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Twenty-Five Years of Hidden Profiles in Group Decision Making: A Meta-Analysis

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Abstract

This meta-analysis summarized findings from 65 studies using the hidden profile paradigm (101 independent effects, 3,189 groups). Results showed (a) groups mentioned two standard deviations more pieces of common information than unique information; (b) hidden profile groups were eight times less likely to find the solution than were groups having full information; (c) two measures of information pooling, including the percentage of unique information mentioned out of total available information (the *information coverage* measure) and the percentage of unique information out of total discussion (the *discussion focus* measure), were positively related to decision quality, but the effect of information coverage was stronger than that of discussion focus; and communication medium did not affect (d) unique information pooling or (e) group decision quality. Group size, total information load, the proportion of unique information, task demonstrability, and hidden profile strength were found to moderate these effects. Results are discussed in terms of how they offer conceptual advancement for future hidden profile research.

Keywords

hidden profile, information sharing, meta-analysis, group decision making

With the publication of their 1985 article, Stasser and Titus introduced the hidden profile paradigm, which opened one of the most fruitful avenues of research on group decision making today. The startling implication of their study—that group discussion is a poor means of exchanging new information—spawned dozens of studies that have reproduced their findings and have sought explanations and solutions to the problem. A number of conceptual articles have been published, discussing how the hidden profile paradigm can inform research on creativity (Stasser & Birchmeier, 2003), decision making (e.g., Brodbeck, Kerschreiter, Mojzisch, & Schulz-Hardt, 2007), and transactive memory systems (Yuan & McLeod, 2009). Qualitative reviews have provided historical (Stasser & Titus, 2003) and critical (Wittenbaum, Hollingshead, & Botero, 2004) perspectives on the contributions of this experimental paradigm to knowledge about small group decision making. Two recent meta-analyses of the more general information sharing paradigm have provided quantitative reviews that include the moderation effect of hidden profiles on information exchange (Mesmer-Magnus & DeChurch, 2009; Reimer, Reimer, & Czienskowski, 2010). The current article, focused exclusively on the hidden profile paradigm, complements these previous meta-analyses by examining the main effects associated with hidden profile studies and exploring the moderators of those effects.

We were guided by Wittenbaum et al.'s (2004) use of the input-process-output model of group decision making in developing the coding categories for effect sizes and moderator variables examined in this meta-analysis. Our adaptation of that model adds to the literature by examining the direct effect of input on output (see Figure 1). Effect Size 1 quantifies the differential in the pooling of unique and common information (i.e., *process*), Effect Size 2 examines the detriment in performance associated with hidden profiles (i.e., *output*), Effect Size 3 assesses the impact of discussing unique information on group decision quality (i.e., *the linkage between process and output*), Effect Size 4 examines the direct effect of communication technology on unique information pooling, (i.e., *the effect of input on process*), and Effect Size 5 investigates how communication technology influences group decision quality (i.e., *the direct effect of input on output*).

Our examination of the whole input-process-output chain also extends the previous meta-analyses, each of which focused on only a part of this model. Specifically, Mesmer-Magnus and DeChurch (2009) examined the effects of information sharing on decision quality, cohesion, and group

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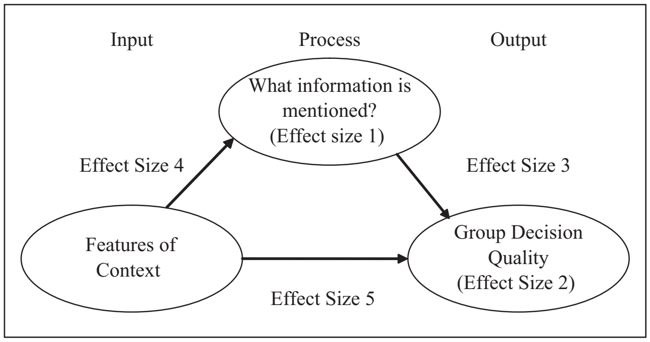

Figure 1. Framework for understanding information sharing in groups solving hidden profiles (partially adapted from Wittenbaum, Hollingshead, & Botero, 2004)
Effect size 1: Difference between common and unique information mentioned during group discussion.
Effect Size 2: The impact of manifest versus hidden profile tasks on decision quality.
Effect Size 3: The effect of pooling unique information on group decision quality.
Effect Size 4: The effect of communication technology on information pooling.
Effect Size 5: The effect of communication technology on decision quality.

member satisfaction (i.e., process – output) and included hidden versus nonhidden profile tasks as a moderator variable. Reimer, Reimer, and Czienskowski (2010) focused on bias in information sampling (i.e., input – process) and also considered hidden versus nonhidden profile as a moderator variable. Our analysis offers further extensions by examining main effects and moderator variables not considered in either of the previous publications, for instance, the impact of communication technology and hidden profile strength on information pooling and decision making.

In the following section we present a brief overview of the theoretical principles that have guided the design of the hidden profile paradigm (e.g., pooling of unique information in discussion and its impact on decision making) and the corresponding effect sizes that form the cornerstones of the paradigm. We then present rationales for the specific effect sizes and moderator variables we examine.

The Hidden Profile Paradigm

The hidden profile paradigm describes a biased pattern of information distribution in which some information, prior to group discussion, is shared by all group members and some is unique to individual members (Stasser & Titus, 1985); the common information favors a suboptimal decision alternative, whereas all the unique information combined reveals the optimal alternative, and thus the optimal decision choice is hidden to the group as a whole and can be discovered only when all individuals share their unique information and the group applies the information to the decision under consideration. Stasser and Titus (1985, 2003) developed this paradigm as a research tool to test normative and informational influence in group decision making (Deutsch & Gerard, 1955). The persuasive arguments theory of influence (Burnstein & Vinokur, 1977) proposes that novel arguments are more influential than familiar ones. Following this logic, Stasser and Titus (1985) predicted that group members should be more interested in hearing novel information contributed by the other members, should be more persuaded by that information, and therefore should readily discover the hidden profile as the members seek to hear previously unknown information from each other. Instead, however, hidden profile groups mostly failed to discover the optimal decision, and the uniquely held information was hardly mentioned. Numerous follow-up studies, discussed in the already mentioned reviews (Brodbeck et al., 2007; Mesmer-Magnus & DeChurch, 2009; Reimer, Reimer, & Czienskowski, 2010; Stasser & Titus, 2003; Wittenbaum et al., 2004), replicated this initial discovery and examined factors that affect information pooling and group decision quality. Because of the unanswered questions involving the paradigm, the current meta-analysis therefore aims to offer additional insights on the impact of this paradigm on group decision making.

Effect Size 1: Difference Between Common and Unique Information Mentioned During Group Discussion

Because uniquely held information is the key to solving hidden profile tasks, the effectiveness of group discussion in pooling unique information becomes a critical effect size to understand the hidden profile paradigm. Previous studies have consistently found that group members discuss disproportionately more common than unique information (e.g., Henningsen, Henningsen, Jakobsen, & Borton, 2004; Schittekatte & van Hiel, 1996; Stasser & Titus, 2003; Wittenbaum et al., 2004). Although some research has identified factors that reduce this differential (e.g., Reimer, Kuendig, Hoffrage, Park, & Hinsz, 2007; Reimer, Reimer, & Hinsz, 2010), most studies find that a differential nevertheless remains. For example, Stasser, Stewart, and Wittenbaum (1995) found that designating group members to be experts in some domain of the information reduced, but did not eliminate, the advantage of common over unique information. Furthermore, Larson, Christensen, Franz, and Abbott (1998) found that team leaders could increase the amount of unique information shared, but the teams still generally discussed more common than unique information.

The predominance of common over unique information can be attributed to three factors (Wittenbaum et al., 2004). First, the probability of any piece of information being mentioned in discussion is directly related to the number of people who have access to that information (Gigone & Hastie, 1993; Stasser, Taylor, & Hanna, 1989), and because more people have access to common information, it has an inherent advantage of being pooled more frequently. Second, people tend to mention information that is consistent with

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their prediscussion preferences (Gigone & Hastie, 1993; Mojzisch, Grouneva, & Schulz-Hardt, 2010). In typical hidden profile tasks, individual members' prediscussion preferences are in line with the common information. Third, consistent with social comparison theory (Festinger, 1954), people judge the importance and accuracy of their information based on others' evaluations (Postmes, Spears, & Cihangir, 2001). Information that is also familiar to other group members will tend to be socially validated, and mutual enhancement will lead group members to be more likely to mention and repeat shared information (Larson, Foster-Fishman, & Keys, 1994; Mojzisch et al., 2010; Stewart & Staser, 1995).

