correlation (ICC) (one-way analysis of variance) to indicate consistency between raters (Bartko, 1966; Shrout and Fleiss, 1979). ICC was 0.77 and highly significant ($p<.0001$). One-way ICC can be interpreted as a correlation. Hence, 0.77 is very reasonable.

Empowerment. Team members also completed a team empowerment scale comprised of three items inspired by research on self-managed and autonomous work groups (Gulowsen, 1972; Cordery, Mueller, and Smith, 1991; Cohen, Ledford, and Spreitzer, 1996). Each item was again measured on a 7-point Likert scale. Principal component analysis revealed that the items constituted a single factor accounting for 73 percent of the variance. Cronbach's alpha was .82. ICC was 0.74 ($p<.0001$).

Knowledge management system. Furthermore, team members completed a three item scale assessing the perceived availability of an organizational knowledge system. This scale was created through the interviews and pilot testing. As assessed through a principle component analysis, the three items loaded on one factor, explaining 80 percent of the variance in responses.

Cronbach's alpha was .87. Moreover, the ICC of 0.86 (p<.0001) indicated that the different team members agreed to a large extent on this attribute. Table 2 displays the confirmatory factor analyses for all three variables. Additionally, to confirm discriminant validity, exploratory factor analysis on all nine items clearly resulted in the anticipated three factors.

----- Please insert Table 2 about here -----

Control variables. Several control variables were included in the analyses. We controlled for task routinization because learning behavior may be less at issue for teams with routine tasks (Mohrman, Cohen, and Mohrman, 1995). The variable was measured using three items adopted from Withey, Daft, Cooper (1983); 'our work is routine', people in this team do about the same job in the same way most of the time', and 'team members perform repetitive activities in doing their jobs' (Cronbach's alpha .83; ICC .53, p<.). We controlled for team size because larger teams, for instance, have more potential for heterogeneity (Pelled, Eisenhardt, and Xin, 1999). Furthermore, we included dummy-variables to control for company, country, and team-type.

Measurement of the Dependent Variable Learning Behavior

Learning behavior. Earlier, we described team learning behavior as a cycle of experimentation, reflective communication, and knowledge codification. These are different actions that complement each other and together constitute learning behavior. Therefore, drawing from the measurement development described earlier, we first measured the three activities separately. *Experimentation* was measured using three 7-point items: 'this team comes up with many new ideas about how work should be done', 'if a new way of doing work is introduced, it often comes from within the team', 'this team is frequently the source of ideas that are copied by other teams' (Cronbach's alpha .74; ICC .66, p<.0001). Confirmatory factor analysis indicated one factor explaining 66 percent of the variance. *Communication* was measured through three items: 'there

is open communication in this team', 'everyone has a chance to express their opinion', 'team members maintain a high level of idea exchange' (Cronbach's alpha .89; ICC .85, p<.0001). Confirmatory factor analysis again resulted in one factor explaining 82 percent of the variance. Finally, *codification* was measured using the following items: 'this team carefully documents how we do our work', 'this team has a formal system to capture our good ideas', and 'this team attempts to record our best practices' (Cronbach's alpha .93; ICC .80, p<.0001), which loaded on one factor that explained 87 percent of the variance in responses. Next, the composite variable 'learning behavior' was computed by multiplying these three measures. Our argument is that the elements relate to each other in a multiplicative rather than an additive way because one element cannot substitute for another; for example, a lack of experimentation cannot be compensated for by means of more internal communication. All three elements of the learning cycle have to be present, in order for a team to engage in learning behavior.

Validity. We performed several analyses to verify the construct validity of the team learning behavior variable. Edmondson (1999) showed that teams that engage in learning behavior are more effective. Therefore, to test convergent validity, we asked teams to rate their effectiveness on a multi-item scale developed based on both pre-existing scales (Hackman, 1987) and our interview process. In addition, the team's external leader - identified as the person to whom the team has to report, and who can be expected to be knowledgeable about the team's output - was asked to respond to the effectiveness items. We were able to obtain 78 team leader responses. Regression analysis was used to test the prediction that team learning behavior is related to team effectiveness. The results are displayed in Table 3. The models indicate that learning behavior is indeed positively related to team effectiveness, as assessed by members, as well as by external leaders. The variable explained 7.9 percent of the variance in self-assessed effectiveness and 4.8 percent of the variance in leader-assessed effectiveness.

