Communication Monographs
Vol. 74, No. 1, March 2007, pp. 1–28

Routledge
Taylor & Francis Group

Effects of the Information Environment on Group Discussions and Decisions in the Hidden-Profile Paradigm

Torsten Reimer, Sascha Kuendig, Ulrich Hoffrage, Ernest Park & Verlin Hinsz

Research on the Information Sampling Model (ISM) revealed that information items that are known to all group members at the outset (shared information) are more likely to be mentioned during discussion than information items that are only known to individual members (unshared information) (Stasser & Titus, 1985; Wittenbaum, Hollingshead, & Botero, 2004). In prior studies involving the ISM, groups typically functioned in a very specific information environment: All information items were provided in form of unique cues, which described only one of the choice alternatives among which the groups had to choose. Because this specific information environment may impact group discussions and decisions, we included an experimental condition incorporating common cues. In contrast to unique cues, common cues provide information on each and every choice option. As expected, groups in the common-cue condition showed a weaker sampling advantage for shared information, and chose the hidden-profile alternative more often than groups in the classic unique-cue condition.

Keywords: Group Decision Making; Communication; Information-Sampling Model; Information Sharing; Cue-Based Decision Strategy; Alternative-Based Decision Strategy; Group Performance; Unique and Common Cues; Group Discussion; Hidden Profile; Decision Strategies

---

Torsten Reimer was at the Max Planck Institute for Human Development in Berlin, Germany, when the research was conducted and is now an Assistant Professor of Persuasion and Social Influence in the Communication Department at the University of Maryland, College Park. Sascha Kuendig (MA) is a graduate student in Psychology at the University of Basel, Switzerland; Ulrich Hoffrage is Professor of Decision Theory and Risk at HEC Lausanne, Switzerland; Ernest Park is an Assistant Professor of Psychology at Cleveland State University; and Verlin Hinsz is Professor of Organizational and Social Psychology at North Dakota State University. We are grateful to Daniel Meier for his support with coding the discussion and to the Editor Alan Sillars and two anonymous reviewers for their helpful comments on our manuscript. Correspondence to: Torsten Reimer, University of Maryland, Department of Communication, 2114 Skinner Building, College Park, MD 20742-7635, USA. E-mail: treimer@umd.edu

ISSN 0363-7751 (print)/ISSN 1479-5787 (online) © 2007 National Communication Association
DOI: 10.1080/03637750701209947

Research involving individual decision making indicates that features of the information environment and the decision context can affect how decision makers search for information, when they stop their information search, and how they integrate the acquired information into a decision (Gigerenzer, Todd, & the ABC Research Group, 1999). There is ample evidence suggesting that the way decision-makers sample information—be it internally from memory or from an external source—depends on contextual factors (Fiedler & Juslin, 2006). For example, people search for less information during a decision task when they are under time pressure (Rieskamp & Hoffrage, 1999), or when information is costly or redundant (Broeder, 2000). Information sampling also has a long tradition of prominence in research concerning decision-making groups (Burnstein & Vinokur, 1977; Hinsz, Tindale, & Vollrath, 1997; Hirokawa & Poole, 1996; Stasser & Titus, 1985; Vinokur & Burnstein, 1978). In a group context, information sampling can refer to the retrieval and search process group members enact (sampling from external sources; e.g., Schulz-Hardt, Frey, Lüthgens, & Moscovici, 2000) and to the information that is mentioned and exchanged during group discussions (sampling from internal sources; e.g., Stasser & Titus, 1985). Group discussions provide a convenient data source that facilitates studying information sampling processes: Which information items does an individual group member mention during a discussion—that is, how do individual group members sample from their knowledge base? And which information items are discussed by the group—that is, how do groups sample from the knowledge that is available to the group as a whole?

Questions such as these are important because information exchange can strongly affect group outcomes (Vroom, 1969; Winquist & Larson, 1998). For example, whether or not group members mention and discuss information that is relevant to a problem can influence group performance (see Hinsz et al., 1997, for various examples). In addition, the exchange (Romano & Nunamaker, 2001) and validation of information (Wittenbaum & Park, 2001) sometimes serve as primary team goals that constitute an important function of team meetings (Monge, McSween, & Wyer, 1989). As Wittenbaum, Hollingshead, and Botero (2004) note, teamwork often requires that group members learn how to pool knowledge effectively between members with heterogeneous expertise and experience.

The Sampling Advantage for Shared Information

Given the importance of understanding information exchange in groups, the fundamental issue of identifying various influences on the nature of information sampling in groups is necessary to address. Similar to research on decision making by individuals, evidence suggests that features of the task (e.g., Hastie, Penrod, & Pennington, 1983) and of the information environment can affect what information groups sample during discussions (Stasser & Titus, 1985; Wittenbaum et al., 2004). A critical feature of the information environment in a group context is the distribution of knowledge among group members. Studies that held the set of information items known by groups constant but manipulated how this information was dispersed among group members revealed a counterintuitive finding (Stasser & Titus, 1985): Groups often discuss shared information that is already known to everybody, whereas unshared information items that are not known to all group members are less likely to be mentioned during group discussions (for an overview see Stasser & Birchmeier, 2003; Wittenbaum & Stasser, 1996). To account for this sampling advantage for shared information, Stasser and Titus (1985) introduced the Information Sampling Model (ISM). The ISM predicts the content of group discussions on the basis of individual group members' contributions to a discussion. According to the ISM, the probability that an individual information item will be discussed is a function of the probability of individual members mentioning the item (Davis, 1969, 1982; Lorge & Solomon, 1955; Stasser & Titus, 1985). Because shared information is known to more group members than unshared information, the ISM predicts that it is also more likely to be discussed by the group. Numerous studies showing that groups discuss higher proportions of their shared than unshared information support this claim (Stasser & Birchmeier, 2003; Wittenbaum et al., 2004).

Open Questions

In addition to identifying when a sampling advantage for shared information will occur, the ISM also predicts how much shared and unshared information will be exchanged throughout the course of a discussion. However, only a few empirical studies have directly tested the effectiveness of this model in making point predictions (e.g., Schittekatte, 1996; Stasser, Taylor, & Hanna, 1989). Moreover, and related to this point, the ISM assumes that members randomly sample from their knowledge base—an assumption that might not always be tenable (Brodbeck, Kerschreiter, Mojzisch, Frey, & Schulz-Hardt, 2002; Henningsen & Henningsen, 2004; Stasser et al., 1989; Wittenbaum, 1998; Wittenbaum et al., 2004). A central aim of the present study was to determine whether this assumption holds by comparing the predictions of a model that assumes that group members mention equal proportions of their shared and unshared information items with those for a model that includes a parameter that reflects the extent to which group members deviate from mentioning equal proportions of their shared and unshared information.

Research relating to the ISM identifies the distribution of information as one central feature of a group's information environment that affects information sampling. We extended this work by adding another environmental feature that might influence the tendencies of group members to selectively sample shared versus unshared information. Specifically, we compared information environments that contained either common or unique cues. Whereas the *sharedness of information* refers to whether an information item is one that multiple group members know (shared information) or that only one group member knows (unshared information), *cue commonality* refers to whether multiple (common cue) or only one of the decision alternatives (unique cue) has a known value for this particular cue. For example, imagine that a group of friends are making a decision about where to eat, and that they have narrowed their options to four alternatives. If at least two know that the Mexican restaurant they are considering is 20 minutes away, then this fact is a *shared* piece of information. If only one of the friends knows that the Mexican restaurant recently expanded its menu, then that piece of information is *unshared*. Now, imagine that at least one member of the group has visited each of the restaurants in the past. The group therefore knows the price range of each of the restaurants. In this example, price range would be a *common cue*, because the group has information concerning each of the decision alternatives in regard to this particular attribute (e.g., price). In contrast, imagine that only one of the group members has been to one of these restaurants and knows that this one has outdoor seating. None of the other group members can speak for any of the other restaurants in regard to this attribute. Seating options would be an example of a *unique cue*, because the group has knowledge about this cue for only one of the decision alternatives. Note that the two dimensions of information sharedness and cue commonality are orthogonal. Thus, information types can be combined to be presented in a number of ways—information items can exist as common or unique cues, and can be shared or unshared.

Even though the sampling advantage for shared information has been evident in a variety of groups performing a variety of decision tasks, all of the studies have one feature in common—they have held cue commonality constant. Group members were provided with shared and unshared information for unique cues that describe only one of the alternatives (see Fraidin, 2004; Reimer & Hoffrage, 2005, in press; Reimer, Hoffrage, & Katsikopoulos, in press). However, there is evidence from research relating to individuals that cue commonality can affect which information a receiver samples and integrates into a decision. The presentation of unique cues typically instigates an *alternative-based* decision strategy (Burke, 1990, 1995; also see Johnson, Payne, & Bettman, 1988; Payne, Bettman, & Johnson, 1988). Because the potential alternatives cannot be compared along the same cues, the decisionmaker forms a global impression of each alternative. Then, he or she chooses the alternative that creates the best overall impression—for example, the one with the most positive and least negative features. In contrast, when provided with common cues for which all alternatives have a value, decisionmakers are more likely to implement a *cue-based* decision strategy by comparing alternatives on common features or dimensions (Burke, 1990, 1995). Thus, cue commonality can systematically influence what decision strategies are adopted at the individual level. These ideas may potentially extend beyond the individual level, and may apply at the group level as well. For example, does cue commonality also affect how group members sample information, the content of group discussion, and ultimately the group decision (Reimer & Hoffrage, 2005)? Hence, the second major aim of our study was to empirically test for effects of cue commonality and potential interactions with information sharedness on group discussions and decisions.

