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Discussion of Shared and Unshared Information in Decision-Making Groups

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The effects of task importance and group decision training on the discussion behavior of decision-making groups were investigated. Three-person groups decided which of 3 hypothetical faculty candidates would be the best person to teach an introductory psychology course. Prior to discussion, some of the information about each candidate was given to all group members (shared information), whereas the remainder was randomly divided among them (unshared information). In general, groups discussed much more of their shared information than their unshared information. Increasing the importance of the task slowed the rate at which information was brought forth during discussion. By contrast, group decision training increased the amount of both shared and unshared information discussed and altered the sequential flow of shared and unshared information into the discussion: Discussion in untrained groups focused first on shared information and then on unshared information; discussion in trained groups did not shift focus over time. Results are discussed in terms of an information-sampling model of group discussion and the role of discussion in group decision-making effectiveness.

Decisions about important social, organizational, and political issues are frequently made by groups rather than individuals. Using groups to make decisions is often justified on the grounds that groups can bring more intellectual resources to bear on a problem, which in turn should increase the probability that a high-quality decision will result (e.g., Vroom & Jago, 1988). One such resource is the diverse store of knowledge held by group members. Because of differences in background and experience, group members frequently have different information about the choice alternatives under consideration. To exploit this knowledge, decision-making groups usually attempt to pool the unique information their members hold. This is typically done through face-to-face discussion, though other alternatives exist (e.g., Ancona & Caldwell, 1990; Larson & Christensen, 1993; Moore, 1987; Rice & Shook, 1990).

How well group discussion actually serves this information-pooling function is open to question. Evidence suggests, for example, that the information group members choose to mention during discussion is significantly influenced by the information that other members have already brought out (e.g., Fisher & Ellis, 1990; Scheidel & Crowell, 1964), by members' prediscussion preferences (e.g., Judd, 1975, cited in Moscovici, 1985), and by status differences within the group (e.g., Kelley, 1951; Shaw, 1981).

Even more dramatic is the influence that the prediscussion distribution of decision-relevant information can have on the content of group discussion. Prior to discussion, information pertaining to the various choice alternatives may be distributed more or less widely among group members. Some of that information may be available to every member of the group, whereas some of it may be available only to one group member or another. Stasser and Titus (1985, 1987) referred to the former as *shared* information and to the latter as *unshared* information. In general, groups tend to discuss much more of the information they initially shared in common than the information that initially was unshared (e.g., Engel, 1992; Stasser, 1991; Stasser & Stewart, 1992; Stasser, Taylor, & Hanna, 1989; Stasser & Titus, 1985, 1987; Stewart & Stasser, 1993; Stewart, Wittenbaum, & Stasser, 1992). Discussing more shared than unshared information is clearly a suboptimal use of group resources. Indeed, groups might actually be better off discussing more of their unshared information because doing so would add to their *collective* (i.e., shared) knowledge base, whereas discussing already-shared information does not. To see this, consider what would happen if a group's shared information favored one choice alternative, whereas their unshared information favored another. Even if members were to discuss *only* their unshared information, the overall pattern of support for the two alternatives should become evident to everyone in the group. This would not be the case were they to discuss only their shared information.

The present research examined in greater detail the discussion of shared and unshared information by decision-making groups. It had two main objectives: (a) to investigate two factors that might reduce the discussion advantage enjoyed by shared information and (b) to explore how the shared–unshared infor-

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mational content of group discussion changes over time. An information-sampling model of group discussion was used to derive hypotheses relating to each of these objectives and is presented next.

Information-Sampling Model

Stasser and Titus (1985, 1987) suggested that group discussion can be usefully modeled as a sampling process in which the content of discussion is obtained by sampling from the pool of information that members collectively hold (cf. Burnstein & Vinokur, 1977). They argued that this sampling process is essentially disjunctive in nature in that only one member need recall and mention a given piece of information to bring it to the attention of the group. Consequently, the more members there are who can potentially mention a piece of information, the more likely it is that that information will actually be discussed.

More formally, Stasser and Titus (1987; see also Lorge & Solomon, 1955) proposed that whether a given item of information is discussed by a group depends both on n, the number of members who held that information prior to discussion, and on $p(M)$, the probability that any one of those members will actually mention it during discussion; $p(M)$ is presumed to be a joint function of the members' ability to recall the information, the opportunity they have to mention it during discussion, and their motivation to participate in the discussion. Thus, the probability, $p(D)$, that a given item of information will actually be discussed is defined as

$$p(D) = 1 - [1 - p(M)]^n. \qquad (1)$$

For unshared information, $n = 1$, so $p(D_{\text{unshared}}) = p(M)$. For shared information, on the other hand, $n > 1$, so $p(D_{\text{shared}}) > p(M)$, except when $p(M) = 0$ or 1, in which case $p(D_{\text{shared}}) = p(M)$. By implication then $p(D_{\text{shared}}) > p(D_{\text{unshared}})$, except when $p(M) = 0$ or 1. Thus, under most conditions shared information is expected to have a discussion advantage over unshared information. This advantage becomes increasingly large as $p(M)$ departs from 0 or 1 and is maximized at a value of $p(M)$ that depends on n. Stasser, Taylor, and Hanna (1989) have shown this value to be .42 in three-person groups and .30 in six-person groups. Figure 1 illustrates the relationship between $p(M)$ and the discussion advantage of shared information for a three-person group.

An important implication of the information-sampling model suggested by Figure 1 is that the discussion advantage enjoyed by shared information can be reduced by increasing[1] $p(M)$ above a critical value, $p(M)_{\text{crit}}$. The value of $p(M)_{\text{crit}}$ depends on the initial value of $p(M)$. When $p(M)$ is initially at or above the discussion advantage maximum value (.42 in Figure 1) then $p(M)_{\text{crit}} = p(M)$, which means that increasing $p(M)$ by any amount should reduce the discussion advantage of shared information. The greater the increase in $p(M)$, the greater the discussion-advantage reduction. On the other hand, when $p(M)$ is initially below the discussion-advantage maximum value, then $p(M)_{\text{crit}}$ is defined as the point at which the right-hand slope of the discussion-advantage curve intersects the ordinate of the initial $p(M)$ value. For example, if in a three-person group $p(M) = .20$ (Point a in Figure 1), then $p(D_{\text{unshared}}) = .20$, $p(D_{\text{shared}}) = .49$, the discussion advantage of shared information is $.49 - .20 = .29$, and $p(M)_{\text{crit}} = .68$ (Point b in Figure 1). That is, in this example the discussion advantage of shared information can be reduced only if $p(M)$ is increased above .68. If $p(M)$ is increased, but not above .68, then the discussion advantage of shared information should become even larger.

Reducing the Discussion Advantage of Shared Information

Task Importance

One factor that seems likely to increase $p(M)$ is the perceived importance of the task. Hackman and Oldham (1980) argued that people find tasks meaningful and are motivated to perform them well when those tasks are perceived to have a substantial impact either on their own lives or on the lives of others. When tasks are important and affect real-world events in a significant way, people are more willing to expend energy to do their best. Consistent with this idea, when the task is to make an important decision, people are generally more diligent in their search for information (e.g., Beatty & Smith, 1987; Gilliland, Schmitt, & Wood, 1993; Nichols-Hoppe & Beach, 1990) and use more effortful, analytic strategies to evaluate that information (Johnson & Payne, 1985; McAllister, Mitchell, & Beach, 1979). In the case of *group* decision making, we also expect that an important decision will increase members' motivation to *discuss* the information they hold because doing so should be seen as benefiting the overall quality of the decision. Thus, because motivation to contribute to the discussion is one factor presumed to influence $p(M)$, we predicted that perceptions of task importance would increase $p(M)$. Furthermore, we expected that if task importance increased $p(M)$ significantly above $p(M)_{\text{crit}}$, then the tendency to discuss more shared than unshared information would decrease.

Group Decision Training

The present research also examined whether training in group decision making can affect $p(M)$. The particular type of training investigated emphasized both strategy planning and information vigilance. The strategy-planning portion of the training was in part a structural intervention in which groups were asked to set aside the first few minutes of their discussion period for the purpose of planning how they were going to go about making their decision. Research indicates that groups often do not spontaneously discuss their task-performance strategies (Hackman & Morris, 1975). More typically, they simply begin the task with whatever implicit, undiscussed strategies the

[1] The model also predicts that the discussion advantage of shared information can sometimes be reduced by moving $p(M)$ toward 0. However, this would mean discussing *less* of the available information, which would be counterproductive for making an informed decision. Thus, this alternative is not considered here.