---- Please insert Table 3 about here -----

Furthermore, learning can be expected to be less relevant for teams with a more routine task (Argyris and Schön, 1978; Mohrman, Cohen, and Mohrman, 1995). Hence, we created an interaction between task routinization and team learning behavior. As shown in Table 3, the estimates are negative, as expected, indicating that the relationship between team learning behavior and effectiveness is smaller for teams with a more routine task.

Finally, discriminant validity was established through factor analysis, in order to verify the distinctiveness of our constructs. To ensure that the three variables concerning organizational context – leader encouragement, empowerment, and knowledge management system - are clearly distinct from the dependent variable learning behavior, we performed a series of exploratory factor analysis, i.e., principal component analysis with varimax rotation. The nine items used to measure (the different elements of) learning behavior were entered into a factor analysis together with the three items of leader encouragement. Likewise, for the items making up empowerment, and the items used to measure knowledge management system. Finally, an exploratory factor analysis was conducted including all of the scales. The analyses showed that only one item used to measure team learning behavior loaded on a factor concerning organizational context, with a value over .4. However, in the same analysis, this item also had a loading over .7 on its intended factor/variable. Therefore, it was retained. Together, these analyses demonstrate the construct validity of our operationalization of team learning behavior.

RESULTS

Table 4 reports descriptive statistics and a correlation matrix. Table 5 presents the results of the OLS regression analyses used to test the hypotheses.

----- Please insert Tables 4 and 5 about here -----

Demographic composition and learning behavior. Hypothesis 1 predicts that the relationship between demographic heterogeneity and learning behavior is U-shaped. Models 1 and 2 in Table 5 display models with separate measures for demographic heterogeneity. Squares of all variables are added to allow for a curvi-linear relationship. None of the variables, however, is significant. Likewise, when they are entered into the equation separately and/or when the subgroup-variables are added to the model. Together, the variables do explain 5.2 percent of the variance in model 2. In models 3 and 4 the separate measures for heterogeneity are replaced by the composite measure. In model 3, the variable and its square have the predicted sign but are insignificant. When subgroups are controlled for, however, in model 4, the linear and quadratic terms become highly significant, in the hypothesized direction, demonstrating a curvilinear relationship. The bottom of the resulting U-shape is about halfway the observed data-range, which supports hypothesis 1.

The different models show that, only when corrected for the subgroups that emerge due to the differences in backgrounds between team members, cumulative team heterogeneity and learning behavior display the predicted curvi-linear (U-shaped) relationship. Compared to highly homogeneous teams, demographic heterogeneity in teams has a negative influence on team learning behavior. This negative influence, however, is partly shrouded by the positive influence of mild subgroups that emerge in some teams due to demographic differences. *If* subgroups are measured directly, the negative effect of demographic heterogeneity becomes visible.

The estimates of the variable subgroups and its square, which indicate the distinctness of subgroups in a team, are significant as hypothesized. Hypothesis 2 predicted that mild subgroup

formation will have a positive influence on learning behavior, while sharply defined subgroups will be negatively associated with learning behavior. The estimates confirm hypothesis 2. The peak of the relationship is well within the range of the data, supporting the predicted inverted U-shape. Together, demographic diversity and subgroups explain 11.5 percent of the variance in team learning behavior. Conjointly, the results regarding team heterogeneity and subgroup formation display an interesting relationship; both are caused by differences and similarities between team members, but have very different effects, dependent on whether the differences cumulate within the same members, or are dispersed across different people. Moreover, they clearly indicate that heterogeneity and subgroups have to be considered simultaneously, rather than in isolation.

Figure 1 displays the relationship between team heterogeneity and learning behavior over a range of plus and minus 2 standard deviations. This coincides with the observed data range with the exception of two outliers of extreme levels of heterogeneity (observed heterogeneity = .55). Figure 2 illustrates the relationship between subgroups and team learning behavior, displaying a range of plus and minus 2 standard deviations, which again matches with the sample's data range. The size of the effects of both independent variables – i.e., the height and depth of the curves – indicates that team heterogeneity may have a negative influence of about 30 on learning behavior (while the average value of learning behavior in the sample is 39), but that almost the entire effect can be nullified by the positive influence of subgroups, *if* these emerge.

