Integrating Knowledge in Groups: How Formal Interventions Enable Flexibility

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Abstract
Recent perspectives have focused on the role of the firm in the generation and use of knowledge. These perspectives suggest that, while knowledge is “owned” at the individual level, the integration of this knowledge to a collective level is necessary. This integration of knowledge typically takes place in groups. In our experimental study, we examine how individuals in groups engage in micro-level interactions to effectively integrate knowledge by examining the effects of using three formal interventions: Information Sharing, Questioning Others, and Managing Time. In particular, we observe that simple formal interventions can improve knowledge integration when they lead to “windows of opportunity” for group members to consider ways to improve their work process that go beyond the formal intervention instructions. The most effective groups used these formal interventions to focus their attention into organized clusters of activity, during which they significantly changed their work process and improved their subsequent knowledge integration. In particular, groups in the Questioning Others and Managing Time conditions exhibited greater knowledge integration than groups in the Information Sharing and Control conditions. Groups with high-knowledge integration paced their attention to both adaptive improvements to their process and task execution. Overall, this study identifies simple structures, interruptions, and time pacing as central to the emerging concept of group flexibility by which members enhance their performance on novel and/or ambiguous tasks. We note links to complexity theory and knowledge-based thinking as well.

A fundamental activity of groups is the integration of individual knowledge into collective knowledge. Indeed, there are many organizational situations in which individuals with specialized knowledge must integrate their knowledge in a group to realize its value. Examples include multifunctional product development groups working on a common product (Dougherty 1992, Ancona and Caldwell 1992), top management teams whose members represent different business functions and who must make strategic choices about their collective business (Eisenhardt 1989, Eisenhardt and Bourgeois 1988), and teams of factory representatives working on manufacturing process improvements (Tyre and Orlikowski 1994).

Central to the effectiveness of these groups is the knowledge integration process. That is, to be useful, the knowledge that is “owned” by individual members of such groups (Spender and Grant 1996) must spiral upward to groups and even organizations, where it can be exploited to further the goals of the organization (Nonaka 1994). Moreover, as knowledge is increasingly recognized as a primary strategic resource for organizations (Grant 1996, Kogut and Zander 1992), the work of groups in the knowledge domain becomes central to organizational success. Yet, while the knowledge integration process within groups is important, it is not always effective. That is, critical information is often not used by members (Stasser and Stewart 1992). Obstacles to an effective process include lack of familiarity among individuals, distinctive thought worlds, disparities in verbal skill, insufficient conflict, unfamiliar language, status differences, and physical distance (e.g., Bechky 1999, Dougherty 1992, Eisenhardt 1989, Gruenfeld et al. 1996, Szulanski 1996).

Formal interventions that focus on the improvement of the group process are a potential way to achieve superior knowledge integration. These formal interventions provide explicit instructions for the group to follow and help guide the discussion among members (Okhuysen 2001, Pavitt 1993, 1994). These process interventions are designed to create a more structured group discussion, and enhance the communication of personally held information. They range from simple formal interventions such as basic instructions to share information (Henry 1995,
Okhuysen (2001) to more complex interventions like the Nominal Group Technique (Bartunek and Murnighan 1984) and the Delphi Technique (Dalkey 1968). These formal interventions are intended to structure the group process so that more knowledge is revealed and effectively combined.

But while formal interventions can improve the knowledge integration process in a group, little is known about how and when they will work. Formal interventions are often effective, but sometimes they have no effect or can even be detrimental (Green 1975, Price 1985). This inability to predict their effects stems from our incomplete understanding about how formal interventions operate. Researchers rarely examine how these interventions actually work to help groups modify their process to more effectively integrate knowledge. Instead, they focus on differences in outcomes across groups with little attention to actual changes in the interactions among individuals (Pavitt 1993).

The purpose of this study is to explore how formal interventions improve knowledge integration in groups. Related research suggests that simple formal interventions can improve knowledge integration (Okhuysen 2001) and affect the time pacing of those improvements (Okhuysen and Waller 2002). This research extends that work by examining how and why several distinct formal interventions that differ in crucial ways function. Second, we rely on rich and comprehensive data on actual group process to study these interventions and their related effects on process mechanisms. Third, we make theoretical and empirical distinctions between the knowledge integration process and knowledge integration per se. In particular, the knowledge integration process involves the actions of group members by which they share their individual knowledge within the group and combine it to create new knowledge. By contrast, knowledge integration is the outcome of this process, consisting of both the shared knowledge of individuals and the combined knowledge that emerges from their interactions. This latter distinction enables further theoretical understanding of the effect of formal interventions on knowledge integration.

We examine these issues by using three simple formal interventions (i.e., managing time, questioning others, sharing information) within problem-solving groups whose members possess specialized knowledge. While we recognize the limits of laboratory settings, we chose this approach to crystallize our focus on group dynamics of knowledge integration at a level of precision that is rarely possible to achieve in the field. We chose simple interventions because they can be powerful (e.g., Henry 1995, Okhuysen 2001) and because they build on related work on how formal interventions operate more generally (Okhuysen 2001, Okhuysen and Waller 2002).

There are several major results. We find that simple formal interventions can change the knowledge integration process by creating a second agenda of activity in addition to the primary task of designing a car, making a funding choice, or engaging in some other problem-solving activity. When group members switch their attention to this second agenda, they make changes in line with the guidelines of the intervention. Second, when formal interventions improve the resulting knowledge integration, they do so by triggering the emergence of clusters of attention switches in close temporal proximity. During these “windows of opportunity,” group members engage in discussions about ways to improve their process that go beyond the specifics of the particular formal intervention. These clusters subsequently yield a changed knowledge integration process and an improved knowledge integration outcome. Finally, we find that not all simple formal interventions have these positive effects. Surprisingly, even though their primary focus is improving knowledge integration per se, formal interventions that result in “self-focus” by individuals may not do so. Rather, effective formal interventions cause individuals to shift their focus to others in the group, which stimulates interactions among group members. Remarkably, these interventions can be effective, even when they encourage interactions that are not directly related to knowledge integration. Overall, our study highlights the importance of other-directed interaction for effective knowledge integration, and the efficacy of simple structures for enabling or shaping flexibility to improve process interactions among group members.

