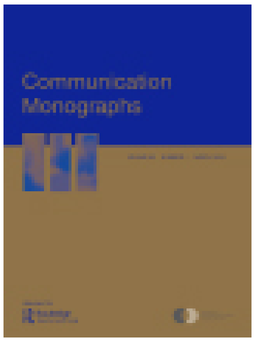

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Torsten Reimer, Andrea Reimer & Uwe Czienskowski

Groups often focus their discussions on information that all members know at the outset. To test how robust the sampling advantage for shared information is, a meta-analysis was conducted. The analysis integrated findings from 20 publications (45 independent effects), in which information sharedness was manipulated. Groups discussed more shared than unshared information overall. However, the observed sampling advantage was smaller than expected. Groups attenuated the discussion bias in particular when they had to choose among a small number of decision alternatives and when they had less than 30 minutes discussion time. Moreover, groups performing a hidden-profile task tended to display a smaller discussion bias than groups performing tasks with equally attractive alternatives.

Keywords: Group Discussion; Information Sharing; Discussion Bias; Hidden Profile; Meta-Analysis

Research into groups and teams indicates that members often discuss what is already known to all at the outset. Decision-making groups tend to focus their discussions on information their members already know (shared information) rather than what individuals may uniquely possess (unshared information) (for overviews, see Stasser & Birchmeier, 2003; Wittenbaum, Hollingshead, & Botero, 2004; Wittenbaum & Stasser, 1996). The biased information exchange favoring shared information can hamper decision making and impair individual and team learning (e.g., Ellis et al., 2003; Gouran & Hirokawa, 1983; Hollingshead, 1996; Pavitt, 1994; Vroom, 1969;

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Winquist & Larson, 1998). This analysis set out to examine the robustness of the discussion bias by reviewing the results of published studies that compared the amount of shared and unshared information that groups pooled during discussions.

Specifically, the analysis had two major goals. First, the analysis aimed to determine the prevalence of the discussion bias, including whether groups accentuate or attenuate the tendency to focus in their discussions on shared information. Using the Information Sampling Model by Stasser and Titus (1987) as a baseline to estimate the expected sampling advantage for shared information, the analysis compared the baseline with the observed sampling advantage reported in published studies. Second, the analysis set out to estimate the effect size regarding the discussion bias and to explore the role of moderator variables, which were derived from the literature. Specifically, the analysis aimed to explore whether the use of a hidden profile accentuates or attenuates the ostensible virtue of unshared information, and whether the time available to groups for discussion and the number of available decision alternatives moderated the discussion bias. To answer these research questions, a meta-analysis was conducted to estimate the size of the effect of information sharedness on information pooling and to systematically test for moderator variables.

The Study of Information Sampling in Groups

In studies on information sampling, groups are typically asked to reach a joint decision by choosing from a set of choice alternatives. Such tasks include choosing a company for a financial investment, selecting a suspect in a murder mystery, selecting an individual for student body president, or developing a diagnosis for a hypothetical medical case (for overviews, see Stasser & Birchmeier, 2003; Wittenbaum & Stasser, 1996). The decision alternatives are typically described by positive, negative, and neutral features or cues. Crucially, to control for the task-specific knowledge group members bring to the group discussion and to manipulate the sharedness of information, the experimenter distributes information regarding the choice alternatives among group members in a systematic way. Some of the information items are given to all group members at the outset; these items are "shared." Some information items are only given to single group members; these items are "unshared." Usually, studies start out with an individual session during which participants have some time to familiarize themselves with the task and the descriptions of the choice alternatives. At the end of their individual session, participants are asked to indicate their individual preference (for exceptions, see Reimer, Reimer, & Hinsz, in press; Schittekatte, 1996). Subsequently, participants discuss the task as part of a group and reach a group decision. During group discussions, members usually no longer have access to their materials and must recall the details of the decision alternatives they received at the outset (for exceptions, see Hollingshead, 1996; Lavery, Franz, Winquist, & Larson, 1999). To find out how many of the shared and unshared information items groups pool during their discussions, researchers videotaped and coded the group discussions.

Surprisingly, several studies found that groups tend to focus their discussions on shared information at the expense of unshared information, which limits the potential for meetings to foster individual and group learning. One reason why the reported discussion bias favoring shared information remains puzzling and counterintuitive is that unshared information is typically assumed to be more informative, relevant, and diagnostic (Stasser & Titus, 1987). If members both perceive unshared information to be more relevant than shared information and aim to make relevant contributions to a discussion (e.g., Bonito, 2007), one would expect group members to exchange a higher percentage of their unshared information.

In this context, it is important to see that a discussion bias in favor of shared information at the group level does not require that the individual group members have a preference for shared information, too; a discussion bias on the group level can occur even if the individual members exchange a higher rate of their unshared than of their shared information (see, for examples, Figure 1; Reimer, Kuendig, Hoffrage,