-------Please insert Figures 1 and 2 about here -----

Organizational context and learning behavior. Throughout the different models, the variable leader encouragement is positively associated with team learning behavior and statistically significant. This raises support for hypothesis 3; teams that sense that they are actively

encouraged by their external leader to search for ways to improve their effectiveness engage more in learning behavior. The variable empowerment is also positive and significant throughout the different models. This raises strong support for hypothesis 4; the more a team feels (formally) empowered, the more inclined the group is to display learning behavior. Furthermore, the variable knowledge management system is positively and significantly related to team learning behavior. This strongly supports hypothesis 5. The more aware teams are of the availability of an knowledge management system in the organization the more they display a propensity to engage in learning behavior. Together, in model 4, the three variables explain 24.9 percent of the variance in team learning behavior. This illustrates the relevance of a stimulating organizational context.

DISCUSSION

The purpose of this research was to examine team learning behavior, and to explore what makes teams inclined to engage in it. We proposed that learning behavior is a composite construct, in the sense that teams have to display a number of complementary actions that together shape team learning behavior. Teams need to develop alternative ways of accomplishing their task, collectively communicate and reflect on their actions, and converge upon a solution by appointing and codifying insights. Our measurement of team learning behavior consisted of these elements. Variables pertaining to the demographic composition of the team and the support received through elements in the organizational context, which were derived from organizational learning and team literatures, were well able to explain the extent to which teams engaged in learning behavior. Learning behavior, in turn, was positively associated with team effectiveness.

We positioned our research to help inform the team design literature (Gladstein, 1984; Hackman, 1987; Ancona and Caldwell, 1992) and, hence, examined the influence of variables that can be

managed to stimulate team learning behavior. We assessed the composition of teams in terms of members' demographic backgrounds and concrete elements in the organizational context. Sorting out how these characteristics drive learning behavior not only advances our understanding of the behavior of teams but also gives us direct leads on how to improve the use of teams in organizations.

Our findings indicate that the teams that engaged most in learning behavior were teams with either very low or very high levels of demographic heterogeneity. Previous research has emphasized two effects regarding intra-team heterogeneity (e.g., Miller, Burke, and Glick, 1998): a positive effect, associated with a richer diversity of information and perspectives, and a negative effect due to weaker cohesion and less mutual understanding. We argue that the decrease in cohesion and understanding inhibits the positive effects of heterogeneity from materializing. As a result, teams with moderate levels of heterogeneity are less apt to engage in learning behavior. The positive effects of heterogeneity *are* unleashed, however, if the heterogeneity results in the formation of mild subgroups. Drawing, among others, from social psychology literatures, such as social identity theory (e.g., Platow, McClintock, and Liebrand, 1990), belief congruence theory (e.g., Tajfel and Turner, 1986), and optimal distinctiveness theory (Brewer, 1991; 1993), we argued that mild subgroups enable individuals to bring their unique viewpoints to the table and be heard, while at the same time balancing needs for belonging. In addition, teams with extreme levels of heterogeneity were found to engage in learning behavior. We suggest that such teams also provide for a safe and healthy environment to create, share, and implement ideas (Edmondson, 1999) because they engender a sense of "unity in variety" (Earley and Mosakowski, 2000).

A substantial contribution of our research lies in our inquiry regarding the effect of subgroups. Our results indicated that the impacts of heterogeneity can only be uncovered if subgroup

formation is taken into account. The prevailing idea in the literature to date regarding the effect of subgroups is that they cause dysfunctional divides to occur in teams (Lau and Murnighan, 1998). Yet, our research indicates that mild subgroups may actually have a *positive* influence on learning behavior. Mild subgroups provide for the 'back-up' and psychological safety and efficacy for members to explore, express, and improve their opinions. It is only when subgroups become strong and distinct that communication and interaction within teams become rigid and counter-productive (Earley and Mosakowski, 2000) and learning behavior is hampered.

Finally, we extend research on the relevance of a team's organizational context for learning behavior (Edmondson, 1999). While we acknowledge that a leader does not typically take part directly in the internal processes in a team that shape learning behavior, our results shed light on the relevance of the external leader and his/her role in stimulating learning. A leader can provide feedback and raise awareness of a team's responsibility for performance, and stimulate a team to engage in actions that may improve its output. Equally important in our model was the amount of empowerment that a team experiences. The more input they have on decisions that shape their activities, the more teams use this leeway to try to develop novel solutions that improve their performance. The strongest influence on learning behavior, however, was found with regard to the availability of an organizational knowledge management system. Teams embedded in organizations that have a system in place that helped them capture and exchange their findings and ideas were much more actively engaged in the activities of searching for and adopting new solutions that comprise learning behavior.