More broadly, our study contributes to several research streams. Our study links to the group process literature by extending our understanding of how and why simple formal interventions work. Together with related work (Okhuysen 2001, Okhuysen and Waller 2002), our study elaborates on the concept of group flexibility by which members improve their performance on ambiguous and/or novel tasks. Simple structuring mechanisms, interruptions, and timing emerge as constructs central to group flexibility. Our study also ties to the organizational literature on adaptation, especially complexity theory. It suggests that simple formal interventions provide simple rules that act as a source of semi-structure (Brown and Eisenhardt 1997, Eisenhardt and Sull 2001) that can help groups self-organize their improvement and pace their attention to both adapting and executing their task. Both more and less structuring may be less effective. We also draw implications for the knowledge view of organization, particularly the distinctions between knowledge...
sharing vs. integration, and knowledge as resource vs. knowledge as knowing.

**Theoretical Background and Hypotheses**

Formal interventions improve knowledge integration in groups by providing specific behavioral directives for members to follow (Pavitt 1993, 1994). Formal interventions structure the group interaction so that knowledge is more effectively introduced and combined. As stated earlier, these interventions range from simple instructions like sharing information among members (Henry 1995), to more complex interventions such as Devil’s Advocacy (Schweiger et al. 1989), to very complex interventions like the Nominal Group Technique (Bartunek and Murmihan 1984). Formal interventions have been used in a variety of settings where knowledge integration is relevant, including idea generation (Diehl and Stroebe 1987), strategic decision making (Cook and Hammond 1982, Schweiger and Finger 1984, Schwenk and Cosier 1993), and problem solving (Guzzo 1982).

**Primary Effect of Formal Interventions**

We propose that a major effect of a formal intervention is to add a second agenda that is focused on improving some aspect of the knowledge integration process. That is, group members gain an additional process-oriented task to focus on during their activities (Gersick 1989, Henry 1995). The primary task is the completion of the principal activity of the group (e.g., solving a problem, making a decision), and the second agenda or task becomes following the instructions of the formal intervention (Okhuysen 2001).

As a result of this second agenda, group members occasionally shift their attention from their primary task to the directives for improved knowledge integration prescribed by the second agenda. In addition, the formal intervention creates process goals related to the behaviors dictated by the intervention (Weingart 1992). This behavior can provide an immediate source of feedback that is separate from progress on the task (Weldon et al. 1991). Group members may observe discrepancies between their actual group behaviors and their achievement of the process goals suggested by the intervention (Bandura 1993, Campion and Lord 1982, Lord and Kernan 1987). Once reminded of the intervention and/or alerted to process discrepancies, group members may verbally interrupt the rest of the group with an attention switch to the directives of the formal intervention.

A good example of using a second agenda to redirect the work of the group is provided by Gersick’s (1988, 1989) research on the effects of deadlines on groups. Gersick found that deadlines created a second agenda such that group members not only had to engage in their primary task (e.g., design a commercial, create a plan for an off site meeting), but also had to attend to completion of the task by a particular time. In response to these deadlines, members occasionally interrupted the efforts of the group to discuss time-related issues such as progress relative to time, time remaining, and changes in process given the remaining time.

Thus, we expect that formal interventions will lead group members to switch their attention to those aspects of the knowledge integration process dictated by the formal intervention. These group members may then verbally interrupt the group and explicitly switch their attention to consideration of the knowledge integration behaviors related to the formal intervention. In hypothesis form:

**HYPOTHESIS 1.** Formal interventions increase the number of switches to the knowledge integration behavior targeted by the formal intervention.

**Spillover Effects of Formal Interventions**

Once a group member articulates a switch in the conversation to the second agenda, several effects are likely. First, after a switch to consider the formal intervention, other group members will be reminded of the second agenda, and are likely to switch their attention to the second agenda as well. Second, because the formal intervention provides process goals related to the knowledge integration process that are separate from the task (Weldon et al. 1991), group members are likely to become attentive to discrepancies between actual group behaviors and those suggested by the intervention (Abelson 1981, Campion and Lord 1982). Third, because their attention has now been shifted to discrepancy-seeking behavior related to an aspect of the knowledge integration process, group members are more likely to notice other discrepancies between the group’s behaviors and the goals of the group. In particular, they often become attentive to feedback, both positive and negative, about their performance vs. their goals, which they can then use to judge their current course of action (Bandura 1993, Campion and Lord 1982). At the same time, group members are also more likely to become aware of alternative paths to improve their performance (Campion and Lord 1982, Lindsey et al. 1995, Lord and Kernan 1987), such as changing the conversation to focus on the expertise of different people or on different combinations of individual knowledge. This heightened awareness of both their performance and possibilities for changing the course for knowledge integration expands the focus of the group to improvements that go beyond the formal intervention. In other words, there are “spillover” effects that transcend...
the initial interruption. Finally, group members may see the interruption as a legitimate opportunity to address pent-up problems—problems unrelated to the initial attention switch. That is, the interruption becomes a “time out” from normal activities (Tyre and Orlikowski 1994) that creates an opportunity to deal with process issues that group members may have observed, but have not addressed. Because the group is already in a discrepancy-seeking mode, members are more confident that they can legitimately bring up new approaches to the knowledge integration process without being rebutted or ignored, even though these suggestions may be beyond the focus of the formal intervention.

This spillover behavior, after an interruption, has been observed in past research at several levels of analysis. At the organizational level, Meyer (1982) examined the impact of a severe environmental attention switch, a doctors’ strike, on hospitals. He described how managers at some hospitals realized that they could change their strategies and work processes in ways that were far more wide reaching than the immediate strike. Some managers took advantage of the break provided by the strike to broadly modify their operations in ways that transcended the immediate issues of the strike. Similarly, Graebner and Eisenhardt (2002) observed that, when the management teams of entrepreneurial firms faced significant interruptions, such as the need to hire a direct sales force or replace their chief executive officer (CEO), they took the opportunity to also consider broader changes in strategy, including being acquired. At the group level, Tyre et al. (1996) observed that interruptions in work routines became opportunities to address problems that had been noted, but not addressed. Both planned and unplanned breaks in production schedules created legitimate “time outs,” during which group members made changes around a variety of issues that went well beyond the immediate cause of the schedule interruption. In other words, these interruptions became opportunities to engage in broad-based change. Similarly, in our case of formal interventions, we expect that group members will switch their attention to other aspects of the knowledge integration process that were not targeted by the formal intervention after an initial attention switch. These arguments lead to the second hypothesis.

**Hypothesis 2.** Formal interventions increase the number of attention switches to other knowledge integration behaviors that are not the target of the formal intervention.