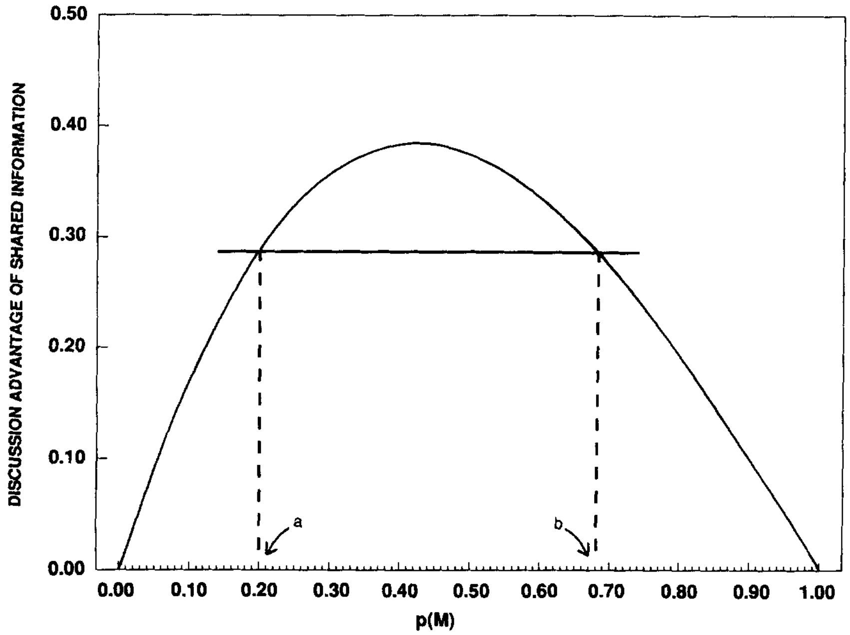

Figure 1. The predicted relationship between $p(M)$ and the size of the discussion advantage of shared information for a three-person group.

members have in mind. On the other hand, when groups can be induced to consider explicitly how a task should be accomplished, their performance often improves (e.g., Hackman, Weiss, & Brousseau, 1974, cited in Hackman & Morris, 1975; Hirokawa, 1980, 1982; Orasanu & Salas, 1993). This is especially true when there is no generally accepted procedure for accomplishing the task and when the task demands a high degree of coordination and information exchange. These characteristics typify a great many group decision-making tasks, including the one used in the present research.

The other part of our group decision-training intervention was devoted to increasing members' information vigilance. Janis and Mann (1977) argued that ineffective decision making occurs when individuals do not search adequately for solutions, when they do not take responsibility for the decision, or when they disregard important information. To help groups overcome these barriers to effective decision making, Bottger and Yetton (1987) devised a short program of information-vigilance training based on recommendations made by Janis and Mann (1977) and Maier (1970). An instructor reviewed several kinds of decision-making behavior that can diminish the quality of a decision (e.g., inadequate search for information and unconflicted adherence to the first solution considered) and then asked group members to think about these behaviors in relation to their own decision-making situation. This training significantly increased the amount of information discussed by groups and led to a higher quality decision. Unfortunately, Bottger and Yetton's (1987) results do not indicate whether information-vigilance training also reduces the discussion advantage of shared information.

In the present study, information vigilance training similar to that used by Bottger and Yetton (1987) was combined with strategy-planning instructions. We anticipated that this combined intervention would increase $p(M)$. Furthermore, we expected that if it increased $p(M)$ above $p(M)_{crit}$, then the discussion advantage of shared information would decrease.

Predicting *When* Shared and Unshared Information Will Be Discussed

Equation 1 is useful for estimating the likelihood of an individual item of shared or unshared information being raised in discussion and, by implication, for predicting how much of an entire set of shared or unshared information will be brought to light. However, because this expression ignores the temporal aspect of group discussion, it makes no predictions about *when* during discussion shared and unshared information are most likely to surface. On the other hand, the basic information-sampling model does make such predictions if account is taken of how the pools of not-yet-discussed shared and unshared information change as material is gradually drawn from them and brought into the group discussion. Below we present such an account, making use of the details in the following example.

Consider a 3-person selection committee that must decide which of three candidates to hire for a job. Eighteen separate items of information exist about each candidate, but prior to discussion each committee member is aware of only 10 items per candidate. Six of these are items that everyone else on the committee is also aware of (i.e., they are shared information), whereas the remaining 4 are items that no one else is aware of (i.e., they are unshared information). Thus, prior to discussion, the 18 items of information about each candidate are distributed among the 3 committee members in such a way that one third of that information is shared in common by everyone and two thirds are unshared. However, no one on the committee knows in advance which information is shared and which is unshared.

Despite the fact that in this example there are only half as many shared items as unshared items, the information-sampling model predicts that shared information is likely to dominate discussion, at least initially. This is because initially there are more *sampling opportunities* for shared than for unshared information. At the start of discussion, there are 6 items of information about each of the 3 candidates that are each held by all 3 committee members, for a total of $6 \times 3 \times 3 = 54$ opportunities to introduce shared information into discussion. In contrast, there are 12 items of information about each of the 3 candidates that are each held by only 1 committee member, for a total of $12 \times 3 \times 1 = 36$ opportunities to introduce unshared information. Thus, assuming that members are able to recall all of the information they were originally aware of, at the outset of discussion the probability of sampling (i.e., discussing) an item of shared information is $54/(54 + 36) = .60$, whereas the probability of sampling an item of unshared information is $36/(54 + 36) = .40$.

These probabilities are not static, however; they change each time new information is introduced into the conversation. When an item of unshared information is brought forth, the number of opportunities to introduce additional, not-yet-discussed unshared information is reduced by 1 (because only one committee member was originally aware of the just-mentioned unshared information). In contrast, each time an item of shared information is brought forth, the number of opportunities to introduce additional, not-yet-discussed shared information is reduced by 3 (because three members were originally aware of the just-mentioned shared information). We refer to these two numbers (1 and 3) as sampling opportunity reduction values (SORV). Because $\text{SORV}_{\text{shared}} > \text{SORV}_{\text{unshared}}$, as more and more information is raised in discussion, the opportunities to introduce additional items of shared information tend to decrease at a faster rate than do the opportunities to introduce additional items of unshared information. Consequently, the probability of discussing additional items of shared information tends to decrease over time, whereas the probability of discussing additional items of unshared information tends to increase.

The foregoing analysis presumes that the three committee members all have perfect recall. More realistically, group members are apt to recall only a portion of the information to which they were originally exposed. Symbolically, if $p(R)$ is the percentage of decision-relevant information (both shared and unshared)[2] that members are able to recall, then it should often be that $p(R) < 1.00$. Furthermore, in the case of shared information, when $p(R) < 1.00$, the specific subset of information recalled is likely to vary somewhat from one group member to another. If so, then $\text{SORV}_{\text{shared}}$ should be less than the total number of members initially exposed to the shared information. This is because when different group members recall different (though perhaps overlapping) subsets of shared information, it is less likely during discussion that all of them would have been able to recall any particular item of just-mentioned shared information. Thus, we formally define SORV as

$$\text{SORV} = 1 + [(n - 1) \times Cp(R)], \tag{2}$$

where n is the number of members who were exposed to the information before discussion and $Cp(R)$ is the conditional probability that, given one group member has already recalled (i.e., mentioned) an item, another randomly selected member could also have recalled (and thus mentioned) that same item. Equation 2 states that for each item of information brought forth in discussion, the number of opportunities to introduce additional, not-yet-discussed information is reduced by one (for the person who brought out the just-mentioned item) plus an amount equal to the number of other group members initially exposed to that item $(n - 1)$ weighted by the conditional probability that any one of them could have independently recalled it. In the case of unshared information, by definition $n = 1$ and $Cp(R_{\text{unshared}}) = 0$, so that $\text{SORV}_{\text{unshared}} = 1$. In the case of shared information, however, $n > 1$, and $Cp(R_{\text{shared}})$ must be determined empirically. In the present research, we estimate $Cp(R_{\text{shared}})$ as

$$Cp(R_{\text{shared}}) = \sum_{i=1}^{s} p(R_i)^2 / \sum_{i=1}^{s} p(R_i), \tag{3}$$

where $p(R_i)$ is the probability of recalling the ith item of shared information and s is the total amount of shared information. Operationally, $p(R_i)$ can be defined as the proportion of subjects recalling the ith item in a free recall task.

It is important to note that when $p(R) = 1.00$, $Cp(R_{\text{shared}}) = 1.00$. However, when $p(R) < 1.00$, $Cp(R_{\text{shared}})$ can take on any value such that $p(R) \leq Cp(R_{\text{shared}}) \leq 1.00$.[3] If members recall exactly the same subset of shared information, then $Cp(R_{\text{shared}}) = 1.00$. If they recall completely independent subsets of shared information, then $Cp(R_{\text{shared}}) = p(R)$. Most situations are likely to be intermediate between these two extremes, and so $Cp(R_{\text{shared}})$ should typically lie between $p(R)$ and 1.00.

