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The dissemination of critical, unshared information in decision-making groups: the effects of pre-discussion dissent

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Abstract

Previous research in group decision making has found that in situations of a hidden profile (i.e. the best choice alternative is hidden from individual members as they consider their pre-discussion information), unshared information is disproportionately neglected and sub-optimal group choices are highly likely. In an experimental study, three-person groups decided which of three candidates to select for a professorial appointment. We hypothesised that minority dissent in pre-discussion preferences improves the consideration of unshared information in groups and increases the discovery rate of hidden profiles. As predicted, consideration of unshared information increased with minority dissent. The expectation of an improvement of group decision quality was partially supported. In diversity groups (i.e. each member prefers a different alternative) consideration of unshared information and group decision quality was significantly higher than in simple minority groups. Results are discussed in the light of theories of minority influence. The benefits of using the hidden profile paradigm with minority and diversity groups for theory development in the area of group decision making are highlighted. Copyright © 2002 John Wiley & Sons, Ltd.

INTRODUCTION

Groups are often employed for decision making because it is assumed that they can bring more intellectual resources to bear on a decision problem than individuals, thereby increasing the probability that group decisions are higher in quality than individual decisions. However, the history of group research documents numerous times when group performance in decision-making is sub-optimal (for reviews see, e.g. Hill, 1982; Hinsz, 1990; McGrath, 1984; Steiner, 1972). For instance, we have known for decades that majorities win right or wrong, whether it comes from research on

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conformity pressure (Asch, 1951), on groupthink (Esser & Smith, 1998; Janis, 1972, 1982), on social decision schemes (Davis, 1969, 1973; Levine, 1999), or, more recently, on the sunk cost effect (Smith, Tindale, & Steiner, 1998).

Research about information sampling bias in group decision making, beginning with the work from Stasser and Titus (1985, 1987), adds nicely to this history. It concentrates on the lost opportunity for groups to consider all information members hold for group decision making. Stasser and colleagues presume that the primary task of decision-making groups is to reach a consensus (Stasser, Kerr, & Davis, 1989) which is typically built on the exchange of information. Knowing that groups possess more resources and recall more information than any one individual group member (Clark & Stephenson, 1989; Hinsz, 1990), optimal pooling of information during group discussion should result in group decisions that are more informed than any of the group members individual decisions. This should be particularly true when group members hold a diverse store of decision-relevant information and therefore a high proportion of the total information available in the group is new to individual group members (i.e. unshared information).

In practice, the effectiveness of group decision processes has become an increasingly important organisational concern — especially in environments with a diverse work force (Williams & O'Reilly, 1998). Proper information pooling is critical, for instance, in cross-functional teams where representatives of different organisational functions and expertise are combined to ensure diversity in knowledge and perspectives for effective decision-making and problem solving (Gruenfeld, Mannix, Williams, & Neale, 1995). However, groups whose members know different facts are often ineffective at integrating their unique information. There is a growing body of evidence that much more of the *shared information* (information previously known by all group members) is pooled during group discussion than of *unshared information* (information previously known by only one group member) (e.g. Larson, Foster-Fishman, & Keys, 1994; Stasser, 1992; Stasser, Stewart, & Wittenbaum, 1995; Stasser & Titus, 1985, 1987; Stewart & Stasser, 1995; Winquist & Larson, 1998). When shared and unshared information have different decisional implications, the group choice tends to be the one implied by shared information (e.g. Stasser & Stewart, 1992; Stasser & Titus, 1985). This is of particular importance in a situation in which the superior decision alternative is hidden from individual group members as they consider their pre-discussion information. This situation has been labelled a *hidden profile*.

HIDDEN PROFILES

A simple example of a hidden profile with two decisional alternatives in a three person group holding a pool of equally important items is described in Table 1.

Table 1. Example of a hidden profile

	Items favouring A	Items favouring B	Item distribution	Decisional implication
Individual level				
X	A_1, A_2	B_1, B_2, B_3	3 B > 2 A	**B**
Y	A_1, A_3	B_1, B_2, B_3	3 B > 2 A	**B**
Z	A_1, A_4	B_1, B_2, B_3	3 B > 2 A	**B**
Group level				
X∪Y∪Z	A_1, A_2, A_3, A_4	B_1, B_2, B_3	3 B < 4 A	**A**

Note: Choice of alternative B is implied by each of the group members' partial item pools: X := A_1, A_2, B_1, B_2, B_3; Y := A_1, A_3, B_1, B_2, B_3; Z := A_1, A_4, B_1, B_2, B_3. Choice of alternative A is implied by the group's total item pool: X∪Y∪Z := A_1, A_2, A_3, A_4, B_1, B_2, B_3. According to the total item pool available at the group level alternative A is superior to alternative B.

In our simplified example of a hidden profile the choice of alternative B is implied by each of the partial item pools held by each group member ($X := A_1, A_2, B_1, B_2, B_3$; $Y := A_1, A_3, B_1, B_2, B_3$; $Z := A_1, A_4, B_1, B_2, B_3$), each with three different items supporting alternative B and only two different items supporting alternative A. Whereas the choice of alternative A is implied by the group's total item pool ($A_1, A_2, A_3, A_4, B_1, B_2, B_3$) with four different items supporting alternative A and only three different items supporting alternative B. According to the group's potential resources (i.e. the total item pool), alternative A is the best choice. As can also be seen, in situations that have a hidden profile shared information points to other choices than the best. The decisional implication of all shared items together (A_1, B_1, B_2, B_3) is alternative B, whereas the decisional implication of all unshared items (A_2, A_3, A_4) as well as the implication of the total item set is alternative A. Previous research has consistently shown that groups frequently fail to discover hidden profiles (e.g. Stasser, 1992; Wittenbaum & Stasser, 1996). Thus, for situations in which benefits of group decision-making should be the highest, sub-optimal choices are most likely. Note that it is exactly in the situation of a hidden profile that groups have a distinct advantage over individual decision makers. Here, the group has the potential for identifying a superior decision alternative (based on the sum total of information) that none of the group members initially favoured based on their incomplete individual slices of information.

THEORETICAL EXPLANATIONS FOR THE HIDDEN PROFILE EFFECT

In the literature, two major explanations for the apparent sub-optimal group choices in hidden profile situations have been suggested.

The first explanation was proposed in the collective information sampling model (Stasser & Stewart, 1992; Stasser, Taylor, & Hanna, 1989; Stasser & Titus, 1985, 1987; Stewart & Stasser, 1998). The tendency of groups to pool more of their shared than of their unshared information is seen as a consequence of the unequal probabilities of discussing shared versus unshared information (*information pooling bias*). The more members who can recall an item and mention it, the higher the probability that it will in fact be discussed. Furthermore, the model presumes that the information actually pooled has a strong influence on group decisions (see Figure 1, first row).

Others have further investigated social psychological variables that potentially foster the dominance of shared information during discussion; for example, social validation (Parks & Cowlin, 1996) and mutual enhancement (Wittenbaum, Hubbell, & Zuckermann, 1999).