**Clusters of Attention Switches**

The previous hypothesis argues that when group members switch their attention to the formal intervention, they are also likely to switch their attention to other behaviors to broadly look for ways to improve their knowledge integration process. In other words, there is a “spillover” effect from the initial attention switch. This argument assumes that these attention switches occur in close temporal proximity in what we term “clusters.” Thus, these clusters of attention switches create focused time periods during which groups center their attention on improving their knowledge integration process. Clusters emerge as group members balance making process improvements with execution of the primary task (Tyre and Orlikowski 1994, Sastry 1997). Similar focused time periods for making wide-ranging changes to process have been observed in previous studies of groups. For example, Gersick’s (1989) groups clustered their efforts to improve their process. After an initial attention switch focused on the time remaining—a salient concern given the tight deadline—groups considered other avenues to improve their process within a short period of change. During this period, groups were, for example, more likely to consider seeking advice from external authorities, to consolidate the knowledge that they gathered to that point to create a common understanding going forward, and to generally reassess their approach to the task. Tyre and Orlikowski (1994) also found that an initial interruption (i.e., either a planned or unplanned break in the production schedule) was quickly followed by a burst of attention to address a variety of pent-up needs while, at the same time, members attended to the original cause of the interruption. There was a short “window of opportunity,” during which members made numerous course corrections to their approach for executing their task. Waller (1999) also found that flight crews who effectively responded to nonroutine events, significantly changed their process, including reprioritizing subtasks and changing task responsibilities among crew members, during a focused time period immediately after the event. In the case of problem-solving groups, we expect that formal interventions will prompt group members to cluster their attention switches to knowledge integration behaviors in close temporal proximity such that they form “windows of opportunity” for making course corrections to the knowledge integration process as well.

**Hypothesis 3.** Formal interventions increase the organization of attention switches to knowledge integration behaviors into clusters.

Clusters of attention switches are likely to exhibit several characteristics. In particular, larger clusters (i.e., more attention switches) are likely to be associated with more attention to different aspects of the knowledge integration process. Similarly, more group members are
probably participating in larger clusters because interruptions to a process tend to engage members, who are otherwise distracted, to bring their attention back to the group activity (Tyre et al. 1996). Further, in larger clusters, more members are probably creating ideas and contributing knowledge, which, in turn, makes the group more engaging for members and triggers more ideas. Larger clusters are, therefore, also likely to be associated with more fully engaged members who make more suggestions for improving the process. Finally, because they are focused on varied aspects of the knowledge integration process and involve many group members making multiple suggestions for change, larger clusters of attention switches are likely to result in greater changes in the knowledge integration process after the cluster. These process changes are also likely to lead members into new ways of integrating their information and to greater gains in knowledge integration after the cluster.

HYPOTHESIS 4. Clusters of attention switches that include more attention switches will (a) consider more aspects of the knowledge integration process, (b) have a greater number of group members participating, (c) have a greater number of specific suggestions for improving the knowledge integration process being proposed, (d) have greater change in the knowledge integration process after the cluster, or (e) have greater gains in knowledge integration after the cluster.

Knowledge Integration
Finally, we expect that formal interventions will improve knowledge integration among individuals with specialized information and engaged in a collective problem-solving task because they give group members specific guidance on how to improve their knowledge integration process (Bartunek and Murnighan 1984, Dalkey 1968, Henry 1995). Groups often underutilize the knowledge of members, and explicit directives that guide process improvement are likely to result in greater knowledge integration. Second, as we have hypothesized, formal interventions trigger the emergence of attention switches that are organized into clusters that create focused time periods, during which group members can generate possible improvements to their knowledge integration process that go beyond the initial attention switch. These clusters also provide opportunities to address accumulated problems, such as insufficient contribution by a particular group member, thus providing an opportunity for full engagement by members and for greater knowledge integration (Tyre et al. 1996).

We also hypothesized that after these clusters, groups are more likely to change their process in ways that lead members into new approaches for integrating their knowledge. Given that the work of groups is often ambiguous and complex (Matthews et al. 1994, Weldon et al. 1991), groups may need several “course corrections.” Therefore, multiple clusters of attention switches to consider possible process improvements can help groups adapt their task execution by clarifying appropriate process improvements, given their current state of task progress. We expect that, through the specific behavioral directives of formal interventions and their related course corrections to the knowledge integration process, formal interventions will lead to greater knowledge integration.

HYPOTHESIS 5. Groups using a formal intervention will have greater knowledge integration than groups not using a formal intervention.

Methods
Subjects
We tested our hypotheses using an experimental setting. An experimental setting enabled us to examine the effects of formal interventions in a sharply focused manner that is difficult to match in field settings. To ensure that subjects would be highly motivated, we selected a task that the subjects would believe to be important and a setting where they would have some personal experience. The task was the identification of key facts that were related to a salmonellosis outbreak in a fast-food restaurant. The case was fictitious and written by the first author. Salmonellosis food poisoning incidents are relatively rare in institutional food service settings because multiple, simultaneous, and interdependent system failures are necessary for an outbreak to occur. For example, a source of contamination must exist either in the food itself or near it, and must be combined with improper food preparation and handling practices.

One hundred and eighty subjects from an introductory organization behavior course at a major United States university were randomly assigned to 45 4-member groups. Five groups were excluded from the final analysis. Two groups had a missing member, one had difficulties with recording equipment, and two failed to properly identify their instructions in the post-experimental questionnaire. The remaining 40 groups were included in the final analysis, for a total of 160 participants. The mean age of the participants was 23 years, 69% were male, and had an average of 3 years of full-time work experience.

Task
The cover sheet for the case explained that the task was to diagnose the causes of the salmonellosis outbreak, and that the information necessary to complete the task was distributed equally among group members. The cover
sheet described the roles of the group members (e.g., all participants belonged to a health department task force investigating the food-poisoning incident) and the task for the group. All case information was contained in exhibits (e.g., time sheets, schedule sheets, cooking instructions, training records) and narrative form (e.g., newspaper clippings). The case was designed so that the information was evenly divided among the four group members and required interdependent effort to perform the task. The case materials were divided into five equal parts. Each part received two-fifths of the total information, one-fifth of which was common to all group members, and the additional fifth was unique to each member. The cover sheet described this distribution of information. This distribution of information is intended to simulate specialization within firms, particularly the typical situation of problemsolving groups in which members possess some information in common, but also information that is unique.

**Experimental Design**

The experiment had a 1 × 4 design, with each cell including 10, 4-member groups. There were one control and three experimental conditions. Our expectation was that the groups in the control condition would engage in typical group behavior such as incomplete sharing of information (Stasser and Stewart 1992, Stasser et al. 1995), insufficient questioning of each other (Schweiger and Finger 1984, Schweiger et al. 1989), and satisfying rather than optimizing behavior (Hoffman et al. 1994).