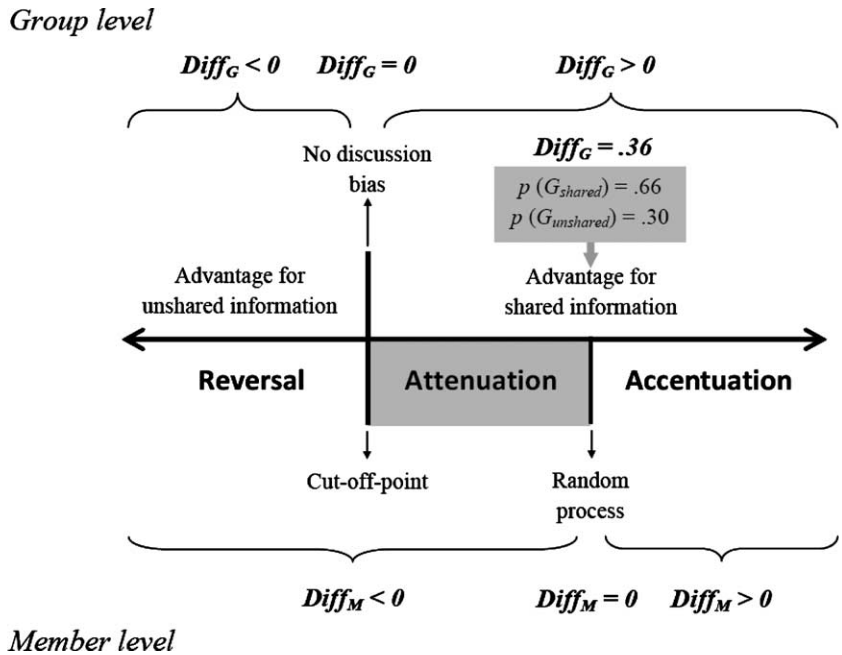

Figure 1 The relationship between the discussion bias in favor of shared information on the group level and the individual group members' sampling behaviors. $Diff_G$ refers to the discussion bias on the group level and is defined as the difference between $p(G_{shared})$ and $p(G_{unshared})$. Conversely, $Diff_M$ refers to the individual members' tendencies to mention shared and unshared information and is defined as the difference between $p(M_{shared})$ and $p(M_{unshared})$. As this figure illustrates, a discussion bias in favor of shared information can occur on the group level ($Diff_G > 0$) even if the individual members exchange a higher proportion of their unshared than of their shared information ($Diff_M < 0$; see, for examples and boundary conditions, Reimer et al., 2007; Stasser et al., 1989). Reimer et al. (2007) provided a formula that can be used to determine the cutoff point for $Diff_M$. When $Diff_M$ is smaller than the cutoff point, groups will pool higher percentages of their unshared than of their shared information.

Park, & Hinsz, 2007; Stasser, Taylor, & Hanna, 1989). As Stasser and Titus (1987) noted, when each group member discloses shared and unshared information at the same rate (thus, not showing any tendency to favor shared over unshared information), a sampling advantage in favor of shared information will occur on the group level. This is because shared information has a greater chance to be pooled because it is known to more group members. Stasser and Titus introduced a model that can be used to calculate the expected sampling advantage for shared information when group members randomly select information and do not differ in participation rates. The Information Sampling Model can be used as a baseline to determine whether groups accentuate or attenuate the discussion bias (see Reimer et al., 2007).

The relationship between the discussion bias at the group level ($Diff_G$) and the individual group members' tendencies to mention shared and unshared information during a discussion ($Diff_M$) is illustrated in Figure 1. $Diff_G$ is defined as the difference between two probabilities, the probability that the group discusses a shared information item, $p(G_{shared})$, and the probability that the group discusses an unshared information item, $p(G_{unshared})$:

$$Diff_G = p(G_{shared}) - p(G_{unshared}). \tag{1}$$

Typically, empirical studies estimate $p(G_{shared})$ and $p(G_{unshared})$ using the average percentages of shared and unshared information items mentioned at least once during group discussions (see Reimer et al., 2007; Stasser & Titus, 1987). A $Diff_G = 0$ indicates that the groups in a study exchanged the same percentages of their shared and unshared information items overall; (2) a $Diff_G > 0$ indicates that groups discussed more of their shared information; and (3) a $Diff_G < 0$ indicates that groups discussed more of their unshared information.

In analogy to $Diff_G$, the coefficient $Diff_M$ quantifies to what extent the individual members of a group exchange higher rates of their shared or unshared information:

$$Diff_M = p(M_{shared}) - p(M_{unshared}) \tag{2}$$

where $p(M_{shared})$ is an individual group member's probability to mention a shared information item and $p(M_{unshared})$ is an individual group member's probability to mention an unshared information item. How are $Diff_G$ and $Diff_M$ related to each other?

Stasser and Titus (1987) provided a formula that allows estimating $Diff_G$ when $Diff_M = 0$, and when group members do not systematically differ in participation rates. Under these conditions, $p(G_{unshared})$ and $p(G_{shared})$ can be determined as follows:

$$p(G_{unshared}) = p(M_{unshared}) \tag{3}$$

and

$$p(G_{shared}) = 1 - [1 - p(M_{unshared})]^n \tag{4}$$

where n refers to the number of group members.

These formulas can be used to calculate the discussion advantage one would expect had group members randomly sampled from their shared and unshared information (see Stasser & Titus, 1987). For example, in a three-member group, in which members sample 30% of their shared and unshared information, $p(M_{unshared}) = .30$, $p(M_{shared}) = .30$, $Diff_M = 0$, one would expect that the group will discuss 30% of the available unshared but 66% of the available shared information, $p(G_{unshared}) = .30$, $p(G_{shared}) = .66$, $Diff_G = .36$.

The analysis we conducted aimed to explore whether the observed discussion bias, which was reported in the literature, systematically differs from the discussion advantage one would expect based on the Information Sampling Model (Stasser & Titus, 1987), leading to the first research question:

> RQ1: Do groups accentuate or attenuate the sampling advantage one would expect based on the Information Sampling Model, and what is the size of the overall effect?