Including $p(R)$ and $Cp(R_{\text{shared}})$ in the information-sampling model influences the rate at which the probability of discussing shared information decreases over time. In general, as $p(R)$ decreases, the probability of discussing shared information decreases at a faster rate. This effect is strongest when $Cp(R_{\text{shared}})$ is near 1.00 and weakest when $Cp(R_{\text{shared}})$ approaches $p(R)$. For instance, in the present example, when $p(R) = Cp(R_{\text{shared}}) = 1.00$ (i.e., the perfect recall case), the initial sampling advantage

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[2] While acknowledging that group members may have less-than-perfect recall, our analysis nevertheless assumes that their recall is unbiased, in the sense that they do not favor one type of information (shared or unshared) over the other. This is the same as assuming that the information itself is equally memorable across the two information types.

[3] $Cp(R_{\text{shared}})$ can be less than $p(R)$, but only if members systematically remember *different* items of shared information. This possibility seems highly unlikely under conditions similar to those investigated in the present research and so is not considered here.

held by shared information is completely lost after 15 items of information are discussed. Reducing $p(R)$ to .50 speeds this process, though to a different degree depending on $Cp(R_{\text{shared}})$. If $p(R) = Cp(R_{\text{shared}}) = .50$, the discussion advantage of shared information is lost after 13 items of information are discussed. By contrast, when $p(R) = .50$ and $Cp(R_{\text{shared}}) = 1.00$, that advantage is lost after just 7 items are discussed.[4]

Thus, the information-sampling model makes two general predictions. First, it predicts that the probability of an item of shared information being mentioned in discussion is a monotonically decreasing function over the k opportunities to introduce previously unmentioned information (where k = the total number of items of information; in the present example, k = 18 × 3 = 54). The exact shape and location of this function depends on the number of decision alternatives, the amount of information that exists about those alternatives, how much of that information is shared among group members, the size of the group, and the group members' memory.[5] The probability of introducing unshared information follows the complementary, monotonically increasing function. Second, when there are initially more sampling opportunities for shared information, more shared information is predicted to come to light early in discussion. Over time, however, the sampling opportunities will change to favor unshared information. Thus, shared information will tend to be discussed before unshared information. The present experiment tested these two predictions by observing the sequential order in which information was mentioned by group members during discussion.

Repeating Shared and Unshared Information

A final issue addressed in the present study concerns the repetition of already-discussed shared and unshared information. When a piece of unshared information is raised during discussion, the effect is to convert it to shared information. In principle at least, once an item of unshared information has been mentioned, any member of the group should be able to repeat it later on. Thus, if repetition is viewed as a process of sampling from a pool of already-discussed information, it might be expected that discussed items of previously unshared information will be just as likely to be repeated as discussed items of previously shared information, so that there should be no repetition advantage for previously shared information.

However, this line of reasoning makes two important assumptions. First, it assumes that once mentioned, items of previously unshared information will be just as easy to recall as items of previously shared information. Yet this assumption ignores the fact that members will have had two exposures to the previously shared information (i.e., before discussion and then again during discussion) but only a single exposure to much of the previously unshared information (i.e., during discussion, except for those items of unshared information that they themselves held before discussion). Thus, after it is initially raised in discussion, previously shared information may still be easier to recall than previously unshared information.

A second assumption is that the mentioned items of shared and unshared information will be perceived as equally reliable by those who originally were not aware of the unshared information. It is possible, however, that when a mentioned item of information cannot be verified by reference to one's own (or a third party's) memory, its reliability will be suspect, making it less deserving of repetition. Stewart and Stasser (1993) provided indirect evidence in support of this idea. Mentioned items of unshared information were more likely to be included in a group's collectively endorsed written summary of recalled candidate information when the unshared information was brought out by a subject-matter expert (which presumably confers high reliability on that information) than when it was brought out by a nonexpert.

Thus, it is conceivable that after it is initially introduced, shared information may also enjoy a repetition advantage over unshared information, either because it is easier to recall from memory, because it seems more reliable, or both. Consistent with this prediction, Stasser, Taylor, and Hanna (1989) found that groups repeated significantly more of their previously shared information than they did of their previously unshared

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[4] These values are obtained by weighting the number of items of information per candidate by $p(R)$ and then, given $Cp(R_{\text{shared}})$, determining the total number of items that must be discussed before the compound probability of introducing shared information falls below .50. Thus, in the example used here, and for $p(R) = .50$, but $Cp(R_{\text{shared}}) = 1.00$, at the start of discussion there are $(.5 \times 6) \times 3 \times 3 = 27$ opportunities to introduce shared information and $(.5 \times 12) \times 3 \times 1 = 18$ opportunities to introduce unshared information. This leaves the initial probability of discussing an item of shared information unchanged from the perfect recall case at $27/(27 + 18) = .60$. However, the probability of discussing *additional* items of shared information will be lower than was the case for perfect recall. This is because the difference between $\text{SORV}_{\text{shared}}$ (computed as $1 + [(3 - 1) \times 1.00] = 3$) and $\text{SORV}_{\text{unshared}}$ (computed as $1 + [(1 - 1) \times 0] = 1$) has a larger impact given the new base values (i.e., 27 and 18) than it would have given the old base values (i.e., 54 and 36). Thus, the probability that the *second* piece of information brought out in discussion will be shared information is $p(\text{shared}_2) = .60\,[51/(51 + 36)] + .40[54/(54 + 35)] = .5944$ for $p(R) = Cp(R_{\text{shared}}) = 1.00$, and $p(\text{shared}_2) = .60\,[24/(24 + 18)] + .40\,[27/(27 + 17)] = .5883$ for $p(R) = .50$, and $Cp(R_{\text{shared}}) = 1.00$. This difference is small, but becomes increasingly larger as more and more information is brought into discussion. For example, the probability that the 20th piece of information brought out in discussion will be shared information is $p(\text{shared}_{20}) = .46$ when $p(R) = Cp(R_{\text{shared}}) = 1.00$, but only $p(\text{shared}_{20}) = .18$ when $p(R) = .50$ and $Cp(R_{\text{shared}}) = 1.00$. On the other hand, the same probability is $p(\text{shared}_{20}) = .42$ if $p(R) = Cp(R_{\text{shared}}) = .50$, thus illustrating the moderating influence of $Cp(R_{\text{shared}})$.

[5] This function tends to be concave with respect to the baseline for values of $p(\text{shared}_k)$ above approximately .2, and convex for values of $p(\text{shared}_k)$ below approximately .1. Furthermore, the overall slope of the function becomes steeper (i.e., the probability of discussing shared information decreases more rapidly) as (a) the number of decision alternatives decreases, (b) the number of items of information per alternative decreases, (c) the members' ability to recall that information decreases, (d) the percentage of information that is shared increases, (e) the members' tendency to recall the same subset of shared information increases, and (f) the size of the group increases. Increasing the percentage of information that is shared and increasing the size of the group also pushes the function's starting value (i.e., the probability of mentioning shared information at the outset of the discussion) higher.

information. Given the similarity of the experimental procedures used in the present study to those used by Stasser, Taylor, and Hanna (1989), a similar pattern of results was expected here.

Overview of the Present Study

In the present study we used a situation very much like the three-person committee example described earlier. Three-person student groups decided which of three hypothetical faculty candidates would be the best person to teach an introductory psychology course. Prior to discussion, one third of the information about each candidate was given to all three group members (shared information), whereas the remaining two thirds was randomly distributed among them (unshared information). We manipulated the perceived importance of the decision-making task and whether members received group decision training prior to discussion, and we observed how much shared and unshared information came to light during group discussion and in what order. The following seven hypotheses were tested:

Hypothesis 1: In general, groups will discuss more of their shared information than of their unshared information.

Hypothesis 2: Increasing the perceived importance of the task will increase the amount of information groups discuss.

Hypothesis 3: Providing group decision training will increase the amount of information groups discuss.

Hypothesis 4: If either increasing the perceived importance of the task or providing group decision training increases $p(M)$ above $p(M)_{crit}$, then the discussion advantage predicted for shared information (Hypothesis 1) will decrease. On the other hand, if either manipulation increases $p(M)$, but to a point that is still below $p(M)_{crit}$, then the discussion advantage predicted for shared information will increase.

Hypothesis 5: Shared information will, on average, be mentioned earlier in discussion than unshared information.

Hypothesis 6: As discussion proceeds, the probability of mentioning shared information will decrease and the probability of mentioning unshared information will increase.[6]

Hypothesis 7: Groups will repeat more of their shared information than of their unshared information.