In their meta-analysis of information exchange, Reimer, Reimer, & Czienskowski. (2010) reported that the differential between common and unique information was only about half the value that would be predicted by the probability sampling argument (see Stasser, 1992). Furthermore, they found that the differential was even smaller for hidden-profile than for non-hidden-profile tasks (i.e., tasks with equally attractive alternatives), and they suggested that hidden profiles therefore may actually attenuate the bias toward discussing common information. Their work, however, did not examine decision quality, which we discuss later with respect to Effect Size 3—whether this bias affects task performance. Moreover, the current analysis extends Reimer et al.'s findings by quantifying the discussion bias specifically for hidden profiles.

One challenge we encountered in meta-analyzing the differential between pooling common and unique information was the significant heterogeneity across studies in the operationalizations of information pooling. In our view, these operational variations point to fundamental differences in the conceptualization of information pooling that have not yet been systematically addressed in the hidden profile literature. The operationalizations can be classified into two distinct categories. The first, *information coverage,* focuses on how much of the available unique (or common) information is mentioned during group discussion. Information coverage is typically a ratio of the unique (or common) information mentioned during discussion out of the total pieces of unique (or common) information available in the experiment (e.g., Larson, Christensen, Abbott, & Franz, 1996). The second category, *focus of discussion*, was first identified by Stasser and Stewart (1992) and represents how much of a group's discussion is spent on unique (or common) information. This measure is a ratio of the amount of unique (or common) information mentioned during group discussion out of the total amount of actual discussion. The operational distinction between information coverage and focus of discussion is based primarily on the differences between the denominators of these two measures. At the same time, both numerators and denominators also vary between counting the *pieces* of items mentioned (excluding repetition) and counting the *times* the items are mentioned (including repetition).

To illustrate the operational differences between the information coverage and discussion focus measures of pooling, consider a hidden profile task containing 15 pieces of information, of which, prior to discussion, 6 pieces are distributed as unique information to individual group members and the remaining 9 pieces are common to all group members. Suppose that one group mentions 36 total pieces of information of all types—counted as first mentions plus repetitions—and this group mentions all 6 of the pieces of unique information once. This group's coverage of unique information is 1.0 (6 / 6 = 1.0), and its discussion focus is 0.17 (6 / 36 = 0.17). We found that taking into account the variations between counting pieces of information (excluding repetition) versus the number of mentions (including repetition) along with the differences in the denominators yielded too few studies within each resulting combination to allow for meaningful meta-analysis. Accordingly, the comparisons between information pooling measures reported in the current article were limited to the broad conceptual distinctions defined by the denominators.

As far as we are aware no studies have directly compared information coverage and discussion focus. Stasser and Stewart (1992), for example, did compare discussion focus to the total number of times that unique information was mentioned, but the number of total information *mentions* is not the same as the *proportion* of the available information that was covered in the discussion. The current meta-analysis thus contributes to the largely unexplored question of the relative sizes of the effects associated with how much of the available information is pooled versus how much attention is paid to information once it is pooled.

Effect Size 2: The Impact of Manifest Versus Hidden Profile Groups on Decision Quality

A consistent finding is that decision quality is poorer in groups facing a hidden profile than a manifest profile (i.e., an information distribution pattern in which all group members have access to the full set of information; Greitemeyer & Schulz-Hardt, 2003; Lavery, Franz, Winquist, & Larson, 1999), but exactly how much worse groups with hidden profiles perform has generally not been quantified. The Mesmer-Magnus and DeChurch (2009) meta-analysis found that pooling of unique information more strongly predicts decision quality for hidden-profile than for non-hidden-profile tasks (Effect Size 3 in our study), but they did not directly examine the difference in performance between hidden-profile and non-hidden-profile groups (Effect Size 2 in our study). A direct analysis of differences in performance between hidden profile and manifest profiles, and of the factors that may moderate those differences, can produce new understanding of the impacts of hidden profile information distributions on group performance.

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Effect Size 3: The Effect of Pooling Unique Information on Decision Quality

A core assumption underlying the hidden profile paradigm is that pooling unique information is key to task performance and therefore should be positively related to decision quality (Wittenbaum et al., 2004). Empirical support for this fundamental proposition across individual studies has been mixed, however. For example, Larson et al. (1998), Stewart, Billings, and Stasser (1998), and Winquist and Larson (1998) found a positive relationship between pooling unique information and task performance quality, whereas Greitemeyer, Schulz-Hardt, Brodbeck, and Frey (2006) found no relationship. The Mesmer-Magnus and DeChurch (2009) meta-analysis nevertheless found that across studies, pooling unique information significantly predicts decision quality overall.

Initially, we speculated whether the different ways of operationalizing information pooling discussed in the previous section (i.e., information coverage vs. discussion focus) could help to account for these disparities. But the evidence from the few studies that contain these two types of measures does not paint a very clear picture. Stasser and Stewart (1992) reported that *focus* on unique information (percentage of unique information out of actual group discussion) significantly predicted decision quality, whereas the sheer number of times that unique information was mentioned did not correlate with decision quality. Furthermore, they reported that the "total number of facts" (p. 431) mentioned of all types correlated negatively with decision quality. They did not examine, however, the relationship between decision quality and the proportion of the available unique information mentioned (information coverage). Stewart and Stasser (1998) and Stewart et al. (1998) similarly found that focus on unique information predicted decision quality and that total information mentioned correlated negatively with quality. Stewart and Stasser introduced an additional focus measure (labeled sampling focus) in which they divided the number of unique items mentioned at least once by the total of all information mentioned at least once (i.e., eliminating repetitions) and found this sampling focus measure was more strongly correlated with decision quality than was the previous focus measure. These two studies also did not report the relationship between decision quality and the information coverage measure of pooling.

It is important that the three studies reviewed above used the same murder mystery task, and we cannot exclude the possibility that their discrepancy may be task dependent. We therefore also speculated that differences in task type could provide an additional explanation for the discrepancies in findings involving the role of pooling unique information in discovering hidden profiles. We hope to clarify some of the discrepancies with the current analysis by examining how task type moderates the effect of information pooling on decision quality for the two different pooling measures.

Effect Sizes 4 and 5: Effects of Communication Technology on Unique Information Pooling and on Decision Quality

One of the most frequently explored contextual input factors in the hidden profile literature has been communication technology (Wittenbaum et al., 2004). Researchers have suggested that group communication and decision support systems should help groups solve hidden profiles because these technologies can increase information available to group members and improve the structuring of discussion processes (e.g., Dennis, 1996a, 1996b; Huang, Raman, & Wei, 1993; McLeod, Baron, Marti, & Yoon, 1997). Empirical tests of this argument, however, have produced mixed results. For instance, Hollingshead (1996a, 1996b) found that both information sharing and decision quality were generally poorer in groups supported by computer-mediated communication (CMC) than in groups communicating face-to-face (FtF). Other studies have found that although technology increased pooling of both common and unique information, these improvements in information pooling either did not affect decision quality or resulted in worse decision quality (e.g., Campbell & Stasser, 2006; Dennis, 1996a, 1996b; McLeod et al., 1997; Mennecke & Valacich, 1998). Lam and Schaubroeck (2000) found that hidden profile groups using group decision support systems pooled more unique information and outperformed FtF groups only when the information distribution led to differences between members in their prediscussion decision preferences; otherwise technology had no effect. Therefore, one objective of the current meta-analysis is to explore the overall difference between CMC and FtF conditions, and associated moderator effects across multiple studies.

Potential Moderator Variables

Guided by previously published reviews of hidden profile and information sharing literature and our own review of existing literature, we identified five variables for which sufficient data were available to test potential moderation effects: group size, total information load, the percentage of unique information out of total information available, task type, and hidden profile strength. Among these moderator variables, group size, total information load, and the percentage of unique information out of total information available are factors that may influence each individual team member's information load and hence his or her capability of bringing up unique information (e.g., Stasser & Stewart, 1992). Task type and hidden profile strength are included because they have been shown to influence motivation and

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process of information pooling (e.g., Hollingshead, 1996b; Kelly & Karau, 1999).

Group Size

The empirical results for the effects of group size on the predominance of common over unique information (Effect Size 1) and on the relationship between pooling unique information and decision quality (Effect Size 3) have been mixed (Wittenbaum et al., 2004). Some studies have found that larger groups pool more unique information than do smaller groups (e.g., Stasser & Stewart, 1992), some have found higher pooling of unique information in smaller groups (Cruz, Boster, & Rodriguez, 1997; Stasser et al., 1989), and others have found group size makes no difference in information pooling or decision quality (e.g., Mennecke, 1997).