Below we describe the ISM by Stasser and Titus (1987) in more detail. In line with Stasser and Titus, we adopt the notion that group discussions can be described as a sampling process. In particular, we outline how individual group members' information sampling will affect the expected sampling advantage at the group level.

Consistent with most prior studies of information sharing, we use a hidden-profile task to illustrate the ISM. With a distribution of information among group members as it is typically realized in hidden-profile studies, the sampling of shared versus unshared information may have decisional consequences (Stasser & Birchmeier, 2003; Winquist & Larson, 1998). We then advance hypotheses concerning how cue commonality may affect information sampling in groups and describe a study in which we tested them. Finally, we discuss some implications of the current study and outline directions for future research on information sampling in groups.

The Hidden-Profile Effect

Most studies investigating the sampling advantage for shared information have used a hidden-profile task (e.g., Stasser & Titus, 1985, 1987; for a study involving another type of task, see Stasser et al., 1989). For success in this task, the exchange of unshared information items is key. Groups perform a choice task, for which they have to make a selection among several alternatives. One alternative has a higher sum score (i.e., greater difference between the number of positive and negative attributes or cues) than the others and is typically assumed to be the best choice (Stasser & Titus, 1985, Footnote 1; for hidden-profile environments including an external criterion, see Reimer & Hoffrage, 2005). However, the overall profile of this alternative is hidden from individual group members because information about the alternatives' cues is initially distributed among group members in a biased fashion. Specifically, group members begin with more positive (and fewer negative) pieces of information concerning an inferior alternative. Thus, the critical issue is whether group members exchange unshared information concerning the superior alternative. Consider the following example: A four-member personnel committee has to decide which of two candidates, A or B, is better suited for a position. Example 1 in Table 1 shows how the information about the two candidates is distributed among the members of the committee. Each candidate is described in terms of several cues (e.g., has special computer skills; speaks a particular foreign language). For the sake of simplicity, let us consider that all of the cues are positive and, therefore, favor the candidate if they are presented.

Two columns in Table 1 list the cues for each candidate, and four rows depict the particular set of knowledge that each group member has at the onset of the group decision process. Each group member has information about Candidate A for Cues 1 to 4. In addition, Group Members 1, 2, 3, and 4 know that Candidate B can be described by Cues 5 to 12. But each one of these four group members only knows two things about Candidate B. Note that the four committee members all have the same information about Candidate A (shared information items), but their knowledge about Candidate B is unique (unshared information items). As a consequence, Candidate B has the highest overall sum score, but this fact is initially hidden from each group member.

Empirical studies have repeatedly shown that groups fail to detect hidden profiles (see, for recent overviews, Kerr & Tindale, 2004; Stasser & Birchmeier, 2003;

Table 1 Two Hidden Profiles in Information Environments with Two Alternatives (Candidate A and B), Four Group Members (Members 1 to 4), and Twelve or Eight Positive Cues (Cues 1 to 12). The Profile on Candidate B is Hidden to the Individual Group Members

Group member	Knowledge about Candidate A	Knowledge about Candidate B	Decision
Example 1: Unique cues			
Member 1	Cues 1, 2, 3, 4	Cues 5, 9	Candidate A
Member 2	Cues 1, 2, 3, 4	Cues 6, 10	Candidate A
Member 3	Cues 1, 2, 3, 4	Cues 7, 11	Candidate A
Member 4	Cues 1, 2, 3, 4	Cues 8, 12	Candidate A
Omniscient member	Cues 1, 2, 3, 4	Cues 5, 6, 7, 8, 9, 10, 11, 12	Candidate B
Example 2: Common cues			
Member 1	Cues *1*, 2, 3, 4	Cues *1*, 5	Candidate A
Member 2	Cues 1, *2*, 3, 4	Cues *2*, 6	Candidate A
Member 3	Cues 1, 2, *3*, 4	Cues *3*, 7	Candidate A
Member 4	Cues 1, 2, 3, *4*	Cues *4*, 8	Candidate A
Omniscient member	Cues *1*, *2*, *3*, *4*	Cues *1*, *2*, *3*, *4*, 5, 6, 7, 8	Candidate B

Note: In the examples, cues are assumed to be positive throughout. Thus, each cue speaks, if present, in favor of the particular candidate. Moreover, information about Candidate A is shared and information about Candidate B is unshared throughout. In both examples, there are four cues in favor of Candidate A and eight cues in favor of Candidate B. However, the Cues 1 to 4 discriminate only in Example 1 (unique-cue condition) but do not discriminate in Example 2 (common-cue condition). Cues that do not discriminate are written in italics. Further note that the two examples are standardized with regard to the number of information items that are known to the group and the individual group members as well as with regard to the two candidates' sum scores. However, Examples 1 and 2 necessarily differ in the number of cues (twelve vs. eight).

Wittenbaum et al., 2004). In our context, the following two explanations for why groups are unable to solve hidden-profile tasks are central: The first explanation centers on what happens prior to the group discussion. Because of the way that information about each alternative is distributed, group members typically develop a preference for the inferior option (Gigone & Hastie, 1993; Hollingshead, 1996; Kelly & Karau, 1999; Winquist & Larson, 1998). When group members enter a discussion with a shared preference, groups only rarely consider another alternative and, thus, fail to detect the hidden profile (Brodbeck et al., 2002; Reimer, 1999). The second explanation concerns the group discussion itself and is based on the sampling advantage for shared information introduced above (Larson, Foster-Fishman, & Keys, 1994; Stasser et al., 1989; Stasser & Titus, 1987). If group members in our example primarily exchange their shared information on Candidate A, they will fail to become aware that there are actually more cues in favor of Candidate B. Note that these explanations are not mutually exclusive. Rather, several authors have claimed that the individual members' preferences for an inferior alternative can accentuate the tendency to exchange only shared information, which typically favors group members' individual preferences due to the biased distributions of information in hidden-profile tasks (e.g., Brodbeck et al., 2002; Dennis, 1996; Kelly & Karau, 1999; Kelly & Loving, 2004).

The Information Sampling Model (ISM)

The hidden-profile literature illustrates that the way groups sample their shared and unshared information during discussion can have decisional consequences. Stasser and Titus (1985, 1987) have introduced a general model that enables predictions about when a sampling advantage for shared information will arise in a group. Specifically, the probability that a group discusses an information item, $p(D)$, is a function of the number of group members who have access to this information item, n, and the individual group members' probability to mention this item, $p(M)$. Under the assumption that $p(M)$ is the same for all members, that is, group members sample from their shared and unshared information with the same rate and members do not differ in participation rates,

$$p(D) = 1 - [1 - p(M)]^n \tag{1}$$

According to the ISM, the probability of the group discussing an item, $p(D)$, increases as the likelihood that an individual member's abilities and opportunities to recall and contribute information, $p(M)$, increase, and as the number of members who can potentially recall an item, n, increases (Stasser & Titus, 1987). Importantly, when a piece of information is completely shared, n is equivalent to the size of the group, whereas $n = 1$ when information is unshared. Therefore, the sampling of shared information should be more likely to occur than the sampling of unshared information because more group members can potentially bring this knowledge to the group's attention. For example, imagine the likelihood that a member mentions an item, $p(M)$, is .30 and the group consists of three members. If group members sample their information randomly, the likelihood of the group's discussing this piece of information will be about twice as high if it is shared than if it is unshared (.66 vs. .30, respectively).

Note that the model not only predicts a sampling advantage for shared information in this situation, but it also allows for making precise predictions concerning the amount of shared and unshared information a group will discuss. Stasser et al. (1989) directly tested the sampling advantage predicted from the model by estimating $p(M)$ on the basis of the average amount of unshared information that was mentioned during discussion, and by comparing the predicted amount of shared information with the observed amount of shared information. Specifically, Stasser et al. (1989) calculated $p(M)$ from the proportions of unshared information discussed to predict the probability of shared information being discussed:

$$p(D_{\text{shared}}) = 1 - [1 - p(M_{\text{unshared}})]^n \tag{2}$$

Stasser et al. (1989) reported that their three-person groups exchanged about 12% of their unshared information and, thus, $p(M_{\text{unshared}}) = .12$. Equation 2 predicts $1 - (1 - .12)^3 = .32$ for shared information. Therefore, the model predicted that groups would discuss 32% of their shared information on average, which was essentially what was found across these three-person groups (30%) (Stasser et al., 1989). For six-person groups, the model slightly overpredicted the relative frequency with which shared information would be discussed by .12 (.79 predicted vs. .67 observed).