Some researchers suggested that the discussion bias is particularly prevalent when groups are asked to perform hidden-profile tasks. The following section introduces three context variables that have been discussed as potential moderator variables in the literature: whether groups performed a hidden-profile task or a task with equally attractive alternatives, the time available to groups for discussion, and the number of available decision alternatives.

The Hidden-Profile Task

Most studies of the discussion bias used a hidden-profile task, in which the exchange of unshared information is particularly important to the successful performance of the task. Hidden-profile tasks are constructed such that one of the choice alternatives has a higher sum score (i.e., a greater difference between the number of positive and negative attributes or cues) than the others and is, therefore, presumably the best choice (see Stasser & Titus, 1985). However, the overall profile of this alternative remains unknown to individual group members because the distribution of information items is biased. Specifically, group members begin with more positive (and fewer negative) pieces of information concerning an inferior alternative. Whereas group members' information items favoring the inferior alternative are shared, items favoring the superior alternative are unshared. Thus, to be able to detect the hidden profile, group members must exchange and integrate unshared information (for examples, see Henningsen & Henningsen, 2003; Reimer et al., 2007; Van Swol, 2009; Wittenbaum et al., 2004).

Groups performing hidden-profile tasks might display a particularly strong discussion bias because the shared items in these tasks are preference congruent, whereas the unshared items are preference incongruent. This is not typically the case in tasks in which the choice alternatives are equally attractive and in which each alternative is supported by some shared as well as some unshared information (e.g., see Schittekatte, 1996; Stasser et al., 1989; Stewart & Stasser, 1995; Van Hiel & Schittekatte, 1998; Wittenbaum, 2000). With hidden-profile tasks, shared information items typically support the preferences group members have before they enter group discussions, whereas unshared items support the hidden-profile alternative, which most group members do not prefer at the outset (Wittenbaum et al., 2004).

Several strands of research indicate that group members tend to focus more on information that is preference congruent than on information that is preference incongruent (Gigone & Hastie, 1993; also see Brodbeck, Kerschreiter, Mojzisch, Frey, & Schulz-Hardt, 2002; Reimer, 1999; Schulz-Hardt, Brodbeck, Mojzisch, Kerschreiter, & Frey, 2006). For example, people evaluate new information in light of their preferences and better recall preference-congruent information than preference-incongruent information (Greitemeyer & Schulz-Hardt, 2003). In a similar vein, some studies indicate that when searching for information groups prefer that which is preference congruent (Schulz-Hardt, Frey, Luethgens, & Moscovici, 2000). Based on these considerations, one might expect the tendency to discuss more shared than unshared information to be stronger in groups performing hidden-profile tasks than in groups that do not have such tasks to perform.

Even though this assumption makes sense on theoretical grounds, little empirical evidence supports it, largely because studies lack direct comparisons regarding the discussion of shared information and unshared information involving different types of profiles. When given hidden-profile tasks, groups may attend more to shared information without accentuating its advantage in group discussion. Lavery et al. (1999), who directly compared the amount of shared and unshared information that participants discussed for different profiles, uncovered no evidence for the hypothesis that groups show a greater tendency to discuss shared information when performing hidden-profile tasks. In light of that study, one might expect no systematic differences in the discussion bias for groups performing hidden-profile tasks and others that are not.

Some work even suggests that the tendency to focus discussions on shared information might be weaker and attenuated in groups performing hidden-profile tasks. Because unshared information has decisional consequences in the performance of hidden-profile tasks, it is particularly diagnostic in such cases. Stasser and Titus (1987) noted earlier that unshared information in hidden-profile tasks should be particularly persuasive in referring to the potential of unshared items of information to alter the initial preferences of group members. Fraidin (2004) compared connected and disconnected hidden profiles and noted that the perceived importance of unshared information related to the discussion advantage for shared information. Groups whose members perceived unshared information as important discussed similar proportions of their shared and unshared information. Thus, groups may adapt their discussion behavior to the task they face and exchange higher rates of unshared information in tasks with a hidden profile. The analysis aimed to shed some light on these conflicting considerations by answering the following research question:

RQ2: Does the type of task (hidden profile vs. nonhidden profile) moderate the discussion bias favoring shared information?

Some studies indicate that the time available to groups for discussion and the number of available decision alternatives moderate the discussion bias. Both variables have been shown to influence the extent to which individual deciders (Payne, Bettman, & Johnson, 1988) as well as groups (Kelly & Karau, 1999) focus on relevant information. The role of these two variables in information sharing will be discussed next.

Discussion Time

Karau and Kelly (1992) proposed an Attentional Focus Model, which asserts that time pressure increases the focus on task-relevant aspects in decision-making groups. Several studies demonstrated that groups working under time constraints exchanged information at a faster rate (Karau & Kelly, 1992; Kelly & Karau, 1999; Kelly & Loving, 2004; Parks & Cowlin, 1995). Moreover, and consistent with the Attentional Focus Model, group members disclose more relevant and diagnostic information (ratio of valenced to neutral facts) during discussions when time is perceived as limited (see Kelly & Loving, 2004; Reimer et al., in press). Kelly and Karau (1999) conducted a study in which they manipulated information sharedness and observed that time pressure led groups to pool more unshared information during discussions, especially when this information was highly diagnostic. The authors systematically varied the relevance of unshared information by manipulating the strength of the incorrect initial preference of members performing a hidden-profile task.

Research involving the Attentional Focus Model, when considered alongside research on individuals (Payne et al., 1988), suggests that groups focus on relevant information when time is limited or perceived as limited (Kelly & Loving, 2004). Thus, if unshared information is understood by group members to be more relevant than shared information, groups may attenuate the discussion bias favoring shared information when discussion time is limited. This idea led to the third research question:

RQ3: Does discussion time moderate the discussion bias?