Method

Design and Subjects

The study involved a 2 (important vs. unimportant decision-making task) × 2 (training vs. no training in group decision making) × 2 (shared vs. unshared decision-relevant information) complete factorial experimental design, in which the last of these was a repeated, within-groups factor.[7] The primary data for the study were obtained from 219 undergraduate students at The University of Illinois at Chicago who were randomly assigned to 73 3-person decision-making groups. Because of equipment difficulties, the voice recordings for 6 of these groups were inaudible and could not be coded. The data reported here are thus based on 67 groups. In addition to these, a separate sample of 76 subjects was used to obtain estimates of $p(R)$ and $Cp(R_{shared})$. From 5 to 18 subjects participated in each experimental session, and all subjects participated in partial fulfillment of a course requirement.

Group Decision Task

Subjects individually studied written descriptions of three hypothetical faculty candidates and then met in three-person groups to decide which of these would be the best person to teach an introductory psychology course. These written descriptions were based on three faculty member profiles, each of which contained 18 separate items of information (e.g., concerning the faculty member's usual class requirements, teaching style, testing format, reputation as a researcher and practitioner, etc.). The information included in these profiles was selected with the goal of creating three realistic choice alternatives that were about equally attractive.

Six (33%) of the 18 items of information from each profile were included in the written descriptions given to all three group members and thus constituted the information that members shared prior to discussion (shared information). The remaining 12 items (67%) from each profile were evenly divided among the written descriptions given to group members and thus constituted the information that members did not share before discussion (unshared information). To avoid confounding the content of the items with their shared–unshared status, different items were assigned to the shared and unshared information sets across groups. In this way, within each between-groups treatment condition every item of information was shared in approximately one third of the groups and was unshared in the rest.

Thus, prior to discussion, every group member read three faculty candidate descriptions that each contained 10 items of information: 6 items that every other group member also had and 4 that no one else had. All 18 items of information for each candidate were therefore presented to at least one, and in some cases to all three, group members prior to discussion, so that in the aggregate, every group was given all of the information about all three candidates.

Procedure

When they first arrived, subjects met in a large room where all of the instructions for the experiment were given in both written and oral form. All subjects participating in the same experimental session were assigned to the same between-groups treatment condition.

The experiment was introduced as a study of group decision making. Subjects were told that they would each be given written descriptions of three hypothetical candidates for the position of instructor in an introductory psychology course. It was explained that after studying these descriptions they would meet in three-person groups to decide which candidate was the best person for the job. Subjects were also told that the written descriptions they would receive would vary somewhat from the descriptions given to other members of their group. The alleged reason for this was to simulate real decision-making groups, which often consist of people with different points of view, as well as different sources and types of information about the candidates or issues in question.

Task-importance manipulation. Immediately after explaining the

[6] This hypothesis is concerned only with the linear component of the probability function. Although the model also predicts a quadratic component (i.e., the probability function is expected to be *concave* with respect to the baseline; see Figure 2), a power analysis suggests that the latter component is far too small to be detected given the number of groups used.

[7] The proper unit of analysis in this study is the three-person group. Thus, the term *within-groups factor* implies that repeated measures were taken from the same experimental unit. This is analogous to a "within-subjects factor" in a study where the individual is the proper unit of analysis.

task, the experimenter introduced the task-importance manipulation. For approximately half of the subjects, the experimenter made remarks intended to enhance the perceived importance of the task (*important task* condition). Specifically, she stated that the Department of Psychology was very interested in the decisions the groups were about to make and that this was the first time the department had tried to determine what characteristics undergraduate students prefer in an introductory psychology instructor. The task was thus cast as an important opportunity for them to let the department know what they thought. Subjects were told that their group decisions would be reported both to staff members in the department and to faculty who were preparing to teach introductory psychology the following term. Thus, it was suggested that their group decisions could have a direct impact on the way future instructors are selected and teach.

For the remaining subjects, the experimenter made remarks intended to minimize the perceived importance of the task (*unimportant task* condition). She explained that the sole purpose of the session was to test her equipment and to determine whether groups would have enough time to make a decision. The experimenter stated that she would not use the decisions themselves for any purpose whatsoever and offered a brief apology for this fact.

Group decision training. Approximately half of the subjects in each task-importance condition were then given training in group decision making (*trained* condition). This training was patterned after the interventions used by Hackman et al. (1974, cited in Hackman & Morris, 1975) and Bottger and Yetton (1987) and was delivered in three parts. The first part consisted of instructions to take 5 min at the start of discussion to plan the work so as to maximize the group's effectiveness. It was recommended that the members talk about what they needed to do to choose the best faculty candidate, how the discussion might best be structured for this to happen, what they should do if the discussion gets off track, and what the responsibilities of each group member are. Subjects were instructed to address these issues, develop a specific plan of action, and then follow that plan as they discussed the three faculty candidates. The second part of the training consisted of a short review of three common barriers to effective group decision making. These included (a) adopting the first solution proposed without further evaluating its consequences, (b) engaging in unconflicted change, that is, changing their minds uncritically when a new solution is suggested, and (c) ignoring important information. The experimenter suggested several information-vigilant strategies that could be used to help avoid these barriers (e.g., searching their memories again to determine whether they know more about the candidates, regarding as important each and every piece of information they are aware of, and discussing with one another their doubts about proposed decisions). The third part of the training consisted of a 4-min videotape presentation of a three-person group implementing these various suggestions in a discussion about three candidates for student body president. Half of the videotape was devoted to strategy planning (e.g., "I think what is most important is that we try not to make a decision before we have looked at what we like and dislike about everyone"), and half was devoted to information vigilance during discussion (e.g., "You seemed to change your mind pretty quickly there. Remember, we are supposed to avoid changing our minds quickly, because we might miss some important information"). The videotape concluded before a group consensus emerged.[8]

The remaining subjects did not receive any training in group decision making (*untrained* condition). Instead, they heard a brief lecture about how people become faculty members (i.e., covering the application process, degree requirements, and graduate training) and saw a short videotape on the career demands and paths of faculty members. These activities took about the same amount of time to complete as did those in the group decision-training condition.

When subjects indicated that they understood the instructions, the faculty member descriptions were distributed. Subjects were given 7 min to study all three descriptions. They were cautioned to study these descriptions carefully, as they would not be able to refer to them again once their group discussion began. At the end of the 7-min study period, subjects reported privately which of the three faculty candidates they most preferred and returned the written descriptions to the experimenter. Three-person groups were then assembled and directed to separate rooms where they were given 20 min to decide which of the three faculty candidates was the best person to teach an introductory psychology course. The experimenter was not present during these discussions. When each group reached a decision, they notified the experimenter. The experimenter recorded their choice and gave each member a brief postexperimental questionnaire to complete privately. After all three members finished the questionnaire, the experimenter debriefed them, asked them not to discuss the experiment with their classmates, and then thanked and dismissed them.

Parameter Estimation Sample

An independent sample of 76 subjects drawn from the same population as those participating in the main study were run through exactly the same experimental procedures (with approximately equal numbers in each treatment condition), except they did not engage in a group discussion. Rather, following the 7-min study period these subjects were given a free recall test. They were handed a separate piece of paper for each faculty candidate and asked to write down all of the information about each one that they could recall. They were allowed as much time as they wanted to do this, though no one took more than about 10 min. These data were used to obtain estimates of $p(R)$ and $Cp(R_{\text{shared}})$.

Behavior Coding of the Group Discussions

An audio tape recording of each group discussion was obtained by means of a portable tape recorder placed in plain view of the group members. Two research assistants who were unaware of the study hypotheses and the treatment conditions under investigation coded these tapes. A two-step coding procedure was used. Each coder performed Step 1 for approximately half of the tapes and Step 2 for the remaining tapes.

The purpose of Step 1 was to determine the sequential order in which group members mentioned items of information about the three faculty candidates. A specially designed coding sheet listed all 18 items of information for each of the three candidates. As the coders listened to each tape, they wrote *1* next to the first item mentioned, *2* next to the second item mentioned, and so on. An item was marked if and only if (a) the utterance heard on the tape could be identified unambiguously as one of the items contained in the original faculty profiles and (b) that item was correctly paired with the faculty member to whom it belonged. The latter criterion was considered to have been met either if the speaker explicitly identified the faculty member to whom the item belonged or if the discussion context enabled the coder to infer with a high degree of confidence that the speaker knew to whom the item belonged. If an item was repeated, it was assigned an additional sequence number for each repetition. Thus, for example, if "Candidate C only gives essay tests" (a correct pairing of information and faculty member) was the 1st, 13th, and 20th statements made in a discussion, then that item would occupy three separate positions in the sequential code for that group. An item was considered to have been repeated if and only if at least one other

[8] A transcript of the videotape is available from James R. Larson, Jr.

piece of information was mentioned since the last mention of the item in question, although the intervening information did not have to be codable (e.g., it could have been too general a statement, not obviously paired with a particular faculty member, or incorrectly paired). Thus, it was possible for the same item to occupy two adjacent positions in the sequential code, though this happened only 1% of the time.