According to Stasser et al. (1989), there are several potential reasons for why the model might fail to make correct point predictions. For example, the ISM presumes that the participation rate among group members does not differ. In the six-person groups Stasser et al. studied, participation rates among group members varied substantially. When Equation 1 was corrected to consider the variability in participation rates, the adjusted model predicted the sampling advantage almost perfectly (Stasser et al., 1989).

Another assumption of the ISM that might be systematically violated at times is that information is sampled randomly, and that every piece of information, be it shared or unshared, has an equal chance of being recalled and mentioned by a group member (Wittenbaum et al., 2004). For example, Stasser et al. (1989; also see Fisher, 1980) considered that the flow of discussion may follow themes, and, thus, discussing an item might affect the likelihood of what will be discussed next. As mentioned previously in the overview of the hidden profile effect, one reason why group members might not randomly sample their information is that they have preferences for an alternative and focus on information that is congruent with such preferences.

In group decision-making literature, a number of studies demonstrated preference-congruent information processing in groups (Hinsz et al., 1997; Larson & Christensen, 1993). For example, research on the confirmation bias in information acquisition revealed a tendency for group members to collect information that supports the preference or decision of the group (Schulz-Hardt et al., 2000). In a similar vein, research by Greitemeyer and Schulz-Hardt (2003) on the evaluation of information in hidden-profile tasks showed that when individuals reviewed the information presented during a discussion, those items that were congruent with the participants' own preferences were judged to be more credible and important. If there is a tendency to favor information that is congruent with one's initial preferences, and to deem it as more credible and important, then information that supports one's views should hold a sampling advantage. As mentioned earlier, in hidden-profile tasks this translates into a sampling advantage for shared information (Wittenbaum et al., 2004). This is because hidden-profile tasks are typically designed so that shared information is congruent with group members' preferences at the outset (preference-congruent information), whereas unshared information is incongruent with group members' preferences (preference-incongruent information; see Table 1 for an example; also see Brodbeck et al., 2002; Dennis, 1996; Kelly & Karau, 1999; Kelly & Loving, 2004; Wittenbaum, 1998).

Similar to how Stasser et al. (1989) adjusted their model for variability in participation rates, in the next section we demonstrate how the ISM can be modified to include a parameter that reflects the extent to which group members deviate from mentioning equal proportions of their shared and unshared information. Note that the assumption that information is randomly sampled did not seem to be violated in the Stasser et al. (1989) study. However, Stasser and colleagues did not use a hidden-profile task in their study, and their task was constructed such that group members were unlikely to have an initial decision preference.

Adjusting for Information Sampling Tendencies by Group Members

If a preference in favoring shared over unshared pieces of information (or vice versa) exists at the individual level, the assumption that $p(M_{\text{shared}}) = p(M_{\text{unshared}})$ is no longer valid. In this case, it is reasonable to extend Equation 1 by including a sampling coefficient, s, that represents the individual group members' sampling behavior:

$$p(D_{\text{shared}}) = 1 - [1 - (s \times p(M_{\text{unshared}}))]^n \tag{3}$$

The s parameter reflects the individual group members' preferences for either shared or unshared information and can be defined by

$$s = p(M_{\text{shared}})/p(M_{\text{unshared}}) \tag{4}$$

By calculating this s parameter, three qualitatively distinct scenarios can be identified: (1) If $s = 1$, individual group members are equally likely to mention shared and unshared information; (2) if $s > 1$, individuals favor shared information over unshared information; and (3) if $s < 1$, individuals sample unshared more than shared information.

The ISM assumes that the group members participate equally and sample their information randomly. If this is the case, the s-coefficient can be determined on the basis of the observed amount of shared and unshared information the members of a group discuss:

$$s = \frac{1 - \sqrt[n]{1 - p(D_{\text{shared}})}}{p(D_{\text{unshared}})} \tag{5}$$

Under these conditions, Equation 5 provides a useful tool for using group data to infer if there is a sampling advantage at the individual level. Consider a three-person group that exchanges 40% of the shared and 30% of the unshared information ($p(D_{\text{shared}}) = .40$ and $p(D_{\text{unshared}}) = .30$). This group shows a sampling advantage for shared information. However, according to Equation 1, the prediction would be that the group members would exchange 66% of the shared information. Thus, in this case, the observed sampling advantage at the group level would be lower than what we would expect had group members randomly sampled from their information. Equation 5 allows for computing the respective s parameter, which amounts to $s = .52$ in the same example. In other words, group members sample about twice as often from their pool of unshared versus shared information. Interestingly, this preference for unshared information would not offset the sampling advantage for shared information at the group level because of the biased information distribution.

Equation 5 can be also used to determine what conditions are necessary to offset the sampling advantage for shared information at the group level by setting $p(D_{\text{shared}}) = p(D_{\text{unshared}})$. For instance, if members of our three-member group would like to exchange 30% of both their shared and unshared information, the individual members would have to sample not half, but close to one-third (2.7 times fewer) the amount of shared relative to unshared information ($s = .37$).

The tendency to favor preference-congruent information is one plausible reason why group members might accentuate the sampling advantage for shared information. Even though several scholars have noted this possibility, there are only few studies that provide evidence for the claim by reporting data on the group-member level (Brodbeck et al., 2002; Henningsen & Henningsen, 2004; Wittenbaum, 1998). Unfortunately, these investigations either did not indicate whether there was a sampling advantage at the group level, or did not report data for group discussions, but instead inferred from recall data what groups might have discussed (Brodbeck et al., 2002). In the study reported below, we directly compared information sampling on the member level and the group level, and we included an aspect that we thought might affect the individual group members' sampling behavior, namely, whether group members had access to common or to unique cues. In the following section, we explore how this feature of the information environment can affect information sharing and group decision making in hidden-profile tasks.

Common vs. Unique Cues

Example 1 in Table 1 is adapted from tasks that are typically used in research utilizing hidden profiles. Even though it contains fewer alternatives and items of information and is, thus, a simplified version of such tasks, it highlights an important feature that is common to past research in this domain. Alternatives are described by unique cues that reference only one of the considered options. In Example 1, the group has no knowledge about Candidate B concerning Cues 1 to 4. Under these information structure constraints, it is reasonable to assume that group members would form individual preferences on the basis of an alternative-based decision strategy (Burke, 1995; Reimer & Hoffrage, 2006).

Group discussions and decisions might be different in a situation in which group members can compare alternatives on common cues and process their information in a cue-wise manner (Reimer & Hoffrage, 2005; also see Fraidin, 2004). An information environment containing common cues is illustrated in the second example of Table 1. As is indicated by the last row, which represents the "omniscient group member," there are again four cues in favor of Candidate A and eight cues in favor of Candidate B. However, in this example, both Candidates A and B can be described by Cues 1 to 4. If group members mention a candidate in respect to Cues 1 to 4 during their discussion, they might also bring up what they know about the other candidates in regards to these cues. This process should lead to several outcomes. First of all, the group members should realize that the cues that support Candidate A do not discriminate between Candidates A and B. Second, this process should prompt the discussion of unshared information. Imagine that Group Member 1 tells the group that a plus for Candidate A is that he/she can be described by Cue 2. The other members of the group will agree because this is a shared piece of information that they all know. But after Group Member 1 mentions Cue 2, Group Member 2 may, in turn, mention that Cue 2 also pertains to Candidate B, something the group does not already know.

In short, this cue-based processing may facilitate the discussion of unshared information because when a shared piece of information is mentioned, any corresponding information may be brought to the group's attention, even if it is unshared. Note that the information structure provided in the second example is decisionmaker-friendly insofar as a group will always detect the hidden profile if they process the available information in a cue-wise fashion by looking for cues that discriminate between the alternatives. However, this would require that the individual group members bring to the group's attention that the respective common cues do not discriminate between candidates. Also note that the information environments in terms of the number of information items that are available to the individual group members as well as the candidates' sum scores are identical in the two examples displayed in Table 1. As a consequence, according to the ISM as described in Equation 1, the sampling of shared and unshared information should not differ between these two conditions.