Gigone and Hastie (1993) suggested an alternative explanation as to why group decisions tend to favour choices implicit in shared information. They posit that the pre-discussion distribution of information determines the distribution of group members' decisional preferences, and it is the overall pattern of the members' preferences that determines the group decision (i.e. common knowledge effect). We therefore labelled Gigone and Hastie's explanation 'preference negotiation model' (see Figure 1, second row). From the only experimental studies designed to test between the preference negotiation explanation and the biased information pooling explanation (Gigone & Hastie, 1993, 1997), the conclusion was drawn that the pattern of pre-discussion preferences is the predominant force, 'It was as if the group members exchanged and combined their opinions but paid little attention to anything else' (Gigone & Hastie, 1997, p. 132).

The basic explanatory difference between the two models resembles a common distinction made between persuasive arguments theory (Burnstein & Vinokur, 1977) and social comparison theory (Myers, 1978) for explaining the group polarisation phenomenon (i.e. group induced shifts in individual choice and judgement). Burnstein and Vinokur (1977) proposed that group polarisation

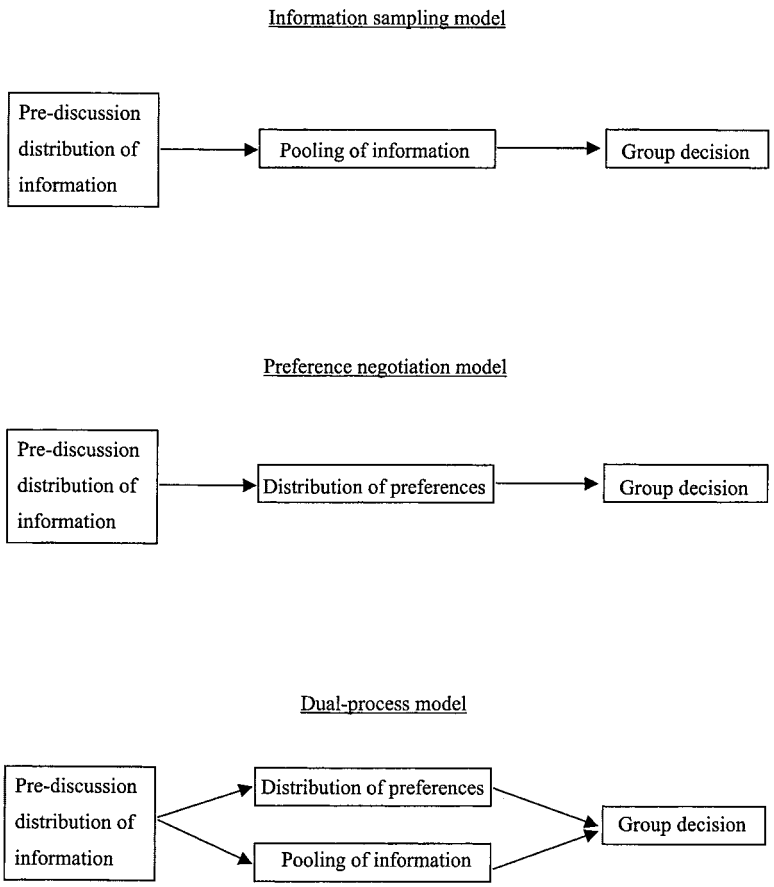

Figure 1. Three perspectives on the relationship between pre-discussion distribution of information, distribution of preferences and group decision making

could be understood in terms of argument sampling during group discussion. Their Persuasive Arguments Theory (PAT) holds that an individual's choice on an issue is a function of the number and persuasiveness of pro and contra arguments recalled by that person when formulating his/her position. Similar to PAT, the biased information sampling model portrays group discussion as a process of sampling arguments or facts from an available domain of items. Social Comparison Theory (SCT) explains group polarisation in terms of interpersonal comparison processes and asserts that group discussion is unnecessary to produce shifts in choice. A member must merely recognise that his/her own position differs from others to induce shift (*mere exposure effect*). Similarly, the preference negotiation model presumes that information pooling during group discussion has no additional impact on group decision making beyond the impact of pre-discussion preferences. As has been argued in Isenberg (1986) using meta-analytic evidence, both mechanisms, PAT and SCT, seem to be involved in the group polarisation phenomenon.

Such an integrative approach was recently suggested for the hidden profile phenomenon as well. The dual-process model from Winquist and Larson (1998) posits that group decisions are shaped by (a) the arguments brought to light (information sampling model) and (b) members' negotiations of the weighting of their varying pre-discussion opinions (preference negotiation model), see Figure 1, third

row. Both initial preferences reflecting predominantly shared information (prior to discussion) and biased information sampling (during discussion) contribute to the greater decisional influence of shared information. The authors only partially tested their dual-process model by demonstrating that, in situations of a hidden profile, the more unshared information groups pooled, the more likely they were to select the better choice alternative (see also Larson, Christensen, Franz, & Abbott, 1998). The effect remained stable after controlling for the distribution of pre-discussion preferences within groups. Furthermore, the authors *post hoc* hypothesised that the mediational influence of group discussion, and thus, of unshared information, should be the strongest when members do not have uniform pre-discussion preferences favouring one particular choice alternative. Thus, dissent in pre-discussion preferences may reduce the hidden profile effect.

The relationship between dissent in pre-discussion preferences and group decision quality is neither explicitly addressed in the dual process model nor was it sufficiently investigated in the literature about the information sampling model and the preference negotiation model. From a theoretical point of view, however, dissent in pre-discussion preferences should simultaneously block both processes that, according to the dual-process model, hinder groups from solving hidden profiles. On the one hand, dissent should prevent premature closure of preference negotiation, which is most likely under uniform pre-discussion preferences. On the other hand, dissent should debias group discussion by increasing the amount of unshared information exchanged by the group members. The mediating mechanisms leading to this debiasing will be outlined in the following section.

DISSENT AND INFORMATION POOLING IN GROUP DECISION MAKING

Theories that directly address the relationship between dissent in pre-discussion preferences and a group's potential for discovering unshared information during group discussions are to be found in research about minority influence (cf. Moscovici, 1980; Nemeth, 1986; Wood, Lundgren, Ouellette, Busceme, & Blackstone, 1994).

According to Moscovici (1980), a minority exerts influence by creating and maintaining conflict. A consistent minority produces conversion (change in attitude or opinion based on cognitive validation) rather than compliance (change in obvious behaviour, not in private attitude or opinion), which is the mechanism by which a majority exerts influence. More recently, the focus of minority influence research shifted away from the persuasive power of minorities versus majorities (in the sense of 'winning') toward a process oriented approach concentrating on the quality of thought and ultimately the quality of decision regardless of who, if anyone, has the correct solution initially. Nemeth (1986) assumes that both majorities and minorities stimulate cognitive effort. However, depending on the source of dissent, the type of effort exerted is different. Majorities induce convergent thinking and a focus on their perspective and the focal issue of debate. Individuals exposed to majority influence try to ascertain the truth or falseness of the majority's position and they concentrate on the focal issue. By contrast, individuals exposed to minority dissent think in a divergent manner, they consider multiple perspectives, one of which is that posed by the minority (De Dreu & De Vries, 1996; Nemeth & Rogers, 1996) and they consider issues related to the focal issue (De Dreu, De Vries, Gordijn, & Schuurman,1999). The more consistently a minority position is upheld, the broader and more critically the overall problem is analysed. Minority influence also hinders the group from falling prey to a confirmation bias in information acquisition, that is, to predominantly collect information supporting the decisional alternative that is favoured within the group (Schulz-Hardt, Frey, Lüthgens, & Moscovici, 2000). Thus, minority influence facilitates open-mindedness towards alternative solutions. Additionally, Nemeth and Kwan (1987) reported that minority influence improves the quality of group

decisions independent from the quality of choice preferred by the minority member. Thus, it appears that minority-induced divergent thinking can increase the likelihood of identifying new and qualitatively superior decisional alternatives, which were not preferred by any of the group members before discussion.