Previous studies have presented conceptual disagreements about the predicted impact of group size on the likelihood of discovering hidden profiles. On one hand, the biased sampling model (Stasser et al., 1989) predicts that the gap between the probability of mentioning common information and the probability of mentioning unique information increases with group size, for two reasons. First, as group size increases more people can bring up the same piece of information, which increases the probability of mentioning common information. Second, social loafing is more likely in large groups, and thus as group size increases, individual members are less likely to bring up their unique information (Boster, Hale, & Mongeau, 1990). To the extent that pooling unique information is related to decision quality, then this line of reasoning would predict that decision quality would decrease with group size. On the other hand, as group size increases, the average information load as well as the general cognitive load on each individual member decrease (Hinsz, Tindale, & Vollrath, 1997). With less information to remember and lower interference with cognitive processing, the probability of remembering and processing unique information may increase. This line of reasoning predicts that large groups have a better chance of solving hidden profiles than do small groups. The results of the Reimer, Reimer, & Czienskowski (2010) meta-analysis showed a larger sampling advantage of common information for groups with four or more members than for groups with three members. Although these results appear in their data tables, no explicit theoretical or methodological discussion of group size appears in the article. Here we build on their findings by examining group size as a continuous variable.

Research is limited on how group size moderates the difference between hidden versus manifest profile quality (Effect Size 2) and the effects of technology on information pooling (Effect Size 4) and on decision quality (Effect Size 5). We nevertheless believe that examining moderators of these effects will provide fruitful direction for future research. Hence, the following question is explored:

Research Question 1: Does group size moderate (a) the difference between the number of pieces of common and of unique information mentioned in group discussion, (b) the detriment in performance between hidden profile groups and manifest groups, (c) the effect of pooling unique information on group decision quality, (d) the difference in pooling unique information between CMC groups and FtF groups, and (e) the difference in performance between CMC groups and FtF groups?

Total Information Load

We extend the previous meta-analyses by adding data on the impact of two factors related to cognitive load—total information load and the proportion of unique information. Total information load involves the total pieces of information contained in the task. As suggested earlier, because the amount of information is related to the cognitive load on group members (Hinsz et al., 1997), the likelihood of each group member recalling information correctly should vary directly with the total amount of information. Stasser and Titus (1987) also demonstrated that the tendency to repeat common information (Effect Size 1) decreases as the total amount of information available to decision makers decreases. Consequently, groups would be expected to make better decisions as information load decreases because they are more likely to discuss unique information (Effect Size 2). With respect to information load's influence on the effect of technology, as already noted, technology can sometimes help groups to pool more information (Effect Size 4) but does not generally lead to better quality decisions (Effect Size 5). Therefore, to the extent that technology may interfere with a group's ability to process information once it has been pooled (McLeod et al., 1997), increasing information load might worsen this problem. This meta-analysis aims to shed light on these conflicting results by addressing the following research question:

Research Question 2: Does total information load moderate (a) the difference between the number of pieces of common and unique information mentioned in group discussion, (b) the detriment in performance between hidden profile groups and manifest groups, (c) the effect of pooling unique information on group decision quality, (d) the difference in pooling unique information between CMC groups and FtF groups, and (e) the difference in performance between CMC groups and FtF groups?

The Percentage of Unique Information Out of Total Information Available

The literature has reported equivocal effects of the proportion of unique information on decision quality. Stasser and Titus (1987) found that as the proportion of unique information held prior to discussion increased, the tendency to

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mention common information decreased (Effect Size 1). Their explanation was that a high proportion of unique information may have created dissent among members at the start of group discussion, which in turn may have triggered pooling of unique information. Cruz and his colleagues (1997) found, on the other hand, that increasing the proportion of unique information decreased the likelihood that groups discover hidden profiles (Effect Size 3). They reasoned that as the ratio of unique to common information increases, the dispersion of information also increases, thus raising the baseline difficulty of solving the hidden profile. The meta-analysis sheds light on these conflicting findings by addressing the following research question.

> *Research Question 3:* Does the ratio of unique information out of total information moderate (a) the difference between the number of pieces of common and unique information mentioned in group discussion, (b) the detriment in performance between hidden profile groups and manifest groups, (c) the effect of pooling unique information on group decision quality, (d) the difference in pooling unique information between CMC groups and FtF groups, and (e) the difference in performance between CMC groups and FtF groups?

Task Type

It has been long recognized in small group research that task type affects group decision making (e.g., Hollingshead, 1996b; Kaplan & Miller, 1987; Laughlin, 1980). The commonly used hidden profile tasks vary in a number of characteristics, particularly the demonstrability of the correct response (Laughlin & Ellis, 1986; Mesmer-Magnus & DeChurch, 2009). In the current analysis, we compare hidden profile tasks with high versus low solution demonstrability. We define *high demonstrability* as a solution that is derived through a logical or mathematical calculation such that the full set of information reveals an unequivocal correct answer. The classic example of this type of task is the murder mystery task developed by Stasser and Stewart (1992), in which the full set of information provides evidence to rule out definitively two out of three crime suspects. We define *low demonstrability* as a task whose solution is determined by judgments about the valence and importance of the individual pieces of information about each decision alternative. An example is the student body president election task (e.g., Stasser & Titus, 1987), in which the best choice is the one with the highest net positive attributes. These kinds of tasks are less demonstrable because even if the full set of attributes for each candidate were known, there could still be variance in the subjective judgments about the value of particular pieces of information. Although it has been shown that information pooling and task performance are affected by group members' assumptions about whether or not there exists a clear right answer (Stasser & Stewart, 1992; Stewart & Stasser, 1998), our analysis here focuses on the independent effects exerted by the structure inherent to each task.

Hidden profile studies have found that when groups work on a high demonstrability task, they pool information (Effect Size 1), particularly unique information, more thoroughly than when they work on low demonstrability tasks (Botero & Wittenbaum, 2002; Campbell & Stasser, 2006; Stasser & Stewart, 1992; Stewart & Stasser, 1998). Moreover, information sharing predicts group decision quality for intellective tasks more strongly than for judgment tasks (Mesmer-Magnus & DeChurch, 2009). The explanation for these effects is that to the extent that group members define their task as one of finding the correct solution, they should be motivated to collect necessary information and arguments to defend their choice. If, however, they see the task as finding the most preferred solution, their decision-making process will be governed by the desire to reach consensus and thus will be likely to invoke normative influence processes (Kaplan & Miller, 1987). The current meta-analysis seeks to quantify the effects of task type on information pooling, to replicate the Mesmer-Magnus and DeChurch (2009) finding on the moderating effect of task type on the relationship between information pooling and decision quality, and to explore the moderating effect of task type on other effect sizes. The next research question focuses on the moderation effect of task type.

> *Research Question 4:* Does task type moderate (a) the difference between the number of pieces of common and unique information mentioned in group discussion, (b) the detriment in performance between hidden profile groups and manifest groups, (c) the effect of pooling unique information on group decision quality, (d) the difference in pooling unique information between CMC groups and FtF groups, and (e) the difference in performance between CMC groups and FtF groups?

Hidden Profile Strength

We define this moderator as how strongly the prediscussion information distribution leads the group away from the correct decision alternative. Kelly and Karau (1999) operationalized this factor as how strongly individual group members preferred a suboptimal alternative prior to discussion, but far more frequently this factor has been operationalized as the degree of dissent among individual members' prediscussion preferences. In particular, a strong hidden profile refers to those tasks where all group members prefer the *same* suboptimal choice before group discussion and a weak hidden profile refers to those tasks where group members favor different choices before group discussion.

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Schulz-Hardt, Brodbeck, Mojzisch, Kerschreiter, and Frey (2006), for example, found that a weak hidden profile—operationalized as prediscussion dissent—led both to more information pooling and to better decision quality, as compared to a strong hidden profile. Similarly, Brodbeck, Kerschreiter, Mojzisch, Frey, and Schulz-Hardt (2002) reported that a weak hidden profile was associated with greater consideration of unique information as well as higher decision quality. According to Schulz-Hardt et al. (2006), two underlying reasons explain this finding. First, based on social decision scheme theory (Davis, 1973) and the common knowledge effect (Gigone & Hastie, 1993, 1997), group members' prediscussion preferences serve as the bases for group discussion. So making premature decisions based on the prediscussion preferences precludes a comprehensive discussion of all available information. The second reason is that only dissent can motivate group members to retrieve their unique information and can promote an intensive discussion on all available information. Take minority influence studies (e.g., Brodbeck et al., 2002; McLeod et al., 1997) as an example. Minority dissent has been found to provoke majority members to self-check their own positions, which assists groups to evaluate all available information, including that contradictory to their own prediscussion preference. Taken all together, we examine the following research question:

Research Question 5: Does hidden profile strength moderate (a) the difference between the number of pieces of common and unique information mentioned in group discussion, (b) the detriment in performance between hidden profile groups and manifest groups, (c) the effect of pooling unique information on group decision quality, (d) the difference in pooling unique information between CMC groups and FtF groups, and (e) the difference in performance between CMC groups and FtF groups?