Due to the manipulation of cue commonality, the two examples necessarily vary with regard to the number of cues. The group has information relating to 12 different cues in the unique-cue example and information concerning 8 different cues in the common-cue example. We conducted a study to determine whether cue commonality affects group discussions and decisions. One consequence of the differences in the number of cues is that group members in the unique-cue environment have to process more information on cues they have not heard of prior to discussion than members in the common-cue environment. To ascertain whether potential differences between the conditions of unique and common cues are attributable to the fact that group members in unique cue environments have to process more novel cues during discussion, we set up an additional condition as a design feature, in which each group member had access to all available cues at the onset (but not necessarily to information about whether a cue pertains to a particular candidate). Table 2, which refers to the information of Group Member 1 in our second example, illustrates such a complete cue-list condition. According to the common-cue example in Table 1, Group Member 1 receives the information that Cues 1 to 4 pertain to Candidate A and Cues 1 and 5 pertain to Candidate B. Note that this group member has no knowledge about Cues 6 to 8 (and, respectively, each of the other three group members also has access to only five out of the eight cues that are available in the group). In contrast to such an incomplete cue-list condition, in which group members receive different lists of cues, in the complete cue-list condition, each member receives the same cue × candidate grid. As a consequence, when provided with a complete list of cues, group members' grids only differ in the cell entries but not in the columns and rows. The rationale for this manipulation of cue knowledge

Table 2 Group Member 1's Information on the Two Candidates in the Environment with Common Cues and a Complete or Incomplete List of Cues

Cue	Candidate A	Candidate B		
1	1	1	Incomplete cue list	Complete cue list
2	1		Incomplete cue list	Complete cue list
3	1		Incomplete cue list	Complete cue list
4	1		Incomplete cue list	Complete cue list
5		1	Incomplete cue list	Complete cue list
6				Complete cue list
7				Complete cue list
8				Complete cue list

Note: In the incomplete cue-list condition, those cues on which a member does not have any information are excluded from the group member's information grid. For example, Group Member 1 would receive a grid with five rows displaying the Cues 1 to 5. As a consequence, the cues displayed in the rows vary from group member to group member. Conversely, in the complete cue-list condition, each group member receives the full 8 × 2 grid including cues, on which the group member has no information about whether a cue pertains to a particular candidate.

(complete vs. incomplete cue-list) was as follows: If potential differences between the common- and unique-cue conditions are due to the fact that members in the unique-cue condition have to process more information on novel and unconsidered cues than members in the common-cue condition, these differences between the unique- and common-cue conditions should vanish when members have access to the whole set of cues, on which their group has any information.

Overview of Current Study

The main purpose of the study was to explore if common-cue environments attenuate the sampling advantage for shared information and facilitate the detection of hidden profiles. Given the difficulty that groups have in pooling their unshared information (Stasser & Birchmeier, 2003; Wittenbaum et al., 2004; Wittenbaum & Stasser, 1996), it is important to understand whether contextual factors such as the commonality of the provided cues affect the nature of group discussion and decisions. Specifically, the current study was designed to test the following hypotheses and research questions: (1) To test the hypothesis that groups, as well as the individual group members, will exhibit a larger sampling advantage for shared information in information environments with unique cues than in environments with common cues (sampling hypothesis). (2) To test the hypothesis that groups will detect hidden profiles less frequently in an environment with unique than in an environment with common cues (detection hypothesis). (3) To compare the predictive accuracy of the models described in Equations 1 and 3 in hidden-profile tasks in which group members have initial preferences that are supported by their shared information. (4) To explore how well the alternative-based and cue-based decision rules predict group decisions. We expected that group decisions in the unique-cue environment can be better described by an alternative-based decision strategy whereas group decisions in the common-cue environment can be better described by a cue-based decision strategy (strategy hypothesis). (5) In light of the fact that environments with common and unique cues necessarily differ in the number of cues if the number of information items is held constant (see Table 1), to determine if potential differences between the common- and unique-cue conditions are attributable to differences in cue knowledge.

Method

Sample and Design

The sample had 180 students (101 females, 78 males, and 1 unknown) from the Free University in Berlin, with a mean age of 24 years. Participants received 8 Euros.

This study was a 2 (cue commonality: common vs. unique) $\times$ 2 (cue knowledge: complete vs. incomplete cue list) + 2 (control conditions: common vs. unique cues) between-subjects design. Fifty 3-person groups were randomly assigned to one of the four experimental conditions of cue commonality and cue knowledge (with 13 groups in each of the two common-cue conditions and 12 groups in each of the two unique-cue conditions). The control conditions were included to determine whether individual group members and groups preferred the candidate with the highest sum score when group members initially had all of the information. Thus, in the control conditions, each group member received all available pieces of information, as in the omniscient-member condition in Table 1. As a consequence, because group members in the control conditions always knew all available cues, all participants in the control conditions had access to the complete list of cues used in their condition. Ten 3-person groups were randomly assigned to one of the two control conditions of common vs. unique cues.

Task and Materials

We adopted a task used in prior research (Greitemeyer & Schulz-Hardt, 2003; Kerschreiter, Mojzisch, Schulz-Hardt, Brodbeck, & Frey, 2003). In this task, participants are asked to imagine that they are members of a search committee that has to decide which of three candidates (A, B, or C) is best suited for an open sales manager position. Similar to the two examples in Table 1, the conditions of unique and common cues differed in whether the information items referred to different cues (unique-cue condition) or to identical cues (common-cue condition). In contrast to the two examples, we also included neutral and negative cues to be able to hold the pieces of information the group had on the three candidates constant (see Table 3).

According to the candidates' overall sum scores (i.e., the number of positive cues minus the number of negative cues), Candidate C was the best suited, Candidate B was the second best suited, and Candidate A was the least suited for the position. Thus, in the control condition, in which group members received all the information

Table 3 Information Environment Used in the Study: Each Candidates' Number of Positive, Neutral, and Negative Cues Known to Each Group (and, in parentheses, to Each Individual Group Member), the Overall Number of Cues, and Each Candidate's Sum Score (see Greitemeyer & Schulz-Hardt, 2003)

	Number of cues		
Cue valence	Candidate A	Candidate B	Candidate C
Positive	6 (6)	6 (4)	9 (3)
Neutral	3 (1)	6 (2)	3 (3)
Negative	6 (2)	3 (3)	3 (3)
Overall number	15 (9)	15 (9)	15 (9)
Candidates' sum scores	0 (4)	3 (1)	6 (0)

Note: The numbers without parentheses refer to the group level and to the level of the individual group members within the control condition. The numbers in parentheses refer to the level of the individual group members in the experimental conditions. The candidates' sum scores were computed by subtracting the number of negative cues from the number of positive cues. As is indicated by the sum scores, Candidate C has the highest overall sum score but the information is distributed among the individual group members such that each has more positive information on Candidate A. The numbers displayed in the table were identical in all experimental conditions.

that was available in their group, the individual group members as well as the groups were expected to choose Candidate C. In the experimental conditions, groups received the very same information as in the control conditions. However, the individual participants had only a subset of the information items prior to their group discussion. As Table 3 shows (see number in parentheses), the information was distributed such that the individual group members had more positive cues for Candidate A than for Candidate C, whose profile was hidden to group members. All six positive cues concerning Candidate A were shared among group members, whereas all nine positive cues about Candidate C were unshared. In addition, the three negative cues concerning Candidate C were shared, whereas the negative cues concerning Candidate A were unshared. The number of positive, neutral, and negative cues for each candidate was identical for all participants within each experimental group, as well as across experimental conditions.

The information was presented to participants in the form of a grid with the cues for their respective condition defining the rows and the three candidates' names defining the columns. As in the example in Table 2, a "1" in a cell indicated that the candidate possessed the respective cue (e.g., was born in a certain city) or that this was a pronounced characteristic of the candidate, respectively (e.g., if a candidate had certain skills). Whereas the order of the candidates (i.e., the columns) was fixed, cues (i.e., the rows) were presented in a random order. For the common-cue condition, we selected cues from the unique-cue condition such that candidates were equally attractive in both types of cue conditions.

As with the two examples in Table 1, the unique- and common-cue conditions did not differ in the number of available information items, but they necessarily differed with respect to the number of cues that were presented. To determine whether or not knowledge about the cues that is available in a group impacts group discussions and decisions, we added cue knowledge as an experimental factor. In the complete cue-list condition, each participant in a group received a grid with a complete set of cues (see Table 2). Conversely, in the incomplete cue-list condition, the superfluous cues on which a group member did not have any information regarding the candidates were deleted from his or her grid. The factor of cue knowledge (complete vs. incomplete list of cues) was fully crossed with the factor of cue commonality (common vs. unique cues).

Measures and Procedure

After reporting to the research site, participants were reviewed information indicating that their task would involve simulating a committee meeting. In line with prior studies, they were instructed to try to make a good decision and that there were no advantages to completing the task earlier (e.g., early dismissal; see Kelly & Karau, 1999). Participants were asked to carefully read the presented materials about the three candidates individually, in preparation for the subsequent committee meeting task. They were aware that their materials would not be at their disposal during the group discussion. Moreover, they were informed that the other members of their group might not have identical information about the candidates, that all of the information provided was veridical, and that group members did not have contradictory information.

The participants had 10 minutes to read the profiles of the three candidates and to make an individual decision as to who was the best-suited candidate. They completed a short questionnaire on which they indicated how confident they were in their choice (from 0 = very unsure to 10 = very sure). Following this individual task, mock committees consisting of three group members were formed. All groups had 15 minutes to interact and make a group decision about which candidate to hire to fill the sales manager vacancy. The discussions were videotaped. One coder coded all group discussions on a master sheet. For reliability purposes, a second independent coder rated the discussions of 12 groups. We determined agreement between the two raters on the basis of intraclass correlation coefficients (ICC), which were computed separately for each measure used (i.e., for the proportion of shared and unshared information items discussed, for the exchanged information on positive and negative cues, and for the three decision alternatives). The ICCs ranged from .98 to 1.00 (all $ps < .001$) and, thus, indicated almost perfect agreement between the two raters. The few cases, in which raters disagreed, were resolved by discussion. Subsequent to the group decisions, the group provided a joint confidence rating about their decision on the same 11-point scale they individually had used.