When applied to the situation of a hidden profile, pre-discussion dissent in opinion or preferences, as described for minority influence, should promote divergent thinking, consideration of multiple perspectives and more exhaustive consideration of the total available information — including unshared information — which in turn should facilitate the discovery of hidden profiles. Furthermore, independent of the quality of choice initially preferred and promoted by minority members, should the thinking of the other group members diverge from their initially preferred alternatives thereby also increasing the likelihood to discover hidden profiles. Thus, the following hypotheses were formulated:

Hypothesis 1: Pre-discussion dissent in preferences raises consideration of unshared information.
Hypothesis 2: Pre-discussion dissent in preferences raises the quality of group decision-making (i.e. discovery of a hidden profile).
Hypothesis 3: The relationship between pre-discussion dissent and quality of group decision-making is mediated by the consideration of unshared information.

MINORITY INFLUENCE IN PREVIOUS HIDDEN PROFILE STUDIES

The effects of minority influence and dissent in situations of a hidden profile have been investigated experimentally in previous studies. However, several draw backs in design and analysis of the studies preclude firm conclusions. In Stewart and Stasser's (1998) study, one group member (the minority) was fully informed about all pre-discussion information, which the other group members (the majority) received in a distributed manner. In that condition, the quality of group choice was higher as compared to a control condition (no informed minority member). Similarly, McLeod, Baron, Marti, and Yoon (1997) provided one group member with the total information, which the other three group members received in a distributed manner. They found that the arguments put forward by informed minority members influenced the individual preferences of majority members. However, the facilitative effects of informed minorities found in both studies cannot be unequivocally attributed to minority *dissent*. In each study one group member was made a task expert by giving full information. On the one hand, these minority members can perceive themselves as task experts as they learn about their superior expertise during the experiment and therefore take a leading role during group discussions. On the other hand, they can gain high status in the groups as the other group members learn about their superior task expertise who are then allowed to exert more influence over group decisions. Consequently, the facilitative effects reported in the above cited studies might have been caused by social influence processes related to the higher *task relevant status* (cf. Wittenbaum, 1998) of the minority member rather than to minority dissent. Furthermore, in Stewart and Stasser's (1998) study, the experimental groups had a higher likelihood to solve the task by chance because they disposed of a fully informed member who tended to favour the superior choice.

The classic study by Stasser and Titus (1985), which introduced the hidden profile phenomenon to the literature, circumvented these problems in its design. It attempted to demonstrate that group discussion is more likely to result in the discovery of a hidden profile when there is disagreement due to conflicting patterns of information across group members. Their experimental condition (labelled "unshared information/conflict") comprised four person groups with two fractions of two members, each member of the one fraction held partial information in favour of alternative B, each member of the other fraction held partial information in favour of alternative C, while alternative A should have

been chosen by the group when the sum total information were optimally pooled. No significant effects of conflicting patterns of information on information pooling and group decision making were found. We assumed that this finding is due to manipulating conflicting patterns of pre-discussion *information* that only partially resulted in the expected conflicting patterns of *actual pre-discussion preferences*. In fact, we calculated a maximum of only 15 out of 57 groups (i.e. 27%) in which actual distributions of pre-discussion *preferences* were obtained that corresponded with the respective distributional patterns of pre-discussion *information* that were experimentally manipulated (cf. Stasser & Titus, 1985, Table 4, p. 1474). Thus, disagreement or (in our term) *dissent* may just not have been introduced to a sufficient extent to warrant significant effects on the consideration of shared and unshared information and group decision making.

THE PRESENT STUDY

The purpose of the present study was to investigate the effects of pre-discussion dissent on the dissemination of unshared information (Hypothesis 1) and group decision quality (Hypothesis 2), and to investigate the mediating role of dissemination of unshared information (Hypothesis 3). In order to omit the threat of confounding status-related influence of an expert (i.e. a fully informed minority member) with minority influence via dissent, an experimental paradigm was used that omits fully informing the designated minority member. In order to ascertain group dissent to sufficient extent, we compared the effects of distribution patterns of pre-discussion information and *actual* pre-discussion preferences on group decision quality and the actual dissent experienced by group members. Further analyses were then undertaken with the conditions that result in sufficient experienced dissent. With these features, the present study comprises the first investigation of the effects of minority *dissent* on the dissemination of information and the quality of group choice in hidden profile situations. Moreover, this is one of the very few studies about minority dissent with *real groups* (as compared to bogus groups) investigating both minority and majority influence at the same time.

METHOD

Participants and Design

One hundred and sixty-two Ludwig-Maximilians-University (LMU) students from the Psychology Department participated in the experiment in groups of three persons in exchange for DM 15,- (about $7). The design of the study was an Information distribution factorial with four conditions: (a) full information to all members favouring alternative A (AAA), (b) partial information to all members favouring consensually alternative B (hidden profile BBB), (c) partial information to minority and majority members favouring alternatives B and C (hidden profile CBB), and (d) partial information to minority members favouring alternative A and to majority members favouring alternative B (hidden profile ABB). The AAA condition serves as a control condition estimating the level of potential performance of groups with fully informed members. BBB serves as a hidden profile condition with no minority dissent. ABB and CBB serve as hidden profile conditions with minority dissent of two different types. In the ABB condition a minority of one is given information favouring the superior alternative A (‘superior’ in the sense that the choice of alternative A is strongly implied by the group’s total information) and a majority of two given information favouring the inferior alternative B (‘inferior’ in the sense that choice of alternative B is less implied by the group’s total information). In

the CBB condition a minority of one is given information favouring the inferior alternative C and a majority of two given information favouring another inferior alternative B. The rational for comparison of CBB and ABB was to test the theoretical presumption that independent from whether the superior or inferior choice is favoured by the designated minority member, dissent should have a positive effect on information pooling and group decision-making (Nemeth & Kwan, 1987).

Material

Participants read summary descriptions with a list of statements in different content areas (scientific qualification, teaching qualities, social competence and private status, e.g. married, number of children) for each of three hypothetical academic job applicants to a professorial appointment in the Psychology Department at LMU. The candidates' profiles given to the whole group of three participants comprise altogether 36 different items. They were constructed on the basis of an independent pilot study with a sample of $N = 48$ participants drawn from the same population from which the current sample was obtained. In the pilot study, 45 attributes were rated with respect to how desirable they are for a person holding a professorial position at LMU. For each of the three job candidates (A, B, C), we chose 12 characteristics matched by content area that were rated positive (i.e. highly desirable), neutral (i.e. neither desirable nor undesirable), or negative (i.e. undesirable). Candidate A (superior alternative) was designated the most preferable of all candidates considering the total number of 36 items (6 positive, 3 neutral, 3 negative), followed by candidates B and C (each with 3 positive, 6 neutral, 3 negative items), labelled as the incorrect alternatives.

In the full information condition (AAA), each member of the three person group received all 36 items in the form of the three candidates profiles (control group).