Method

Literature Search

Through four literature search methods, 144 published and unpublished studies were identified. First, a computerized bibliographic search was conducted in the following databases: PsycINFO, ABI/INFORM, EBSCOhost, Business Source Premier, PsycARTICLES, Web of Science, and UMI Dissertations Publishing using the following keywords: *common information bias, hidden profile, information sampling, confirmation bias, shared information, distributed information, information sharing, information pooling, unshared information, group decision making*, and *unique and common cues.* Second, the computerized search was cross-checked with the reference lists in review articles on hidden profiles and the two recent meta-analyses (e.g., Mesmer-Magnus & DeChurch, 2009; Reimer, Reimer, & Czienskowski, 2010; Stasser & Titus, 2003; Wittenbaum et al., 2004). Third, we posted calls for manuscripts on the listservers of the Organizational Behavior and Managerial and Organizational Cognition Divisions of the Academy of Management, the Organization and Group Communication Divisions of the National Communication Association, and the Organization Communication Division of the International Communication Association, asking people to send us their published and unpublished manuscripts as well as raw data. We received five sets of raw data, but only three contained data relevant to the effect sizes examined in the current analysis. Fourth, we directly contacted several researchers who have published articles on hidden profile studies and asked them for their unpublished manuscripts and further referrals.

Inclusion Criteria and Variable Coding

The major inclusion criteria were that (a) data were collected on human participants, rather than generated through a computer simulation; (b) a hidden profile task with one correct or preferred answer was used; and (c) data were reported such that the five effect sizes described above could be calculated. The final sample consisted of 101 effect sizes from 65 studies with 3,189 groups and 11,317 participants. The studies included for the tests of each effect size are listed in Tables 1 to 5.[1]

The unique or common information mentioned during group discussion was coded for the two operationalizations mentioned earlier. It was coded as *information coverage* when authors reported using the ratio of the number of pieces of unique or common information out of total pieces of information of the respective types available in the experiment; it was coded as *discussion focus* if the authors reported the ratio of the number of pieces of information mentioned out of the total of all information mentioned during discussion. The dependent variable of *decision quality* was coded as whether or not groups had discovered the hidden profile (i.e., whether they had identified the right suspect, chosen the right job candidate, etc.). We assigned a value of 0 for incorrect and 1 for correct decisions. We then coded the following information from each of the articles as moderator variables: (a) *group size*, (b) *total information load*, (c) *percentage of unique information out of total information available*, (d) *task type* (1 = *high demonstrability task*, 0 = *low demonstrability task*), and (e) *hidden profile strength* (1 = *strong hidden profile task*, 0 = *weak hidden profile task*).

Every study was coded by two of the authors, and the interrater agreement percentages were calculated for the coding of all variables. Initial interrater agreements were 100% for decision quality, group size, total pieces of information, and ratio of unique information out of total information available; 95% for task type; 86% for hidden profile strength, and 89% for operationalization of unique information pooling. Differences in coding were resolved through discussion among all of the authors.

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Table 1. Differences in Common Versus Unique Information Mentioned During Group Discussion

Author	Sample size[a]	Effect size (std. mean difference)	Moderator variables: Group size	Total information load	Ratio of unique information vs. total information	Task type[b]	Hidden profile strength[c]
Botero and Wittenbaum (2002)	50	0.34	3	24	0.38	1	0
Campbell and Stasser (2006) FtF[d]	33	0.94	3	24	0.75	1	0
Campbell and Stasser (2006) CMC[d]	33	0.65	3	24	0.75	1	0
Christensen, Larson, Abbott, Ardolino, Franz, and Pfeiffer (2000)	24	3.84	3	31	0.48	0	1
Cruz, Boster, and Rodriguez (1997)	51	2.14	—[e]	36	0.49	0	1
Dennis (1996a)	14	1.87	10	76	0.68	0	0
Dennis (1996b)	40	2.27	6	54	0.72	0	0
Devine (1999)	60	3.16	4	700	0.73	1	0
Dose (2003)	56	2.35	4	30	0.30	0	0
Franz and Larson (2002)	129	1.09	3	30	0.50	0	0
Greitemeyer, Schulz-Hardt, Brodbeck, and Frey (2006)	38	8.00	3	45	0.60	0	1
Henningsen and Henningsen (2003)	37	1.25	3	29	0.31	0	1
Henningsen, Henningsen, Jakobsen, and Borton (2004)	47	2.16	4	—	—	0	—
Kelly and Karau (1999)	45	0.71	3	60	0.50	0	1
Klein, Jacobs, Gemoets, Licata, and Lambert (2003)	58	0.61	3	50	0.36	0	0
Klocke (2007)	30	2.93	3	40	0.60	0	—
Larson, Christensen, Abbott, and Franz (1996)	38	1.70	3	—	—	0	0
Larson, Christensen, Franz, and Abbott (1998)	26	3.70	3	—	—	0	0
Larson, Foster-Fishman, and Keys (1994)	65	2.77	3	18	0.67	1	0
Lavery, Franz, Winquist, and Larson (1999)	33	1.63	3	9	0.67	0	1
McLeod (2004)	49	4.11	4	50	0.42	0	0
Mojzisch, Grouneva, and Schulz-Hardt (2010)	60	5.13	3	45	0.60	0	—
Reimer, Kuendig, Hoffrage, Park, and Hinsz (2007)	60	4.56	3	45	—	0	1
Reimer, Reimer, and Hinsz (2010)	106	1.29	3	45	0.60	0	1
Savadori, van Swol, and Sniezek (2001)	47	2.09	3	60	0.60	0	1
Schittekatte and van Hiel (1996)	46	2.17	4	42	—	0	0
Scholten, van Knippenberg, Nijstad, and De Dreu (2007)	53	1.21	3	36	0.50	0	1
Schulz-Hardt, Brodbeck, Mojzisch, Kerschreiter, and Frey (2006)	113	1.66	3	40	0.60	0	—
Toma and Butera (2009), 1[f]	30	2.44	3	28	0.32	1	0
Toma and Butera (2009), 2	28	2.34	3	28	0.32	1	0
van Swol (2009)	39	3.67	3	35	0.60	0	0
Vathanophas and Liang (2007)	48	0.54	3	36	—	1	0
Winquist and Larson (1998)	68	0.66	3	24	0.50	0	0

[a]Sample size = # of groups in the study.
[b]Task type: 1 = *tasks with high demonstrability*, 0 = *tasks with low demonstrability*.
[c]Hidden profile strength: 1 = *strong hidden profile*, 0 = *weak hidden profile*.
[d]For this study, because the authors reported results of unique and common information mentioned during group discussion separately for face-to-face (FtF) groups and computer-mediated communication (CMC) groups, we reported them as two studies.
[e]— = The variable is a manipulated factor in the study.
[f]Toma and Butera (2009), 1 refers to the first experimental study in this article, and Toma and Butera (2009), 2 refers to the second experimental study in this article.

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Table 2. The Impact of Manifest Versus Hidden Profile Tasks on Decision Quality

			Moderator variables				
Author	Sample size[a]	Effect size (odds ratio)[b]	Group size	Total information load	Ratio of unique information vs. total information	Task type[c]	Hidden profile strength[d]
Boster, Hale, and Mongeau (1990)	80	108.77	4	24	0.67	0	1
Brodbeck, Kerschreiter, Mojzisch, Frey, and Schulz-Hardt (2002)	54	18.06	3	36	0.50	0	—
Cruz, Boster, and Rodriguez (1997)	100	89.24	—[e]	36	0.49	0	1
Cruz, Henningsen, and Smith (1999)	40	4.00	4	74	—	1	1
Faulmuller, Kerschreiter, Mojzisch, and Schulz-Hardt (2010)	30	106.33	3	45	0.60	0	—
Fraidin (2004)	184	2.12	2	20	0.60	1	1
Gigone and Hastie (1993)	40	1.51	3	6	0.67	0	0
Gigone and Hastie (1997)	40	1.58	3	6	0.67	0	0
Greitemeyer and Schulz-Hardt (2003)	89	184.79	3	45	0.62	0	1
Gruenfeld, Mannix, Williams, and Neale (1996)	71	0.94	3	24	0.38	1	0
Henningsen and Henningsen (2003)	37	17.96	3	29	0.31	0	1
Henningsen and Henningsen (2007)	22	161.00	3	—	0.43	0	1
Hollingshead (1996b)	62	5.72	3	36	0.50	0	0
Kelly and Karau (1999)	71	9.69	3	60	0.50	0	1
Klein, Jacobs, Gemoets, Licata, and Lambert (2003)	58	19.87	3	50	0.48	0	0
Lam and Schaubroeck (2000)	72	14.44	4	34	0.50	0	—
Mojzisch, Grouneva, and Schulz-Hardt (2010)	60	104.59	3	45	0.60	0	—
Reimer, Reimer, and Hinsz (2010)	112	5.07	3	45	0.60	0	1
Schulz-Hardt, Brodbeck, Mojzisch, Kerschreiter, and Frey (2006)	135	6.53	3	40	0.60	0	—
Stasser and Stewart (1992)	83	5.28	—	24	0.38	1	0
Stasser, Stewart, and Wittenbaum (1995)	96	2.46	3	24	0.38	1	0
Stasser and Titus (1985)	56	17.70	4	48	0.50	0	—
Stewart, Billings, and Stasser (1998)	81	4.86	3	24	0.38	1	0
Stewart and Stasser (1998)	88	1.28	4	24	0.38	1	0

[a]Sample size = # of groups in the study.
[b]An odds ratio of 1 indicates that the likelihood of arriving at the right decision in the manifest-profile condition is the same as with the hidden profile groups. An odds ratio of 1.75 indicates that the likelihood of the manifest-profile groups making the right decision is 75% more than for the hidden-profile groups.
[c]Task type: 1 = *tasks with high demonstrability*, 0 = *tasks with low demonstrability*.
[d]Hidden profile strength: 1 = *strong hidden profile*, 0 = *weak hidden profile*.
[e]— = The variable is a manipulated factor in the study.