Following the group sessions, the participants again made a private individual decision and completed a questionnaire in which they provided confidence ratings. Finally, they completed a recall test individually by marking in an empty version of the Cue × Candidate grid which cues pertained to which candidates. This grid included all possible cues about which one's group had any information.

Results

Control conditions. As expected, in the vast majority of cases, group members, as well as groups, decided in favor of the candidate with the highest overall sum score (Candidate C) when group members had access to all available pieces of information (see Table 3). Prior to discussion, 80% (24 of 30) of the individual group members favored Candidate C. Likewise, with only one exception, Candidate C was also chosen by the groups throughout. Thus, the groups clearly preferred Candidate C when the individual group members had all available pieces of information. This held true in both the common- and unique-cues conditions.

Experimental conditions: Manipulation check. All of the following analyses refer to the experimental conditions, in which group members were initially provided with a biased set of information items that obscured the attractiveness of Candidate C. As expected, the hidden-profile manipulation was successful. In the experimental condition, most participants (81%; 122 of 150) chose Candidate A before group discussion.

Sampling advantage at the group member level. In the next step, we analyzed the proportions of shared and unshared information items that were mentioned by the individual group members (group member level), the proportions of shared and unshared information that were exchanged during discussion (group level), and the predictions of the ISM that relate these two levels of analyses to each other (see Equations 1 and 3). Because of likely dependencies among the data provided by members of the same group, we first averaged across the members within each group and conducted the analyses regarding the group member level on the basis of these pooled individuals (see Schittekatte, 1996; Stasser & Titus, 1985).[1]

Consistent with the sampling hypothesis, in the unique-cue condition group members mentioned higher proportions of their shared ($M = 0.26$, $SD = 0.10$) than of their unshared information items ($M = 0.16$, $SD = 0.11$), $t(23) = 6.13$, $p < .01$. In contrast, in the common-cue condition shared information items ($M = 0.37$, $SD = 0.21$) were no more likely to be mentioned than unshared information items ($M = 0.37$, $SD = 0.29$), $t(25) = 0.28$, $p = .79$.

Accordingly, a $2 \times 2 \times 2$ ANOVA on the number of relevant information items discussed by the pooled individuals with cue commonality (common vs. unique) and cue knowledge (known vs. unknown) as between-subjects factors and information sharedness (shared vs. unshared information items) as a within-subjects factor revealed the following effects: a main effect for cue commonality, $F(1, 46) = 8.96$, $p < .01$, $\eta^2 = .16$, a main effect for information sharedness, $F(1, 46) = 7.41$, $p < .01$, $\eta^2 = .14$, and, most importantly, a significant interaction between cue commonality and information sharedness, $F(1, 46) = 5.03$, $p < .05$, $\eta^2 = .10$. These effects are in line with the sampling hypothesis, as the sampling advantage for shared information was more pronounced in the unique than in the common-cue condition, in which no such effect surfaced. The s-coefficient in the unique-cue condition was 1.63, which indicated that shared information was more likely to be mentioned in this condition than unshared information (see Equation 4). In the common-cue condition, in which group members mentioned almost identical percentages of shared and unshared information on average, the s-coefficient was 1.[2] Cue knowledge did not show any significant statistical effect on the number of information items discussed nor on any of the other variables included in the analyses reported below (all Fs < 1). Therefore, when reporting the results of the subsequent analyses we will exclude this factor.

Sampling advantage at the group level. In the next step, we analyzed if there is a sampling advantage for shared information on the group level and whether the sampling advantage for shared information is moderated by cue commonality. On average, groups discussed 45% of the information available to them. As expected, cue commonality related to how many shared and unshared pieces of information were mentioned during group discussion. A 2×2 ANOVA with cue commonality (common vs. unique) as a between-subjects factor and information sharedness (shared vs. unshared information items) as a within-subjects factor revealed a main effect for cue commonality, $F(1, 48) = 9.14$, $p < .01$, $\eta^2 = .16$. Groups discussed a higher proportion of their information in the common-cue condition ($M = 0.55$, $SD = 0.26$) than in the unique-cue condition ($M = 0.37$, $SD = 0.12$).

In line with prior studies, the analyses also indicated a sampling advantage for shared information, as groups discussed higher proportions of their shared ($M = 0.63$, $SD = 0.21$) than of their unshared information ($M = 0.30$, $SD = 0.25$): information sharedness, $F(1, 48) = 249.87$, $p < .01$, $\eta^2 = .84$. At the group level, the sampling advantage for shared information held in the common-cue condition, $t(25) = 8.14$, $p < .01$, as well as in the unique-cue condition, $t(23) = 15.69$, $p < .01$. However, in line with the findings at the individual level, the sampling advantage was more pronounced in the unique than in the common-cue condition, which accounts for the significant interaction of cue commonality and information sharedness, $F(1, 48) = 9.15$, $p < .01$, $\eta^2 = .16$.

Predicting information exchange on the basis of the Information Sampling Model (ISM). How are the sampling advantage at the individual level and the sampling advantage at the group level related? Are the models described in Equations 1 and 3 capable of predicting the amount of shared information that is discussed by the groups?

Recall that the model described in Equation 1 assumes that the likelihood of individual group members discussing shared and unshared pieces of information is equal, whereas Equation 3 includes a parameter involving group members' tendencies for sampling information. These two models differ in how they predict the proportion of shared information that is discussed in a group, $p(\mathrm{D}_{\mathrm{shared}})$. The first model uses the proportion of unshared information mentioned by individual group members ($p(M_{\mathrm{unshared}})$), while the second model multiplies this measure by the s-coefficient, which is equivalent to using the proportion of shared information mentioned by individual group members ($p(M_{\mathrm{shared}})$). Table 4 shows the observed mean proportion of shared information items that were discussed ($p(D_{\mathrm{shared}})$) and the observed mean proportion of shared ($p(M_{\mathrm{shared}})$) and of unshared information items ($p(M_{\mathrm{unshared}})$) that were mentioned by the individual group members.

In Table 4 one sees that the accuracy of the two models depended on whether group members had access to unique or to common cues. This is consistent with the observation how the s-scores differed between these two conditions. In the common-cue condition—in which the s-score was 1 and in which the assumption $p(M_{shared}) = p(M_{unshared})$ therefore held—both models made identical predictions. They tended to slightly overestimate the amount of shared information discussed (by .07), a result also found by Stasser et al. (1989) and Schittekatte (1996). In the unique-cue condition, however, the first model that was based on $p(M_{unshared})$ underestimated the amount of shared information discussed (difference of .16), and the second model that was based on $p(M_{shared})$ predicted the proportion of shared information discussed by the groups almost perfectly (difference of .02).[3]

Predicted and observed group decisions. We assessed whether the groups discussed more evidence in favor of Candidate A than in favor of Candidate C and what group decisions would be expected if groups used an alternative-based or a cue-based decision strategy. We first computed a sum score for Candidates A and C by counting the number of positive and negative cues that were mentioned during each group discussion. Then, we subtracted Candidate A's scores from Candidate C's score (see Kelly & Karau, 1999). Using this procedure, a positive score indicates that the evidence discussed favored Candidate C (whose profile was hidden to the individual group members), whereas a negative score indicates that the cumulative evidence favored Candidate A (the alternative initially preferred by most). Note that this score should be positive if group members in the common-cue condition always brought to their group's attention that the common cues did not discriminate between candidates.

In line with the findings on the sampling advantage reported in Table 4, the sum scores were significantly more negative in the condition of unique cues ($M = -3.17$, $SD = 1.61$) than in the condition of common cues ($M = -1.15$, $SD = 2.41$), $t(48) = -3.44$, $p < .01$, which is in line with the observed differences in the sampling advantage. However, even in the common-cue condition, most of the groups

Table 4 Predictions of the Sampling Advantage for Shared Information: Observed and Predicted Proportions of Shared Information Items that were Exchanged in Groups ($p(\mathrm{D}_{shared})$)

	Cue commonality	
	Common cues	Unique cues
Observed $p(\mathrm{D}_{shared})$	.68	.57
Observed $p(M_{unshared})$	.37	.16
Observed $p(M_{shared})$	.37	.26
Predicted $p'(D_{shared})$ based on		
Classic model: $p(M_{unshared})$	.75	.41
Extended model: $p(M_{shared})$	.75	.59

Note: Observed $p(D_{shared})$ denotes the observed relative frequency of discussed shared information items, $p(M_{unshared})$ denotes the probability that an individual group member mentions an unshared information item, $p(M_{shared})$ denotes the probability that an individual group member mentions a shared information item, and p' (D_{shared}) denotes the predicted probability of $p(D_{shared})$ based on $p(M_{unshared})$ or $p(M_{shared})$.

displayed a sampling advantage for shared information due to the biased distribution of information and, thus, discussed more pieces of information in favor of Candidate A than in favor of Candidate C. As a consequence, in most groups there were at least some occasions when group members failed to bring to the group's attention that a common cue did not discriminate.