Step 2 of the coding process was performed by a different coder and had two objectives: (a) to verify and correct the sequential code created in Step 1 and (b) to determine the approximate time at which each item of information was mentioned. The latter was accomplished by having the second coder mark the last item in the sequential code that was mentioned during each minute of discussion. Because half of the groups (those in the trained condition) were instructed to take 5 min at the beginning of discussion to plan their decision-making strategy, coders began timing only when the group actually started to discuss the three faculty candidates. Thus, the temporal code, and the scores derived from it, always excluded whatever time was taken at the beginning of the 20-min period to discuss things not directly related to the three choice alternatives.

The coders were each given several hours of training to ensure that they could reliably perform both coding steps. Training consisted of a thorough explanation of the coding criteria and several practice sessions in which they jointly performed the coding task using practice tapes. During these practice sessions, disagreements about how various discussion segments should be coded were used as opportunities to clarify and refine the coding criteria.

To estimate reliability, both coders performed Step 1 of the coding procedure for 37 (55%) of the groups. When compared on an item-by-item basis, their rank orderings agreed 81% of the time. The most common form of disagreement was when one coder marked an item that the other did not. This occurred most often with repeats of previously mentioned items. Less frequent forms included disagreements about which item was heard and about the order in which adjacent items were heard. Once coder reliability on Step 1 was established, one set of codes for each of these 37 groups was randomly discarded, and the remaining set underwent Step 2 of the coding procedure.

Dependent Measures

The dependent measures of primary interest were derived from the coded group discussions. These include the overall proportions of shared and unshared information mentioned for the *first time* and the overall proportions of previously mentioned shared and unshared information that were *repeated.* Mean rank and mean time-of-mention scores were also computed for shared and unshared information discussed for the first time. Mean rank scores were determined from an adjusted rank ordering that eliminated the rank positions of repeated items. These adjusted ranks reflect the precise serial order in which new information was brought into discussion. The adjusted rank ordering was also used to compute the proportion of groups mentioning shared versus unshared information in each of the first 20 rank positions. Mean time-of-mention scores were determined by averaging the time scores for the relevant items. The time score for each item was simply the minute of discussion (Min 1, Min 2, etc.) during which it was mentioned. Finally, the faculty preferences expressed by subjects prior to discussion, along with the group choices, were also analyzed as dependent measures.

The postexperimental questionnaire contained a series of 6-point Likert-type items (1 = *strongly disagree* and 6 = *strongly agree*) that were used to assess the effectiveness of the between-groups experimental manipulations. Four items assessed the perceived importance of the decision-making task (e.g., "The decision that my group made will contribute to a greater purpose"). Responses to these items were highly correlated (coefficient α = .93) and so were averaged to check the effectiveness of the task-importance manipulation. Five additional items focused on the group's strategy-planning and information-vigilant behavior (e.g., "My group planned how it would work together to solve this problem"). Responses to these items were also highly correlated (coefficient α = .82) and so were averaged to assess the effectiveness of the group decision-training manipulation. The group decision-training manipulation was also checked by having two additional research assistants who were not involved with the primary coding of the group discussions listen to each audiotape to determine (a) whether the group planned in advance how they would work on the task and (b) how often group members made each of several information-vigilant comments during the group discussion (e.g., stating that the group should avoid making a quick decision). These two assistants exhibited 100% agreement in coding this information.

Results

Manipulation Checks

Because of the likely nonindependence of responses among members of the same three-person group, manipulation check scores from the postexperimental questionnaire were averaged across group members prior to analysis (cf. Myers, DiCecco, & Lorch, 1981).

For task importance, subjects in the important-task condition (M = 4.79) rated the task as being significantly more important than did subjects in the unimportant-task condition (M = 4.34), $t(65) = 3.59$, $p < .001$. Groups in the important-task condition (M = 10.47 min) also took significantly longer to make a decision than did groups in the unimportant task condition (M = 7.39 min), $t(65) = 2.26$, $p < .02$. The latter result is consistent with what would be expected for tasks differing in importance and, together with the subjects' questionnaire responses, suggests that the task-importance manipulation was successful.

For group decision training, subjects in the trained condition (M = 4.40) reported that their groups engaged in significantly more strategy-planning and information-vigilant behavior than did subjects in the untrained condition (M = 3.64), $t(65) = 7.92$, $p < .001$. This result is corroborated by evidence from the audio tape recordings. All 33 (100%) groups in the trained condition planned in advance how they would work on the task, whereas only 7 (21%) groups in the untrained condition did so, $\chi^2(1, N = 67) = 43.89$, $p < .001$. Furthermore, groups in the trained condition (M = 1.50) made significantly more information-vigilant comments than did groups in the untrained condition (M = .48), $t(65) = 3.07$, $p < .005$. Finally, groups in the trained condition (M = 11.85 min) took significantly longer to make a decision than did groups in the untrained condition (M = 6.15 min), $t(65) = 4.63$, $p < .001$. Taken together, these results suggest that the group decision-training manipulation was also successful.

Proportion of Shared and Unshared Information Discussed Overall

The mean proportion of shared and unshared information mentioned at least once during discussion by groups in each treatment condition is reported in Table 1. These data were analyzed using a 2 (important vs. unimportant task) × 2 (trained vs. untrained groups) × 2 (shared vs. unshared information) complete factorial mixed design analysis of variance (ANOVA).

Hypothesis 1 predicted that, in general, groups would discuss more of their shared information than they would of their unshared information. As can be seen in Table 1, across all four treatment conditions, groups discussed a much larger proportion of their shared information ($M = .44$) than they did of their unshared information ($M = .24$), $F(1, 63) = 122.96$, $p < .001$. The simple main effect for information type (i.e., shared vs. unshared) was significant within both task-importance conditions as well as within both group-decision-training conditions ($p < .001$ for each). Thus, Hypothesis 1 was strongly supported.

Hypothesis 2 predicted that increasing the perceived importance of the task would increase the amount of information groups discussed. Results from the overall ANOVA reveal that groups in the important-task condition ($M = .35$) did not discuss significantly more information than groups in the unimportant-task condition ($M = .32$), $F(1, 63) < 1.00$. None of the interaction terms involving task importance approached significance either. Thus, Hypothesis 2 was not supported by these data.

Hypothesis 3 predicted that providing group decision training would increase the amount of information groups discussed. As can be seen in Table 1, groups in the trained condition ($M = .40$) discussed significantly more information than groups in the untrained condition ($M = .28$), $F(1, 63) = 16.68$, $p < .001$. The simple main effect for group decision training was significant within both task-importance conditions as well as for both shared and unshared information ($p < .001$ for each). Thus, Hypothesis 3 was strongly supported.

Hypothesis 4 predicted that if either the task-importance or group decision-training manipulation increased $p(M)$ above $p(M)_{crit}$, then the discussion advantage predicted for shared information would decrease. On the other hand, if either manipulation increased $p(M)$, but to a point that was still below $p(M)_{crit}$, then the discussion advantage predicted for shared information would increase. Following Stasser, Taylor, and Hanna (1989), $p(M)$ was estimated as the proportion of unshared information discussed. Thus, in the untrained unimportant-task condition $p(M) = .19$, so that $p(M)_{crit}$ was approximately .70 (cf. Figure 1).

As can be seen in Table 1, groups in the trained condition ($M = .29$) discussed significantly more of their unshared information than did groups in the untrained condition ($M = .19$), $F(1, 63) = 16.22$, $p < .001$. Thus, group decision training significantly increased $p(M)$, though to a point still well below $p(M)_{crit}$ ($p < .001$). In contrast, the task-importance manipulation had no discernible effect on the amount of unshared information discussed, $F(1, 63) < 1.00$. As a consequence, group decision training, but not task importance, was predicted to *increase* the discussion advantage of shared information.

Contrary to expectations, it was found that although the difference between the proportion of shared and unshared information mentioned at least once during discussion was slightly larger among groups in the trained condition ($M_{diff} = .21$) than in the untrained condition ($M_{diff} = .18$), this difference was small, and the two-way interaction between information type (shared vs. unshared) and group decision training did not approach significance, $F(1, 63) < 1.00$. Thus, Hypothesis 4 was not supported.