In each of the three other conditions, the information was distributed within the three person groups to model a hidden profile in the form of three different types (see Table 2). In the consent condition (BBB), which is the 'classical' hidden profile condition most often used in the literature (e.g. Stasser, 1992), each member received information that should result in an individual pre-discussion preference for candidate B because according to the list of person characteristics this profile is the most favourable (3 positive, 4 neutral, 1 negative) as compared to candidates A (2 positive, 3 neutral, 3 negative) and C (1 positive, 6 neutral, 1 negative). In the dissent condition with a minority preferring an inferior alternative (CBB), the designated minority member received information that should result in a preference for candidate C (3 positive, 4 neutral, 1 negative) as compared to candidates A (2 positive, 3 neutral, 3 negative) and B (1 positive, 6 neutral, 1 negative). Both majority members should prefer candidate B (3 positive, 4 neutral, 1 negative) as compared to candidates A (2 positive, 3 neutral, 3 negative) and C (1 positive, 6 neutral, 1 negative). In the dissent condition with a minority preferring the superior alternative (ABB), the designated minority received information that should result in a preference for candidate A (6 positive, 2 neutral, 0 negative) as compared to candidates B (3 positive, 4 neutral, 1 negative) and C (1 positive, 6 neutral, 1 negative). Both majority members should prefer candidate B (3 positive, 4 neutral, 1 negative) as compared to candidates A (2 positive, 3 neutral, 3 negative) and C (1 positive, 6 neutral, 1 negative). Overall, in all conditions groups received exactly the same total information and all groups in the three hidden profile conditions received identical proportions of shared to unshared items.

Procedure

In each experimental condition, the procedure was identical except for the aforementioned differences in the candidates' descriptions given to each group member. From a list of volunteers, participants

Table 2. Distribution of information about each candidate before group discussion

	Candidate		
Condition and information valence	A	B	C
Full information/consensual AAA			
Positive	6	3	3
Neutral	3	6	6
Negative	3	3	3
Hidden profile/consensual BBB			
Positive	2-2-2	3	1-1-1
Neutral	3	3/1-1-1	6
Negative	3	1-1-1	1-1-1
Hidden profile/inferior minority CBB			
Positive	2-2-2	3 [1]	1-1 [3]
Neutral	3	3/1-1 [6]	6 [4]
Negative	3	1-1-1	1-1-1
Hidden profile/superior minority ABB			
Positive	2-2 [6]	3	1-1-1
Neutral	3 [2]	3/1-1-1	6
Negative	3 [0]	1-1-1	1-1-1

Note: Numbers with hyphens are unshared items, without hyphens shared. For example, '2-2-2' means six items are unshared, two different ones for each group member and '6' means six items are totally shared among group members. In the hidden-profile minority conditions CBB, ABB, the designated minority member received information profiles that differ from the majority members as is indicated by the numbers in square brackets.

were randomly assigned to groups of three persons and invited via telephone for an experimental session. If not all three of them attended, they were assigned to a different experiment. Preliminary instructions stated that in this study we were interested in group decision making and that we modelled a realistic case of a professorial appointment in our department.

Participants were instructed to study the lists of candidate descriptions individually and to document their preference and job-suitability ratings for each candidate on a questionnaire sheet. They were cautioned to read the candidate descriptions carefully because they would not be able to refer to the lists once the group discussion begun. Participants were alerted to the possibility that their individual candidate descriptions might be incomplete and their fellow group members might have information of which they were currently unaware. They were told that this was being done to simulate real world group decision making, where people often enter into group discussions with more or less different background information. After reading the candidate descriptions and documenting their preferences and suitability ratings the participants had to hand in the lists of candidate descriptions.

The instructions for the subsequent group discussion contained the underlined information that there is one best candidate that can be identified when the information of all group members is pooled during discussion. Thus, the task was framed as an intellective task, a condition known to raise the likelihood of discovering a hidden profile as compared to framing the task as a judgmental one (Stasser & Stewart, 1992). The groups were told that 20 minutes are usually sufficient for group decision making (this level was established by pre-testing), however, the time limit was not enforced. The actual discussion time was secretly assessed. No group exceeded the time limit for more than 8 minutes and no deviation from normal distribution was evident.

After the groups reached a decision about which candidate to choose, a collective rating of the job-suitability (from 1 to 7) of each candidate was made. Then, each group member again documented his

or her individual preference, candidate ratings, and recall of information per candidate in a prepared questionnaire sheet. Each attribute documented in the individual post discussion recall was categorised according to the candidate it originally referred to and whether correct or incorrect indication of the candidate was given, as well as item content (item number 1 to 36) and the correctness of content description.

Finally, participants were asked to state their belief of what the research question was. None of them came close to our research hypotheses.

Dependent Variables

Experienced Group Dissent

The extent of dissent experienced during group discussion was rated (from 1 to 7) by each group member and aggregated to a group level score.

Consideration of Unshared Information

Consideration of unshared information was estimated on the basis of the individual post-discussion recall per three-person group. We counted the number of correctly recalled items (correct in content and attributed to the correct candidate) that were obviously *adopted* from other group members during discussion. Adoption of a new item was inferred when a valid item was recalled by a group member that he or she had not received as part of the information given before group discussion. The raw score for each group was used because the proportion of shared to unshared items and the maximum number of newly adopted items per group (12 items) are the same in all experimental groups. We called this variable 'information gain' because it reflects consideration of unshared information that is new to individual group members.

Individual and Group Choices

The choices made by individuals (pre and post discussion) and the group choices were scored as either superior (alternative A) or inferior (alternatives B or C).

Discussion Time

Experimenters secretly measured the time from the beginning of group discussions until the final group choice was stated. In minority research processing time has been used as an indicator of the *quantity* of information processing (De Dreu *et al.*, 1999). In hidden profile studies processing time was rarely investigated. Moreover, the evidence so far is contradictory. In an unpublished study, Abele-Brehm and Schäfer-Pietig (presentation at the Congress of the German Psychological Society, Hamburg, 1994) report a significant positive relationship between dissent and discussion time, whereas Parks and Nelson (1999) have found no such relationship. The theoretical reasoning in the present study rests upon the assumption that dissent improves consideration of unshared information via the *quality* of information processing (divergent thinking, consideration of multiple perspectives, consideration of high proportions of unshared information). If an effect of dissent on the consideration

of unshared information is found it could principally be attributed to either the quantity or the quality of information processing or both. Therefore, it is tested whether the here assumed effect of dissent on the consideration of unshared information (Hypothesis 1) holds over and above potential effects of discussion time.

RESULTS

In a first step, our data was analysed in an analogue fashion to the Stasser and Titus (1985) study by comparing the relative frequencies of pre-discussion preferences and group decisions. In the second step, the experimentally manipulated patterns of information distribution were mapped onto the obtained patterns of pre-discussion preferences in order to analyse the amount of overlap between expected and obtained distributions. Additionally, we analysed whether the manipulated patterns of pre-discussion information are not sufficiently associated with the extent to which dissent in group discussion is experienced by the group members, whereas the patterns of pre-discussion preferences are, and thus, should be used for further analyses. In the third step, we tested Hypothesis 1 (positive relationship between dissent in pre-discussion preferences and consideration of unshared information), Hypothesis 2 (positive relationship between dissent and quality of group decision), and Hypothesis 3 (consideration of unshared information mediates the relationship between dissent and group decision quality).