Table 5 shows that the groups in the common-cue condition detected hidden profiles more often than the groups in the unique-cue condition as expected. It provides an overview of the observed pre- and postdiscussion individual preferences and the observed group decisions. As previously mentioned, a substantial majority of group members initially favored Candidate A. There were only three groups in which a majority of two group members favored Candidate C prior to group discussion. As is indicated by the numbers in parentheses in Table 5, these three groups also decided in favor of Candidate C.[4]

What about the remaining groups? How often did the groups in which Candidate C was not already favored by a majority of group members chose this Candidate after group deliberation and, thus, detected a hidden profile? As Table 5 marks, in the unique-cue condition, none of these groups detected the hidden profile. Instead, the groups stuck to the initial preferences of their members throughout. Conversely, in the common-cue condition, 25% of the groups (6 out of 24) deviated from the prediscussion majority in favor of Candidate A, and 20% of the groups (5 out of 25) detected the hidden profile (in one group, two members favored Candidate B). Thus,

Table 5 Frequencies of Observed Pre- and Postdiscussion Individual Preferences and Group Decisions

Condition		Candidate			
Cue commonality	Cue knowledge	A	B	C	N
Prediscussion preferences					
Common cues	Complete list	31	3	5	39
Common cues	Incomplete list	34	1	4	39
Unique cues	Complete list	26	5	5	36
Unique cues	Incomplete list	31	0	5	36
Group decisions					
Common cues	Complete list	9	1	2 (1)	13
Common cues	Incomplete list	9	1	3	13
Unique cues	Complete list	11	0	0 (1)	12
Unique cues	Incomplete list	11	0	0 (1)	12
Postdiscussion preferences					
Common cues	Complete list	27	3	6 (3)	39
Common cues	Incomplete list	27	3	9	39
Unique cues	Complete list	31	2	0 (3)	36
Unique cues	Incomplete list	30	0	3 (3)	36

Note: Candidate C is the candidate whose profile is hidden (see Table 3). There were three groups in which a majority of two group members preferred Candidate C at the outset. The decisions of these three groups and the postdiscussion preferences of the respective group members are given in parentheses.

groups in the common-cue condition deviated more often from the prediscussion majority (Fisher's Exact Test $p < .01$) and detected the hidden profile more frequently than groups in the unique-cue condition (Fisher's Exact Test $p = .035$). This finding supports the detection hypothesis.

How well did the decision strategies predict group decisions? Overall, the alternative-based[5)] as well as the cue-based decision rules predicted group decisions quite well. Both strategies yielded predictions concerning how groups integrate the information discussed into a decision. While the alternative-based decision strategy correctly predicted the groups' accuracy in 88% of the 24 group decisions in the unique-cue condition, the rate with which hidden-profile detections were correctly predicted by this rule was somewhat smaller in the common-cue condition. In the latter condition, the alternative-based strategy correctly predicted group accuracy in 63% of 26 group decisions. The cue-based decision strategy achieved a rate of 83% in the unique and of 72% in the common-cue condition. Both decision rules yielded identical predictions in most cases by correctly predicting that groups will not detect hidden profiles. As a consequence, the hypothesis that group decisions in the unique-cue condition can be better described by an alternative-based decision strategy, whereas group decisions in the common-cue condition can be better described by a cue-based decision strategy, was not confirmed, $\chi^2 = .69$; $p = .41$.

Recall advantage for shared information. On average, group members recalled 70% of the relevant positive and negative cues that they received prior to discussion, and 52% of the information known by the group as a whole. Those in the common-cue condition not only discussed more information items, but they also recalled a higher percentage of their information ($M = 0.75$, $SD = 0.14$) than those in the unique-cue condition ($M = 0.64$, $SD = 0.07$); cue commonality, $F(1, 48) = 9.26$, $p < .01$, $\eta^2 = .16$. In addition, shared information showed an advantage in recall. Group members in both the unique-cue condition ($M_{\text{shared}} = 0.67$, $SD = 0.07$, $M_{\text{unshared}} = 0.56$, $SD = 0.13$) and the common-cue condition recalled a higher percentage of their shared than of their unshared information ($M_{\text{shared}} = 0.78$, $SD = 0.15$, $M_{\text{unshared}} = 0.66$, $SD = 0.18$); information sharedness, $F(1, 48) = 31.41$, $p < .01$, $\eta^2 = .40$; interaction between cue commonality and information sharedness, $F(1, 48) = 0.03$, $p = .87$, $\eta^2 < .01$. Adding the factor of cue knowledge to the analysis did not change these effects. The main effect for cue knowledge, $F(1, 46) = 1.76$, $p = .19$, $\eta^2 = .04$, as well as interactions including cue knowledge as a factor were not significant (Fs < 1.13, ps $> .29$, η^2s $< .03$).

There were 70 cases in which group members did not bring to the group's attention that a common cue does not discriminate among candidates. In these cases, information about Candidates A or B concerning a positive common cue or information on Candidates B or C concerning a negative common cue was discussed by the group, but it was not mentioned that Candidate C (positive cue) or Candidate A (negative cue) can be characterized by this cue also. Interestingly, these omissions were not primarily attributable to a lack of recall. In only 17% of the 70 cases did group members fail to recall that a positive cue pertained to Candidate C or that a negative cue pertained to Candidate A.

Observed and predicted postdiscussion individual preferences. The postdiscussion individual preferences also appear in Table 5. As is indicated by the frequencies in Table 5, the individual group members' postdiscussion preferences mirrored the decisions of the groups. Group members only rarely deviated from the decisions of their groups when asked for individual preferences.

Confidence ratings. Groups also indicated how confident they were that their decision was correct as did the individual members regarding their final private opinions. Similar to the analyses of the group discussions, we first averaged across the individual members' confidence ratings within each group and conducted the analyses on the basis of these pooled individuals. Analyses on the postdiscussion confidence ratings indicated that neither cue commonality nor cue knowledge had a systematic effect on group confidence ratings ($M = 6.30$, $SD = 2.17$; all $Fs < 1.30$, $\eta^2 = .02$). Likewise, neither of the two factors had a significant effect on the pooled individuals' postdiscussion confidence ratings ($M = 6.21$, $SD = 1.87$; all $Fs < 1$). Groups who did ($M = 6.50$, $SD = 1.60$) and who did not choose Candidate C ($M =$ 6.26, $SD = 2.27$) did not differ significantly in how confident they were about their choices, $t(48) = -0.28$, $p = .78$.

Consistent with the work by Stasser and Titus (1987), groups were more confident about their choices ($M = 6.30$, $SD = 2.17$) than the pooled individuals' prediscussion preferences indicated ($M = 4.82$, $SD = 1.30$), $t(49) = 6.05$, $p < .01$. Postdiscussion confidence ratings resembled group confidence ratings. The pooled individual postdiscussion confidence ratings ($M = 6.21$, $SD = 1.87$) did not differ systematically from the group confidence ratings, $t(49) = 0.71$, $p = .48$, but they did exceed the pooled individual prediscussion confidence ratings, $t(49) = -6.83$, $p < .01$.

Discussion

One issue that is often raised in the context of work groups, teams, and committees is the diversity of group members. Diversity in group membership can take shape in numerous ways, such as through demographic characteristics, personality, and differences in attitudes and ability. Group member differences in expertise and knowledge are often valued in such groups because it is assumed that this form of diversity will provide groups with the flexibility necessary to succeed at a task (Moreland, Levine, & Wingert, 1996). Particularly, groups should be better informed than any one group member alone. But do group members bring their relevant unique knowledge and expertise to the table? Do group members who vary in what they know utilize the potential of their group by sharing their task-relevant unique knowledge during group discussion? These types of questions instigated an important line of research in communication and group decision making that centers on information exchange during group discussion (Stasser & Titus, 1985; Wittenbaum et al., 2004).

Research involving the hidden-profile paradigm shows that the way the information relating to a problem is distributed among the group members—and, thus, group members' diversity in problem-related knowledge—can largely affect group discussions and decisions. The current study complements this literature by demonstrating how having access to unique or common cues influences information exchange, information recall, and group decisions (for research that compares various dimensions of diversity, see Henningsen & Henningsen, 2004).

Information Sampling

We observed a sampling advantage for shared information in the common, as well as unique-cue, conditions. However, in line with the sampling hypothesis, groups in the unique-cue condition showed a stronger sampling advantage for shared information than groups in the common-cue condition. Moreover, whereas the individual group members in the unique-cue condition accentuated this effect by mentioning higher proportions of their shared information than of their unshared information, no such tendencies emerged in the common-cue condition. Participants in the latter condition mentioned similar amounts of their shared and unshared information. Thus, groups, as well as the individual group members, showed a larger sampling advantage for shared information in the unique-cue condition than in the common-cue condition, which supports the sampling hypothesis.

As a consequence, the predictive accuracy of the ISM depended on cue commonality. In case of common cues, the *s* parameter turned out to be 1, and the model described in Equation 1 predicted the amount of shared information that was discussed in the groups well. Conversely, in the condition of unique cues, the *s* parameter was greater than 1. As a consequence, the model described in Equation 3 predicted the sampling advantage in the unique-cue condition better than the model described in Equation 1.