Three formal interventions were chosen to assist groups in improving their knowledge integration process. The interventions were “sharing information,” “questioning others,” and “managing time.” These interventions were selected based on: (1) the distinctiveness of the behaviors that they would be likely to stimulate, (2) the degree to which the behaviors could be used to obtain feedback on the knowledge integration process, and (3) the likely effectiveness of these knowledge integration behaviors for improving that process. Groups in each condition received a common set of instructions for the session, including notification that the information for the task was distributed among the team members. The groups in the control condition did not receive any additional information beyond the general instructions.

**Sharing Information Condition.** Sharing information was selected because it can aid in increasing communication to exchange critical knowledge about the case (Henry 1995, Stasser et al. 1995). We expected that this condition would stimulate behavior specifically associated with effective knowledge integration because it focuses on encouraging group members to reveal uniquely held information. The following instruction was provided in bold on the instruction sheet.

The amount of information provided by Good-Food, Inc. is quite large, which will make your task harder. In order to more effectively complete the task, please share the information in your possession during your discussion.

The sharing information formal intervention was expected to result in the following knowledge integration behaviors: (1) motivate group members to share knowledge not held in common, (2) focus attention on the unique knowledge held by each group member, and (3) provide the group members with legitimate opportunities to present their knowledge at self-selected times.

**Questioning Others Condition.** Questioning others was selected because it is a critical element in the effectiveness of problem-solving groups (Schweiger and Finger 1984, Schweiger et al. 1989) and an important indicator of effective problem solving (Nutt 1984). Like the sharing information condition, we expected that this intervention would be closely associated with knowledge integration because it centers on encouraging group members to ask others to reveal uniquely held information. The following instruction was given in bold on the instruction sheet.

The amount of information provided by Good-Food, Inc. is quite large, which will make your task harder. In order to more effectively complete the task, please question the different members of the group for possible causes of the salmonellosis outbreak during your discussion.

In terms of knowledge integration behaviors, the questioning others condition was expected to: (1) focus attention on the knowledge of others, (2) motivate group members to ask others about their uniquely held knowledge, and (3) provide the group members with legitimate opportunities to engage in polling behavior with others at self-selected times.

**Managing Time Condition.** Although not explicitly related to knowledge integration, managing time was selected because research has found that a concern for managing time can be associated with a general improvement in the knowledge integration process. A focus on time management can enhance a group’s focus on effective task execution and improve overall performance (Gersick 1988, 1989, Tyre et al. 1996). The following instruction was given in bold lettering on the instruction sheet:

The amount of information provided by Good-Food, Inc. is quite large, which will make your task harder. In order to more effectively complete the task, please manage your time carefully during your discussion.

The managing time condition was expected to increase
knowledge integration behaviors by: (1) focusing the energies of the group by providing a clear yardstick for its activities, (2) providing the group with an accessible metric to judge their process, (3) providing members with legitimate opportunities to modify their activities at self-selected times, and (4) motivating members to suggest time management approaches for the group.

**Procedure**

After arrival, group members received a written description of the work for the session. In addition to informed consent forms, subjects were asked to complete a short questionnaire. The case materials were then distributed to group members. Individuals had 20 minutes to privately review the materials. After the review period, groups had 60 minutes to discuss the case with team members and develop a diagnosis of the causes for the salmonellosis outbreak. Because the average completion time for the pilot groups was 40 minutes, 60 minutes provided ample time for the completion of the task. The maximum time taken was 55 minutes. All discussion periods were videotaped. After executing the task, subjects completed a debriefing questionnaire.

**Coding**

The videotape of each group was transcribed and analyzed by two independent coders. The coders were blind to the treatment conditions, the purpose of the experiment, and the hypotheses being tested. The coders were trained by using sample transcripts from pilot sessions. The coding began when the coders achieved an initial interrater agreement of 90% on the sample transcripts.

**Coding Attention Switches.** An attention switch was coded every time the group departed from a discussion of the case to some other topic such as managing time. Coders categorized the attention switches into three categories: sharing information, questioning others, and managing time. They also created two additional categories (i.e., “Social” and “Other”) to account for other departures from discussion of the case content (e.g., jokes, plans for activities after the experiment).

**Coding Clusters.** Once the attention switches were coded, they were graphed according to their time of occurrence on a 60-minute timeline, in 30-second intervals for each group. An adjacent set of attention switches was labeled a “cluster.” Adjacency between attention switches was defined as two attention switches occurring within 90 seconds of each other. If a third attention switch occurred within 90 seconds of the second, all were considered adjacent, and so on. In addition, each interruption (either a single attention switch or a cluster of attention switches) in all 40 groups was coded according to the number of attention switches it included, number of types of attention switches it included, number of different group members speaking, and number of specific suggestions for improving the knowledge integration process.

**Coding Knowledge Integration.** A knowledge integration score was computed by summing the number of facts that the group identified related to the food poisoning outbreak. Twenty-six critical case facts were present, including “simple” critical facts and “combined” critical facts. Simple critical facts could be found in a single information packet. For example, the time of day when the incident occurred could be identified from a single information packet. Combined critical facts required several individuals’ information, because the fact was the result of synthesizing information from two or more packets. For example, identifying a missing worker required combining scheduling and time sheet information, each “owned” by a different group member. This separation of knowledge into “simple” and “combined” critical facts corresponds to our definition of knowledge integration as consisting of both the shared knowledge of individuals and the combined knowledge that emerges from the interaction of group members. The case included 16 simple facts and 10 combined ones. Each time one of the critical facts was identified in the group discussion, it was scored by the coder. We also computed a second measure of knowledge integration to enhance robustness. Two coders evaluated each group’s final written diagnosis of the food poisoning incident on a 10-point scale based on the completeness and quality of the diagnosis.

**Results**

**Manipulation Checks**

In the pre-experimental questionnaire, subjects were asked to rank the importance of food safety compared to five other safety issues (highway, campus, toy, airline, and drug) that were salient at the time of the experiment to gauge the relevance of the problem. Ninety-three percent of subjects (149/160) ranked food poisoning first or second. In addition, subjects found the problem interesting (mean 4.16 on a 5-point Likert scale), and expended substantial effort on it (4.08 on a 5-point Likert scale). There were no statistically significant differences across experimental conditions on these measures. Manipulation checks were computed from the debriefing questionnaire. Ninety-five percent of groups (40/42) had at least three members who correctly identified the formal intervention for their group and 86% of participants (138/160) properly identified their group’s formal
intervention. In addition, 97% of participants who properly identified their formal intervention (133/138) indicated that the group used the prescribed process during their discussion. All groups used in the analysis had at least three members who properly identified their formal intervention.