Relative Frequencies of Pre-discussion Preferences and Group Decisions

Overall, the individual pre-discussion preferences between the four experimental conditions (see Table 3) are significantly different from each other, $\chi^2_{(6,N=162)} = 72.86,\ p < 0.001$. In the full information AAA condition, candidate A was significantly more often chosen than in all hidden profile conditions combined, $\chi^2_{(1,N=162)} = 49.36,\ p < 0.001$. Obviously, in situations of a hidden profile, individual pre-discussion preferences are biased against the superior solution. In the CBB condition candidate C was significantly more often chosen than in the BBB condition, $\chi^2_{(1,N=87)} = 8.90,\ p < 0.01$, whereas in the ABB condition, candidate A was significantly more often chosen than in the BBB condition, $\chi^2_{(1,N=96)} = 12.73,\ p < 0.001$.

Table 3. Relative frequencies of individual pre-discussion preferences and group decisions

	Candidate			
Conditions	A	B	C	*N*
Individual pre-discussion preferences				
Full information, AAA	.76	.17	.07	30
Hidden profile, consent BBB	.04	.86	.10	51
Hidden profile, minority CBB	.08	.56	.36	36
Hidden profile, minority ABB	.31	.58	.11	45
Group decisions				
Full information, AAA	.80	.10	.10	10
Hidden profile, consent BBB	.00	.94	.06	17
Hidden profile, minority CBB	.17	.66	.17	12
Hidden profile, minority ABB	.20	.73	.07	15

The group choices (see Table 3) are also significantly different between the four experimental conditions, $\chi^2_{(6,N=54)} = 25.34$, $p < 0.001$. In the full information AAA condition, candidate A was significantly more often chosen than in all hidden profile conditions combined, $\chi^2_{(1,N=54)} = 21.00$, $p < 0.001$. In the CBB condition, neither candidate C nor candidate A was significantly more often chosen than in the consensual BBB condition, $\chi^2_{(1,N=29)} = 0.88$, $p = 0.37$ and $\chi^2_{(1,N=29)} = 3.04$, $p = 0.16$, respectively. Also, in the ABB condition, the higher frequency with which candidate A was chosen as compared to the BBB condition was not significantly different, $\chi^2_{(1,N=32)} = 3.75$, $p = 0.09$.

So far, the present study's findings correspond with the findings reported by Stasser and Titus (1985). Obviously, in hidden-profile situations, groups make choices that do not reflect the total information given to all group members. Furthermore, conflicting patterns of pre-discussion information do not increase the likelihood of shifting preferences toward the hidden and superior alternative when information was unshared.

Expected and Actual Preference Distributions

Unless we can be very confident that conflicting patterns of information introduce minority dissent to a sufficient extent, the above analysis does not deliver a valid representation of the relationship between minority dissent, information exchange during discussion, and group decision making. Therefore, we investigated the degree of overlap between the expected patterns of pre-discussion preferences (i.e. expected on the basis of the patterns of information) and the patterns of pre-discussion preferences actually obtained. Additionally, the strength of association between the more or less conflicting patterns of pre-discussion information distribution and group dissent experienced by the group members was investigated.

In Table 4, the patterns of pre-discussion preferences as they are to be expected on the basis of the manipulated patterns of information distribution (columns AAA, BBB, CBB, ABB) are mapped onto the obtained patterns of pre-discussion preferences (rows aaa, bbb, cbb, abb, abc, aab, acc, ccb). On the diagonal from the first line - first column to the fourth line - fourth column, the numbers of groups are given in which the expected and the actual patterns of preferences match (AAA-aaa, $N = 5$; BBB-bbb, $N = 11$; CBB-cbb, $N = 9$; ABB-abb, $N = 8$). Altogether 33 out of 54 groups (61%) showed actual

Table 4. Expected and actual pre-discussion preferences and experienced group dissent

Actual preferences		Expected preferences				Experienced group dissent	
		AAA	BBB	CBB	ABB		
	N	10	17	12	15	*Mean*	*SD*
aaa	5	5	–	–	–	1.80[a]	0.45
bbb	12	–	11	–	1	2.56[a]	0.89
cbb	13	–	3	9	1	4.00[b]	1.16
abb	10	–	2	–	8	4.57[b]	1.01
abc	6	–	–	2	4	4.50[b]	0.59
aab	5	4	–	–	1	–	
acc	1	–	–	1	–	–	
ccb	2	1	1	–	–	–	
Experienced	*Mean*	3.23[a]	3.20[a]	4.19[a]	4.13[a]		
group dissent	*SD*	1.66	1.39	1.27	0.88		

Note: Means with different superscripts are significantly different from one another (Scheffé-test) with at least $p < 0.05$.

pre-discussion preference distributions that are to be expected on the basis of the manipulated distributions of information. Thus, patterns of pre-discussion information distribution only partially predict respective patterns of preferences. The 61% prediction rate we found is more than twice as high as the 27% evident in the study by Stasser and Titus (1985), and it is almost equal in size to the 62% overlap reported by Wittenbaum (1998).

Among the actually obtained preference distributions, a new pattern of conflicting preferences was found (labelled 'abc') indicating that each group member holds a different initial preference. The abc preference distribution is of particular interest because in these groups (we call them *diversity groups*) each member represents a minority against a heterogeneous majority of two group members each preferring a different choice — different with respect to the third member and different with respect to each other. Minority influence should be highest in these groups.

The preference distributions aaa, bbb, cbb, abb, and abc were used for further analyses. The distributions acc and ccb are not further considered because the number of cell entries in these categories is below $N = 5$. The distribution aab is not further considered because four groups (out of five) resulted from the full information AAA condition, which does not constitute a hidden profile.

Patterns of Information Distribution and Experienced Group Dissent

The extent to which conflicting patterns of information distribution are associated with group dissent experienced by group members was investigated next. In Table 4, the means and standard deviations of experienced group dissent are given for each of the experimental conditions representing different patterns of information distribution at the bottom of the respective columns AAA, BBB, CBB, and ABB. An ANOVA with experienced group dissent as dependent variable and the factor 'pattern of information distribution' (AAA, BBB, CBB, ABB) resulted in no significant effect, $F(3, 50) = 2.42$, $p = 0.08$, $Eta^2 = 0.13$. With *post hoc* multiple comparisons (Scheffé) a uniform dimension was evident (AAA = BBB = CBB = ABB). It appears that the more or less conflicting patterns of information distribution are not sufficiently related to experienced dissent in decision-making groups. Unless they correspond with respective patterns of pre-discussion preferences to substantial extent they are to be considered insufficient for introducing the form of dissent necessary for properly investigating the effects of minority dissent on group decision-making.

Patterns of Actual Pre-discussion Preferences and Experienced Group Dissent

In Table 4, the means and standard deviations of experienced group dissent are given for the newly created categories representing the actually obtained pre-discussion preference distributions aaa, bbb, cbb, abb, abc. An ANOVA was conducted with experienced group dissent as dependent variable and the factor 'pattern of preferences' (aaa, bbb, cbb, abb, abc). Between the different patterns of preferences significant differences of substantial effect size were evident, $F(4, 41) = 12.75$, $p < 0.001$, $Eta^2 = 0.55$. *Post hoc* multiple comparisons (Scheffé) revealed a clear pattern of significant group differences, (aaa = bbb) < (cbb = abb = abc). It corresponds to the assumption that high experienced group dissent is associated with patterns of conflicting preferences (cbb, abb, abc) and low experienced group dissent is associated with patterns of consensual preferences (aaa, bbb).