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Table 3a. The Effect of Information Coverage on Group Decision Quality

Author	Sample size[a]	Effect size (correlation)	Moderator variables: Group size	Total information load	Ratio of unique information vs. total information	Task type[b]	Hidden profile strength[c]
Botero and Wittenbaum (2002)	50	0.17	3	24	0.38	1	0
Campbell and Stasser (2006)	95	0.54	3	24	0.75	1	0
Cruz, Boster, and Rodriguez (1997)	80	0.92	—[d]	36	—	0	1
Greitemeyer, Schulz-Hardt, Brodbeck, and Frey (2006)	28	0.37	3	45	0.60	0	1
Henningsen, Henningsen, Jakobsen, and Borton (2004)	47	0.97	4	—	—	0	—
Kerr and Murthy (2009)	32	0.57	4	13	0.31	1	—
Klocke (2007)	30	0.23	3	40	0.60	0	—
Larson, Christensen, Franz, and Abbott (1998)	22	0.52	3	—	—	0	0
McLeod (2004)	49	0.22	4	50	0.42	0	0
Phillips, Mannix, Neale, and Gruenfeld (2004)	34	0.39	3	42	—	1	0
Schulz-Hardt, Brodbeck, Mojzisch, Kerschreiter, and Frey (2006)	115	0.37	3	40	0.60	0	—
Trindel (2007)	76	0.66	3	—	—	1	—
Winquist and Larson (1998)	68	0.43	3	24	0.50	0	0

[a]Sample size = # of groups in the study.
[b]Task type: 1 = *tasks with high demonstrability*, 0 = *tasks with low demonstrability*.
[c]Hidden profile strength: 1 = *strong hidden profile*, 0 = *weak hidden profile*.
[d]— = The variable is a manipulated factor in the study.

Table 3b. The Effect of Discussion Focus on Group Decision Quality

Author	Sample size[a]	Effect size (correlation)	Moderator variables: Group size	Total information load	Ratio of unique information vs. total information	Task type[b]	Hidden profile strength[c]
Botero and Wittenbaum (2002)	50	−0.02	3	24	0.38	1	0
Botero and Wittenbaum (2002) (with repetition)	50	0.32	3	24	0.38	1	0
Klocke (2007)	30	0.23	3	40	0.60	0	—
McLeod (2004)	49	0.09	4	50	0.42	0	0
Schulz-Hardt, Brodbeck, Mojzisch, Kerschreiter, and Frey (2006)	115	0.21	3	40	0.60	0	—
Stasser and Stewart (1992) (with repetition)	81	0.39	—[d]	24	—	1	0
Stewart, Billings, and Stasser (1998)	80	0.47	—	24	—	1	0
Stewart and Stasser (1998)	84	0.18	4	24	—	1	0
Stewart and Stasser (1998) (with repetition)	35	0.27	4	24	—	1	0

[a]Sample size = # of groups in the study.
[b]Task type: 1 = *tasks with high demonstrability*, 0 = *tasks with low demonstrability*.
[c]Hidden profile strength: 1 = *strong hidden profile*, 0 = *weak hidden profile*.
[d]— = The variable is a manipulated factor in the study.

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Table 4. The Effect of Communication technology (CMC vs. FtF) on Unique Information Pooling

			Moderator variables				
Author	Sample size[a]	Effect size (std. mean difference)	Group size	Total information load	Ratio of unique information vs. total information	Task type[b]	Hidden profile strength[c]
Dennis (1996a)	14	1.65	10	76	0.68	0	0
Dennis (1996b)	40	0.001	6	54	0.72	0	0
Dennis, Hilmer, and Taylor (1997)	17	1.78	10	—[d]	—	0	0
Kerr and Murthy (2009)	32	−1.20	4	13	0.31	1	—
Lam and Schaubroeck (2000)	72	1.53	3	36	0.32	0	—
Shirani (2006)	48	1.41	4	10	0.40	0	—
Straus (1996)[e]	54	0.003	3	—	—	0	0

[a]Sample size = # of groups in the study.
[b]An odds ratio of 1 indicates that the likelihood of arriving at the right decision in the CMC condition is the same as with the FtF groups. Task type: 1 = *tasks with high demonstrability*, 0 = *tasks with low demonstrability*.
[c]Hidden profile strength: 1 = *strong hidden profile*, 0 = *weak hidden profile*.
[d]— = The variable is a manipulated factor in the study.
[e]The author reported that the *F* value is smaller than 1, so we assigned .01 as the input for this study.

Table 5. The Effect of Communication Technology on Group Decision Quality

			Moderator variables				
Author	Sample size[a]	Effect size (odds ratio)[b]	Group size	Total information load	Ratio of unique information vs. total information	Task type[c]	Hidden profile strength[d]
Campbell and Stasser (2006)	95	1.18	3	24	0.63	1	0
Dennis (1996a)	14	1.00	10	76	0.32	0	0
Dennis (1996b)	21	0.88	6	54	0.72	0	0
Dennis, Hilmer, and Taylor (1997)	17	1.60	10	—[e]	—	0	0
Graetz, Boyle, Kimble, Thompson, and Garloch (1998)	23	13.20	4	30	0.30	0	1
Hollingshead (1996a)	52	1.38	3	24	0.63	0	0
Hollingshead (1996b)	82	1.94	3	36	0.50	1	0
Kerr and Murthy (2009)	32	4.80	4	13	0.30	1	—
Lagroue (2006)	16	0.21	—	—	—	0	—
Lam and Schaubroeck (2000)	72	0.45	3	36	0.32	0	—
Marin (1993)	34	1.44	4	48	0.55	0	1
McLeod, Baron, Marti, and Yoon (1997)	59	19.26	4	—	—	0	0
Mennecke and Valacich (1998)	31	1.70	4	48	0.75	0	0
Murthy and Kerr (2004)	35	0.44	4	—	—	1	—
Straus (1996)	54	0.72	3	—	—	0	0

[a]Sample size = # of groups in the study.
[b]An odds ratio of 1 indicates that the likelihood of arriving at the right decision in the CMC condition is the same as with the FtF groups. An odds ratio greater than 1 indicates that CMC groups have a lower chance of making the correct choice than the FtF groups.
[c]Task type: 1 = *tasks with high demonstrability*, 0 = *tasks with low demonstrability*.
[d]Hidden profile strength: 1 = *strong hidden profile*, 0 = *weak hidden profile*.
[e]— = The variable is a manipulated factor in the study.

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Analysis

Effect sizes. The software program Comprehensive Meta-Analysis (CMA, Version 2.2.046; Pierce, 2008) was used to calculate and analyze the effect size statistics. All results were obtained from random-effect models in which the error term is composed of variation from both within-study variability and between-study differences (Borenstein, Hedges, Higgins, & Rothstein, 2006; Hedges, 1994; Lipsey & Wilson, 2001; Rosenthal, 1995; Rosenthal & DiMatteo, 2001). A random-effect model assumes that observed effect sizes are drawn from a population of studies with varying effect sizes, in contrast to a fixed-effect model, which assumes that within-study variability is the main factor contributing to differences in results across studies (Cooper & Hedges, 1994). To test for the presence of potential moderators, homogeneity tests using the Q_{within} (Q_w) statistic were carried out to examine variances among the respective sets of effect sizes. When the hypothesis of homogeneity was rejected, moderators were introduced to explain heterogeneity in results across studies. The moderation test was conducted one moderator at a time because moderator tests in meta-analyses are analogous to multiple regression analysis for effect sizes (Hedges & Pigott, 2004); significant reduction in sample size and statistical power occurs because of listwise deletion of studies that did not provide sufficient information to code all five moderators. Regardless, chi-square tests and correlation analyses were conducted among categorical and continuous moderators to examine the level of association among these moderator variables. The results showed that two categorical indicators (task type and hidden profile strength) were independent of each other, and correlations among moderator variables were not significant, indicating that the results from the single-moderator regression analyses would not change much from multiple regression models, if these models could be run. Given such tests, we proceeded with a random-effect single-moderator test using CMA.