The Number of Decision Alternatives

Several researchers suggested that the way group members process information and the decision strategies they use can influence information exchange (e.g., see Reimer & Hoffrage, 2005, in press; Stasser, 1988). Hollingshead (1996), for instance, found that groups asked to apply a rank-order procedure exchanged significantly more unshared information than groups instructed to choose the best alternative. Relatedly, several studies reported that the mere number of decision alternatives a group may consider affects group discussion. For example, Parks and Cowlin (1995) observed that groups asked to make a choice among two alternatives discussed significantly more of their information than groups considering three- or four-choice alternatives. Parks and Cowlin did not examine whether the number of decision alternatives had an influence on the discussion bias favoring shared information. However, Kelly and Karau (1999) suggested that "discussing two alternatives might facilitate direct comparisons in a way that would heighten attention to unshared information" (p. 1351). Drawing upon these findings and suggestions, the final research question of this analysis focused on whether the number of decision alternatives groups choose from is related to the discussion bias favoring shared information.

> RQ4: Does the number of decision alternatives among which groups can choose moderate the discussion bias?

A meta-analysis of published studies addressed the four research questions. The meta-analysis included group size and information load as additional variables, both of which are related to the Information Sampling Model and also turned out to have some influence on the discussion bias favoring shared information (for studies manipulating group size or information load, see Cruz, Boster, & Rodriguez, 1997; Schittekatte, 1996; Stasser et al., 1989; Stasser & Titus, 1987).

Method

First, a thorough literature search (using various relevant search terms such as "information sharing" and "shared information") selected all articles that had a relevant term in their title, list of keywords, abstract, or main text. Subsequently, the analysis included those studies that reported the proportions or absolute numbers of discussed shared and unshared information items and provided sufficient information to estimate effect sizes. For example, it was not possible to include studies having reports of information recall but nothing concerning group discussions (e.g., Brodbeck et al., 2002; Stasser & Titus, 1985) or studies that involved only partially shared information, that is, information held by more than one but not by all group members (e.g., Schittekatte & Van Hiel, 1996). Likewise, studies were not included if they reported only the means but no standard deviations or test statistics regarding the percentages of shared and unshared information the groups pooled during their discussions (e.g., Lam & Schaubroeck, 2000; Liljenquist, Galinski, & Kray, 2004; Parks & Cowlin, 1995). The examination covered 20 publications (with 45 independent studies or effects) that were indexed in PsychInfo. The total number of groups across the studies was 1176.

Second, one of the authors coded for each of the selected studies each of the following variables, which were used to determine effect sizes and sampling variances: (1) the means and standard deviations of the percentages of shared and unshared information items the groups pooled during their discussions; (2) the number of groups that participated in a study; (3) statistics regarding the discussion bias; and (4) the reported reliability between the raters who coded the group discussions.

Third, the same coder extracted the following variables, which were used as potential moderator variables in the meta-analysis: (5) whether the task did or did not have a hidden profile (profile condition); (6) the time groups could spend on their discussions (discussion time); (7) the number of decision alternatives from which groups could choose (decision alternatives); (8) the number of group members (group size); and (9) the number of information items that were given to groups (information load).

Fourth, another author randomly selected a sample of 10 studies or conditions out of the 20 publications and independently coded the same variables. With the exception of two scores, the codings were identical, indicating a high reliability of the codings. In two cases, the coded percentages of shared and unshared information differed slightly; these differences occurred because the second coder had determined the percentages by averaging the numbers of several independent conditions that were given in a table, whereas the first coder had identified a paragraph in the same publication in which the respective percentages were reported directly. The small differences were due to rounding errors.

Initially, several additional variables were coded including demographic variables such as participants' age and gender. These variables were not included in the analysis because they were not reported in a sufficient number of studies. For example, only a small number of publications reported the gender of participants. Likewise, additional characteristics of the tasks were initially coded; for example, whether a task had a superior choice alternative or not. However, it turned out that all studies that could be included in the analyses used either a hidden profile or a task with equally attractive alternatives (e.g., Stasser et al., 1989). Tasks with equally attractive alternatives are constructed such that group members' preferences are spread across the choice set and are typically not very strong at the outset.

Results

How many of their shared and unshared pieces of information did groups pool during discussions by mentioning them at least once? Across all studies, groups pooled on average $M = 54.44\%$ ($SD = 17.86\%$) of their shared and $M = 33.53\%$ ($SD = 13.91\%$) of their unshared information, $p(G_{shared}) = .54$, $p(G_{unshared}) = .34$. Thus, on average, about half of the shared and two-thirds of the unshared information went unmentioned during discussions. For each of the 45 studies or independent effects, a difference score was computed subtracting the percentage of unshared information items from the percentage of shared information items discussed by groups. The difference was positive in all 45 cases, indicating that groups exchanged a higher percentage of their shared than of their unshared information items. On average, groups pooled $M = 20.91\%$ ($SD = 10.60\%$) more of the shared than of the unshared information received prior to the group discussions, $Diff_G = .21$.