Considering these results, we are confident that the preference distributions obtained introduce differences in group dissent to a sufficient extent for properly investigating the effects of minority dissent on group decision making. Therefore, subsequent analyses for testing Hypotheses 1 to 3 were

conducted with the newly formed categories of pre-discussion preference distributions, bbb, cbb, abb, and abc.[1]

Hypothesis 1: Consideration of Unshared Information (Information Gain)

The amount of unshared information new to individual group members that was recalled in the post-test (*information gain*) was compared across the four preference distributions with a one factorial ANOVA.[2] A significant effect was evident, $F(3, 36) = 13.87$, $p < 0.001$, $Eta^2 = 0.54$. The highest information gain was obtained in diversity groups (abc = 11.20), followed by minority groups (abb = 6.10, cbb = 5.54) and by consensual groups (bbb = 3.75). The four within group means (see Table 5) were compared with *post hoc* multiple comparison tests (LSD). The obtained pattern of significant differences between the four categories, bbb < (cbb = abb) < abc, is in line with Hypothesis 1 stating that consideration of unshared information improves with dissent in pre-discussion preferences.[3,4] Note that information gain was significantly different between preference distributions that differ in dissent, no matter whether a minority member favouring the superior alternative A was part of the groups (abb < abc) or not (bbb < cbb). This finding can be taken as evidence for an effect of

Table 5. Group performance measures by categories of pre-discussion preferences

	Pre-discussion preferences			
	Consent	Minority		Diversity
Dependent variables	bbb *Mean* *SD*	cbb *Mean* *SD*	abb *Mean* *SD*	abc *Mean* *SD*
Information gain	3.75^{a}	5.54^{b}	6.10^{b}	11.20^{c}*
	2.14	2.22	2.18	2.17
Proportion correct	0.00^{a}	0.00^{a}	0.10^{a}	0.50^{b}
Discussion time	6.63^{a}	14.38^{b}	15.20^{b}	19.00^{b}
	2.42	6.42	4.16	6.42
	$N = 12$	$N = 13$	$N = 10$	$N = 6$

Note: Means with different superscripts are significantly different from one another (LSD) with at least $p < 0.05$.
*$N = 5$ (see footnote 2).

[1]The control condition aaa was not involved in these analyses because it does not constitute a hidden profile.
[2]One abc group was dropped from this particular analysis due to an error in the experimenter's instruction for the individual post-discussion recall. Due to this error group members had developed the understanding that they should only report the items they knew all along from the beginning. Since this particular error can only affect individual recall after group discussion the particular group was excluded from all analyses involving data from post group discussion recall but not from the other analyses that solely comprise variables assessed prior to the time when the experimenters' error occurred.
[3]The induction of different individual preferences via the distribution of pre-discussion information given to individual group members in the ABB and CBB condition necessarily results in some items of information being held by two group members (partially shared items). Despite the fact that in each experimental condition an equal amount of items per group can be gained, it could be argued that the probability of a partially shared item to be gained is higher than the probability of a totally unshared item. Therefore we recalculated the information gain using only those items that are totally unshared in all experimental conditions. Again, a significant effect on information gain supporting Hypothesis 1 was evident, $F(3, 36) = 3.33$, $p < 0.05$, $Eta^2 = 0.22$.
[4]Following the reasoning of one reviewer that some individuals have preferences that are inconsistent with the information given to them, we calculated the differences in information gain only between groups in which individual preferences and information distribution are consistent, BBB-bbb (3.91, $N = 11$), CBB-cbb (5.22, $N = 9$) and ABB-abb (6.25, $N = 8$). In these groups the expected pre-discussion distribution of preferences (based on information distribution) and the actual obtained preferences fully overlap (see Table 4). Again, a significant effect on information gain in the expected direction was evident, $F(3, 24) = 2.67$, $p < 0.05$, $Eta^2 = 0.18$.

minority dissent on information gain that is independent from the absence or presence of one member in the group who prefers the correct alternative.

Accounting for Discussion Time

Comparisons of discussion time across the four preference distributions (see Table 5) with a one factorial ANOVA resulted in a significant effect, $F(3, 37) = 10.66$, $p < 0.001$, $Eta^2 = 0.46$).[5] The longest discussion time was obtained in diversity groups (abc = 19.00 min), followed by minority groups (abb = 14.38 min, cbb = 15.20 min) and by consensual groups (bbb = 6.63 min). *Post hoc* multiple comparison tests (LSD) resulted in the following pattern of significant differences, bbb < ((cbb = abb), (cbb < abc), (abb = abc)). The pattern of finding supports the view that discussion time increases with minority dissent. Because discussion time is also positively related with information gain ($r = 0.48$, $p < 0.01$), it is possible that the above described effects of pre-discussion minority dissent on information gain are mediated by the time devoted to information exchange during group discussion (i.e. quantity of information processing) and not by divergent thinking induced by minority dissent (i.e. quality of information processing). Thus, it was tested whether discussion time mediates the relationship between pre-discussion dissent and information gain. We first coded the degree of pre-discussion dissent in preferences on an ordinal scale (1 = consent [bbb], 2 = minority dissent [cbb, abb], 3 = diversity dissent [abc]) and computed Spearman correlations ($N = 40$).[2] Group discussion time is positively associated with pre-discussion dissent in preferences ($r_s = 0.70$, $p < 0.001$) and with information gain ($r_s = 0.52$, $p < 0.01$), and information gain is positively associated with pre-discussion dissent ($r_s = 0.61$, $p < 0.001$).

Under these conditions a test of mediation is feasible (Baron & Kenny, 1986). Two regression models were computed. In the first regression equation, information gain was regressed on pre-discussion dissent in preferences, $R^2 = 0.46$, $\beta = 0.68$, $p < 0.001$. In the second regression equation, discussion time was introduced before regressing information gain on pre-discussion dissent in preferences, $\Delta R^2 = 0.24$, $\beta = 0.63$, $p < 0.001$. There is no reduction evident when comparing the Beta-values before controlling for discussion time ($\beta = 0.68$) and after controlling for discussion time ($\beta = 0.63$). Thus, it is unlikely that the effect of minority dissent in pre-discussion preferences on information gain is mediated by the sheer quantity of information processing. This result increases our confidence that dissent, as hypothesised, induces divergent thinking, that in turn, led to increased consideration of unshared information.

Hypothesis 2: Group Decision Quality

Comparing proportions of groups solving the hidden profile (i.e. choosing the superior alternative A) across the four preference distributions (see Table 5) with Pearson Chi-square resulted in a significant effect, $\chi^2_{(3,N=41)} = 13.74$, $p < 0.01$. Sommers-d was used to test the association between proportion of groups solving the hidden profile and the ordinal sequence, bbb < cbb < abb < abc (Sommers-d = 0.20, $p < 0.03$). The highest proportion was obtained in diversity groups (abc = 0.50), followed by minority groups with a minority member preferring the superior alternative A (abb = 0.10) followed by minority groups with a minority member preferring an inferior alternative (cbb = 0.00) and consensual groups (bbb = 0.00). For a comparison with the control group condition, all five fully informed consensual groups (see Table 4) chose the superior alternative A (aaa = 1.00).