Finally, as an exploratory analysis, the percentage of shared information actually mentioned during discussion was correlated with the percentage of shared information that Equation 1 predicts should have been mentioned, again using the proportion of unshared information discussed as an estimate of $p(M)$. The correlation was .78, $df = 31$, $p < .001$, in the untrained condition and .27, $df = 32$, $p > .10$, in the trained condition. These correlations were significantly different from one another ($z = 3.03$, $p < .005$). Thus, Equation 1 appears to have been much more predictive of the groups' actual discussion behavior in the untrained condition than in the trained condition.

Table 1
Mean Proportion of Shared and Unshared Information Mentioned at Least Once During Group Discussion

Information type	Untrained groups: Unimportant task ($n = 18$)	Untrained groups: Important task ($n = 16$)	Trained groups: Unimportant task ($n = 15$)	Trained groups: Important task ($n = 18$)
Shared				
M	.37	.37	.49	.52
SD	.18	.19	.16	.13
Unshared				
M	.19	.18	.27	.31
SD	.09	.10	.11	.11

Mean Rank and Time Scores for Shared and Unshared Information First Entering the Group Discussion

Hypothesis 5 predicted that shared information would, on average, be mentioned earlier during discussion than unshared information. To test this hypothesis, the rank and time data from the sequential coding of the group discussions were analyzed. Mean rank and mean time scores were computed for the first mention of all shared information brought out in each discussion and, separately, for the first mention of all unshared information brought out.

The mean rank and mean time scores were submitted to separate 2 × 2 × 2 complete factorial mixed-design ANOVAs. These analyses yielded similar results. In comparison with unshared information ($M = 9.17$), shared information ($M = 8.34$) had a significantly lower mean rank score, $F(1, 63) = 7.37$, $p < .01$, indicating that on average, shared information was mentioned earlier than unshared information. This effect was also significant in the analysis of the mean time scores ($p < .05$) and for both measures when the overall amounts of shared and unshared information discussed were entered as a covariate ($p < .05$ in each). The latter result indicates that this effect is not merely an artifact produced by different absolute amounts of shared and unshared information being brought into the conversation. Interestingly, however, although the two-way interaction between information type and group decision training was not significant in any of these analyses, in each one the simple main effect for information type was significant for groups in the untrained condition ($p < .05$ in each) but not for groups in the trained condition ($p > .25$ in each). The nature of these effects can be seen in Table 2. Thus, support for Hypothesis 5 appears to have come primarily from groups in the untrained condition.

The only other effect that was significant for both measures was the main effect for group decision training. Groups in the trained condition had significantly higher mean rank and mean time scores than groups in the untrained condition ($p < .001$ in each). This reflects the previously reported finding that group decision training significantly increased the amount (and hence the mean rank and time scores) of information brought into discussion.

Finally, there was a significant main effect for task importance that appeared only in the analysis of the mean time scores. Groups in the important-task condition had higher mean time scores ($M = 4.29$) than groups in the unimportant-task condition ($M = 3.33$), $F(1, 63) = 4.63$, $p < .05$. This effect is consistent with the previously reported finding that groups in the important-task condition took significantly longer to come to a decision than did groups in the unimportant-task condition. However, the fact that task importance had no effect on the mean rank scores, and that groups in the two task-importance conditions did not differ in the overall amounts of information they discussed, suggests that the sole impact of the task-importance manipulation was to cause groups to proceed more slowly in making their decision.

Sequential Entry of Shared and Unshared Information

Hypothesis 6 predicted that the probability of mentioning shared information would decrease as discussion progressed. Specifically, the first item of information introduced in discussion was expected to have a .60 probability of being shared information, with all subsequently introduced items having successively lower probabilities of being shared information. To test this hypothesis, the proportion of groups bringing out shared information as the 1st item mentioned, as the 2nd item mentioned, as the 3rd item mentioned, and so on, was computed for each of the first 20 new items of information introduced.[9] A regression line describing the relationship between the serial position of the items and the proportion of groups in which those items were shared information was then fit to these data. Because of the previously reported difference in the simple main effect for information type across the two group decision-training conditions, regression lines were computed for groups in the trained and untrained conditions separately. These regression lines are plotted in Figure 2.

As can be seen, these two regression lines are quite different from one another. In the trained condition, the regression coefficient (β) was $-.0012$, which is not significantly different from zero, $t(18) < 1.00$. By contrast, in the untrained condition the regression coefficient was $-.0129$, which is significantly different not only from zero, $t(18) = 3.17$, $p < .01$, but also from the coefficient observed in the trained condition, $t(36) = 2.07$, $p < .05$. The latter result was obtained by regressing the proportion of groups mentioning shared information onto the serial position of the items, an effects-coded group-decision-training condition variable, and the interaction between the two, and then testing the significance of the interaction term.

Figure 2 also contains a plot of the theoretically derived exact probabilities of introducing shared information that would be expected given $p(R) = .53$ and $Cp(R_{\mathrm{shared}}) = .59$. These two parameters were estimated from the performance of the 76 subjects who, rather than participate in a group discussion, instead completed the free recall task. As a frame of reference, the range of possible probability curves for $p(R) = .53$ given all values of $Cp(R_{\mathrm{shared}})$ such that $p(R) \leq Cp(R_{\mathrm{shared}}) \leq 1.00$ is shown in the shaded portion of the figure.

As can be seen, the obtained data for groups in the untrained condition are generally consistent with the predictions of the information-sampling model. Importantly, the slope of the regression line in that condition does not differ significantly from the slope of the linear component ($\beta = -.0103$) of the theoretically derived curve when $p(R) = .53$ and $Cp(R_{\mathrm{shared}}) = .59$, $t(18) = .63$, $p = ns$.

To summarize, in the untrained condition the sequential entry of information into the group discussions seems well-described by a sampling process that initially favors shared information, but that over time comes to favor unshared information. In contrast, this sampling process does not adequately describe the flow of information into the discussions of groups in the trained condition. This difference is what gives rise to the previously reported mixed support for Hypothesis 5 obtained from the analyses of the mean rank and time scores.

Group Discussion Strategies

The sequential analysis reported above clearly demonstrates that something other than (or perhaps in addition to) the pro-

Table 2
Mean Rank and Time Scores for Shared and Unshared Information Brought Out During Group Discussion

	Untrained groups		Trained groups	
Measure	Unshared information	Shared information	Unshared information	Shared information
Rank				
M	7.86	6.65	10.53	10.08
SD	3.57	3.34	2.95	2.80
Time				
M	2.98	2.45	5.01	4.91
SD	1.77	1.40	1.68	1.88

[9] Not every group brought out as many as 20 items of information during discussion, although over half discussed at least 17 items and more than a third discussed at least 20. The obtained proportions are therefore based on fewer and fewer groups as one moves from the 1st to the 20th item of new information mentioned.

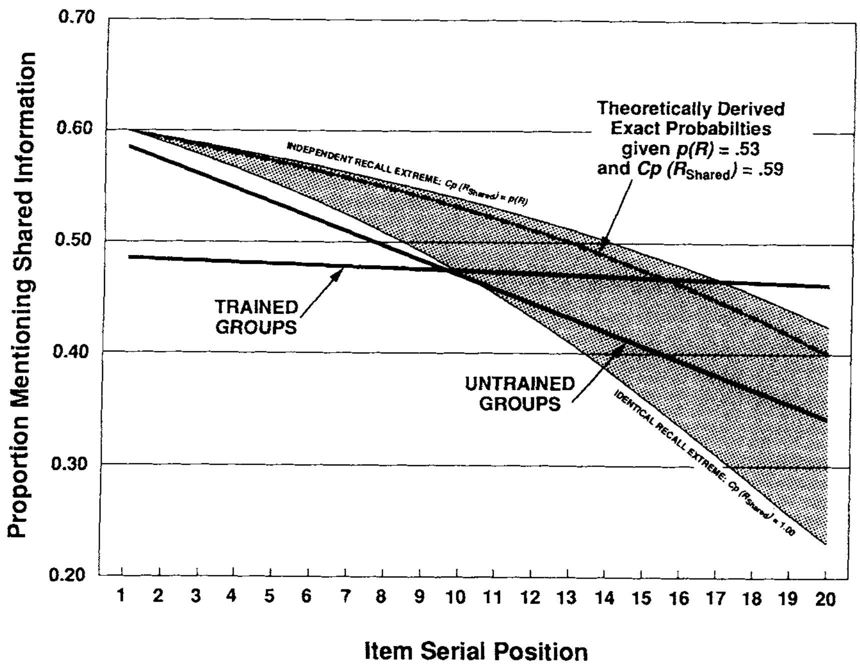

Figure 2. Regression lines showing the relationship between item serial position and the proportion of groups in which the item was shared information, as well as a plot of the theoretically derived exact probabilities of mentioning shared information given $p(R) = .53$ and $Cp(R_{\text{shared}}) = .59$.

posed sampling process operates among groups given group decision training. In an effort to uncover what that alternative process might be, we examined the discussion strategies that groups used. Strategy differences among groups become evident when mean rank and time scores are computed separately for the information discussed about each of the three faculty candidates. Because the rank and time analyses lead to similar conclusions, only the results for the mean rank analysis are reported here.