What would be the expected average difference across the 45 studies if group members had randomly sampled from their information? To answer the first research question, the expected percentage of shared information discussed given the observed percentage of unshared information discussed was estimated for each study (see Stasser & Titus, 1985, for an example). First, the observed relative frequency of unshared information items that were mentioned at least once was used as an estimator for $p(M_{unshared})$ and $p(G_{unshared})$ (see Equation 3). Equation 4 was used to estimate the expected $p(G_{shared})$ for each individual study. Next, $p(G_{unshared})$ and

$p(G_{shared})$ were transformed into percentages and the difference between these percentages was computed for each study. Finally, these differences were averaged to estimate the discussion advantage in favor of shared information one would expect had group members randomly selected and pooled shared and unshared information. Based on the Information Sampling Model, one would expect an average difference of $M = 37.86\%$ ($SD = 8.52\%$) across the 45 studies. This expected average difference was almost twice as large as the observed average difference of 20.91%, $t(44) = 11.02$, $p < .01$, $d = 1.76$. The respective observed $Diff_G$ was .21, whereas the expected $Diff_G$ was .38. Thus, this analysis suggests that groups pooled more of their shared than unshared information. However, at the same time, groups attenuated the bias; the observed sampling advantage for shared information was considerably smaller than the expected advantage.

Are there any systematic differences between studies or is the sharedness effect homogeneous across studies? How large is the effect when the differences are weighted by sample sizes and corrected for unreliable measures and other statistical artifacts (see Hunter & Schmidt, 2004)? To answer these questions and to address the research questions regarding the role of task characteristics, the size of the sharedness effect was determined and systematic tests of moderator variables were conducted. The effect sizes as well as sampling variances were estimated based on the random-effects model by Hunter and Schmidt (2004).

Estimating Effect Sizes and Sampling Variance

In the meta-analysis, the sharedness of information was treated as a within-subjects factor throughout and the effect size d was computed for each of the 45 studies or independent conditions (see Hunter & Schmidt, 2004). When appropriate, correction functions that are recommended in the literature to correct for statistical artifacts were included. Different from standard meta-analyses in other research areas, the sharedness effect here refers to differences in two variables that are correlated. In recent years, several researchers have argued that meta-analytic procedures, which were originally developed for studies employing between-subjects designs, are inappropriate when used for within-subjects designs because they tend to systematically overestimate effect sizes (see Dunlap, Cortina, Vaslow, & Burke, 1996; Hunter & Schmidt, 2004; Morris & DeShon, 2002). As a consequence, the analysis implemented correction functions for correlated designs and procedures that have been developed for within-subjects designs.

Whenever a publication reported the two means as well as the standard deviations for the percentages of shared and unshared information and the N, the d-value could be computed directly (Dunlap et al., 1996). In that case, the d-value was estimated by dividing the observed differences of shared and unshared information that had been calculated to determine $Diff_G$ by the pooled sampling variance (Cohen, 1988, p. 44). The standard deviations for the two means were given in 33 cases. In 12 cases, no standard deviations were provided but a t- or F-statistic was reported. Standard transformations for t- and F-statistics typically overestimate the true effect sizes in correlated designs (Dunlap et al., 1996; Hunter & Schmidt, 2004). For this reason, when estimating an effect size from reported statistics (such as t- or F-values), the estimated effect size was corrected for the correlations between the two measurements (see Dunlap et al., 1996, p. 171). As an estimation of this correlation, this analysis used the correlation between the exchanged proportions of shared and unshared information across all 45 studies, $r = .81$.

As recommended by Hunter and Schmidt (2004), this analysis also corrected effect sizes for measurement errors in the dependent variable, that is, the percentages of shared and unshared information that were pooled. For this procedure, the reported interrater reliabilities were used as an estimation of the accuracy with which the dependent variable was measured. In a few cases, authors did not report interrater reliabilities for the discussion data. In those cases, the average interrater reliability, $r = .86$, of the remaining studies was used as an estimator (Hunter & Schmidt, 2004, pp. 303ff). Finally, the effect sizes were corrected for distortions due to small samples using the procedure described by Hedges and Olkin (1985; also see Hunter & Schmidt, 2004, pp. 266ff).

In the next step, the sampling variance was estimated to determine confidence intervals and the proportion of variance in the effect sizes that was accounted for by error variance. We followed the approach by Morris and DeShon (2002, first formula in their Table 2), who developed and recommended specific procedures for within-subjects designs. As the effect sizes, the weight to be given to each single effect and the sampling error variance for each of the effects were corrected for imperfect reliability (Hunter & Schmidt, 2004, p. 305).

Meta-Analytic Results

Table 1 shows the means, standard deviations, and correlations between the main variables and the average corrected effect size *d*. The average effect size was $d = 1.34$ ($SD = 0.73$). Rosenthal and Rubin (1982; Rosenthal, Rosnow, & Rubin, 2000) introduced the binomial effect size display (BESD) to interpret the strength of effect sizes (for an application, see Allen, Howard, & Grimes, 1997). BESD displays changes in success rates, which typically refer to survival rates or cure rates attributable to a certain

Table 1 Correlations between the Effect Size and the Coded Variables, and Means, Standard Deviations, and *N*s of the Respective Measures

	d	PC	DT	DA	GS	IL	*M*	*SD*	*N*
Effect size (*d*)	—						1.34	0.73	45
Profile condition† (PC)	−.14	—					—	—	45
Discussion time (DT)	.35*	.32	—				29.30	16.94	37
Number of decision alternatives (DA)	.44**	.21	.87**	—			3.19	0.77	42
Group size (GS)	.38**	.05	.44**	.42**	—		3.54	1.04	45
Information load (IL)	.01	−.41**	−.31	−.42**	−.05	—	38.33	17.89	45

†Studies in which groups performed a hidden profile are coded with 1 and studies in which groups did not have such tasks to perform with 0.
$^{*}p < .05$, $^{**}p < .01$.

treatment procedure (Rosenthal & Rubin, 1982, p. 166). In our case, the "success rates" refer to the amount of shared and unshared information groups exchange during their discussions. Based on the BESD, the observed effect of information sharedness is rather large. The effect size translates into a difference of success rates between the conditions of shared and unshared information of about 56% (or a point-biserial r of .56). As Table 1 shows, the effect size correlated significantly with the number of decision alternatives, group size, and discussion time. Moreover, some of the coded variables systematically correlated with each other. Particularly, the more decision alternatives researchers used in their study, the more time did they give their groups to discuss the task and form a decision, $r = .87$, $p < .01$.