Limitations and Directions for Future Research

The choices made in this research also lead to some clear study limitations. In focusing on the relationship between learning behavior on the one hand and the demographic characteristics of a team and the organizational context in which it is embedded on the other hand, we omitted a

number of possible intermediating, or even moderating, variables. Prior research has, for instance, indicated the relevance for team effectiveness of attributes such as communication, cohesion, social integration, and emotional and task conflict (e.g., Smith et al., 1994; Jehn, Northcraft, and Neale, 1999; Pelled, Eisenhardt, and Xin, 1999). Our research did not provide direct insight into the interaction between members. Likewise, team beliefs about efficacy and safety can be expected to be shaped by the explanatory variables we examine and, in turn, shape learning behavior (Edmondson, 1999; Gibson, 1999). For example, research on how such beliefs are influenced by team composition would clearly complement the findings of our study. In a similar vein, examining the belief structures of individuals and teams more directly (Sutcliffe, 1994) would enable us to see how heterogeneity in perceptions, rather than heterogeneity in terms of background, influences the kind of solutions that teams search for and implement. It may also give us more insight into the functioning of subgroups. In this study, for instance, we have examined how the clustering of demographic traits results in different team behaviors; we have not looked at the clustering of beliefs, or at the perception of team members about the existence of subgroups within their team. In sum, our study design enabled us to establish a link between team design characteristics and the learning behavior that ensues from it, but it does not provide for a direct view on what goes on inside the team. We welcome research that directly examines intra-team behavior and beliefs.

This also points to a methodological limitation of our study. We largely rely on data collected through surveys. Observing teams and their actions, however, would allow for a direct assessment of learning behavior, rather than rely on the perception of the team's members. Or, put differently, do teams indeed do what they believe they are doing? Likewise for the elements in an organization's context. We have measured the extent to which teams *perceive* they are encouraged by their leader, have been empowered, and whether there is a knowledge management system available. Comparing these measures with other indicators of these

attributes might be a valuable addition to our research. Furthermore, direct observations of organizations, teams, and their behavior would allow for examination of the solutions that are explored and implemented by teams. Our study examines the process of learning; assessments of the *outcomes* of learning, in terms of the changes that get implemented, would add to our research and lead to more complete understanding of learning in teams.

Finally, our findings examined learning behavior across various types of teams stemming from a number of countries. While, as a result, we are confident that our findings are generalizable across different settings, we acknowledge that learning behavior and its stimulants may differ across diverse cultures, tasks, and situations. For example, a top management team facing a radical change in its institutional environment may differ from a work team that is expected to continuously improve its work methods (e.g., Hackman, 1987; Milliken, 1990; Hambrick, Cho, and Chen, 1996; Jehn, Northcraft, and Neale, 1999). Team learning behavior may be more or less relevant, and more or less effective, under different circumstances. Future research that examines the relationship between learning behavior and effectiveness taking into account different conditions – for instance, timing and urgency (Eisenhardt, 1989; Gersick, 1994; Hambrick, Cho, and Chen, 1996; Waller, 1999) – would complement the insights from our study.

Conclusion

Teams are implemented in organizations because they are thought to be an effective way to cope with the uncertainty created by the environment (Guzzo, 1995). Some argue that strategic change and continuous organizational adaptation emerge from an organization at the team level, rather than being initiated by top management, especially in fast-changing environments (e.g., Burgelman, 1994; Brown and Eisenhardt, 1997). Consequently, it is of critical importance to understand how novel ideas come to light in teams and organizations, and what fosters their creation. In this paper, we analyzed how teams are stimulated to engage in a set of actions that

collectively lead to enhanced effectiveness. We labeled this 'team learning behavior' and proposed and tested a theory of the manner in which it is stimulated by a team's composition and its organizational context. It is our hope that this investigation will broaden and reinforce interest in this important area of research.