** Interrater Reliability**

Two independent coders worked from transcripts of the videotapes. The coders categorized the attention switches according to the specific type of agenda switch (sharing information, questioning others, or managing time) and, as noted above, created two additional categories, labeled “Social” and “Other” to account for the other attention switches. These 5 categories accounted for 100% of attention switches. The coders also coded the identification of critical facts by each group. Initial agreement between the two coders was 93%. After the initial coding, all discrepancies were discussed by the two coders. The resolution of these discrepancies increased agreement to 97%.

The analyses were performed using all attention switches identified, and repeated excluding the Social and Other categories, which were less than 10% of attention switches. There were no differences in the significance or direction of the findings. Thus, for simplicity, the Social and Other categories are omitted from the subsequent presentation of results.

** Attention Switches**

Hypothesis 1 proposed that formal interventions increase the amount of attention switching to the behavior prescribed by the formal intervention. We argued that this was the primary effect of formal interventions. To test this hypothesis, we compared the control group with each of the experimental conditions, testing for a difference in the mean number of targeted attention switches.

The results (see Table 1) support this hypothesis. Specifically, asking a group to manage their time increases the use of managing time switches (Control vs. Time Management: 2.50 vs. 6.20, t(18) = 5.17, p < 0.01), while asking a group to question others also increases the number of switches to questioning others (Control vs. Questioning Others: 2.70 vs. 6.90, t(18) = 4.86, p < 0.01). Finally, directing a group to share information also increased the number of attention switches in the sharing information category (Control vs. Information Sharing: 4.30 vs. 8.60, t(18) = 5.98, p < 0.01). Therefore, Hypothesis 1 was supported in all three conditions.

Hypothesis 2 proposed that formal interventions produce spillover effects such that there is an increase in the number of attention switches to nontargeted process behaviors after the initial attention switch. We tested for a difference in the mean number of attention switches to nontargeted behaviors between the control group and each of the experimental conditions. The results support Hypothesis 2 for two of the three conditions (see Table 1). In the managing time condition, groups had more questioning others attention switches (2.70 vs. 4.40, t(18) = 2.22, p < 0.05) and more sharing information attention switches (4.30 vs. 5.90, t(18) = 2.17, p < 0.05). Groups in the questioning others condition also had more managing time switches (2.50 vs. 3.70, t(18) = 1.78, p < 0.05) and marginally more attention switches to sharing information (4.30 vs. 5.60, t(18) = 1.77, p < 0.10). In contrast, Hypothesis 2 is not supported in the sharing information condition. The number of attention switches to the two spillover categories, managing time and questioning others, was not significantly different from the control groups (2.50 vs. 2.00, t(18) = 0.88, n.s.; 2.70 vs. 3.70, t(18) = 1.26, n.s.). Thus, we find support for spillover activities (Hypothesis 2) in the managing time and questioning others conditions, but not for sharing information.

**Clusters**

Hypothesis 3 proposed that formal interventions would trigger the emergence of clusters of attention switches. We tested this proposition by comparing the proportion of attention switches that occur in clusters across conditions. The results support Hypothesis 3 for two of the three conditions (see Table 2). Groups in the managing time condition showed a significant increase in the proportion of attention switches that appeared in clusters (0.35 vs. 0.52, t(18) = 1.93, p < 0.05). This clustering also occurs for groups in the questioning others condition, where there was also a significant increase in the proportion of attention switches that appeared in clusters (0.35 vs. 0.54, t(18) = 2.42, p < 0.05).

We further explored clusters by looking at the number of attention switches in each cluster (see Table 2). We

| Table 1 | Results for Attention Switching Events by Experimental Condition and Target Behavior |
| --- | --- | --- | --- | --- |
| Experimental Condition (Formal Intervention) | Control | Managing Time | Questioning Others | Sharing Information |
| **Attention Switch Type** | **** | **** | **** | **** |
| Managing Time | 2.50 | 6.20 | 3.70 | 2.00 n.s. |
| Questioning Others | 2.70 | 4.40 | 6.90 | 3.70 n.s. |
| Sharing Information | 4.30 | 5.90 | 5.60 | 8.60 |

\( t \) test for differences in means with the control group. \( *p < 0.05, **p < 0.01, ***p < 0.001, \*p < 0.10. \)
found that groups in the managing time condition showed an increase in the number of clusters with three or more attention switches (0.40 vs. 1.40, \( t(18) = -3.19, p < 0.01 \)) and in the number of clusters with two attention switches (1.00 vs. 1.90, \( t(18) = -1.96, p < 0.05 \)). Groups in the questioning others condition also showed a similar increase in the number of clusters with three or more attention switches (0.40 vs. 1.40, \( t(18) = -2.65, p < 0.01 \)) and in the number of clusters with two attention switches (1.00 vs. 2.00, \( t(18) = -1.79, p < 0.05 \)). In other words, groups in the managing time and questioning others condition are more likely to cluster attention switches.

In contrast, Hypothesis 3 is not supported in the sharing information condition. These groups did not show a significant increase in the proportion of attention switches that appeared in clusters (0.35 vs. 0.39, \( t(18) = -0.49, n.s. \)) They had no significant increase in the number of clusters with three or more attention switches (0.40 vs. 0.70, \( t(18) = -0.97, n.s. \)), and only a marginal increase in the number of clusters with two attention switches (1.00 vs. 1.90, \( t(18) = -1.83, p < 0.10 \)).

Hypothesis 4 proposed that because clusters include greater numbers of attention switches, groups will also have more attention switches to different aspects of process, involve more group members, and propose a greater number of suggestions for process improvement. We performed a one-way analysis of variance for each variable, according to the number of attention switches in each interruption (i.e., single attention switches and clusters of attention switches) to examine these effects. As indicated in Table 3, more attention switches are associated with more types of attention switches \( (F(3, 411) = 640.92, p < 0.001) \) and more aspects of the group process are addressed. In addition, more attention switches are associated with more group members speaking \( (F(3, 411) = 106.24, p < 0.001) \) and a greater number of specific suggestions to improve the process proposed by members \( (F(3, 411) = 62.20, p < 0.001) \).

Hypothesis 4 also proposed that as clusters included greater numbers of attention switches, there would be a greater change in the knowledge integration process from before to after the cluster and a greater knowledge integration gain following the cluster. To obtain a "change" score, we examined the following: person leading the discussion, topic under discussion, changes from seeking confirming to seeking disconfirming evidence (or vice versa), and changes from presenting to combining information (or vice versa). This provided a score for the change from the period prior to the interruption to the period following \( (\text{range} = 0 \text{ for no changes, } 4 \text{ for changes in all measures}) \). We found that more attention switches are associated with a greater change in the knowledge integration process after the interruption \( (F(3, 411) = 217.13, p < 0.001) \).