Table 2 displays the corrected and weighted effects, the 95% confidence intervals, the number of studies (k) and groups (N) separately for each condition of the coded variables, the percentage of variance that was accounted for by sampling variance (Hunter & Schmidt, 2004), and a test for homogeneity (Q). The overall effect was not homogeneous, $Q = 171.64$, $p < .05$, showing that there were considerable differences between studies. This finding justifies the search for moderator variables, including the variables specified in the research questions. In the next step, the continuous variables were categorized and effect sizes were computed for each of the coded

Table 2 Summary Statistics for the Meta-Analysis

	d	95% CI	k	N	% variance accounted	Q	p
Weighted overall effect	1.24	0.16–2.31	45	1176	26.46	171.64	<.05
Profile condition							
Hidden-profile task	1.16	−0.10–2.41	33	767	23.28	126.16	<.05
No hidden-profile task	1.38	0.84–1.92	12	409	50.84	25.98	<.05
Discussion time							
Less than 30 minutes	1.18	−0.09–2.46	22	491	21.99	89.01	<.05
At least 30 minutes	1.60	1.19–2.01	15	394	74.64	18.42	*ns*
Decision alternatives							
Two	0.63	0.48–0.78	5	260	93.16	5.50	*ns*
Three	1.33	0.29–2.37	28	717	26.80	105.99	<.05
Four or more	1.72	1.41–2.03	9	151	82.93	10.51	*ns*
Group size†							
Three members	1.16	−0.05–2.37	31	774	22.08	122.75	<.05
Four or more members	1.37	0.65–2.09	14	402	44.60	36.84	<.05
Information load							
Low (40 items or less)	1.16	−0.01–2.32	24	540	27.26	84.85	<.05
High (more than 40 items)	1.30	0.32–2.28	21	636	26.31	80.40	<.05

†The smallest group had three members. The notation d refers to the weighted, corrected effect of information sharedness. 95% CI indicates the upper and lower values of the 95% confidence interval for the corrected effect. The notation k refers to the number of estimates used to obtain the average corrected effect size. N indicates the total number of groups in the subset of estimates.% variance accounted refers to the ratio of variance expected because of sampling error to the variance of the observed effect sizes. The last two columns display the Q statistic and respective p as an indicator of homogeneity.

variables. As Table 2 shows, all variables seem to have at least some influence on the effect. The differences in effect sizes varied from $\Delta_d = 0.14$ (information load) to $\Delta_d = 1.09$ (two- vs. four-decision alternatives) across the potential moderator variables.

In contrast to what one might expect based on research involving hidden profiles (see Research Question 2), the discussion bias tended to be weaker in studies involving a hidden-profile task ($d = 1.16$) than in studies in which no hidden profile existed ($d = 1.38$). The difference in effect sizes of $\Delta_d = 0.22$ indicates a rather small effect on the discussion bias (the respective BESD success rate difference is about 11%; see Rosenthal & Rubin, 1982). It should be noted that this difference is not significant within the given sample of studies. The confidence intervals overlap and the mean effect size for hidden-profile studies lies within the confidence interval for studies in which no hidden profile existed and vice versa (see Schenker & Gentleman, 2001, for criteria of significance). Also note that the confidence interval for tasks employing hidden profiles includes 0, which is not the case for tasks employing equally attractive alternatives (see the no hidden-profile task condition in Table 2). In other words, the analysis indicated a significant sampling advantage in favor of shared information within studies with equally attractive alternatives, whereas the sampling advantage was not significant in studies employing hidden-profile tasks. Taken together, the meta-analysis does not support the widespread assumption that the discussion bias is stronger when groups perform hidden-profile tasks but rather suggests that the tendency to focus on shared information is more strongly attenuated in such tasks.

Research Question 3 asked if the effect will be smaller when groups have less time for discussion. The meta-analysis supported this assumption. Groups had less than 30 minutes for their discussion in 22 of the studies, and 30 minutes or more in 15 studies; in eight cases, discussion time was not specified. When groups had less than 30 minutes for their discussions ($d = 1.18$), the effect was smaller than when groups had 30 minutes or more ($d = 1.60$).

Did the number of decision alternatives moderate the discussion bias (see Research Question 4)? The discussion bias was the weaker the fewer decision alternatives were used in a study. When group members could choose from three alternatives, the effect size was much stronger ($d = 1.33$) than when they could choose from two alternatives ($d = 0.63$). The effect size for three alternatives also differed from the effect size for four or more alternatives ($d = 1.72$). Both, the difference between two and three alternatives and between three and more alternatives indicate that it matters in particular if groups can choose from two or more alternatives. The BESD success rate differences were 33% and 20%, respectively.

According to the Q tests for homogeneity (Hedges & Olkin, 1985) as well as to the rule of 75% explained variance (see Schmidt & Hunter, 1977), discussion time and decision alternatives were not only the strongest moderators but also yielded subgroups of studies that were homogeneous (see the last three columns in Table 2). The only two conditions in which the effects were still heterogeneous referred to studies in which groups had less than 30 minutes to discuss their task and studies in which groups were asked to choose among three alternatives. This heterogeneity allowed us to investigate whether discussion time and the number of decision alternatives had a joint effect.