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Table 1

Example of Team Heterogeneity and the Incidence of Subgroups

Team 1	member A	member B	member C	member D	overlap pair AB	overlap pair AC	overlap pair AD	overlap pair BC	overlap pair BD	overlap pair CD	homogeneity [1] = ∑ / # pairs	subgroups [2] = S.D.
Age	26	27	52	54	0.947	0.286	0.259	0.313	0.286	0.947		
gender	male	male	female	female	1	0	0	0	0	1		
ethnic background	asian	asian	white	white	1	0	0	0	0	1		
functional background	finance	finance	sales	production	1	0	0	0	0	0		
team tenure	2	5	27	21	0.4	0.074	0.095	0.185	0.238	0.778		
total overlap					4.347	0.36	0.354	0.498	0.524	3.725	1.635	1.872

Team 2	member A	member B	member C	member D	overlap pair AB	overlap pair AC	overlap pair AD	overlap pair BC	overlap pair BD	overlap pair CD	homogeneity	subgroups
Age	26	27	52	54	0.947	0.286	0.259	0.313	0.286	0.947		
gender	male	female	male	female	0	1	0	0	1	0		
ethnic background	asian	white	white	asian	0	0	1	1	0	0		
Functional background	finance	sales	production	finance	0	0	1	0	0	0		
team tenure	2	27	5	21	0.074	0.4	0.095	0.185	0.778	0.238		
total overlap					1.021	1.686	2.354	1.498	2.064	1.185	1.635	0.510

1. Homogeneity is calculated as the average total overlap per pair: ∑ total overlap pair ij / P, where P is the number of pairs on the team. Heterogeneity is the inverse.
2. Subgroup incidence is calculated as the standard deviation of total overlap per pair

Table 2

Results of Confirmatory Factor Analysis of Organizational Context Scales

Item		Factor Leadership Support	Factor Team Empowerment	Factor Knowledge System
1.	Our leader encourages us to go over an activity before we attempt it	.840		
2.	Our leader encourages us to set goals for our team performance	.905		
3.	Our leader encourages us to be aware of our level of performance	.845		
4.	How much input does the team have in: How the team develops skills and abilities		.861	
5.	How much input does the team have in: Planning and scheduling of work		.865	
6.	How much input does the team have in: Planning and determining goals		.843	
7.	This organization attempts to centrally collect best practices			.906
8.	This organization has a formal system to capture good ideas made by teams			.866
9.	This organization has a formal system to share good ideas with other teams			.906

Table 3

OLS Regression Results: Equations with Team Effectiveness as Dependent Variable

	Model[1]			
Variables	member assessed	member assessed	leader assessed	leader assessed
Predictors				
Team learning behavior	14.2***	19.6***	9.16*	13.5**
Team learning behavior x routine task		-8.19***		-5.74†
Control variables				
Team heterogeneity [2]	-.045*	-.049**	.045	.045
Team heterogeneity squared	.075*	.081**	-.066	-.066
Subgroups	-.280	-.404	-4.73**	-4.70**
Subgroups squared	.693	.826	3.73**	3.73**
Routine task	.247*	.450***	.011	.245
Team size	.017	.022	.006	.002
Control dummies				
Kodak	.020	-.006	-.393	-.407
Merck	-.243	-.282	-.269	-.233
GE	-.156	-.133	-1.08*	-.993†
J&J	-.533	-.460	-.469	-.406
Phillipines	-1.25***	-1.23***	-1.97***	-1.96***
Puerto Rico	-.423	-.369	-.984*	-.910*
France	-.655†	-.836*	-1.13*	-1.12*
Project team	-.437*	-.382*	-.373	-.379
Parallel team	-.372*	-.435**	.049	.027
Management team	-.381	-.351	.498	.446
Intercept	6.61*	7.01*	-5.12	-5.32
R-squared	.58	.62	.47	.48
N	113	113	78	78

† p<.10; * p<.05; ** p<.01; *** p<.001

1. Team heterogeneity and subgroups are employed as control variables, since they can be expected to also influence team performance in ways other than through learning behavior (e.g., Lau and Murnighan, 1998; Jehn, Northcraft, and Neale, 1999).
2. Value * 10^3

Table 4

Means, Standard Deviations, and Correlation Coefficients of the Dependent and Independent Variables