A 2 (important vs. unimportant task) × 2 (trained vs. untrained groups) × 3 (faculty candidates) mixed-design ANOVA revealed both a significant candidate main effect, $F(2, 118) = 13.09$, $p < .001$, and a Candidate × Group Decision-Training interaction, $F(2, 118) = 7.74$, $p < .001$. As can be seen in the top half of Table 3, in the untrained condition differences among the mean ranks were small and nonsignificant, indicating a lack of temporal ordering in the discussion of the three candidates in that condition. In the trained condition, by contrast, there was a clear tendency to discuss Candidate A first ($M = 7.46$), Candidate B second ($M = 10.74$), and Candidate C third ($M = 12.91$). These means are all significantly different from one another using Scheffé's test ($p < .05$ for each).

It is also interesting to examine the proportion of information about each candidate that was raised in discussion. These data are reported in the bottom half of Table 3. Once again, a 2 × 2 × 3 mixed-design ANOVA revealed both a significant candidate main effect, $F(2, 126) = 6.22$, $p < .01$, and a Candidate × Group Decision-Training interaction, $F(2, 126) = 3.30$, $p < .05$. As can be seen, across both group decision-training conditions, the mean proportion of items mentioned about each candidate followed the order in which the candidates were discussed. The largest amount of information was brought out about the candidate that tended to be discussed first (i.e., had the lowest mean rank), and the smallest amount of information was brought out about the candidate that tended to be discussed last.

To determine whether these strategy differences can account for the differential flow of shared and unshared information into the discussions of trained and untrained groups, two sets of exploratory analyses were performed. The first consisted of analyzing the information entering each group discussion according to its rank order *within candidate,* a procedure that eliminates any effects attributable to discussing one candidate before another. Specifically, the proportion of groups in the trained and untrained conditions that brought out shared information as the first item mentioned about each candidate, as the second item mentioned about each candidate, and so on, was computed. These proportions were then averaged across candidates, and separate regression lines were fit to the data from the two conditions. The resulting regression coefficients were both significantly different from zero ($\beta = -.0216$, $p < .005$, for the trained condition; $\beta = -.0199$, $p < .03$, for the untrained condition) and did not differ significantly from one another. Thus, when candidate order effects are controlled, the flow of shared and unshared information into the discussion of trained groups appears very similar to that observed for untrained groups.

An alternative to removing the effect of candidate order from the observed data is to add a discussion-order parameter to the information-sampling model. That is, the theoretical probability of each item mentioned being a piece of shared information

Table 3
Mean Rank Scores and Proportion of Information Discussed for Each of the Three Faculty Candidates

Group	Faculty candidates A	B	C
	Mean rank scores		
Untrained			
M	7.86[a]	7.21	8.39[a]
SD	3.88	3.83	4.81
Trained			
M	7.46	10.74	12.91
SD	3.30	3.05	5.10
	Proportion of information discussed		
Untrained			
Proportion	.23	.29	.22
SD	.17	.17	.13
Trained			
Proportion	.42	.37	.30
SD	.16	.13	.16

[a] Three groups in the untrained condition discussed no information about Candidate A, three other groups discussed no information about Candidate C, and one group discussed no information about either Candidate a or Candidate c. Thus, these two means are each based on 30 groups.

can be calculated under various assumptions about the order in which candidate information is sampled.[10] The most extreme assumption is that all of the information to be discussed about one candidate is brought out first, followed by all of the information about a second candidate and then all of the information about the remaining candidate. Incorporating this assumption into the information-sampling model yields a probability curve with a linear trend ($\beta = -.0026$) that is not significantly different from what was originally reported for groups in the trained condition ($\beta = -.0012$). However, when less extreme forms of the candidate–order assumption are used (i.e., forms that permit some deviation from a strict candidate-by-candidate sequence), results do not conform to the empirical observations. Most notably, if the actual proportion of groups in each condition mentioning information about each candidate at each serial position is used to determine the candidate from which information is sampled in the model, results based on proportions from the trained condition do not differ markedly from those based on proportions from the untrained condition: Both yield strong, negatively accelerating curves.

Thus, these two sets of exploratory analyses produced inconsistent evidence. On the one hand, eliminating the effect of candidate order from the discussion data successfully eliminated the observed differences in the way shared and unshared information entered group discussion in the trained and untrained conditions. On the other hand, adding a candidate discussion order parameter to the information-sampling model failed, except under extreme conditions, to produce results that correspond to what was observed in the trained condition. The implications of these inconsistent findings are addressed in the Discussion section.

Table 4
Mean Proportion of Shared and Unshared Information Repeated at Least Once During Group Discussion

Information type	Untrained groups: Unimportant task	Untrained groups: Important task	Trained groups: Unimportant task	Trained groups: Important task
Shared				
M	.35	.39	.49	.43
SD	.19	.27	.26	.21
Unshared				
M	.20	.27	.33	.41
SD	.21	.22	.16	.17

Repeated Information

Hypothesis 7 predicted that groups would repeat more shared information than unshared information. Table 4 shows the mean proportion of previously discussed shared and unshared information that was repeated at least once in each treatment condition. These data were analyzed in a 2 (important vs. unimportant task) × 2 (trained vs. untrained groups) × 2 (shared vs. unshared information) complete factorial mixed-design ANOVA. As can be seen, significantly more shared ($M = .41$) than unshared information ($M = .30$) was repeated, $F(1, 63) = 10.53$, $p < .002$, thus supporting Hypothesis 7. This analysis also revealed a significant main effect for group decision training. Groups in the trained condition ($M = .42$) repeated significantly more information than did groups in the untrained condition ($M = .30$), $F(1, 63) = 8.55$, $p < .01$. No other effects from this analysis approached significance.

Member Prediscussion Preferences and Group Decisions

Prior to discussion, subjects reported which candidate they most preferred. Candidate B was preferred by a majority of subjects (54%), with the remainder split between Candidates A (26%) and C (20%). This pattern differs significantly from what would be expected under an equal-preference model, $\chi^2(2, N = 201) = 37.87$, $p < .001$, and suggests that we were not successful in creating three equally attractive candidates.

The pattern of choices made by groups paralleled the subjects' prediscussion preferences. Candidate B was chosen by a majority of groups (64%), with the remainder split between Candidates A (24%) and C (12%). These percentages did not vary significantly by treatment condition. A social decision scheme analysis (e.g., Davis, 1973; Stasser, Kerr, & Davis, 1989)

[10] In all of the models discussed here, the total amount of information brought out about each candidate was held constant at a level proportional to the average amount of information actually mentioned about each during group discussion.

indicated that the group choices were best explained by a "majority-wins, proportionality otherwise" decision rule, $\chi^2(2, N = 67) = .49, p > .70$).

Discussion

Discussion and Repetition Advantages of Shared Information

Groups in the present study discussed a larger percentage of their shared information than of their unshared information. They also repeated more shared than unshared information. Both of these findings are consistent with previous research by Stasser, Taylor, and Hanna, (1989), and both reflect less-than-optimal group decision-making behavior. By giving disproportionate discussion to information that they already shared in common, groups failed to take account of a large percentage of the (mainly unshared) information available to them.

The tendency to bring more shared than unshared information into discussion is well explained by the information-sampling model. In comparison with unshared information, there were simply more opportunities overall to sample shared information.

As for repeating more shared than unshared information, there are at least two possible explanations. First, the greater exposure that members had to the discussed shared information (i.e., before discussion and then again during discussion) may have made it easier to recall than much of the discussed unshared information, the majority of which they were exposed to only during discussion. Second, because everyone in the group could verify the accuracy of the discussed shared information, that information may have seemed more reliable than the discussed unshared information. Enhanced memorability and greater perceived reliability would both augur a repetition advantage of shared over unshared information.

It should be noted, however, that the effect size for information type was considerably smaller in the analysis of repeated information (i.e., the test of Hypothesis 7; est. $\omega^2 = .06$) than in the analysis of information mentioned for the first time (i.e., the test of Hypothesis 1; est. $\omega^2 = .30$). This suggests that the repetition advantage of shared information was weaker than its initial discussion advantage. Perhaps this repetition advantage could be eliminated altogether if unshared information were made to seem more reliable when first brought to light (e.g., by having a subject-matter expert introduce it; cf. Stasser, 1991, 1992; Stewart & Stasser, 1993). This is an important avenue for future research.