The CMA program can produce effect sizes from a wide variety of data input formats. Depending on the statistics reported in the original studies, the data were entered either in the form of descriptive statistics such as means and standard deviations or as correlations. For Effect Sizes 1 (i.e., the difference in mentions between common and unique information) and 4 (i.e., the effect of technology on information pooling), we calculated standard mean difference. This statistic uses standard deviation as a measurement unit to evaluate differences in means of each type of information across studies (Borenstein, 2005). Cohen's (1988) guidelines for small ($d = 0.20$), medium ($d = 0.50$), and large ($d \geq 0.80$) were applied to our interpretations here. For the analyses involving two dichotomous variables, difference in decision quality between hidden profile and manifest group conditions (i.e., Effect Size 2) and between FtF and CMC conditions (i.e., Effect Size 5), we converted all test statistics into odds ratios. For Effect Size 3, which evaluates the relationship between mentions of unique information and decision quality, the point-biserial r statistic was used because the effect size involves a continuous (mentions of unique information) and a dichotomous variable (decision quality). Cohen's (1988) guidelines for small ($r = .10$), medium ($r = .30$), and large ($r = .50$) effects were adopted to evaluate the magnitude of this effect size.

Moderators. Three continuous moderators, including *group size, total information load*, and *the percentage of unique information out of the total information available*, were assessed using individual random effects metaregressions, meaning that the effect sizes were regressed on the three moderators (Borenstein, 2005). Significant regression slopes (b) of these metaregressions indicate significant moderation effects. Because *task type* and *hidden profile strength* were categorical moderators, $Q_{between}$ (Q_B) was calculated from a random-effect model to compare effect sizes across the two levels of the moderator variable.

Results

Effect Size 1: Difference Between Common and Unique Information Mentioned

Because no studies provided information for calculating the discussion focus measure for the difference between pooling common versus unique information, we report results for the information coverage measure only for this effect size. We later report comparisons of information coverage and discussion focus measures in the results for Effect Size 3, when sufficient numbers of effect sizes were available. A total of 33 effect sizes on the standard mean difference in mentions of common and unique information were available. We coded the means so that a positive effect size indicated higher mentions of common than unique information. Inspection of the effect sizes shown in Table 1 shows that without exception, the mentions of common information exceeded the mentions of unique information, and the combined effect size was significant ($d = 2.03$, $k = 33$, $p < .01$, where k = number of independent effect sizes). This effect size, according to Cohen's (1988) standards, would be considered large and suggests that on average two standard deviations more common than unique information is mentioned when groups work on hidden profile tasks.

Moderators. The Q statistic showed that the heterogeneity was significant ($Q_w = 219.38$, $k = 33$, $p < .01$). We then examined whether the five moderators could explain this heterogeneity in results. First, the difference in mentions of common and unique information was regressed on group size. The slope of the regression line was positive and significantly different from zero ($b = 0.32$, $k = 32$, $p < .01$). Similarly, the regression slope for the total information load was positive and significant ($b = 0.003$, $k = 30$, $p < .01$), though smaller in magnitude. With respect to the percentage of unique information of total information available, the

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Table 6. Differences Between Common and Unique Information Mentioned During Group Discussion (ES1)

	Overall results					Heterogeneity			
Outcomes and moderators	*k*	Std. mean diff.	95% CI for std. mean diff.		*p* value	Q_B	Q_w	*df* (*Q*)	*p* value
Common vs. unique information mentioned	33	2.03	1.71	2.35	< .01		219.38	32	< .01
Moderators									
Task types						1.39		1	0.24
Type with high demonstrability	8	1.70	1.05	2.36					
Type with low demonstrability	25	2.16	1.78	2.54					
Hidden profile strength						0.62		1	0.43
Strong hidden profile	10	2.17	1.47	2.87					
Weak hidden profile	19	1.85	1.45	2.45					
	k	*b*	95% CI		*p* value				
Group size	32	0.32	0.14	0.49	< .01				
Total information load	30	0.003	0.001	0.004	< .01				
Ratio of unique information out of total information	26	1.14	0.09	2.20	.03				

k = number of effect sizes; CI = confidence interval.

Table 7. The Impact of Manifest Versus Hidden Profile Groups on Decision Quality (ES2)

	Overall results					Heterogeneity			
Outcomes and moderators	*k*	Odds ratio	95% CI for odds ratio		*p* value	Q_B	*Qw*	*df* (*Q*)	*p* value
Group decision quality	24	8.05	4.70	13.79	< .01		112.68	23	< .01
Moderators									
Task types						18.92		1	< .01
Type with high demonstrability	7	2.46	1.53	3.96					
Type with low demonstrability	17	15.18	7.78	29.63					
Hidden profile strength						8.52		1	< .01
Strong hidden profile	9	17.09	5.44	53.69					
Weak hidden profile	9	2.62	1.51	4.43					
	k	*B*	95% CI		*p* value				
Group size	22	0.50	0.10	0.89	.01				
Total information load	22	0.04	0.03	0.06	< .01				
Ratio of unique information out of total information	23	1.14	−0.98	3.25	.29				

k = number of effect sizes; CI = confidence interval. A positive effect size of the odds ratio means that manifest groups have a greater chance of making the correct decision than hidden profile groups.

results also showed a positive, and significant slope (b = 1.14, k = 26, p = .03). As described earlier, the Q_B statistic was used to assess the moderation effect of task type. The results showed no significant effect of task demonstrability on the difference in pooling of common and unique information (Q_B = 1.39, df = 1, p = .24; $d_{high\ demonstrability}$ = 1.70, $d_{\text{low demonstrability}}$ = 2.16). Finally, the results indicated *hidden profile strength* does not significantly affect the difference in the pooling of common and unique information (Q_B = 0.62, df = 1, p = .43; $d_{strong\ hidden\ profile}$ = 2.17, $d_{\text{weak hidden profile}}$ = 1.85). Taken together, the moderation tests showed that the predominance of common information mentions increased with group size, information load, and the percentage of information held uniquely prior to discussion, whereas it was not affected by task type nor hidden profile strength. These results are summarized in Table 6.

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Table 8. The Effect of Unique Information Pooled during Group Discussion on Group Decision Quality (ES3)

Outcomes and moderators	Overall results					Heterogeneity			
	k	*r*	95% CI for *r*		*p* value	Q_B	*Qw*	*df* (*Q*)	*p* value
Information coverage and decision quality[a]	13	0.56	0.30	0.74	< .01		216.71	12	< 0.01
Discussion focus and decision quality[b]	9	0.25	0.16	0.35	< .01		76.5	8	< 0.01
Moderators									
Task types						0.57		1	0.45
Type with high demonstrability	11	0.37	0.25	0.49					
Type with low demonstrability	11	0.51	0.15	0.74					
Hidden profile strength						0.79		1	0.37
Strong hidden profile	3	0.64	−0.23	0.94					
Weak hidden profile	12	0.29	0.20	0.39					
	k	*b*	95% CI		*p* value				
Group size	20	0.13	0.00	0.26	0.05				
Total information load	19	−0.002	−0.01	0.004	0.50				
Ratio of unique information out of total information	18	0.45	−0.04	0.94	0.07				

k = number of effect sizes; CI = confidence interval. For the current effect size, although we calculated two correlations, analysis showed that the moderation effects were parallel for both correlations (i.e., the correlation between information coverage and decision quality and the correlation between discussion focus and decision quality). Therefore, we decided to combine two correlations and calculate moderation effects for greater statistical power.
[a]This effect size pertains to the effects of unique information mentioned during group discussion on group decision quality.
[b]This effect size refers to the effect of unique information as the discussion focus on group decision quality.

Effect Size 2: Impact of Manifest Versus Hidden Profiles on Decision Quality

This effect size examined the degree to which hidden profiles are detrimental to decision quality. The 24 effect sizes included in this analysis are reported in Table 2. The significant and positive odds ratio of 8.05 ($k = 24$, $p < .01$) suggests that groups working on a manifest-profile task are 8 times more likely to choose the correct decision alternative than are groups working on a hidden profile task.