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12
1. Team learning behavior	38.7	27.3												
2. Age heterogeneity	.156	.105	.11											
3. Team tenure heterogeneity	.505	.480	.01	.22										
4. Ethnic heterogeneity	.091	.172	-.04	.03	-.02									
5. Functional heterogeneity	.291	.057	.08	.08	.15	-.08								
6. Gender heterogeneity	.099	.144	.11	.19	.20	.08	.28							
7. Team heterogeneity	.291	.058	-.06	.12	.24	.23	.56	.38						
8. Subgroups	.564	.245	-.01	.02	-.02	.22	.26	.47	.42					
9. Leader encouragement	0	1	.63	.08	-.01	-.07	.05	.18	-.07	.10				
10. Team empowerment	0	1	.51	.01	-.04	-.04	.03	.09	.01	.04	.40			
11. Knowledge management system	0	1	.60	.05	.02	.03	-.06	-.06	-.21	-.03	.53	.44		
12. Routine task	0	1	.56	.08	-.03	.05	.06	.09	-.11	.06	.60	.45	.65	
13. Team size	4.64	3.2	.15	.33	.31	.15	.15	.44	.02	.21	.14	.02	.12	.13

* N=156. Correlations with absolute value greater than .17 are significant at the .05 level

Table 5

OLS Regression Results: Equations with Team Learning Behavior as Dependent Variable

	Model			
	1	2	3	4
Variables				
Predictors				
Age diversity	.039	1.89		
Age diversity squared	-.060	-21.1		
Team tenure diversity	2.96	.202		
Team tenure diversity squared	-2.39	-1.59		
Ethnic diversity	31.0	25.6		
Ethnic diversity squared	-56.4	-59.9		
Functional diversity	-.134	-6.65		
Functional diversity squared	24.5	13.8		
Gender diversity	-9.67	-5.41		
Gender diversity squared	9.32	-9.22		
Team diversity [1]			-.113	-1.72***
Team diversity squared			.173	2.82***
Subgroups [1]		.041*		.094***
Subgroups squared		-.040*		-.077***
Leadership stimulus	4.52*	4.79*	6.69**	8.07***
Team empowerment	5.30**	8.09***	7.18***	7.68***
Knowledge system	10.4***	10.5***	11.4***	12.4***
Control variables				
Routine task	3.21	4.00	1.36	2.95
Team size	-.556	-.486	.029	-.276
Control dummies				
Kodak	.461	.131	4.58	4.54
Merck	-1.19	.959	-.523	-1.33
GE	-10.2	-8.24	-9.32	-6.99
J&J	3.77	3.24	7.68	7.16
Phillipines	-5.99	-5.98	-12.0	-6.88
Puerto Rico	9.69	4.75	1.02	-2.61
France	9.61	12.9	-.088	6.75
Project team	-8.64	-9.17	.916	-2.17
Parallel team	-3.77	-5.15	-4.18	-9.33*
Management team	-1.55	-1.23	11.1	7.09
Intercept	42.0***	40.8**	61.5*	278***
R-squared	.69	.75	.615	.74