To obtain a measure of the knowledge integration gain after an interruption (i.e., single attention switch or cluster of attention switches), we counted the number of critical facts identified by members after the interruption, but before the next. We found that more attention switches in the interruption are associated with a greater knowledge integration gain \( (F(3, 411) = 8.50, p < 0.001) \).

Overall, these results support Hypothesis 4. They indicate that larger (i.e., more attention switches) clusters are associated with more attention to different aspects of the knowledge integration process, more specific suggestions for improving the knowledge integration process, and more group members participating. Further, these larger clusters produced more significant change in the group’s subsequent approach to their process and greater knowledge integration gain after the interruption.

**Formal Interventions and Knowledge Integration**

In Hypothesis 5, we proposed that formal interventions improve knowledge integration. We tested for a difference in the mean level of knowledge integration between the control and each of the formal intervention conditions.
We used the total number of critical facts identified as our primary measure of knowledge integration. The results support Hypothesis 5 for two of the three conditions (see Table 4). Groups in the managing time condition had significantly higher knowledge integration (6.10 vs. 9.40, t(18) = −2.19, p < 0.05), as did groups in the questioning others condition (6.10 vs. 9.60, t(18) = −2.06, p < 0.06). In contrast, the knowledge integration of groups in the sharing information condition did not significantly differ from the control groups (6.20 vs. 5.60, t(18) = 0.32, n.s.). We repeated this analysis using a second measure of knowledge integration to examine the robustness of our results. As described earlier, this measure focused on the quality and completeness of the written diagnosis of the case problem. The results using this measure also support Hypothesis 5 for two of the three conditions. Groups in the managing time condition had significantly higher knowledge integration (6.20 vs. 7.75, t(18) = −5.89, p < 0.001) as did groups in the questioning others condition (6.20 vs. 7.45, t(18) = −3.37, p < 0.01). In contrast, groups in the sharing information condition did not have significantly different knowledge integration from the control groups (6.20 vs. 5.90, t(18) = 0.80, n.s.).

We also further examined the relationship between knowledge integration and formal interventions (Hypothesis 5) by splitting knowledge integration into simple and combined critical facts. As described earlier, combined critical facts are those that require the synthesis of knowledge from multiple group members. Simple critical facts are those that could be identified by using knowledge held by one group member. For combined critical facts, the results replicate those presented earlier for knowledge integration. That is, groups in the managing time condition outperformed groups in the control condition (1.40 vs. 4.10, t(18) = −3.80, p < 0.001), as did groups in the questioning others condition (1.40 vs. 3.80, t(18) = −2.80, p < 0.01). Groups in the information sharing condition did not (1.40 vs. 1.20, t(18) = 0.50, n.s.). In contrast, the results differ for simple critical facts. There is
no significant difference between the control groups and the groups in the other conditions. Therefore, these results indicate that improved knowledge integration is due to gains in combined knowledge (i.e., knowledge that depends on the interaction of group members), not gains in knowledge sharing by individual group members. We develop this conceptual distinction between knowledge sharing and knowledge integration in the Discussion.

Finally, we examined the mediation effects of clusters on the relationship between formal interventions and knowledge integration (Baron and Kenny 1986). The formal intervention conditions are significant in explaining knowledge integration (Model 1) and the mediating variable, total number of clusters (Model 2) (see Table 5). The mediating variable, total number of clusters, significantly explains knowledge integration (Model 3). However, the formal intervention conditions are not significant when combined with the total number of clusters to explain knowledge integration (Model 4). Therefore, the relationship between the formal interventions and knowledge integration is fully mediated by the total number of clusters in the knowledge integration process. We repeated this analysis for the percentage of total attention switches in clusters (Models 1, 5–7), with results that also suggest a fully mediated relationship between the formal interventions and knowledge integration.

Clusters

Given the importance of clusters to our results, we performed several additional analyses to explore the relationship between clusters and knowledge integration, and to rule out several alternative explanations (see Table 6).

For completeness, Model 1 repeats the analysis for total number of clusters (Model 3, Table 5). As before, the total number of clusters significantly predicts knowledge integration. Model 2 examines the size of clusters (as measured by the number of attention switches that they include). The results show a significant, positive increase in knowledge integration for clusters with four ($t(36) = 4.38, p < 0.001$) and three ($t(36) = 3.20, p < 0.001$) attention switches. However, clusters with only two attention switches did not significantly affect knowledge integration ($t(36) = 0.98, n.s.$).

Model 3 examines the breadth of clusters (as measured by the number of different types of attention switches in the cluster). The results show a significant increase in knowledge integration for clusters with three ($t(36) = 4.79, p < 0.001$) and two ($t(36) = 2.04, p < 0.05$) types of attention switches. However, clusters with only one type of attention switch did not significantly contribute to knowledge integration ($t(36) = -0.32, n.s.$). Next, we examine two alternative explanations to clustering. In Model 4, we introduce the total number of attention switches. The results show that the total number of attention switches is not significant ($t(38) = 0.15, n.s.$). In Model 5, we analyze the effects of the number of interruptions (i.e., single attention switches and clusters of attention switches). The total number of interruptions is significant and negatively related to knowledge integration ($t(38) = 2.66, p < 0.01$).

Taken together, these results indicate that the formation of large and varied clusters of activity centered on improving the knowledge integration process is a key driver of improved knowledge integration (Model 7, Table 5).

Table 5: Analysis of Mediating Influences of Clusters Between Formal Intervention Conditions and Knowledge Integration

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Total Number of Clusters</th>
<th>Knowledge</th>
<th>Knowledge</th>
<th>Knowledge</th>
<th>Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integration (Model 1)</td>
<td>Integration (Model 2)</td>
<td>Integration (Model 3)</td>
<td>Integration (Model 4)</td>
<td>Integration (Model 5)</td>
<td>Integration (Model 6)</td>
</tr>
<tr>
<td>Constant</td>
<td>6.1</td>
<td>1.3</td>
<td>4.32</td>
<td>1.36**</td>
<td>1.23*</td>
</tr>
<tr>
<td>Total number of clusters</td>
<td>12.71**</td>
<td>11.37**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of total attention switches in clusters</td>
<td>2.0**</td>
<td>2.03</td>
<td>0.17*</td>
<td>1.30</td>
<td></td>
</tr>
<tr>
<td>Managing Time</td>
<td>3.3*</td>
<td>3.5*</td>
<td>1.30</td>
<td>0.91*</td>
<td>1.29</td>
</tr>
<tr>
<td>Questioning Others</td>
<td>3.0*</td>
<td>1.2**</td>
<td>-0.67</td>
<td>0.04</td>
<td>-0.12</td>
</tr>
<tr>
<td>Sharing Information</td>
<td>0.16</td>
<td>0.40</td>
<td>0.20</td>
<td>0.28</td>
<td>0.16</td>
</tr>
</tbody>
</table>

*p < 0.05; **p < 0.01; *p < 0.10.
Models 1, 2, and 3, Table 6). In contrast, more total attention switches (Model 4, Table 6) does not significantly improve knowledge integration. Further, more total interruptions (i.e., single attention switches plus clusters of attention switches) actually lowers knowledge integration (Model 5, Table 6). Therefore, the primary effects of formal interventions on knowledge integration are the clustering of attention switches into periods of significant reflection on the group process by most or all group members, and subsequent change to that process. Effective groups balance between process improvement and task execution by clustering their attention to change efforts. By contrast, ineffective groups engage in frequent, small interruptions that may actually hinder their performance.