[5]Although standard deviations differ visibly between the four categories, the distributions obtained across and within each category did not significantly deviate from the normal distribution. Therefore, data transformation was not necessary.

Further *post hoc* multiple comparisons were conducted in order to infer which of several possible patterns of differences hold. More specifically, the patterns to be expected on the basis of Hypothesis 2 (minority dissent predicts proportion of superior group choices), bbb < (cbb, abb, abc) and bbb < (cbb, abb) < abc respectively, are to be distinguished from the also possible pattern to be expected on the basis of whether the superior alternative A is initially preferred by one member per group or not, (bbb = cbb) < (abb = abc).

Hypothesis 2 received full support, that is, bbb < (cbb, abb, abc), Sommers-d = 0.14, $p < 0.05$, and bbb < (cbb, abb) < abc, Sommers-d = 0.23, $p < 0.03$. However, also the alternative hypothesis cannot be rejected, (bbb, cbb) < (abb, abc), Sommers-d = 0.25, $p < 0.03$. Note that when comparing groups in which one member advocates alternative A, the extent of the minority dissent is positively associated with the detection of a hidden profile. The directional test between the patterns, abc > abb, was significant, Sommers-d = 0.40, $p < 0.05$ (one-sided). Diversity groups (abc) containing three minority members — in other words, one minority member and a heterogenous majority — are more likely to discover a hidden profile than groups with one minority member and a homogenous majority (abb). However, when comparing groups in which no member advocates the superior alternative A, bbb < bbc, no significant difference in group choice was obtained.

Hypothesis 3: Information Gain as a Mediator of the Relationship Between Dissent and Group Decision Quality

At this point, it is yet not clear whether the superior decision quality of diversity groups stems from — as hypothesised — dissent facilitating the exchange of unshared information, or whether it is simply caused by the fact that in diversity groups one member favours the superior alternative from the beginning and, in contrast to abb groups, this member is not overruled by a unanimous majority faction favouring an inferior alternative. Note that although the 50% solution rate in diversity groups lies above the 33% base rate that could be expected on the basis of the latter hypothesis (i.e. if no initial majority faction exists, it is more or less a question of chance which alternative is chosen by the group), due to the low sample size in this condition no powerful test against this base rate is possible. However, the above-mentioned results concerning information gain allow an alternative test between the two hypotheses. If the latter hypothesis were true (superior decision quality in diversity groups is a consequence of one group member initially favouring the superior alternative), then the effect should occur independent of the information gain during group discussion. If, in contrast, the former hypothesis were true (superior decision quality in diversity groups is a consequence of a superior group discussion), then information gain should mediate this effect.

A test of whether information gain mediates the relationship between pre-discussion dissent and group decision quality is feasible because dissent is significantly associated with group decision quality (hidden profile solved = 1, not solved = 0; $r_s = 0.36$, $p < 0.05$) and with information gain ($r_s = 0.61$, $p < 0.001$) and information gain is significantly associated with group decision quality ($r_s = 0.39$, $p < 0.05$). Thus, the following two regression models were computed. First, group decision quality was regressed on pre-discussion dissent in preferences, $R^2 = 0.15$, $\beta = 0.38$, $p < 0.05$. Second, information gain was introduced before regressing group decision quality on pre-discussion dissent in preferences, $\Delta R^2 = 0.02$, $\beta = 0.18$, *ns*).[6] There is a substantial reduction evident when comparing the Beta-values before ($\beta = 0.38$) and after controlling for information gain ($\beta = 0.18$) and the

[6]Ordinary linear regression was used to illustrate the results with the more common R^2 and β statistics. Because the criterion variable is categorical (0, 1) the proper method is binary logistic regression, which rendered the same findings: First regression: Wald = 4.57, $p < 0.05$; second regression, Wald = 0.42, *ns*.

ΔR^2 obtained for dissent in the second regression was not significant. Thus, it is likely that the effect of dissent in pre-discussion preferences on group decision quality is mediated by information gain.

DISCUSSION

Consistent with previous research, the present study shows that groups make sub-optimal choices in hidden profile situations. Furthermore, it replicates Stasser and Titus's (1985) findings that conflicting patterns of pre-discussion information do not increase the likelihood of shifting preferences toward the optimal choice.

However, more refined analyses revealed that the experimentally manipulated patterns of pre-discussion information resulted only partially in the expected patterns of preference distributions. This manipulation in the present experiment (along with others, for example Wittenbaum, 1998) was successful in about 61% of the cases. One explanation is that the manipulation of pre-discussion information is simply not strong enough, that is, the differences between what is considered to be a superior vs. an inferior choice is really only a few more positive and a few less negative attributes. Another explanation is that for the particular decision task studied, there is a broad range of individual theories, ideas and values within the sample of participants that interacts with the set of information items presented and for which it may be difficult to find a set of items that reliably determines the distribution of individual preferences across all groups. A task context for which participants are less experienced or have less diverse and less strong subjective theories and values would be helpful for raising the consistency between information given and individual preferences. This may make it easier to observe the expected effects of pre-discussion dissent on group decision quality. It was further shown that the association between the experimentally manipulated patterns of information distribution and group dissent experienced by the group members was insignificant. It was only when the information led to differences in distributions of preferences that it did predict perceptions of group dissent.

The above findings suggest that prior studies investigating the effects of patterns of information distribution (notably Stasser & Titus, 1985) failed to introduce dissent to a sufficient degree and, therefore, underestimate the potentially facilitative effects of minority dissent on information sampling and group decision making in hidden-profile situations. In the present study the association between different patterns of pre-discussion preferences and experienced group dissent turned out to be significant and strong. Thus, we tested our hypotheses by using the obtained patterns of pre-discussion preferences.

Hypothesis 1 received ample support. Minority dissent in pre-discussion preferences was positively associated with information gain (i.e. proportion of unshared information initially unknown by individual members but obviously adopted during group discussion and recalled thereafter). The facilitative effects of minority dissent on information gain were independent from the presence of a fully informed minority member due to the experimental design used. This rules out the possibility that the high social status of well-informed minority members may have caused the effect. Additionally, minority dissent and information gain were significantly related independently of the presence or absence of a minority member preferring the superior alternative A. This finding is in line with the findings from Nemeth and Kwan (1987). Minority dissent, right or wrong, increases the range of unshared information considered by group members. Finally, the relationship between pre-discussion dissent and information gain remained significant and of substantial effect size after mediation of discussion time was taken into account. This speaks to the assumption that aside of

potential effects of the sheer *quantity* of information processing, the *quality* of information processing induced by minority dissent positively affects the consideration of unshared information (information gain) during group decision-making. This finding is in line with the theory presented by Nemeth and colleagues (for example Nemeth, 1986) concentrating on the quality of information processing under minority influence, which is characterised by divergent thinking, attention to multiple perspectives and exhaustive information consideration.