In addition, the common-cue environment facilitated group discussion—group members exchanged more pieces of information in this environment than in the unique-cue environment. One factor that affects the likelihood of mentioning a piece of information during discussion is whether or not an item can be recalled (Stasser & Titus, 1985; Stasser et al., 1989). Discussing a common cue about one candidate is likely to prompt group members to think about what else they know concerning this cue, namely, what they know with regard to the other candidates. In the common-cue condition, it is possible that when a group member mentions a cue, all of the relevant information pertaining to this cue will become more accessible to the group members (Fraidin, 2004). In line with this reasoning, group members in the common-cue condition not only discussed more information items, but they also remembered more information during the recall test.

The finding that cue commonality affected the number of pooled information items is interesting in itself. However, this finding might also pose questions about the observed differences in the sampling advantage: Can the differences in the sampling advantage for shared information be explained by differences in the participation rate (i.e., by differences in $p(M_{\text{unshared}})$)? It is obvious that there would not be any sampling advantage if group members exchanged all their information. Stasser and Titus (1987) have shown how differences in $p(M_{\text{unshared}})$ affect the expected sampling advantage on the group level. Recall that according to the ISM, the extent of the sampling advantage for shared information depends on group size, the ratio of shared and unshared information group members have access to, and the overall percentage of exchanged items (Stasser et al., 1989). Interestingly, Stasser and Titus (1987) have shown that the relationship between $p(M_{\text{unshared}})$ and the expected sampling advantage is nonlinear: The expected sampling advantage does not necessarily decrease when $p(M_{\text{unshared}})$ increases. We found a $p(M_{\text{unshared}})$ of .37 in the condition of common and a $p(M_{\text{unshared}})$ of .16 in the condition of unique cues. As can be seen in Table 4, for these two probabilities, the ISM would predict a greater sampling advantage for the condition of common than for the condition of unique cues. Whereas the predicted difference is .38 (.75 − .37) in the former condition, it is .25 (.41 − .16) in the latter condition.

Given the numbers of exchanged unshared information items we observed, the model described in Equation 1 predicted an even larger sampling advantage in the condition of common cues. However, we observed a stronger sampling advantage in the condition of unique cues, which cannot be explained by differences in the probabilities of $p(M_{\text{unshared}})$. Likewise, the observed differences between the common- and the unique-cue condition also did not seem to be attributable to the fact that members in the unique-cue condition have to process more information on novel cues than members in the common-cue condition. The variation of cue knowledge did not have any effect rendering the potential alternative hypothesis unlikely that the differences between the conditions of common and unique cues are due to differences in the number of cues. Rather, the current study indicates that the structure of the information environment in terms of cue commonality seems to be more important than the mere number of cues that are used.

Hidden-Profile Detections

In the present study, as expected, groups in the common-cue condition decided in favor of the hidden profile more frequently than groups in the unique-cue condition. However, even in the common-cue condition, not more than 20% of the groups in which a majority of group members favored an inferior alternative at the onset chose the hidden-profile alternative. Even though the common-cue environment was decisionmaker-friendly, in that groups had the opportunity to detect hidden profiles if they searched for cues that discriminated among alternatives, most groups failed at least once to become aware that a common cue did not discriminate. Interestingly, most of these failures did not seem to be due to lack of recall.

One reason for these deviations might be that the individual group members had already formed preferences at the outset and focused in the discussion on preference-congruent information (Gigone & Hastie, 1993, 1997). We observed that the members in the unique cue condition, but not in the common cue condition, sampled more of their preference-congruent shared than of their preference-incongruent unshared information items. However, it might be that members' preferences hindered members in the common-cue condition at times from mentioning that a common cue does not discriminate. In addition, members' preferences might have also affected how members interpreted the information that was discussed. In line with Greitemeyer and Schulz-Hardt (2003), it might be that group members had a tendency to pay more attention to items that were congruent with their preferences and to ignore preference-incongruent information items. It would be interesting to study whether discussions have a stronger effect on group decisions if group members do not enter discussions with preconceived opinions (e.g., Winquist & Larson, 1998). This could also yield more cases in which the alternative-based and the cue-based decision strategies make contradicting predictions.

Future Research Directions and Conclusion

An intriguing feature of the ISM is that it integrates various variables that may affect the likelihood that group members contribute an argument to a discussion or communicate their knowledge, and allows for inclusion of other variables. Future research might reveal whether motivated information exchange can be integrated into the ISM. Wittenbaum et al. (2004) note that the motivation to exchange information might affect the type of information that is exchanged. Specifically, in the information-sampling literature, group members are typically assumed to share a common goal, which might often not be the case. In contrast to this assumption, group members might at times be motivated to conceal information from their teammates. We agree that group members may not randomly sample information items from their knowledge base. However, the question of information sharing still remains: How do group members sample information and which information is discussed by the group? If we want to understand and make predictions about certain aspects of group discussions, the sampling approach to information sharing and the ISM provide a useful baseline. For example, whether motivated information processing enhances or diminishes the sampling advantage at the group level may depend on whether it enhances or diminishes the value of s. Stasser et al. (1989) have shown how Equation 1 can be adapted to a situation in which group members have different participation rates. Accordingly, group members might also have different s-scores and the ISM allows for modeling these differences. For example, it might be that a group consists of members who vary in expertise (e.g., Wittenbaum, 1998). Consistent with prior research on the effects of expertise on the sampling advantage, experts might have a lower s (in particular, an $s < 1$) than nonexperts (who might have an $s > 1$). By integrating this parameter into the ISM equation, predictability might be enhanced.

We agree with Wittenbaum et al. (2004) that it might be interesting to attempt to determine whether effects found in information structures with hidden profiles generalize across other environments (see Reimer & Hoffrage, 2005). By examining additional environmental factors, such as the structure of the information environment (e.g., Reimer & Katsikopoulos, 2004; Rieskamp & Reimer, in press), and by including the corresponding variables into current models, steps can be taken to increase predictability concerning the content of group discussion and in painting a more comprehensive picture of the role of information sharing in decision-making groups.

Notes

[1] Behaviors of the individual members of a group are typically not independent from each other. For this reason, unless stated differently, in all analyses at the level of the individual group members (e.g., on the postdiscussion confidence ratings, the individual contributions to group discussion, and on recall), we first averaged the respective scores across the members of a group and conducted the analyses using these group averages (pooled individuals).

[2] Participants in the common-cue condition had access to common as well as to unique cues (e.g., see the Example 2 in Table 1). Separate analyses for these two classes of data revealed that there was a preference-congruent sampling advantage for unique cues in the common-cue condition but no significant effects for common cues.

[3] Note that this is not trivial. Like the model described in Equation 1, the model described in Equation 3 is not saturated but can potentially fail to predict the proportion of shared information that is discussed by the group. For example, the model's predictions can deviate from the observed proportions of shared information when group members vary in participation rate (see Stasser et al., 1989).

[4] Excluding these three groups from the analyses on the sampling advantage does not change the major results.

[5] The alternative-based decision strategy predicts that a group will choose the hidden-profile alternative when the group discusses more positive (and less negative) cues in favor of the hidden-profile alternative than in favor of the other candidates. Ties were assumed to be resolved by a guessing procedure. A tie occurs when more than one candidate has the highest sum score. When all three candidates had identical sum scores, we assumed that the alternative-based decision strategy correctly predicted hidden-profile choices with .33 and correctly predicted non-hidden-profile choices with .66. In situations, in which Candidate C and either Candidate A or Candidate B had the highest sum score, we assumed that hidden-profile detections were correctly predicted with .50. Finally, when Candidate A and B had the highest sum score, the alternative-based strategy predicted that the group would not choose the hidden-profile alternative. The cue-based decision strategy we tested chooses a cue that has been discussed and that allows for an unequivocal decision by discriminating between alternatives (for other potential group strategies that can be used in this situation, see Reimer & Hoffrage, 2005, in press). Thereby, it is assumed that groups infer that cues do not pertain to candidates for whom cues were not discussed. For example, consider that a group mentions seven cues that favor Candidate A (without discussing these cues in regard to Candidates B or C) and four cues that favor Candidate C (without discussing these cues in regard to Candidates A and B). The cue-based decision strategy would predict that this group chooses the hidden-profile alternative with $p = 4/11$.

References

Brodbeck, F. C., Kerschreiter, R., Mojzisch, A., Frey, D., & Schulz-Hardt, S. (2002). The dissemination of critical, unshared information in decision-making groups: The effects of prediscussion dissent. *European Journal of Social Psychology*, *32*, 35–56.

Broeder, A. (2000). Assessing the empirical validity of the "Take the Best" heuristic as a model of human probabilistic inference. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *26*, 1332–1346.

Burke, S. J. (1990). The effects of missing information on decision strategy selection. *Advances in Consumer Research*, *17*, 250–256.

Burke, S. J. (1995). The dimensional effects of missing information on choice processing. *Journal of Behavioral Decision Making*, *8*, 223–244.