Information Sharing Condition
The information sharing condition had effects that differed from those of the questioning others and managing time formal interventions. Although groups in this condition had significantly more attention switches to information sharing than the control groups (Hypothesis 1), they did not have more spillovers, clusters, or knowledge integration (Hypotheses 2–5). Because the task required the integration of specialized knowledge of group members, these results were surprising. A priori, information sharing by group members seemed closely associated with the task.

To understand these results, we reexamined data from the transcripts and debriefing questionnaires. We found several statistically significant differences between groups in the information sharing condition and other groups. The information sharing groups had the longest conversation turns (1.67 minutes) ($F(3, 730) = 18.97, p < 0.001$). They also believed that they had less opportunities to discuss their own information ($t(78) = 2.48, p < 0.001$), and that others’ information was thoroughly discussed during the group interaction ($t(78) = -1.78, p < 0.05$). This suggests that group members in the information sharing condition were more self-focused, and possibly less able to discriminate the value of their different pieces of information. They took longer speaking turns, were more concerned with revealing their own knowledge, and apparently placed less value on the knowledge of other group members.

Discussion
The purpose of this research is to investigate how formal interventions (i.e., managing time, questioning others, and sharing information) improve knowledge integration in groups. We recognize that our findings are subject to the limitations of laboratory research and future researchers would be wise to confirm these findings with ongoing groups in organizations.

We have several key findings. First, simple formal interventions can increase knowledge integration among individuals in groups when members possess specialized knowledge. Furthermore, while each formal intervention created a second agenda to which group members occasionally turned, the formal interventions that actually improved knowledge integration (i.e., managing time, questioning others) triggered group members to focus their process improvements into clusters. During these clusters, most or all group members stepped back from the task and collectively developed ideas on how to improve
their knowledge integration process. As these clusters became larger, groups significantly changed their knowledge integration process (i.e., changed speakers, content focus, rhetorical mode) and improved their knowledge integration. By contrast, ineffective groups engaged in small, scattered attempts to change their process that did not improve knowledge integration, and sometimes hampered it. Finally, those interventions that directed group members to interact with others were effective—both when the intervention was related to behaviors that directly improve knowledge integration (i.e., questioning others) and more surprisingly, when the intervention behaviors were not directly related to integrating knowledge or even performing the task (i.e., managing time). In contrast, formal interventions that create a self-focus (i.e., sharing information) had no effect on spillovers, clusters, or knowledge integration. Further, these interventions lowered the satisfaction of group members with several aspects of their process.

Implications for Group Process

Our research closely links to the group process literature. It supports the contention that small, common sense interventions can change group process and improve group performance. In particular, the simple formal interventions of managing time and questioning others were sufficient to increase knowledge integration. This is consistent with the observations of Henry (1995, p. 191), who indicates that “individuals bring certain resources to the group, but may not use these resources effectively unless they are encouraged to do so.” She advocates small interventions as an effective way to provide this kind of encouragement, make the process intentional, and thus improve group performance. Elaborate interventions such as Dialectical Inquiry (Schweiger and Finger 1984) may not be necessary to improve group process. Indeed, as we note below, elaborate interventions may even be less effective than simple ones because they constrain the flexibility of groups to adapt.

More significant, by providing a more detailed look at group process than is typically done, our results begin to clarify at least one mechanism by which formal interventions work. As we noted earlier, sometimes formal interventions improve group performance and sometimes they do not (Henry 1995, Hirokawa 1985, Pavitt 1993). We find that simple formal interventions create a second agenda to which group members occasionally turn. In the effective formal interventions, they also create clustered opportunities for change. Clusters with three or four attention switches had the most impact on changing the knowledge integration process and improving knowledge integration. In contrast, in the ineffective formal intervention, the intervention motivated members to become self-centered, with members engaged in the task as individuals rather than jointly. Group members interrupted their problem-solving activities with ineffective, singular attention switches rather than creating significant clusters of change. They talked a lot, worried that they needed to speak more, and undervalued the information of others.

Finally, our findings contribute important pieces to the developing concept of group flexibility by which members are able to adapt their group process in an ongoing fashion to improve performance in ambiguous and/or novel tasks. We find that simple structuring mechanisms, interruptions, and time pacing emerge as central to group flexibility. Simple structuring mechanisms—whether simple formal interventions as we studied or more broadly, familiarity (Okhuysen 2001) and deadlines (Gersick 1988)—can trigger interruptions in task execution to attend to a second agenda. But because they do not sharply constrain what occurs in those interruptions, they enable flexibility in approaches to change.

Interruptions are also central to group flexibility. Interruptions, whether imposed by the natural task environment (Waller 1999) or by a simple structure as in this study, allow members to take advantage of these windows of opportunity to adjust their processes, given their current situation. In situations like the one that our groups faced, the task may be clear (e.g., diagnosing a food-poisoning incident), but how to accomplish the task (e.g., which information is relevant, how to combine information) may not be clear. This research shows that groups facing ambiguous and/or novel tasks can benefit from the flexibility that interruptions provide. By providing occasions for periodic course corrections, interruptions enable groups to adjust their work to match their emerging understanding of the task. Moreover, our results suggest that a group’s understanding about how to accomplish their task is intimately related to when and how they accumulate knowledge. As information is revealed, shared, and integrated by members, the resulting knowledge guides group members on how to alter their process to further enhance their performance. Interruptions then provide the opportunity to consolidate this understanding and adjust the process of the group.