As Table 1 shows, discussion time and the number of decision alternatives were highly correlated across the 45 studies. As a consequence, it might be that the differences in effect sizes that were related to discussion time were due to differences in the number of decision alternatives or vice versa. To explore this possibility, the mean effect sizes for different numbers of decision alternatives were calculated separately for the short and long discussion times. The results of this analysis are displayed in Table 3. In the sample of studies included in the analysis, there was no study in which groups had less than 30 minutes discussion time and more than three decision alternatives from which they could choose (for $k = 0$, no effect size could be computed; see Table 3). Likewise, when discussion time was 30 minutes or longer, researchers always used more than two alternatives. This pattern explains the high correlation between discussion time and the number of decision alternatives. Tellingly, the effect of the number of decision alternatives did not vanish when differences for discussion time were controlled. In particular, the differences in effect sizes between two and three alternatives were still substantial within the studies in which groups had less than 30 minutes for their discussions (see Table 3).

Taken together, the analyses suggest that groups typically discuss a higher percentage of their shared than unshared information. However, the observed discussion bias was considerably smaller than the discussion bias one would expect if groups had randomly sampled from their shared and unshared information. The moderator analysis further suggests that groups seem to attenuate the discussion bias in particular when they have less time for discussion and when they have to choose from fewer alternatives. The effect was particularly small when the choice set comprised only two alternatives. Moreover, the sampling advantage favoring shared information tended to be weaker rather than stronger in studies in which groups performed a hidden-profile task.

Table 3 Summary Statistics for the Meta-Analysis of the Joint Effects of Discussion Time and Decision Alternatives on the Discussion Advantage for Shared Information in Group Discussions

	d	95% CI	*k*	*N*	% variance accounted	*Q*	*p*
Less than 30 min discussion time							
Decision alternatives							
Two	0.54	0.32–0.76	3	108	100	2.54	*ns*
Three	1.34	0.08–2.60	17	359	24.05	65.47	<.05
Four or more	—	—	0	—	—	—	—
At least 30 min discussion time							
Decision alternatives							
Two	—	—	0	—	—	—	—
Three	1.54	1.20–1.87	6	243	70.72	7.72	*ns*
Four or more	1.72	1.41–2.03	9	151	82.93	10.51	*ns*

Discussion

The analysis pursued two major goals. First, to test the robustness of the discussion bias, the analysis estimated the effect of information sharedness across published studies and compared the observed discussion bias with the sampling advantage one would expect based on the Information Sampling Model (Stasser & Titus, 1987). Second, to explore by meta-analysis three research questions regarding the influence of task characteristics on the discussion bias, specific task characteristics were identified that had been derived from the literature on group discussion that moderated the effect sizes for information sharedness. The remainder of this paper lists several limitations of the study, discusses the findings regarding the two major research goals, and derives questions for future research.

Limitations of the Study

As with other integrations of empirical studies, it is important to acknowledge some basic limitations of this meta-analysis. Most importantly, because the findings are products of a correlational, integrative analysis, they are preliminary and deserve further investigation. For example, it cannot be ruled out that there are variables, which were not coded and included in the analysis, that were systematically confounded with the task characteristics studied. Even though no evidence of influence could be found, further experimental research and replications are necessary to rule out the value of potentially confounding variables in accounting for the differences of interest.

Moreover, it is important to note that this analysis examined studies that manipulated information sharedness in decision-making groups, in which group members focused on their decisions and presumably shared the common goal to perform well (see Wittenbaum et al., 2004). Group meetings and discussions can serve several functions (Romano & Nunamaker, 2001). At times, committees and groups do not reach any decisions in their meetings, but instead use them as opportunities to share information. In these situations, the acquisition of knowledge is not only a byproduct of group meetings but their major purpose (Hinsz, Tindale, & Vollrath, 1997; Wuchty, Jones, & Uzzi, 2007). It may well be that groups pool a higher percentage of their unshared information in situations in which the major purpose of a group meeting consists in promoting the exchange of information.

Furthermore, studies were excluded in which researchers used partially shared information, and it was not analyzed to what extent groups repeated their shared and unshared information during their deliberation. Only very few authors reported these data. Likewise, data regarding what information group members recalled after their group discussions (e.g., Greitemeyer & Schulz-Hardt, 2003) were not included. Arguably, when the focus of interest is on individual and group learning, memory data provide an important data source. It may well be that group members at times do not pay much attention to unshared information when it is discussed and therefore may not recall it later. Some research suggests that group members forget new, unshared information more easily than shared information, in particular when unshared information does not support their individual preferences (Greitemeyer & Schulz-Hardt, 2003).

The Attenuation of the Discussion Bias: Findings and Questions for Future Research

The findings as well as the limitations of this meta-analysis suggest several questions for future research. The analyses revealed that decision-making groups discuss a higher percentage of their shared than of their unshared information overall. At the same time, however, the discussion advantage for shared information was less pronounced than expected. As a consequence, one research question deserving further attention is: *How* do groups manage to attenuate the discussion bias? Several mechanisms and processes may be operative in the attenuation of the discussion advantage for shared information.