Impact of Task Importance and Group Decision Training on the Discussion Advantage of Shared Information

Increasing task importance and providing group decision training were both expected to reduce the discussion advantage of shared information, as long as doing so increased $p(M)$ above $p(M)_{crit}$. As it turned out, neither manipulation was successful in this regard.

The task-importance manipulation failed to reduce the discussion advantage of shared information because it was not effective in increasing $p(M)$. We had expected task importance to increase subjects' motivation to perform the task well, and there is evidence that our manipulation did have this effect, at least to some degree. Groups in the important-task condition brought out information at a slower rate, and they took longer overall to make a decision. Both of these findings suggest that groups in the important-task condition were trying harder to make their decisions carefully. Yet, their heightened motivation to perform well did not lead these groups to surface additional candidate information, and thus did not affect the discussion advantage enjoyed by shared information. Perhaps a stronger manipulation of task importance is required in order to affect $p(M)$. Or, maybe $p(M)$ is simply not influenced by changes in task importance, though from a theoretical standpoint this seems less plausible.

The group decision-training manipulation also failed to reduce the discussion advantage of shared information, but for a different reason. Although group decision training did increase $p(M)$, it did not increase it above $p(M)_{crit}$. Instead, $p(M)$ was moved closer to the point at which the discussion advantage of shared information was expected to be greatest (.42). Thus, on the basis of Equation 1 we predicted that this manipulation would actually exacerbate the discussion advantage of shared information. This did not occur, however.

Note that Equation 1 did not merely overpredict the amount of shared information discussed by groups in the trained conditions. Overprediction implies the addition of a constant (or at least systematic) error. Had the group decision-training manipulation produced such an error, the mean difference between the predicted and actual amount of shared information discussed by groups would have been (and was) affected, but the correlation between these variables should have remained fairly constant. Yet this did not occur. The correlation between these variables was strong and significant in the untrained condition, but was weak and nonsignificant in the trained condition. Thus, Equation 1 seems to have been a good predictor of groups' information-pooling behavior only in the untrained condition.

Sequential Entry of Information Into Group Discussion

Perhaps the most intriguing finding from the present study concerns the order in which shared and unshared information entered group discussion and how group decision training affected that order. In the untrained condition, the sequential entry of information into group discussion did not vary significantly from what would be expected on the basis of a stocastic sampling process that initially favors the discussion of shared information, but that over time comes to favor unshared information. By contrast, in the trained condition there was a more uniform flow of shared and unshared information into discussion over time. Significantly, the expected shift in emphasis from shared to unshared information was completely absent among the trained groups. Also observed in the trained condition was the tendency for groups to use a discussion strategy that focused on one candidate at a time. This strategy appears to have been adopted spontaneously, as it was not mentioned during training, either by the experimenter or in the 4-min videotape that subjects saw.

Exploratory analyses conducted to determine whether focusing on one candidate at a time caused the unexpected flow of shared and unshared information into the discussions of trained groups produced contradictory results. On the one hand, removing the effect of candidate order from the actual group discussion data revealed a discussion pattern in the trained condition similar to that initially observed in the untrained condition. On the other hand, incorporating a candidate–order parameter in the information-sampling model failed, except under extreme conditions, to reproduce the original results from the trained condition. The influence of group discussion strategy is implicated by the former result, but not by the latter. What is needed to resolve this issue is an experiment that directly manipulates group discussion strategy and that observes the impact of strategy differences on the sequential entry of shared and unshared information into group discussion. Also useful would be an experiment that orthogonally manipulates the two components of the present group decision-training manipulation (viz., strategy planning and information-vigilance training) in order to determine which one actually produces discussion-strategy differences between groups.

Additional research is also needed to test the information-sampling model itself. For example, the predictions associated with the model's two memory parameters, $p(R)$ and $Cp(R_{\text{shared}})$, should be empirically tested. As previously discussed, the model predicts that the sampling advantage enjoyed by shared information will be lost more quickly at lower levels of $p(R)$. However, the magnitude of this effect is expected to depend on $Cp(R_{\text{shared}})$. When $Cp(R_{\text{shared}})$ is near 1.00, implying that group members recall very similar subsets of shared information, variations in $p(R)$ should have a larger effect than when $Cp(R_{\text{shared}})$ approaches $p(R)$, that is, when group members recall relatively independent subsets of shared information.

Finally, links between the information-sampling model and other variables known to affect group decision making should be explored. For instance, the model's relationship to variables that influence the salience of information become clearer when it is recognized that $Cp(R_{\text{shared}})$ is affected by the differential salience of the shared-information items. To illustrate, if half of an otherwise nonsalient set of shared-information items were made extremely salient, it is likely that group members would begin to recall very similar subsets of that information (i.e., all of the salient items), thereby pushing $Cp(R_{\text{shared}})$ toward 1.00. In the present research we did nothing to make the shared-information items differentially salient, so it is not surprising that $Cp(R_{\text{shared}})$ was near $p(R)$. In everyday life, however, a host of factors can produce differential salience across a given set of information (e.g., factors relating to when and how the information was initially acquired, the apparent relevance of that information to the problem at hand, etc.). The information-sampling model suggests that one way such factors affect group decision making is through their impact on $Cp(R_{\text{shared}})$.

Group Discussion and Group Decision-Making Effectiveness

In the present study, groups in all treatment conditions chose the faculty candidate most preferred by the majority of their members prior to discussion. Thus, group discussion seemed to have had little impact on the overall pattern of decisions that were made. This was not unexpected, however, because the prediscussion information held by each group member was specifically designed to be representative of the total pool of information available to the group as a whole. That is, in all conditions the shared information held by group members prior to discussion favored the same candidate as did the aggregate of their unshared information. Consequently, it would have been surprising had the group choices *not* been consistent with their members' prediscussion preferences.

Yet it is not difficult to imagine a circumstance in which the information held by members prior to discussion is not representative of the total pool of information available to the group as a whole (e.g., Stasser & Titus, 1985). This might happen, for example, if the majority of the information favors one candidate but most or all of that information is unshared. If this were the case, the supporting information would be diffuse in comparison with the nonsupporting information, thus making its decisional implications hard for any one member to appreciate prior to a discussion. Under such conditions, there is a good chance that the members' prediscussion preferences would not favor the objectively best candidate (i.e., the one they would choose were all of the information shared). Stasser (1988) described such situations as having a "hidden profile."

It is precisely when a hidden profile exists that the group discussion variables examined in the present study should begin to impact group decision-making effectiveness. In particular, variables that increase the amount of unshared information groups surface during discussion should also increase the chances that they will "expose" the hidden profile, accurately assess all of the candidates, and select the best one. Group decision training is thus one variable that should benefit group decision-making effectiveness primarily when a hidden profile exists. Our group decision-training manipulation significantly increased the amount of unshared information groups discussed, which is just what is needed if a hidden profile is to be uncovered. On the other hand, when a hidden profile does not exist (e.g., as in the present study), there is little reason to expect a benefit from interventions of this sort.

This line of argument presumes, of course, that once unshared information is raised in discussion it is just as effective at influencing the group's decision as is the shared information that is raised. Evidence from the group polarization literature seems to support this assumption, at least in as much as novel information has been shown to produce significant attitude and opinion change in groups (e.g., Vinokur & Burnstein, 1978a, 1978b; Vinokur, Burnstein, Sechrest, & Wortman, 1985). On the other hand, we found that unshared information is less likely to be repeated during discussion, which may be partly due to its perceived unreliability. Unreliability ought to diminish the information's decisional impact. Furthermore, if the unshared information emerges relatively late in discussion, as the information-sampling model predicts, its impact could be diminished further (cf. Anderson, 1965, 1981). Thus, whether the discussion of unshared information actually does improve the quality of group decision making when a hidden profile exists remains an open question deserving of additional research.

Static Versus Dynamic Views of Group Discussion

Finally, we conclude by reiterating one of the central themes motivating the present study. The information-sampling model original described by Stasser and Titus (1985) provides a useful set of baseline predictions for evaluating the discussion of decision-making groups. However, because its expression (viz., Equation 1) ignores the temporal aspect of group discussion, previous research with this model offers little insight into the texture of group discussion as it unfolds over time.

The present research demonstrated that the basic information-sampling model is also well suited to making predictions about the temporal dynamics of group discussion. By attending to how opportunities to sample not-yet-discussed shared and unshared information change over time, a rich and specific set of predictions about the sequential flow of shared and unshared information into group discussions can be derived. This temporal analysis complements the static approach of prior research and, in combination with it, offers a more comprehensive framework for judging the discussion process in decision-making groups. That empirical data sometimes do not fit this framework highlights the need for further research and suggests avenues that research might profitably take.

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