Moderators. This effect size also displayed significant heterogeneity across studies ($Q_w = 112.68$, $k = 24$, $p < .01$). The test for the moderating effect of group size showed a positive and significant regression slope (b = 0.50, $k = 23$, p = .01), indicating that as group size increases, the detriment to performance of hidden profiles also increases. A similar effect was found for total information load (b = 0.04, $k = 22$, $p < .01$), although the magnitude of this effect was small. The regression slope for the percentage of unique information of total information available was also positive, but its effect did not reach statistical significance (b = 1.14, $k = 23$, p = .29). The results of the moderating effect of task type ($Q_B = 18.92$, df = 1, $p < .01$) showed that the performance detriment of hidden profiles was larger for low demonstrability tasks (odds ratio = 15.18) than for high demonstrability tasks (odds ratio = 2.46). Last, results of hidden profile strength ($Q_B = 8.52$, df = 1, $p < .01$) indicated a significantly larger detriment to performance for strong hidden profile tasks (odds ratio = 17.09) than for weak hidden profile tasks (odds ratio = 2.62). In summary, the moderation tests showed that the detriment to task quality of a hidden profile increased with group size and with information load, for low demonstrability and strong hidden profile tasks, and that the percentage of information held uniquely prior to discussion did not affect the performance detriment of hidden profiles. There results are summarized in Table 7.

Effect Size 3: The Effect of Pooling Unique Information on Group Decision Quality

Effects sizes of the information coverage measure of pooling on decision quality were available from 13 studies (Table 3a) and of the discussion focus measure from 9 studies (Table 3b). Measures using both first mentions and repetitions were combined because the primary interest in this analysis was on the distinction between the denominators—how much of the available unique information was pooled (coverage) versus how much group discussion was spent on that information (focus). In the 3 raw data sets available, we calculated these two measures directly.

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Table 9. The Effects of Communication Technology (CMC vs. FtF) on Unique Information Pooling (ES4)

	Overall results					Heterogeneity		
	k	Std. mean diff.	95% CI for std. mean diff.		*p* value	*Qw*	*df* (*Q*)	*p* value
Random model	7	0.77	−0.20	1.75	.12	46.50	6	< .01

k = number of effect sizes; CI = confidence interval.

Table 10. The Effect of Communication Technology on Solving Hidden Profiles (ES5)

	Overall results					Heterogeneity		
	k	Effect size	95% CI for odds ratio		*p* value	*Qw*	*df* (*Q*)	*p* value
Random model	15	1.45	0.81	2.59	.21	38.5	14	< .01

k = number of effect sizes; CI = confidence interval.

Table 8 shows that information coverage was significantly and positively correlated with decision quality ($r = 0.56$, $k = 13$, $p < .01$), which is a large effect size according to Cohen's standard. The correlation for discussion focus was significant and of a medium size by the Cohen standard ($r = 0.25$, $k = 9$, $p < .01$). This result suggests that both the extent to which group members are thorough in mentioning the available unique information and the extent to which group members focus on unique information are important predictors for decision quality and that information coverage may more strongly predict groups' likelihood of discovering hidden profiles than does discussion focus. The difference between these two correlation coefficients, however, is not statistically significant, $z = 0.73$.

Moderators. The significant heterogeneity across studies of both measures (information coverage, $Q_w = 216.71$, $k = 13$, $p < .01$; and discussion focus, $Q_w = 76.5$, $k = 9$, $p < .01$) suggested the existence of moderators. Preliminary analysis showed that the five moderators had parallel effects on both measures, so we combined them in the tests of moderation effects to increase statistical power. The moderator test for group size showed a significant positive slope ($b = 0.13$, $k = 20$, $p < .01$), suggesting that as group size increases, the pooling of unique information becomes more predictive of decision quality. No significant moderating effects were found for total information load (b = –0.002, $k = 19$, p = .50), for the percentage of unique information of total information available (b = 0.45, $k = 18$, p = .07), for task type ($Q_B = 0.57$, $df = 1$, $p = .45$), or for hidden profile strength ($Q_B = 0.79$, $df = 1$, $p = .37$).

Effect Size 4: Effect of Technology on Unique Information Pooling

The effects sizes included in the analysis of communication technology (CMC vs. FtF) on unique information pooling are shown in Table 4, and the results appear in Table 9. The standard mean difference was not significant ($d = 0.77$, $k = 7$, $p = .12$), suggesting that CMC groups and FtF groups on average pool the same amount of unique information during group discussion. No test for moderators was computed.

Effect Size 5: Effect of Technology on Solving Hidden Profiles

Table 5 contains the effect sizes that were included in this analysis, and the results appear in Table 10. The odds ratio of the impact of CMC versus FtF versus groups on group decision quality was 1.45 ($k = 15$, $p = .21$), indicating that FtF groups and CMC groups generally have an equal chance of solving hidden profiles, and no test for moderators was computed.

Discussion

For 25 years, small group researchers have studied the antecedents, interaction processes, and decision outcomes associated with hidden profile tasks. The research in this area has generally shown that groups do not exchange information efficiently and that decision quality suffers as a result. The current meta-analysis sought to quantify the main effects associated with hidden profiles—the differential between pooling of unique and common information, how strongly this discussion bias and other variables affect groups' decision quality, and the factors moderating these effects. Table 11 presents a summary of our findings, and to facilitate cross-referencing between the results and this discussion, we have numbered each cell in the table. Those cells highlighted in gray reflect overlaps in findings between our and Mesmer-Magnus and DeChurch's (2009) meta-analyses, and those cells with darkened borders reflect the overlaps in findings between our and Reimer, Reimer, & Czienskowski (2010) meta-analyses.

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Table 11. Summary of the Five Effect Sizes and Associated Moderators

	Effect Sizes	Moderators				
Effect sizes meta-analyzed	Magnitude	Group size	Total information load	Ratio of unique information out of total information	Task type	Hidden profile strength
Difference between common and unique information mentioned	1. 2.03**	6. .32**	11. .003**	16. 1.14*	21. 1.39	26. .62
Difference between hidden and manifest profile groups in decision quality	2. 8.05**	7. .50*	12. .04**	17. .45	22. 18.92**	27. 8.52**
Effect of unique information pooled on group decision quality	3. .56**[a]/0.25**[b]	8. .13*	13. –.002	18. .45	23. .57	28. .79
Effect of communication technology on unique information pooling	4. .77	9. —	14. —	19. —	24. —	29. —
Effect of communication technology on group decision quality	5. 1.45	10. —	15. —	20. —	25. —	30. —

** $p < 0.01$ (2-tailed).
[a]This effect sizes pertains to effects of unique information coverage during group discussion on group decision quality.
[b]This effect size refers to effect of unique information as discussion focus on group decision quality.

We replicated the findings from these two analyses that common information is mentioned more frequently than unique information, and our analysis indicated that on average two standard deviations more of the common information than of the unique information is pooled (cell 1 in Table 11). Groups are eight times less likely to discover the optimal decision when working on a hidden profile than on a manifest-profile task (cell 2). Our results also extend their findings by suggesting that information coverage may predict decision quality more strongly than does discussion focus. Consistent with Mesmer-Magnus and DeChurch (2009), we also found that pooling unique information significantly predicts decision quality for hidden profile tasks (cell 3). Our results extend these previous findings by quantifying the overall performance detriment of a hidden profile information distribution. Last, communication technology has generally not been found to help groups to pool unique information (cell 4) or to solve hidden profile problems (cell 5).

At first glance, our findings that information coverage may more strongly predict decision quality than does discussion focus would seem to contradict data reported by Stasser and Stewart (1992), Stewart and Stasser (1998), and Stewart et al. (1998) on the importance of discussion focus. In those studies, however, discussion focus on unique information was compared to the total *number* of times information was mentioned, including repetitions. In contrast, the information coverage measure we defined here is the *proportion* of the total available unique information that is mentioned. A group could get a high score for total information by repeating certain pieces of information, for example, while surfacing only a small proportion of the total information available. Our results show that both the amount of focus on unique information, once it is mentioned, and how many pieces of that information get mentioned are at least equally important for decision quality.

The difference between these two measures in their importance for decision quality may depend on task features. Although the moderating effect of task type on the relationship between information pooling and decision quality did not reach statistical significance, it is nevertheless suggestive to examine the four individual correlations between the two information pooling measures and decision quality for high and low demonstrability tasks (see Table 12). Information coverage appears to be more important for low than high demonstrability tasks whereas the importance of discussion focus does not differ based on task demonstrability. We propose the idea of an *information pooling threshold* as a possible interpretation of this pattern. That is, perhaps a certain amount of the available unique information may need to be pooled before the degree of focus on that information will influence task performance. For tasks with highly demonstrable solutions, once enough of the information is pooled for groups to discover the solution, additional pieces of information pooled may matter little. A task solution with low demonstrability, on the other hand, may require pooling

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Table 12. Correlation Between Information Pooling and Task Performance by Task Demonstrability and Pooling Measure

		Task demonstrability	
		Low	High
ES3: Information pooling measure	Information coverage	.66**	.44**
	Discussion focus	.21**	.28**

** $p < .01$, two-tailed.

of more pieces of the information for group members to become convinced of the validity of that information. For such tasks, the threshold may be higher for how much unique information needs to be pooled before focus on that information affects decision quality. Future research should examine such speculations more systematically, but the current meta-analysis extends previous work by pointing to these as yet unexplored differences in how information pooling has been defined conceptually and operationally. These differences have potentially important implications for decision quality under different task conditions.