It may be that the discussion bias was attenuated because individual group members—perceiving unshared information to be more relevant—had a tendency to mention more of their unshared than of their shared information (see Figure 1). One reasonable assumption is that individuals aspire to make relevant contributions to discussions (Bonito, 2000). Thus, it might be that members exchanged more of their unshared information because this information was ostensibly more relevant. Relevance, however, may depend on the context. An unshared piece of information might appear to be relevant because it leads to new insight into a subject's matter (Bonito, 2007). At other times, a shared piece of information might seem to be more relevant because others can validate it (Wittenbaum, Hubbell, & Zuckerman, 1999). Thus, it would be helpful to arrive at a better understanding of how group members perceive the relevance of information and choose to contribute to a discussion (see Bonito, 2007).

Relatedly, more research to account for differences in participation rates of group members would be desirable. Typically, group members do not participate at the same rate in discussions, and differences in participation presumably can influence the discussion bias on the group level (Jones & Kelly, 2007; Stasser, Vaughan, & Stewart, 2000). How many shared and unshared pieces of information the individual members contributed to discussions was not directly analyzed because this information was only rarely provided in publications (Reimer et al., 2007; Wittenbaum, 1998). Some members may exchange more shared than unshared information, whereas other members might do the reverse. For example, member status (prior task experience vs. no experience) reportedly influences the contribution of shared and unshared information during discussion (Wittenbaum, 1998, 2000).

Further variables that conceivably influence which information participants mention during discussions are: group roles, such as like leader (see Franz & Larson, 2002), and personality characteristics, for instance, the need for cognition versus need for closure. Likewise, group norms (Postmes, Spears, & Cihangir, 2001) and the implementation of discussion procedures can affect the exchange of information (e.g., counterfactual mindset, see Galinsky & Kray, 2004; Liljenquist et al., 2004; rank-ordering of alternatives, see Hollingshead, 1996). Future research, then, might address the issue of how groups attenuate the discussion advantage for shared information by studying individual and context variables, which affect how much information group members contribute to a discussion and which members introduce a high percentage of their unshared information.

Consistent with the Attentional Focus Model (Kelly & Loving, 2004) and with research regarding the role of task characteristics in individuals (Payne et al., 1988), groups attenuated the discussion bias in particular when they had less time and when the number of decision alternatives was small. Moreover, and contrary to what one might expect on the basis of studies regarding information processing in hidden profiles, the tendency to discuss more shared information than unshared information was smaller in hidden-profile tasks. The only publications we found that reported a discussion advantage in favor of *unshared* information on the group level (such that $Diff_G < 0$; see Figure 1) used hidden-profile tasks exclusively (Kelly & Karau, 1999; Klein, Jacobs, Gemoets, Licata, & Lambert, 2003, Exp. 2, inconsistent-label condition; Liljenquist et al., 2004; Stasser, Stewart, & Wittenbaum, 1995). None of these studies could be included in the reported analysis, though, because they did not provide sufficient information to estimate effect sizes.

Those studies alongside the current analysis suggest that hidden-profile tasks facilitate the exchange of unshared information. Groups seem to adapt their discussion behavior to the task they perform by focusing more on their unshared information when facing a hidden-profile task in which unshared information is particularly diagnostic and relevant. The difference between studies using hidden profiles and studies using equally attractive alternatives was rather small ($\Delta_d = 0.22$) and the difference was not significant within the sample of studies that could be included in the analysis (see Schenker & Gentleman, 2001, for a discussion of criteria of significance). In this context it is worth noting, however, that the tests of the presented meta-analysis are rather conservative because effects were corrected for various potential statistical artifacts and because the random-effects model that has been used yields rather wide confidence intervals compared to fixed-effects model that have been predominant in previous meta-analytical research (see Hunter & Schmidt, 2004, for a detailed discussion). More research is needed to discern whether the observed difference between tasks using a hidden profile and tasks using other profiles is substantial and reliable and—if that is the case—how it can be explained.

The result that groups tend to pool more of their unshared information than what one would expect based on the Information Sampling Model matches empirical studies indicating that groups do pay attention to their unique information under certain conditions. For example, recent research revealed that groups are able to detect hidden profiles if group members enter discussions without preferences and if the choice alternatives are described on the basis of common cues (Reimer et al., in press). These task characteristics facilitated the exchange and integration of unshared information and, as a consequence, enabled all groups to detect the hidden profile. Likewise, groups seem to be better able than individuals to generate unique ideas when they are asked to come up with innovative ideas (Reimer, Yao, & Harger, 2009). This research suggests that groups are not generally good or bad at exchanging and considering unshared information but that they rather adapt their discussion behavior to specific task characteristics. In this context, it is important to see that an extensive exchange of information does not necessarily improve the quality of group decisions (see Gouran & Hirokawa, 1983; Reimer & Katsikopoulos, 2004). As noted by Gouran and Hirokawa (1983), communication per se is not what distinguishes effective from ineffective groups, but it is the extent to which interaction leads to particular choices. Consistent with this reasoning, several studies indicate that the quality of group decisions depends on the decision strategies that are used by groups to integrate the information that is exchanged during discussions (e.g., Reimer & Hoffrage, 2006). The meta-analysis identified task characteristics that moderated the discussion bias in favor of shared information. Future research may address the question how groups manage to adapt their discussion behaviors to specific goals and task characteristics and to what extent these behaviors are ecologically rational by matching specific task demands (Reimer & Hoffrage, in press).

Finally, future research could yield fruitful insights into information sharing in groups if it addresses how group members process shared and unshared information in different phases of information processing (including attention, encoding, storage, retrieval, response, and feedback; see Hinsz et al., 1997). Studying what information and knowledge participants in discussions convey provides an important window to understanding social interactions in groups. This research contributes to a deeper understanding regarding the relationships between information sharing, decision making, and individual and group learning.

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