†p<.10; *p<.05; **p<.01; ***p<.001

1. Value*10^{3}

Figure 1. Observed relationship between heterogeneity and team learning behavior

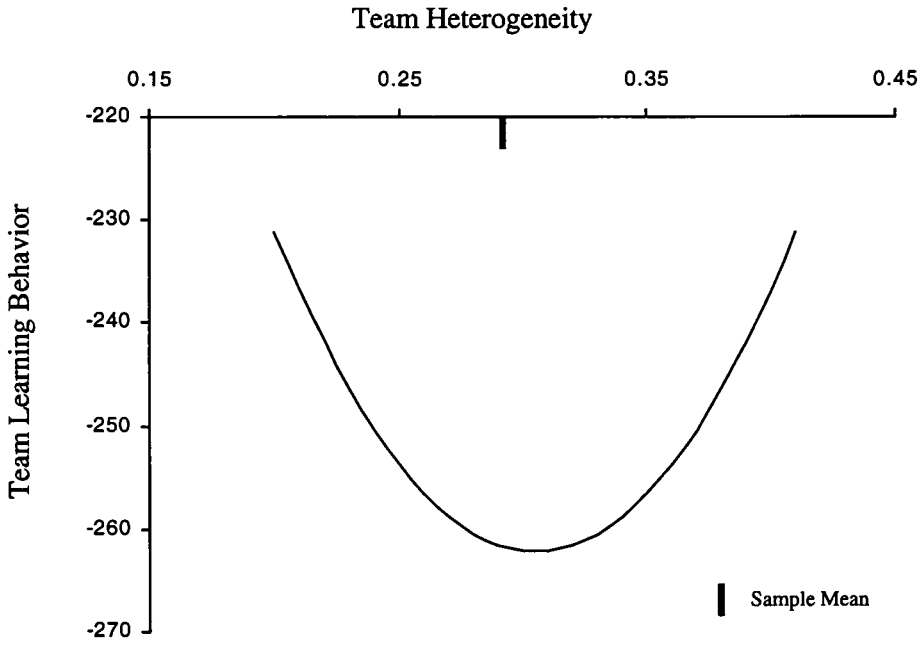
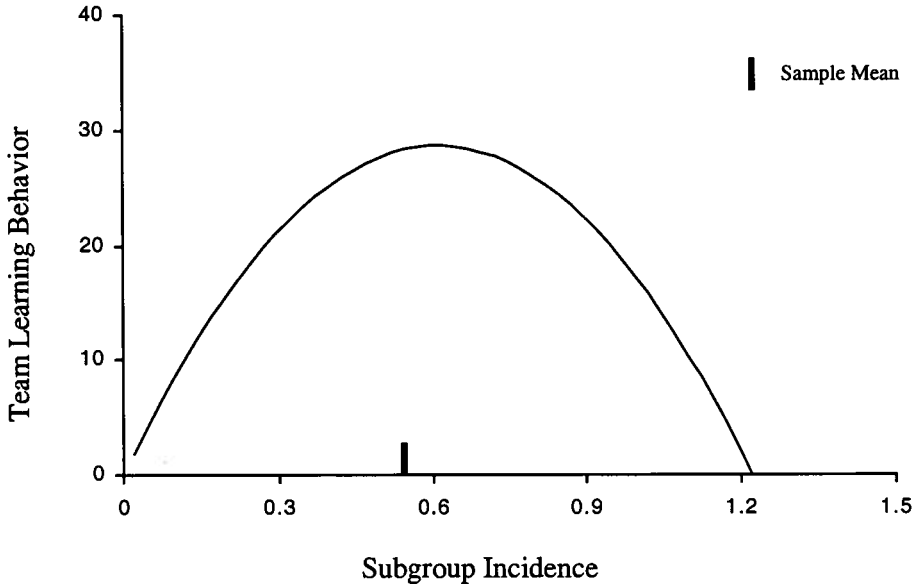


Figure 2. Observed relationship between subgroups and team learning behavior



APPENDIX: Computation of Team Heterogeneity and Subgroups

Total team heterogeneity is computed as follows: First, the overlap for member pair *ij* is computed on each of the attributes (i.e., gender, ethnic background, etc.) Overlap in categorical measures was simply zero or one. For example, if a pair consists of two Asians, the overlap in terms of ethnicity is 1. If a pair consists of an Asian and an African American the overlap in ethnicity is considered to be 0. Overlap in continuous measures is a proportion, where the smallest observed value in the pair is represented as a proportion of the largest value. For instance, overlap in team tenure is represented by the years shared together on the team as a proportion of the longest tenured person. Hence, a pair of 4 and 5 years has an overlap of 0,8. Likewise for a pair of 20 and 25. A similar computation applies to overlap in age. This variable, however, is corrected for the notion that members have a minimum age when they join a team, as well as a maximum, pensionable age (see below). Following, the overlap on the different attributes is summed to arrive at the total overlap of pair *ij*. Total team homogeneity is computed by summing the overlap of the different pairs and dividing it by the number of pairs on the team. Subgroup formation is computed by taking the standard deviation across the different pairs on a team. Formally:

$$\text{Team heterogeneity} = \left(\frac{1}{P} \sum_{i \neq j} \sum_{k} overlap\, X_{k,ij} \right)^{-1}$$

$$\text{Subgroups} = S.D. \sum_{k} overlap\, X_{k,ij}$$

where,
P = number of pairs = (n-1)+(n-2)+….+(n-(n-1)), where n = number of people on the team
S.D. = standard deviation
i = *i*th member on the team; j = *j*th member on the team
k = number of demographic characteristics included in the measure

In this study,
X_1 = if $gender_i$ = $gender_j$, then 1, else 0
X_2 = if $ethnic_i$ = $ethnic_j$, then 1, else 0
X_3 = if $function_i$ = $function_j$, then 1, else 0
X_4 = min($tenure_i$, $tenure_j$) / max($tenure_i$, $tenure_j$)

$X_5 = \min(age_i , age_j) / \max(age_i , age_j) - ({}^{19}/_{65} * (1- (\min(age_i , age_j) / \max(age_i , age_j)) / (1 - {}^{19}/_{65}$)), where 19 is the minimum age of a team member in the sample, 65 the maximum