Furthermore, our findings that the predominance of common over unique information decreases with cognitive and information load are consistent with Reimer , Reimer, & Czienskowski (2010) finding that the discussion bias decreases as the number of decision alternatives decreases. The factors related to cognitive and information load we examined—group size, total pieces of information, and the ratio of unique information in the task—were all directly related to the predominance of common over unique information. In particular, every additional group member was found to increase the gap between mentions of common and unique information by 0.32 standard deviations (cell 6), and every additional piece of information increased the likelihood of mentioning common over unique information by 0.003 standard deviations (cell 11).

The effect of these factors on discussion bias largely carried through to decision quality. Increasing group size raises the likelihood of groups with manifest over hidden profiles discovering the optimal solution (cell 7), as does increasing total information load (cell 12). Moreover, as group size increases (cell 8), pooling unique information becomes more critical for discovering a hidden profile. Percentage of unique information, however, was not found generally to affect the size of the hidden profile performance detriment.

This pattern of results is consistent with the reasoning derived from the biased sampling model (Stasser & Titus, 1987) that common information has a higher chance of being mentioned as the number of people who hold that information increases. But once unique information is mentioned, it appears to have a stronger impact on decision quality in large groups than in small groups. We postulate that unique information may have comparable effects as minority opinions because unique information favors an alternative that is different from the group consensus alternative. Minority views are less likely to be expressed as group size increases (Wood, Lundgren, Ouellette, Busceme, & Blackstone, 1994). The willingness of minority opinion holders to undertake the social risk of being regarded as an opinion deviant, however, may by itself get other group members' attention (McLeod et al., 1997). This could partly explain why unique information in larger groups, although less likely to be mentioned, has a stronger effect on the group decision once it finally does get mentioned.

Although Stasser and Titus (1987) reasoned that a high *percentage of unique information* increases the tendency to recall unique information, the combined results of 26 studies in the current meta-analysis showed no effect (cell 16). Furthermore, the percentage of unique information had no significant effect on the performance gap between groups with hidden profile and with manifest-profile tasks (cell 17). Cruz et al. (1997) examined the impact of both group size and the ratio of unique information on decision quality and found that large group size helps groups with a high unique information ratio to outperform those with a low unique information ratio, whereas small group size has the opposite effect. A useful direction for future research would be to examine more closely the joint effects of cognitive load factor in information exchange and information processing in decision-making groups.

We also found that *task demonstrability* affected size of the performance detriment of hidden profiles (cell 22). The likelihood of a manifest over a hidden profile group finding the optimal task solution increases by a factor of nearly 6 when they work on tasks with high rather than low demonstrability (odds ratios of 15.18 vs. 2.46). This finding complements previous findings that information pooling is more predictive of decision quality (Mesmer-Magnus & DeChurch, 2009) and that the discussion bias toward common information decreases (Reimer, Reimer, & Czienskowski 2010) for high demonstrability tasks. Taken together, the results of these three meta-analyses indicate that hidden profile tasks without a clear preferred solution are most detrimental to information sharing and decision quality.

In addition, the direction of our results on *hidden profile strength* showed that homogeneity of prediscussion preferences (i.e., strong hidden profiles) slightly increased the predominance of common over unique information, as compared to weak hidden profiles, but this difference did not reach statistical significance (cell 26). We nevertheless found that

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strong hidden profiles significantly decrease the chances of a group solving the task, whereas heterogeneity among preferences (i.e., weak hidden profiles) significantly increases them (cell 27). This finding resonates with arguments based on preference bias and mutual enhancement that people stick to their initial choice, especially after receiving validation from other group members who agree with them (Greitemeyer & Schulz-Hardt, 2003; Klocke, 2007). Mojzisch et al. (2010) argued that receiving positive feedback from other group members steers individuals away from scrutinizing valuable unique information and leads groups toward preference negotiation instead. This explains a greater emphasis on preference consistent information, which under a strong hidden profile leads to a suboptimal task solution. In the absence of these conditions, weak hidden profiles allow for dissent to surface, which leads to more thorough information processing and ultimately higher decision quality (Brodbeck et al., 2002).

The results of this meta-analysis suggest that CMC has no net effect on group members' likelihood of mentioning unique information (cell 4) or on finding the optimal solution to a hidden profile task (cell 5), despite the fact that such technologies may provide several features to help groups better contribute and process information (such as anonymity and aids to the group memory; Dennis, 1996a, 1996b). Because few studies use comparable communication technologies, we could not conduct a finer-grained analysis on the role that specific features of technology may play in the pooling and processing of information. In addition, many CMC studies in our analysis were conducted in the 1990s, and it is conceivable that people might adapt to CMC much better with the fast development of computer and Internet technology nowadays, so our results on CMC need to be interpreted cautiously. Future research is needed comparing specific features of different technologies to disentangle the effects of technology on information exchange in small groups.

Directions for Future Research

In addition to providing a quantitative review of existing hidden profile studies, this meta-analysis also uncovered a number of methodological and conceptual issues that are important for future research using hidden profile tasks to take into account.

Different definitions of information pooling. First are the already mentioned conceptual and empirical differences between the information coverage and discussion focus measures of information pooling. A useful direction for future research would be to examine the relationship between these conceptualizations of information pooling and other aspects of *task structure*. For example, in some tasks, each piece of information is uniquely critical to finding the solution, whereas in other tasks each piece of information contributes cumulatively to finding the solution. The murder mystery task (Stasser & Titus, 1985) is the best example of the first type. All of the pieces of information are needed to exonerate unequivocally the innocent suspects. These tasks are analogous to a jigsaw puzzle—each piece of information is necessary to produce the correct answer unequivocally. The second type of task depends on the valence of information about each decision alternative, and the correct answer is the alternative with the highest net valence (e.g., McLeod et al., 1997; Stasser & Titus, 1985). In tasks such as these, groups can still choose the optimal alternative even if all the information has not been mentioned as long as the mentioned information contains the correct ratio of positive to negative information for each alternative.

Returning to the notion of the *information pooling threshold*, task structure may be one of the factors that determines the threshold. For tasks that depend on the net valence of the alternatives, the threshold might be expected to be low—the minimum number of items that would yield the correct rank order of the alternatives. In that case, discussion focus may more strongly predict decision quality than would information coverage. For jigsaw-type tasks, on the other hand, the threshold would need to be high enough to give groups a reasonable idea of how the final solution should look, and hence information coverage would more strongly predict decision quality for these tasks. Studies that directly compare these task types for different operationalizations of information pooling would contribute to our understanding of information exchange and decision making in groups. A fruitful area for research is in examining how the two conceptualizations of information pooling function under these two task structures. We also recommend that researchers include reports of both measures in future studies to facilitate further results comparisons.

Alternative approaches to information pooling. Research should examine other possible dimensions of information pooling as well. The current study limited the analysis of information pooling to counts of information items mentioned because almost all existing studies focus on counting only. More studies are needed that report the content, that is, pooling of arguments *for* or *against* certain decision alternatives or that examine how group member roles relate to the kind of information pooled (e.g., Franz & Larson, 2002; Stasser, Vaughan, & Stewart, 2000) because counting pieces of information without scrutinizing discussion content may overlook the mechanisms through which groups reach decisions. Second, counting ignores differences in the usefulness of information pooled. Certain pieces of information may contain content that is more critical to the task solution than the content that other pieces of information contain. Future research thus will benefit significantly from going beyond merely counting pieces of information pooled.

Direct links between input and output factors. Finally, the adaptation to the input-process-output model that we used as the organizing framework for this analysis represents a call for future research to consider simultaneously the direct

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impact of input factors, such as task type and communication technology, on group decision quality (the output) and the mediation effect of group process. Both social decision scheme theory (Davis, 1973) and propositions derived from the common knowledge effect (Gigone & Hastie, 1993, 1997) predict that the distribution of prediscussion preferences of different decision choices among team members is a reliable predictor of group decision quality, and empirical support for these predictions has been found. For example, Hollingshead (1996b) tested both the direct effect of prediscussion opinions on decision quality and the mediation effect of content of discussion on this relationship and concluded that the "pre-discussion opinions were a major determinant of group decisions" (p. 191). Other studies have also found that prediscussion dissent improves group decision quality, though not necessarily through information exchange (Brodbeck et al., 2002; Greitemeyer & Schulz-Hardt, 2003; Phillips & Loyd, 2006; Schulz-Hardt et al., 2006; van Swol & Seinfeld, 2006). Taken together, this research suggests that studying both the direct effect of the input factors and the mediation effect of the process factors (i.e., information exchange) simultaneously can provide a more comprehensive understanding of how groups resolve hidden profile and other types of tasks in group decision making.

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Note

1. The table displaying all excluded studies can be provided to interested readers on request.

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