Burnstein, E., & Vinokur, A. (1977). Persuasive argumentation and social comparison as determinants of attitude polarization. *Journal of Experimental Social Psychology*, *13*, 315–332.

Davis, J. H. (1969). *Group performance*. Reading, MA: Addison-Wesley.

Davis, J. H. (1982). Social interaction as a combinatorial process in group decisions. In H. Brandstätter, J. H. Davis, & G. Stocker-Kreichgauer (Eds.), *Group decision making* (pp. 27–58). London: Academic Press.

Dennis, A. R. (1996). Information exchange and use in small group decision making. *Small Group Research*, *27*, 532–550.

Fiedler, K., & Juslin, P. (Eds.). (2006). *Information sampling and adaptive cognition*. Cambridge, UK: Cambridge University Press.

Fisher, B. A. (1980). *Small group decision making: Communication and the group process* (2nd ed.). New York: McGraw-Hill.

Fraidin, S. N. (2004). When is one head better than two? Interdependent information in group decision making. *Organizational Behavior and Human Decision Processes*, *93*, 102–113.

Gigerenzer, G., Todd, P. M., & the ABC Research Group. (1999). *Simple heuristics that make us smart*. New York: Oxford University Press.

Gigone, D., & Hastie, R. (1993). The common knowledge effect: Information sampling and group judgment. *Journal of Personality and Social Psychology*, *65*, 959–974.

Gigone, D., & Hastie, R. (1997). The impact of information on small group choice. *Journal of Personality and Social Psychology*, *72*, 132–140.

Greitemeyer, T., & Schulz-Hardt, S. (2003). Preference-consistent evaluation of information in the hidden profile paradigm: Beyond group-level explanations for the dominance of shared information in group decisions. *Journal of Personality and Social Psychology*, *84*, 322–339.

Hastie, R., Penrod, S. D., & Pennington, N. (1983). *Inside the jury*. Cambridge, MA: Harvard University Press.

Henningsen, D. D., & Henningsen, M. L. M. (2004). The effect of individual difference variables on information sharing in decision-making groups. *Human Communication Research*, *30*, 540–555.

Hinsz, V. B., Tindale, R. S., & Vollrath, D. A. (1997). The emerging conceptualization of groups as information processors. *Psychological Bulletin*, *121*, 43–64.

Hirokawa, R. Y., & Poole, M. S. (Eds.). (1996). *Communication and group decision making* (2nd ed.). Thousand Oaks, CA: Sage.

Hollingshead, A. B. (1996). The rank-order effect in group decision making. *Organizational Behavior and Human Decision Processes*, *68*, 181–193.

Johnson, E. J., Payne, J. W., & Bettman, J. R. (1988). Information displays and preference reversals. *Organizational Behavior and Human Decision Processes*, *42*, 1–21.

Kelly, J. R., & Karau, S. J. (1999). Group decision making: The effects of initial preferences and time pressure. *Personality and Social Psychology Bulletin*, *25*, 1342–1354.

Kelly, J. R., & Loving, T. J. (2004). Time pressure and group performance: Exploring underlying processes in the Attentional Focus Model. *Journal of Experimental Social Psychology*, *40*, 185–198.

Kerr, N., & Tindale, R. S. (2004). Group performance and decision making. *Annual Review of Psychology*, *55*, 623–655.

Kerschreiter, R., Mojzisch, A., Schulz-Hardt, S., Brodbeck, F. C., & Frey, D. (2003). Informationsaustausch bei Entscheidungsprozessen in Gruppen: Theorie, Empirie und Implikationen für die Praxis. In S. Stumpf & A. Thomas (Eds.), *Teamarbeit und Teamentwicklung* (pp. 85–118). Göttingen, Germany: Hogrefe.

Larson, J. R., & Christensen, C. (1993). Groups as problem-solving units: Toward a new meaning of social cognition. *British Journal of Social Psychology*, *32*, 5–30.

Larson, J. R., Foster-Fishman, P. G., & Keys, C. B. (1994). Discussion of shared and unshared information in decision-making groups. *Journal of Personality and Social Psychology*, *67*, 446–461.

Lorge, I., & Solomon, H. (1955). Two models of group behavior in the solution of eureka-type problems. *Psychometrika*, *20*, 139–148.

Monge, P. R., McSween, C., & Wyer, J. A. (1989). *A profile of meetings in corporate America: Results of the 3M meeting effectiveness study*. Los Angeles: Annenberg School of Communication, University of Southern California.

Moreland, R. L., Levine, J. M., & Wingert, M. L. (1996). Creating the ideal group: Composition effects at work. In E. H. Witte & J. H. Davis (Eds.), *Understanding group behavior: Small group processes and interpersonal relations* (Vol. 2, pp. 11–35). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Payne, J. W., Bettman, J. R., & Johnson, E. J. (1988). Adaptive strategy selection in decision making. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *14*, 534–552.

Reimer, T. (1999). *Argumentieren und Problemlösen [Arguing and problem solving]*. Lengerich, Germany: Pabst Science Publishers.

Reimer, T., & Hoffrage, U. (2005). Can simple group heuristics detect hidden profiles in randomly generated environments? *Swiss Journal of Psychology*, *64*, 21–37.

Reimer, T., & Hoffrage, U. (2006). The ecological rationality of simple group heuristics: Effects of group member strategies on decision accuracy. *Theory and Decision*, *60*, 403–438.

Reimer, T., & Hoffrage, U. (in press). Combining simple heuristics by a majority rule: The ecological rationality of simple heuristics in a group context. In P. M. Todd, G. Gigerenzer, & the ABC Research Group (Eds.), *Ecological rationality: Intelligence in the world*. New York: Oxford University Press.

Reimer, T., Hoffrage, U., & Katsikopoulos, K. (in press). Entscheidungsheuristiken in Gruppen [Heuristics in group decision-making]. *NeuroPsychoEconomics*.

Reimer, T., & Katsikopoulos, K. (2004). The use of recognition in group decision-making. *Cognitive Science*, *28*, 1009–1029.

Rieskamp, J., & Hoffrage, U. (1999). When do people use simple heuristics, and how can we tell? In G. Gigerenzer, P. M. Todd, & the ABC Research Group (Eds.), *Simple heuristics that make us smart* (pp. 141–167). New York: Oxford University Press.

Rieskamp, J., & Reimer, T. (in press). Ecological rationality. In R. F. Baumeister & K. D. Vohs (Eds.), *Encyclopedia of social psychology*. Thousand Oaks, CA: Sage.

Romano, N. C., Jr., & Nunamaker, J. F., Jr. (2001). Meeting analysis: Findings from research and practice. In *Proceedings of the 34th Hawaii International Conference on System Sciences* (CD-Rom), January 3–6, 2001, Computer Society Press, 2001 (396 pages).

Schittekatte, M. (1996). Facilitating information exchange in small decision-making groups. *European Journal of Social Psychology*, *26*, 537–556.

Schulz-Hardt, S., Frey, D., Lüthgens, C., & Moscovici, S. (2000). Biased information search in group decision making. *Journal of Personality and Social Psychology*, *78*, 655–669.

Stasser, G., & Birchmeier, Z. (2003). Group creativity and collective choice. In P. B. Paulus & B. A. Nijstad (Eds.), *Group creativity* (pp. 85–109). New York: Oxford University Press.

Stasser, G., Taylor, L. A., & Hanna, C. (1989). Information sampling in structured and unstructured discussions of three- and six-person groups. *Journal of Personality and Social Psychology*, *57*, 67–78.

Stasser, G., & Titus, W. (1985). Pooling of unshared information in group decision making: Biased information sampling during discussion. *Journal of Personality and Social Psychology*, *48*, 1467–1478.

Stasser, G., & Titus, W. (1987). Effects of information load and percentage of common information on the dissemination of unique information during group discussion. *Journal of Personality and Social Psychology*, *53*, 81–93.

Vinokur, A., & Burnstein, E. (1978). Novel argumentation and attitude change: The case of polarization following group discussion. *European Journal of Social Psychology*, *8*, 335–348.

Vroom, V. H. (1969). Industrial social psychology. In G. Lindzey & E. Aronson (Eds.), *Handbook of social psychology* (Vol. 5, pp. 196–268). Reading, MA: Addison-Wesley.

Winquist, J. R., & Larson, J. R. (1998). Information pooling: When it impacts group decision making. *Journal of Personality and Social Psychology*, *74*, 371–377.

Wittenbaum, G. M. (1998). Information sampling in decision-making groups: The impact of members' task-relevant status. *Small Group Research*, *29*, 57–84.

Wittenbaum, G. M., Hollingshead, A. B., & Botero, I. C. (2004). From cooperative to motivated information sharing in groups: Moving beyond the hidden profile paradigm. *Communication Monographs*, *71*, 286–310.

Wittenbaum, G. M., & Park, E. S. (2001). The collective preference for shared information. *Current Directions in Psychological Science*, *10*, 70–73.

Wittenbaum, G. M., & Stasser, G. (1996). Management of information in small groups. In J. L. Nye & A. B. Brower (Eds.), *What's social about social cognition?* (pp. 3–28). London: Sage.