Hypothesis 2, predicting that minority dissent in groups is transformed into superior group choices, received partial support. Specifically, diversity groups (abc) obtained a 50% solution rate (i.e. discovery of a hidden profile) as compared to 10% solution rate obtained in minority (abb) groups and 0% solution rate in minority (cbb) and consensual (bbb) groups. The expected difference in solution rate between minority groups (abb) and diversity groups (abc), each with one member favouring the superior alternative A, was significant. However, no indication of a similar pattern for the comparison of minority groups (cbb) and consensual groups (bbb), each containing no member favouring the superior alternative A, was evident. Thus, it could not be unequivocally established that group decision quality solely covaries with minority dissent in pre-discussion preferences. Group decision quality may also depend on whether one group member prefers the superior alternative or not.

However, from testing Hypothesis 3 we know that information gain mediates the relationship between dissent and group decision quality. When considering the potential effect of the presence versus absence of a group member who prefers the superior alternative on group decision quality, what we don't know is, whether information gain about the superior alternative would suffice to improve group decision quality even when no group member prefers the superior alternative. This is an interesting question for future research. However, what we do know is, that the superior decision quality in diversity (abc) groups as compared to minority groups with one member favouring the superior alternative (abb) cannot be a consequence of one group member initially favouring the superior alternative because this is the case in both conditions.

Diversity Groups

A diversity distribution of pre-discussion preferences (abc) was obtained in six groups. To our knowledge, such a distribution has not been investigated before. The more interesting is the finding that diversity groups produced the highest information gain, significantly higher than the information gain produced by simple minority groups (cbb, abb), and the highest quality in group decision-making, again significantly higher than in simple minority groups (cbb, abb). It is mainly this difference, between diversity and simple minority that accounts for the mediating effect obtained for information gain in the relationship between pre-discussion dissent and group decision quality (Hypothesis 3). We offer an explanation for the substantial improvement of information gain and decision quality in diversity groups as compared to simple minority groups. It draws on theorising about minority and majority influence that is simultaneously effective during group discussions which has been seldom studied in previous minority research. An abc distribution creates strong minority influence and only minimal or no counteracting majority influence. Each of three group members holds a minority position, which has to be upheld against a majority of two group members who prefer different choices (a heterogeneous majority). Under such a diversity condition, minority influence resulting in divergent thinking and consideration of multiple perspectives is enhanced because all group members hold a minority position relative to the other members. Also, majority influence resulting in convergent thinking and focusing on the majority position is reduced because of dissent among the majority members' preferences.

Limitations and Future Research

Due to a possible contamination in diversity groups, that is, in all abc groups individual preferences are to be found that are not consistent with the information originally given to group members (see Table 4 and footnote 4), alternative explanations for the high information gain and group decision quality in diversity groups are theoretically possible. It may be that members of diversity groups happen to be rather independent or they have values associated with attributes that do not correspond to the positive, neutral, and negative ratings in the pilot study. This may have made them more susceptible to new information presented by other group members. Regardless of the reason, the possible contamination can only be controlled in future research by introducing diversity groups in the experimental design.

While knowing the limitations, we believe that the differences in information gain and group decision quality found between simple minority groups (cbb, abb) and diversity groups (abc) point toward the potential use of extending traditional paradigms in minority research by comparing minority conditions with a homogenous and a heterogeneous majority in real groups. It seems that diversity groups are particularly helpful to obtain a group situation in which the influence of consensual pre-discussion preferences and opinions on decision-making is reduced or even blocked so that information exchange is facilitated and its impact on subsequent group decisions is enhanced.

A weakness of the present study is the relatively low cell frequencies (especially for diversity groups), which reduces the statistical power for effects of low to moderate size and raise the risk of type two errors. Therefore, wherever possible effect size estimates are reported and alternative hypotheses were explored in detail. Some further protection against spuriousness of findings is given by the fact that all analyses are conducted on the group level (e.g. idiosyncratic individual inconsistencies within groups are averaged out to some extend) and that conservative statistical tests were used.

Underlying mechanisms regarding the actual information exchange during group discussion were not studied in the present work. It is a difference between having information, learning information from other group members, having it linked to a particular judgement and the expression of judgements and information in a group context. The pattern of shared and unshared information recalled after group discussion does not allow to differentiate between these mechanisms. For an example, a detailed account of group discussion content (via audio or videotaping of group discussions) would allow to find out whether the information that is pooled during group discussion should enable the groups to discover the hidden profile or not. The latter would be the case when the information gain for the superior alternative during discussion is not enough to counteract the information pooled in support of an inferior alternative (cf. Greitemeyer, Schulz-Hardt, Brodbeck & Frey, 'Information sampling and group decision-making:the effects of an advocacy decision procedure and task experience', submitted, 2001).

A limitation in generalisability of the findings presented stems from the particular task used. The distinction between intellective and judgemental task type is generally made in the group performance literature (Laughlin & Ellis, 1986; Laughlin & Hollingshead, 1995). Intellective tasks are associated with high demonstrability of plausible or correct solutions or choices, and judgmental tasks with low demonstrability. As was pointed out in both the hidden profile literature (cf. Stasser, 1992) and the group polarisation literature (Isenberg, 1986), the degree to which information exchange during group discussion predicts decision making should be higher for intellective or argument-strong tasks respectively and the degree to which pre-discussion preferences of group members predict decision making should be higher for judgmental or argument poor tasks. In the present study the task was constructed and framed as an intellective task with a superior decision alternative to find. Therefore, the interpretations of the findings do not necessarily apply for judgemental tasks.

Practical Implications

The present study supports the notion that minority dissent, right or wrong, improves the informational basis for decision-making in groups. This is in line with empirical evidence supporting the view that minority influence fosters high quality decisions in organisations which has been reviewed elsewhere (De Dreu & Beersma, 2001; Nemeth & Owens, 1996). The idea of multiplying minority influence that is not counteracted by majority influence put forward here by investigating diversity groups is new. It implies a potential cure for the intriguing problem of hidden-profile situations in which the benefits from group decision making should be the highest whereas in practice sub-optimal group choices are most likely. The hidden-profile phenomenon applies specifically to real groups whose members know different facts, for example cross-functional teams in criminal investigations, medical diagnostics (Larson *et al.*, 1998), or decision-making committees in private and public sectors. According to our data, a lack of sharing privately held information during group decision making could be effectively addressed by composing decision-making committees as diversity groups. However, the expected synergy effects are offset by extended discussion time and the risk of not being able to settle a dispute by majority voting. Thus, composing diversity groups should be considered mainly for decision tasks in which the costs or risks of a sub-optimal choice (or the gains of a superior choice) are perceived to outweigh the costs of long disputes and the risk of not coming to a conclusion within a certain time.

In case natural decision-making groups cannot be composed into diversity groups, an alternative strategy can be the implementation of discussion methods that mimic diversity in preferences. They can be developed by extending techniques like dialectic enquiry (Mason & Mitroff, 1981) or devil's advocacy (Herbert & Estes, 1977) which operate with only two diverging views. Such a method, termed advocacy decision procedure, was recently developed and tested in a hidden-profile experiment reported by Greitemeyer *et al.* (2001). The method mimics diversity groups in that members take turns in advocating for each of three alternatives. It increased the amount of unshared information discussed significantly as compared to a control condition with free discussion (over consecutive task trials). However, the procedure failed to significantly improve the discovery rate of hidden profiles. It may be that, as Nemeth, Connell, Rogers, and Brown (2001) have pointed out, it takes 'authentic' rather then 'feigned' dissent in order to facilitate group decision making.

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