Finally, time pacing is also central to group flexibility. We find that the most effective groups pace the timing of their change efforts such that they balance between improving the process and executing the task (see also Gersick 1994, Sastry 1997), timing these change efforts at the beginning of interruptions. Specifically, these groups organized their efforts to improve their knowledge integration process into more large clusters (i.e., numerous and varied attention switches, participation by most or all group members, numerous specific suggestions for
improvement) than less effective groups. But, they did not spend all of their time improving their process. Indeed, they often had fewer interruptions than less effective groups. Rather, their efforts reflected a balanced timing between improvement and execution. As Waller (1999) noted, it is not simply the execution of improvement behaviors—such as interrupting to seek information or reprioritizing tasks—that enables higher knowledge integration. Instead, the timing of attention to these improvements—clustered immediately after interruptions and paced with task execution—is crucial.

Implications for Structure and Adaptation
Our work has implications more broadly for the link between structure and adaptation. On the one hand, a number of authors have emphasized the negative effects of structure. Dougherty (1992), for example, suggested that established routines and rules create barriers to knowledge integration. Dyer and Nobeoka (2000) highlighted the negative aspects of structure in knowledge transfer within alliance relationships among automotive firms and their suppliers. On the other hand, some authors noted the effectiveness of structured activities for knowledge integration and transfer such as brainstorming events (Hargadon and Sutton 1997) and liaisons between firms (Almeida 1996).

Our work reveals a more subtle relationship. Structure acts not only as a channel for knowledge flows among individuals, but also can provide a platform for changing and improving those flows. In our study, simple formal interventions served as an impetus for group members to self-organize their activities into clusters of attention switches for improving the knowledge integration process. Moreover, consistent with complexity theory (Anderson 1999, Eisenhardt and Bhatia 2002), the simplicity of the formal intervention may be significant. As the control groups showed, the absence of structure made it difficult for groups to organize themselves to effectively adapt their knowledge integration process. Without the imposed structure, group members’ attempts to improve knowledge integration remained disorganized, infrequent, sporadic (not clustered), and not surprisingly, ineffective. At the same time, much greater structure might well have created rigidity that would not have enabled this flexible self-organization to emerge as we have seen in previous studies (Dougherty 1992, Dyer 1999).

Broadly, our formal interventions are simple rules that act as “semi-structures” (Eisenhardt and Sull 2001, Brown and Eisenhardt 1997). As Brown and Eisenhardt (1997, p. 29) argued, semi-structures allow change because they are “sufficiently rigid so that change can be organized to happen, but not so rigid that it cannot occur. Too little structure makes it difficult to coordinate change. Too much structure makes it hard to move.” Our research is consistent with the semi-structure viewpoint. Simple formal interventions imposed a small amount of structure on groups, which then helped their members to self-organize clusters of attention to improving their knowledge integration process. Yet, these interventions did not rigidly lock in their efforts to do so. In fact, they allowed the emergence of new, unpredictable approaches to task execution that suited the immediate situation.

Implications for the Knowledge-Based View
Finally, our research also relates to the knowledge literature. First, our work highlights the distinction between knowledge integration and knowledge sharing. As Eisenhardt and Santos (2002) observe, knowledge-based thinking often relies on loosely defined concepts. Yet, the usefulness of the theory relies on sharply defined constructs to yield precise hypotheses and measurement. Hansen’s (1999) study of knowledge transfer is a good example of the importance of well-defined concepts. By distinguishing between knowledge search and transfer, he was able to tease out different effects of network structure on these processes.

Similarly, our results indicate that it is useful to distinguish precisely between two other knowledge processes: knowledge sharing (i.e., individuals identify and communicate their uniquely held information) and knowledge integration (i.e., several individuals combine their information to create new knowledge). We find that questioning others and managing time improved knowledge integration, but did not affect knowledge sharing. The information sharing condition altered the pattern of discussion, but did not influence knowledge integration. The implication of these results is that knowledge sharing and integration are distinct processes, with different antecedents and outcomes, not different components of the same process. Further, the results indicate that knowledge integration need not happen haphazardly. Rather, group members can consciously improve their knowledge integration as the result of deliberate activities such as formal interventions.

Our research has implications for the debate between knowledge vs. knowing (Cook and Brown 1999, Eisenhardt and Santos 2001). Some authors have focused on “knowledge as a resource” that can be transferred, recombined, licensed, or used (Cohen et al. 2000, Grant 1996) to create value for the firm. Others suggest that this is a reductionist view. They argue for “knowledge as knowing,” which emphasizes the context in which knowledge appears and the ways in which it is gained and used (Cook and Brown 1999, Patriotta and Pettigrew 1999, Spender 1996). Our work sheds some light on this debate.
We find that knowledge integration is not simply a matter of assembling discrete pieces of knowledge, like Lego blocks, as the “knowledge as a resource” view implies. Rather, knowledge integration depends on how members know and integrate their individually held knowledge. When they take breaks to consider different lenses for viewing knowledge (e.g., seeking confirming vs. disconfirming evidence, combining vs. presenting knowledge, shifting leadership in the group, asking others to contribute), they create new “knowledge” from the same information. In other words, the same knowledge can be “known” in multiple ways. Indeed, our findings are much like the proverbial “five blind men touching parts of the elephant.” Each group “knows” the same elephant, but can know it in different ways. Thus, while the factual content of information is important to knowledge integration as suggested by the “knowledge as resource” view, the way in which that knowledge is accessed and the point of view from which it is considered—in other words, the “knowledge as knowing” view—also influences how individual knowledge is combined. More significant, it indicates how the collective value of that knowledge can be increased through alternative combinations that are created through different ways of knowing.

Conclusion
We began this paper with the argument that knowledge is often the most important strategic resource within organizations (Grant 1996), and yet knowledge usually resides with individuals (Nonaka 1994). This implies that knowledge integration is a fundamental process by which firms gain the benefits of knowledge and create competitive advantage (Grant 1996). We conclude by observing that simple formal interventions can improve knowledge integration within groups with specialized knowledge by helping group members to self-organize fruitful attempts at improving their process and to pace those attempts with task execution.

More generally, the research on knowledge often focuses on the characteristics of knowledge such as tacit vs. explicit (e.g., Grant 1996, Kogut and Zander 1992). While knowledge characteristics are important, the structuring of knowledge flows is crucial. The contribution of our paper is to focus on the effects of simple structures on the micro-level interactions among individuals that can result in a changed knowledge integration process and improved knowledge integration. Broadly, we explore the concept of group flexibility. We hope that this research will be a reminder that knowledge processes are ultimately about micro-social interactions among individuals. We also hope that this research will lead scholars to more closely examine the relationship between structure, adaptation, and knowledge. Without structures, knowledge is too disorganized. Without knowledge, structure is not useful.

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Endnotes
1Detailed coding instructions are available from the first author.
2The list of critical facts is available from the first author.
3This hypothesis might be considered a manipulation check. We present these results as a hypothesis to highlight all of the elements in the group knowledge integration process and the logic linking them together.

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